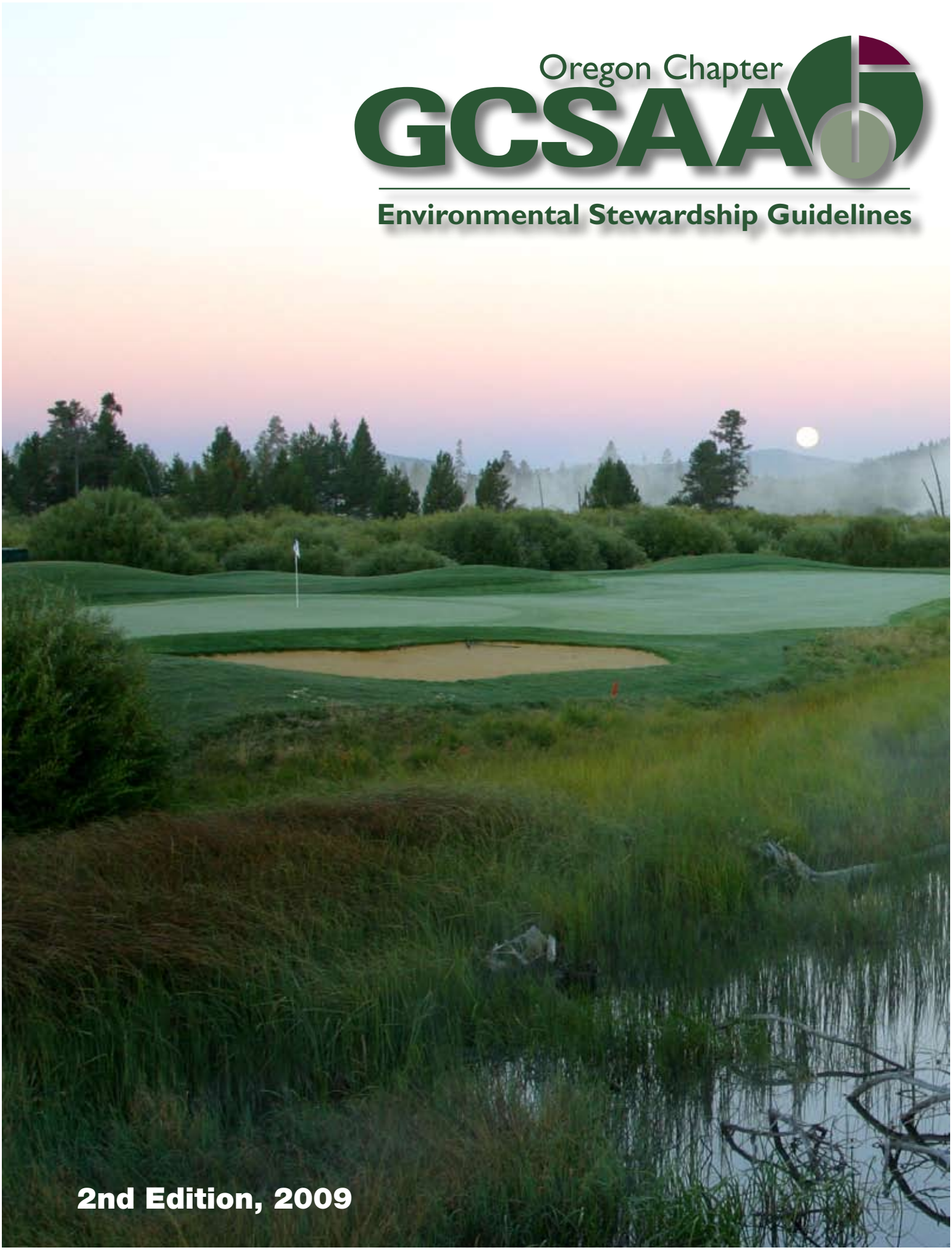
Oregon Chapter

GCSAA

Environmental Stewardship Guidelines



2nd Edition, 2009

Oregon Chapter

GCSAA

Environmental Stewardship Guidelines

September 14, 2009

Prepared for:

Oregon Golf Course Superintendents' Association (OGCSA)

Western Washington Golf Course Superintendents' Association (WWGCSA)

Northwest Turfgrass Association (NTA)

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Acknowledgements

Completing a document such as this *2nd Edition OGCSA Environmental Stewardship Guidelines* requires the help of many people. We had a great foundation for this work and for this we sincerely thank Dr. Michael Hindahl in memoriam. The 1st Edition of the *Guidelines* paved the way for acceptance and promotion of the environmental stewardship practices being performed at golf courses in the Pacific Northwest.

Our first draft of the *2nd Edition Guidelines* benefited by contributions from OGCSA, WWGCSA, and NTA members of the Northwest Golf Course Environmental Alliance. Participants in the first review sessions included Paul Backman, Allan Clemens, Ryan Bancroft, Tony Lasher, David Phipps, Steve Kealy, Jesse Goodling, Rod Nelson, Mike Combs, Chris Goodman, Dr. Eric Miltner, and Steve Thun.

The second draft was sent out for wider review by the regulatory and golf community. We very much appreciate the time and effort that these people contributed to make the document more complete. The organizations that helped and their reviewers included:

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Ackhowledgements

At EnviroLogic Resources, Melanie Bocianowski has been an invaluable team member. Her work developing statistical analyses of the historical golf course water quality database made it possible to develop cogent, thorough, and targeted water quality monitoring programs. Her writing skills were brought to bear in updating and developing new text for the *2nd Edition Guidelines*. Her indefatigable research efforts allowed us to build a document that is a "cookbook" for creating an Environmental Stewardship Program at a golf course—not just in the Pacific Northwest—but anywhere golf and the environment mix (i.e., everywhere).

Other EnviroLogic Resources staff that have been critical in making this document possible include Nancy Smith, Jason Howard, John Gunn, Cheri Baur, and Blair Stephens.

With so many people involved in this effort, I am sure these acknowledgements are incomplete. Thank you very much to each and every one of you.

Tom Calabrese
EnviroLogic Resources, Inc.
Portland, Oregon

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Preface

"To be ahead of the curve . . . " these were the words preached in 2000. The Oregon Golf Course Superintendents' Association created the *Environmental Stewardship Guidelines* and did so with sincere enthusiasm and passion for the environment and industry. Due to mounting pressure from individual environmental groups, pesticide use policies made by local councils, and from state and federal agencies, the OGCSA's Board of Directors called for an Environmental Committee. This committee was chaired by Jesse Goodling, Superintendent at Heron Lakes Golf Course, and was made up of twelve individuals from all facets of the industry. Eleven members of the OGCSA made up the committee, one of which was Dr. Michael Hindahl. Dr. Hindahl initiated the momentum of preparing an "environmental" document that can be used by Superintendents at golf courses, parks, and municipalities. Dr. Hindahl accepted the project's responsibilities and prepared the vast majority of the document and then submitted it to state agencies, Superintendents, industry representatives, and educators for review. These professionals identified the need to help educate and inform the public as well as the need to establish high standards for those who work in the "Green Industry".

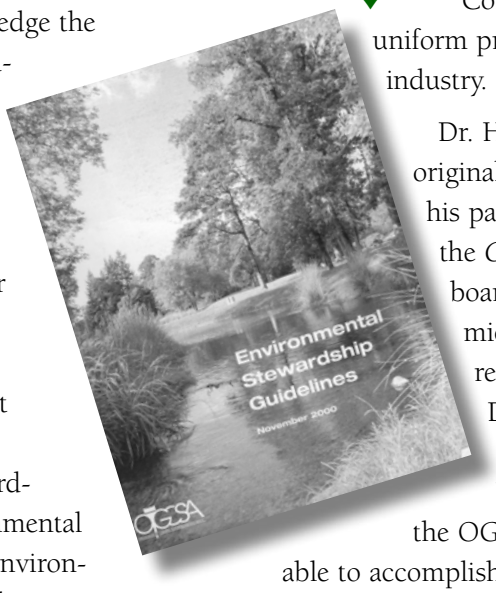
Thanks to Dr. Michael Hindahl's help, this initiative was established and produced a well-respected document, which received national notoriety as the recipient of the 2004 President's Environmental Stewardship Award from the Golf Course Superintendent's Association of America. Before his passing in 2005, Dr. Hindahl had a desire to incorporate more principles into the document. Moving forward with Dr. Hindahl's vision, the Oregon Golf Course Superintendents' Association along with the support of the Western Washington Golf Course Superintendents' Association and the Northwest Turfgrass Association have embarked on a comprehensive update to the *Guidelines*. The Oregon Golf Course Superintendents' Association hopes that this document will be useful to anyone operating an environmentally sustainable property.

Once again, Thank you to Dr. Michael Hindahl, whose passion for golf and the environment has resulted in a document that helps bring golf and the environment closer together. His work has helped to mold the joy of the game with the beauty that surrounds it in an environmentally friendly way. With all his donated time, energy, and devotion to the spirit of the game, he continues to inspire many in the Green Industry to strive for higher standards.

Ryan Bancroft
Past President
OGCSA

Introduction

The role of the golf course Superintendent has evolved into a multitask occupation in which a broad range of complex issues influences golf course management practice. One area of responsibility that has become increasingly influential in directing golf course management decisions is that of environmental stewardship. Environmental stewardship was first formalized in 1996 by the United States Golf Association (USGA) and partners through the Environmental Principles for Golf Courses in the United States (**www.usga.org/turf/articles/environment/general/environmental_principles.html**). These precepts form the backbone of most subsequent environmental stewardship programs. The Oregon Golf Course Superintendents' Association (OGCSA), Western Washington Golf Course Superintendents' Association (WWGCSA) and the Northwest Turfgrass Association (NTA) acknowledge the importance of environmental stewardship, and are committed to promoting golf course management practices that protect and enhance the environment.



In March 2000 the OGCSA, under the guidance of Dr. Michael Hindahl, formed a committee to identify and develop a proactive approach to assist golf course Superintendents with the development of environmental stewardship programs. The resulting Environmental Stewardship Plans are equivalent to environmental management systems (EMS) that allow the Superintendents to perform self-audits and use adaptive management in order to best manage their golf course. The Environmental Stewardship program is a voluntary program. A review of resources and regulatory guidance available at the time revealed that a standardized format for documenting environmental stewardship at golf courses in Oregon was lacking. As a result, the committee decided to create the *OGCSA Environmental Stewardship Guidelines* to meet the following objectives:

- Provide Superintendents with a structured, simple to use format to assist in the development of documented, golf course-specific environmental stewardship programs;
- Provide meaningful and useful feedback to the Superintendent regarding the compatibility of management practices with the environment;
- Provide an efficient and effective means of documenting management practices to address a broad array of environmental issues; and
- Contribute to the development of uniform practices within the golf course industry.

Dr. Hindahl helped develop the original *OGCSA Guidelines* and before his passing away, had begun updating the *Guidelines*. He was an OGCSA board member who held a Ph.D. in microbiology and had extensive research experience. Quoting David Phipps, Stone Creek Golf Club Superintendent, "Without Dr. Hindahl's pioneering efforts, the OGCSA would never have been able to accomplish the level of environmental responsibility we now enjoy."

The primary design goal for the *Guidelines* was to develop a set of comprehensive well-balanced environmental stewardship standards. To meet this goal, a variety of resources were utilized during the development of the document including the Portland (Oregon) Parks and Recreation

Pest Management Policy, *Best Management Practices for Golf Course Development and Operation* (King County Environmental Division), the Audubon Cooperative Sanctuary Program for Golf Courses, the Florida Golf Courses Best Management Practices, Agricultural Water Management and Conservation Planning (Oregon Water Resources Department), GCSAA/EIFG, USGA Green Section, NRCS, NTA, Washington State University (WSU), professional organizations, historical data, and turfgrass literature. Additionally, input from Superintendents, industry representatives, the Oregon Department of Environmental Quality, and Oregon State University was incorporated to yield the finalized document, which included sections on Best Management Practices (BMPs), Integrated Pest Management (IPM), Water Quality Monitoring, and Wildlife Habitat Enhancement.

The *Guidelines* were introduced to the OGCSA membership in November 2000, and over time, a number of *Guidelines*-based environmental stewardship programs have been implemented at golf courses in Oregon and Washington. As Superintendents gained experience utilizing the *Guidelines*, a number of constructive suggestions regarding improvements to the *Guidelines* have been received. Accordingly, the experience-based feedback has been used to generate a revised and updated version of the *Environmental Stewardship Guidelines,* which follows.

The continuing intent of the *Guidelines* is to provide a flexible system for Superintendents to use in the development of documented and effective environmental stewardship programs. For example, while the combination of more than eight sections of the *Guidelines* establishes a comprehensive environmental stewardship program, depending on the circumstances, the Superintendent may elect to use one or more of the sections (e.g., IPM plan) to meet the needs of the golf course. The *Guidelines* are used by golf courses in examining their practices with respect to the environment and identifying improvements that can be made to help improve environmental conditions at the facility. Other issues a golf course may want to consider as a whole include science-based evaluations of their carbon footprint, energy efficiency, green house gas emissions, and green purchasing.

While a major objective of the *Guidelines* is to address environmental issues of concern to the golf industry and community, the possibility always exists that expectations in local or regional locations may differ from the information presented in these *Guidelines*. Accordingly, federal, state, and local regulations, as well as permit conditions should always be reviewed and used as the final basis for the development of individual environmental stewardship programs. Indeed, the incorporation of the *Guidelines* into new golf course development or renovation permit applications and operations plans may provide the best means for communicating environmental commitment at the golf course to the regulators.

Through the documentation developed during implementation of the *Guidelines*, golf courses can demonstrate to the public the positive contribution a course can have on the environment. The golf course Superintendent should prepare a binder that contains the environmental management plans (Best Management Practices, Integrated Pest Management Plan, Water Quality Monitoring Plan, Wellhead Protection Plan, Water Conservation Plan, Wildlife Habitat Enhancement Plan, and Community Involvement Plan). If a plan is modified (through the Action Plan form included herein), these updates, data, and information developed through implementing the plan, would be included in the binder as well, creating a complete record of the environmental efforts and achievements at the golf course.

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ENVIRONMENTAL SETTING 1.0

This first section of the *Guidelines* provides an outline of what should be included in the stewardship binder describing the golf course from an environmental stewardship perspective. The easiest way to present the environmental setting is through a map or series of maps. The map of the golf course should include information that is important to understanding the course-wide hydrologic characteristics such as streams, topography, drainage, and other relevant information. An example of an introductory golf course description map is shown on **Figure 1**.

Environmental stewardship features such as wildlife habitat or buffer areas, water quality sampling locations, and pesticide exclusion zones should also be shown on a map. Some of these maps may be presented in particular sections of the overall Environmental Stewardship Program developed by the golf course (e.g., water quality sampling locations in the Water Quality Monitoring Plan, and pesticide exclusion zones in the Integrated Pest Management Plan).

Features that should be explained in the Environmental Stewardship Plan or included on maps are:

- Golf course hole layout
- Total acreage of the property
- Topography
- Water features
- Stream entry and exit points
- Outside influences on the surface water
- Golfer expectations on manicuring and pesticide use
- Drainage and storm water management systems, including total impervious surface area (pavement, rooftops, etc.)
- Wells—nearby production, irrigation, and monitoring
- Vegetation Types—Forests, Riparian areas
- Pesticide exclusion areas
- Wildlife enhancement and buffer areas
- Wetlands
- Maintenance facilities
- Pesticide and fertilizer container storage areas
- Pesticide mix/load areas
- Oil water separators
- Fuel storage tanks
- Clubhouse facilities and related features
- Equipment wash areas
- Onsite wastewater treatment systems
- Soil types

The golf course is generally part of a larger watershed. How the golf course fits in the hydrologic system and wildlife corridors in the larger

watershed may help the golf course Superintendent to understand how management activities can effect the surrounding environment. In addition, activities conducted by other land owners in the watershed can affect conditions at the golf course.

Issues encountered at golf courses by Superintendents include wellhead protection, local watershed management, water conservation, effectively using plant management products and their potential effects on the environment, and new rules from government agencies. Existing and new rules may fall under multiple regulatory segments. A list of rules and regulations are included in Appendix A. The following is a list of some of the regulatory frameworks that could influence the operations of a golf course:

- 303(d)
- Stormwater
- NPDES Requirements
- Nearby Contaminated Sites
- Wellhead Protection Ordinances
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Puget Sound Partnership
- Waste Management
- Spill Response
- Water Right Permit Regulations

Portions of the Environmental Stewardship Program depend on characterizing conditions locally around the golf course (e.g., wellhead protection).

A map displaying the percentage of impervious area at the golf course demonstrates that a small percentage of the golf course is impervious. The majority of the golf course is suitable for managing storm water in a variety of ways, and urban drainage systems are often funneled through golf courses.

Other information to consider showing on maps as part of the documentation of the golf course Environmental Stewardship Program includes:

- Local watershed and land use maps
- Aerial Photographs
- Site Photographs
- FEMA map use. EPA Watershed site.
- Soil survey maps: Web Soil Survey at www.nrcs.usda.gov/

Depending on the amount of information available for a golf course, more than one map describing conditions/features may be useful.

BEST MANAGEMENT PRACTICES 2.0

This section contains an outline of Best Management Practices (BMPs), which can be defined as general policies and practices that are generally applicable to the golf course management industry. BMPs can be financially beneficial and can be implemented immediately. BMPs are not regulatory or enforcement based. The outline was derived from a variety of relevant industry sources including the Golf Course Superintendents' Association of America (GCSAA); the United States Golf Association (USGA) Green Section; the BMPs for Enhancement of Environmental Quality on Florida Golf Courses; Natural Resource Conservation Service (NRCS); Oregon State University (OSU); King County, Washington; Northwest Turfgrass Association (NTA); and "Best Management Practices for Golf Course Water Use" (Connecticut Department of Environmental Protection, 2006). Listed below are the "9 principles of friendly landscaping" as listed in the Florida Golf Courses BMPs (2006):

- Right plant, right time
- Water efficiently
- Fertilize appropriately
- Mulch
- Attract wildlife
- Manage pests responsibly
- Recycle
- Reduce storm water runoff
- Protect waterways

The priorities for BMP implementation in the Environmental Stewardship Program include the following:

- To correct any identified existing water quality problems;
- To minimize water quality/quantity problems resulting from land use, management practices, and exploitation;
- To improve effectiveness of existing BMPs; and
- To seek additional improvements based on new information.

Incentives for adopting BMPs include the following:

- Reduced environmental impacts;
- Improved turfgrass quality;
- Enhanced golf outing experiences;
- Improved worker safety;
- Efficient use of resources;
- Reduced maintenance expenditures;
- Reduced regulatory requirements; and
- Opportunity for industry self-regulation.

While the BMPs are suitable as written for many golf courses, revisions may be necessary to fully describe golf course-specific BMPs. In this regard, a review of the BMPs listed in this section serves as a valuable tool for the Superintendent to assess his or her current practices, and to identify strengths and weaknesses. BMPs assist the golf course superintendent in evaluating objectives in the context of the individual circumstances at the golf course and in determining a preferred way to implement a task. Some BMPs may not be applicable in all situations.

Additionally, a set of example forms for use in documenting fertilizer applications, pesticide applications, IPM scouting, staff training, and modifications to the BMP program can be found in Appendix F. Record keeping is a very important component of the BMP program, and serves as the basis for self-auditing of implementation performance. An audit program should be included as part of the Environmental Stewardship *Guidelines*.

If questions arise regarding specifics of the following BMPs, they should be addressed by cross-referencing appropriate guidance from relevant resources whenever possible. Examples of available resources include the U.S. Environmental Protection Agency (EPA), the Oregon Department of Environmental Quality (DEQ), Washington Department of Ecology (DOE), Oregon and Washington State Departments of Agriculture, Oregon and Washington Occupational Safety and Health Divisions (OSHA), the fire marshal, the universal building code, and the universal fire code.

The BMPs will be continually reviewed and revised over time to reflect changes in the level of knowledge and changes at the golf courses. BMPs implemented at the golf course should be revisited when water quality data indicate a change may be in order or additional BMPs are adopted.

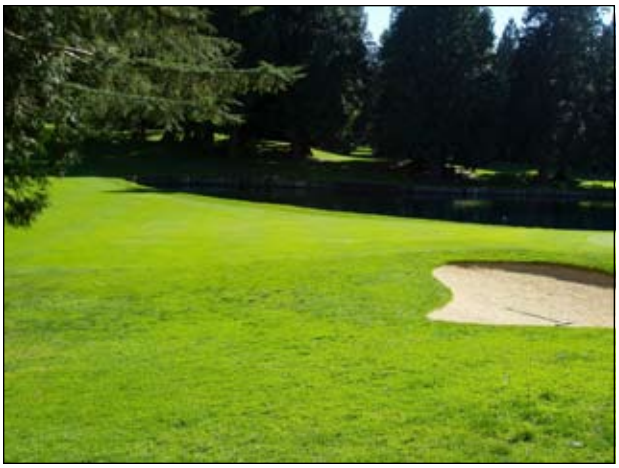
Development of a golf course-specific BMP plan can be accomplished in several ways. The BMPs defined in the *Guidelines* are available through an online BMP development tool that is available at www.greengolfusa.com. Using this tool, BMPs can be selected and a formatted electronic document that reflects the selections can be downloaded by the golf course Superintendent. Alternatively, the Superintendent can create his own plan using these *Guidelines*. BMPs are divided into the following sections:

- Buffer Zones;
- Turfgrass Culture;
- Horticulture Management;
- Fertilization;
- Irrigation;
- Environmental;
- Pest Management;
- Pesticides;
- Petroleum Products;
- Waste Management;
- Safety and Education Program; and
- Environmental Stewardship Program.

2.1 BUFFER ZONES

Buffer zones can provide important benefits, including temperature modulation, erosion control, sedimentation prevention, filtering instream and riparian habitat, biodiversity, and landscape connectivity for wildlife.

1. Establish buffer zones near waterways where appropriate. An example of a map showing buffer zones is presented on **Figure 2**. Consistent with the remainder of this document, an average 25-foot application buffer zone is suggested along natural water bodies. However, the width of the buffer zone may be less (as low as zero) if the buffer zone would interfere with the playability of the golf course. For example, buffer zones may be less when located near a green or tee. With proper fertilizer and pesticide application, turfgrass can be located adjacent to a water body with a limited buffer zone when necessary but applications need to be carefully controlled.



2. Design buffer widths to vary in accordance with landscape position and potential pollutants entering the buffer at a specific location. Minimum buffer widths will vary with the intended buffer function and the specific site conditions including hydrogeology, slope, vegetation types, soil type, presence of wetlands, the type of nutrient or pollutant to be removed, and the golf course layout.

3. Locate vegetated buffers between water bodies, wetlands, and wellheads and any potential pollution sources such as fertilized areas or runoff producing areas, such as impervious surfaces and seasonally saturated areas.

4. Use fact sheets developed by the Environmental Institute for Golf to establish buffer zones (http://www.eifg.org/water/default.asp). Buffer zones may also be a requirement of the use instructions for pesticides and must be followed.
5. Limit fertilizer applications to the extent practical in defined buffer zones. Separate action thresholds must be defined for application of pesticides within buffer zones.
6. Investigate whether waterways on the golf course have additional restrictions for pesticides in buffer zones in regard to the Washington Toxics Coalition versus EPA, January 22, 2004 - the federal judge's order identifies "buffer zone" to be the distance between the waterway, measured at the ordinary high water mark, and where the pesticide active ingredient can be applied. Generally, buffer zones of 20 yards are required when making applications of affected active ingredients using ground equipment. Not all pesticide active ingredients have a court defined "buffer zone" requirement—just certain ones that might harm salmonids. Not all bodies of water have court-defined buffer zones—just ones that have or may have endangered and threatened salmon species. Visit www.streamnet.org to use the Pacific Northwest interactive mapper, which shows fish distribution and data for streams in the Northwest, to decipher whether the stream on the golf course is a threatened salmon-bearing stream. The streamnet website also includes a critical habitat mapper and stream data. The ODA website www.oregon.gov/ODA/PEST/buffers.shtml provides information on the court case, the federal rulings to present, and provides links to useful websites such as the one listed above. The list of pesticides banned in these specific buffer zones is included in Appendix B.

2.2 TURFGRASS CULTURE

Cultural practices on a golf course can have a significant impact on turfgrass health, growth, and playability. Healthy turfgrass is more tolerant of pest pressures. It is important to develop location specific cultural practices (i.e., greens, approaches, tees, fairways, rough, out of play surface waters, and naturalized areas). These cultural practices can be modified based upon microclimates (i.e., shade, slope, or exposure to sun and wind).

2.2.1 Mowing

- Set mowing height appropriately for location.
- Adjust mowing height to relieve turfgrass stress when necessary.
- Increase mowing height for turfgrass grown in shade.
- Maintain sharp blades for a clean cut to reduce turfgrass stress.
- Remove clippings from greens. Leave clippings on tees, fairways, and rough, where feasible. Dispose of collected clippings by scattering them in the rough, as opposed to stockpiling them in the woods (unless a controlled composting program is in place). Do not stockpile within 25 feet of surface waters.

2.2.2 Surface and Soil Profile Management

Golf course playing surfaces perform best when a firm, sandy soil profile is developed for turfgrass growth.

2.2.2.1 Aerification

- Adjust aerification type and frequency to be appropriate for turfgrass location, conditions, and weather.

- Perform routine verticutting to promote an upright growth habit and smoother putting surface.

2.2.2.2 Topdressing

- Apply light topdressing for preventing excess thatch accumulation at the soil surface and maintain a uniform soil profile.
- For greens, use topdressing sand that meets USGA specifications when available to maintain consistent rootzone content. Try to use the same source of sand over time in order to maintain soil profile consistency.

- Apply topdressing following aerification when appropriate.
- Apply light frequent topdressing following verticutting.

2.2.2.3 Seeding and Overseeding

- Select turfgrass species and varieties best suited for the growing environment and the expected use of the area.
- When available, use disease or insect resistant cultivars.

2.2.2.4 Rolling

- Roll greens to provide a smoother, faster playing surface.
- Roll greens to provide a consistent green speed at a higher cutting height.

2.2.2.5 Wear and Tear

- Routinely move cup locations on the greens.
- Vary the points where golf carts enter turfgrass from cart paths to reduce localized wear.

2.2.2.6 *Poa Annua* Discouragement

- Growing Medium Chemistry

- Maintain a low soil pH by using high levels of ferrous sulfate with high rates of water frequently.
- Apply minimal phosphorous to limit seed head production.
- Apply low rates of nitrogen.
- Apply low rates of paclobutrazol.

♦ Minimize soil disturbance

- Perform regular deep needle tine aerification (monthly).
- Use smooth rollers on greens mowers.
- Aerify only at the start of the growing season unless needed to improve drainage locally.
- Overseed with bentgrass.

2.3 HORTICULTURE MANAGEMENT

In addition to turfgrass, golf courses also have other types of vegetation, including trees, ornamental plantings, and flower beds. Effective management of these features can be complementary and supportive of turfgrass growth and environmental initiatives undertaken by the golf course.

2.3.1 Tree Management

Select trees to be planted based on mature size and type of growth appropriate for the planting location, compatibility with soil conditions, other associated plants, climate, and pest resistance properties.

♦ Where appropriate select native trees.

♦ Carefully evaluate locations prior to planting.

- Consider water requirements and influence on shading and air circulation for the surrounding turfgrass.

♦ Consider wildlife habitat.

- Consider the tree's influence on the playing characteristics of the golf course.
- Add tree canopy over surface water to help reduce water temperatures and increase dissolved oxygen.

♦ Complete a tree inventory on the entire property including the natural areas.

♦ Consider wildlife habitat.

♦ Consider aesthetics.

♦ Routinely monitor trees.

- Monitor overall health
- Prune when appropriate to maintain tree health
- Consider influence on playing characteristics
- Monitor for the presence of insects and diseases
- Consider influence on surrounding turfgrass and ornamentals
- Consider hazard potential

- Tree removal
  - Trees may be removed because of disease, age, wind, lightening damage, or hazard potential.
  - Trees may also be removed to increase sunlight and air circulation to specific turfgrass areas.
  - Consult a professional tree service regarding removal that is beyond the scope of routine golf course management practices.
  - Consider the impact removal of the tree will have on surface water shading before removing the tree
- Optimize air circulation.
- Minimize shade for turfgrass areas. Whenever possible, retain shade over waterways to preserve habitat and help control temperature.
- Minimize traffic in shaded areas.
- Remove leaves, fallen limbs, and other debris from turfgrass areas to the controlled composting area or an area where it's staged for disposal. Whenever possible, do not disturb this material in waterways to preserve habitat.

2.3.2 Ornamental Landscape Management

Ornamental plants should be properly selected, planted, and maintained for increased survival, water conservation, and performance in the landscape. The following BMPs were referenced from the Cooperative Extension Service/The University of Georgia College of Agricultural and Environmental Sciences (2009).

- Plant woody ornamentals and herbaceous perennials in the fall and winter. There is less demand for water and nutrients by the top and more energy and food for root growth. With the proper care, ornamentals may also be planted during the spring in the Pacific Northwest.
- Prepare the planting bed properly.
  - Deep till to a depth of 8 to 12 inches.
  - When planting individual plants, dig a wide planting hole to provide a favorable rooting environment.
- Add appropriate amendments to the planting bed (when necessary) to improve the physical properties of the soil—water retention, water infiltration, and drainage—or to enhance its mineral and microbial content.
- Irrigate at night or early in the morning to conserve moisture and avoid evaporative loss of water.
- Practice deep watering in order to encourage strong healthy root systems that are water efficient. Avoid light, frequent irrigation that encourages shallow rooting.
- Avoid over-fertilization and avoid fertilizing during periods of limited rainfall or high temperatures.

2.4 FERTILIZATION

Proper fertilization is essential for turfgrass to sustain desirable color, growth, density, and vigor; to better resist diseases, weeds, and insects; and to provide optimum playability.

2.4.1 Nutrient Testing

- Perform soil nutrient testing at regular intervals (typically every 1 - 3 years with shorter intervals for sand-based soil profiles). Take samples at the same time of year (i.e. Spring) and same depth (i.e. 3 inches) to provide a consistent evaluation of soil nutrient levels from year to year. The samples should also be taken at the end of the fertilization application interval before the next application interval.
- Maintain accurate records of soil sample locations, date of sampling, soil conditions, and test results.
- Use the same laboratory for analyses over time so that results are more comparable.
- Consider using plant tissue testing to evaluate fertility. This is most valuable for micronutrients.

2.4.2 Nitrogen

- Regulate nitrogen application to optimize turfgrass health and prevent disease development. The goal is to use the least amount of nitrogen needed for healthy functional turf.
- Use slow-release nitrogen fertilizers when possible, or low rates of quick-release nitrogen fertilizers to minimize inputs to the environment.
- Adjust nitrogen with consideration to groundwater and surface water vulnerability.
- Consider clipping yield, thatch levels, need for growth, color, growth rate, and tissue testing to determine nitrogen applications.

2.4.3 Phosphorus

- The main goal is to apply the least amount of phosphorus needed for healthy functional turf.
- Use soil test information to determine need.
- Minimize phosphorus applications in areas where phosphorus levels are medium to high based on soil test results, except in the case of establishment operations.
- Be aware of local restrictions on phosphorus use.
- Adjust phosphorus with consideration to groundwater and surface water vulnerability.

2.4.4 Potassium

- Use soil test information to develop target levels.
- Limit potassium inputs to the amount needed to reach target levels.

2.4.5 Calcium, Magnesium, and Micronutrients

- Apply as required to maintain plant health.
- Regularly test soil and plant tissue to avoid deficiency problems.

2.4.6 pH

- Maintain soil pH appropriate for turfgrass type.
- Adjust soil pH if possible to optimize soil nutrient availability using results from soil tests.

2.4.7 Fertilizer Application Practices

- Properly calibrate fertilizer spreaders to ensure accurate application rates.

- Review the weather forecast prior to applications. Avoid applications prior to forecasts for heavy rainfall to minimize potential for run-off.
- Avoid application to impervious surfaces (cart paths, parking lots, etc).
- Avoid applying fertilizer to sand bunkers and water features. Use appropriate application equipment for the area being fertilized.

2.4.8 Buffer Zones

- Follow appropriate buffer zone practices as described in Section 2.1.
- Limit fertilizer applications to the extent practical in defined buffer zones.

2.4.9 Documentation

- Record location, date, weather conditions, and type of fertilizer applied.
- Record rate of nutrient application.
- Record method of nutrient application.
- Record post-application irrigation practices.
- Maintain current inventory of fertilizer on hand.

2.4.10 Storage

- Avoid long-term storage. Store small quantities and order as needed.
- Maintain fertilizer inventory in a dedicated, dry, well-ventilated, enclosed environment.
- Store fertilizer separately from solvents, fuels, and pesticides.

- Sweep up any spilled fertilizer immediately.
- Create a map of fertilizer storage areas and install appropriate placards on exterior of storage area.

2.5 IRRIGATION

To ensure efficient watering, golf courses should have well-designed irrigation systems that maintain the desired level of turfgrass health and playability.

2.5.1 Soil Moisture

- Monitor soil moisture and wettability routinely.

- Maintain soil moisture levels that promote healthy turfgrass.
- Avoid over-application of water to turfgrass.
- Provide adequate drainage to promote healthy root development and help prevent compaction.
- Use moisture sensors to determine effectiveness of irrigation in wetting soil.
- Monitor soil's wettability with the Water Drop Penetration Time (WDPT) Test. If soil resists wetting, use soil surfactants to restore wettability and avoid development of soil water repellency.

2.5.2 Conservation

- Optimize irrigation program to conserve water.
  - Irrigation application rates should not exceed the maximum ability of the soil to absorb and hold the water applied at any one time, with the exception of salt affected soils.
  - Irrigate according to needs of each area of the course specifically.
- Use weather station, evapotranspiration (ET), and/or soil moisture sensor data to assist in irrigation scheduling.
- Consider the use of soil surfactants to ensure uniform delivery of water and solutes to root-zone.
- Reduce irrigation in secondary rough areas and, where possible, eliminate irrigation of non-play areas.
- Irrigate by hand when necessary and practical.
- Conduct an irrigation audit to find out where improvements can be made in irrigation system efficiency.
  - Review the number of turfgrass areas that are irrigated.
  - Identify species that are water conserving.

2.5.3 Water Quality

- Determine that the irrigation source water is suitable for application to turfgrass via water-quality testing.
- Consider long-term implications of irrigation source water quality.
- Treat water as needed to improve suitability for irrigation.

2.5.4 Reclaimed Water

- When possible, use reclaimed water for irrigation.
- Apply water conservation measures even if using reclaimed water.
- The characteristics of reclaimed water vary greatly between sources. Review water quality analytical data or perform water quality testing to determine if any extra management practices are necessary to use the water at the golf course.

2.5.5 Management

- Irrigation systems should be operated based on moisture needs of turfgrass or to water in a fertilizer or chemical application as directed by the label.
- Audit irrigation system, weather station, flow meters, and moisture sensors annually.
- Perform annual maintenance on pump stations.
- Use rain sensors to help eliminate excess watering during rainy weather.
- Monitor system for breaks and malfunctions.
  - Perform leak detection on a regular basis, including in the spring prior to the start of the irrigation season and again at the end of the season.
  - Use isolation valves before all main lines and major laterals to be able to quickly shut off leaking areas before turfgrass is damaged and water is lost.
  - Trim vegetation around and level sprinkler heads and valve boxes as needed.
  - Install leak monitoring devices that will automatically disable the pump in the event of a substantial leak.
- When possible, the irrigation schedule should coincide with other cultural practices such as the application of nutrients.
- Develop a drought emergency plan to address the most critical golf course water demands during times of water use restrictions.
- Limit irrigation to seasons defined in appurtenant water rights.
- Limit irrigation to quantities defined in appurtenant water rights.
- Anti-backflow prevention devices must be used if there is any possibility of water reentering water supply systems in accordance with local regulations. This is especially important if the irrigation water is used to convey pesticides or fertilizers.
- Measure water and energy use monthly and annually.
- Coordinate fertilization and irrigation rate to prevent runoff to surface waters or groundwater leaching.

2.5.6 Irrigation System Design

- Irrigation of greens and green surrounds should be designed to provide inward and outward sprinkler coverage for maximum efficiency and optimal turfgrass maintenance.
- Have operational control of each head to increase irrigation flexibility.
- Have separate irrigation zones for slopes, roughs, and areas surrounding greens.
- System elements should include computerized control systems, weather stations, pump stations, monitoring sensors, and optimum sprinkler heads and nozzles installed at optimum spacing.

- If not already a part of the automated/computerized system/weather station installed at the golf course, install rain shutoff switches to avoid over-watering following significant rainfall.
- Irrigation systems should be designed and installed by qualified specialists.

2.6 ENVIRONMENTAL

Environmental monitoring is a method to determine if outside events are affecting water quality or if the golf course is having an effect on water quality—positively or negatively.

2.6.1 Regulations

- Become familiar with federal, state, and local regulations that apply to golf course operations including those related to habitat, surface water, groundwater, and storm water runoff.
- Implement policies and procedures to achieve compliance with relevant regulations.

2.6.2 Habitat

- Develop golf course operations to optimize preservation and enhancement of wildlife habitat (refer to the "Wildlife Habitat Enhancement" section of the *Guidelines*).
- Where available, obtain advice from organizations and agencies such as Audubon International, local Audubon Society Chapters, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, local watershed councils, etc. to assist in habitat enhancement and applicable regulations.
- Consider the presence of amphibian and other species when selecting pesticide delivery systems.

2.6.3 Storm Water

Storm water management is important at golf courses for many reasons. Storm water runoff can carry pollution to receiving waters, cause erosion, and cause flooding if not managed properly.

- Consider both the quantity and quality of storm water.
- Storm water management should include "natural systems engineering" approaches that maximize the use of natural systems to treat water. Preserve the natural drainage pathways that existed prior to development where possible.
- Storm water management should slow water velocities and reduce peak discharges.
- There should be no discharges from pipes that go directly to surface water.
- Institute buffers and special management zones.
- Minimize the use of impervious surfaces and maximize opportunities for infiltration in permeable areas where possible.
- Minimize use of curbing—create breaks in curbs where water can flow into appropriate landscaped or natural areas to serve as alternative "irrigation" and be naturally filtered.
- Use pervious pavers or pavement for walkways, paths, and parking lots.
- Control surface runoff quantity and quality in parking lots and from roofs with appropriate infiltration and/or treatment practices such as bioretention facilities (rain gardens), infiltration planters, grassy swales, filter strips, and constructed wetlands.

- Channel water from rain gutters into planted areas or water reservoirs.

2.6.4 Monitoring

- Inventory property features with respect to habitat, water quality, and storm water management to define a baseline for measuring improvement and enhancements.
- Monitor and document habitat improvements and related wildlife response (e.g., installation of bird boxes leading to increased bird population).

- Monitor and document water quality of relevant surface and groundwaters to assess impact of golf course management practice (refer to the "Water Quality Monitoring" section of the *Guidelines*).
  - Use a certified analytical lab.
  - Use proper sampling techniques.
- Check the daily weather forecast or your local air quality index to find out if it is a Clean Air Action Day. If it is, reduce activities that add to air pollution. For example, limit the amount of motorized equipment use that day.

2.6.5 Corrective Action

- In the event that monitoring information identifies a potential problem, design and implement action to correct the situation.
- Document the plan using the Action Plan form.
- Evaluate BMPs in the event monitoring identifies a potential problem.
- Document any corrective action taken.

2.6.6 Spill Response

- Develop a specific Standard Operating Procedure (SOP) based on these BMPs.
- Maintain appropriate spill response equipment.
- Train staff on proper use of spill response equipment.
- Train staff on procedures for containing spills and avoiding injury.
- Where appropriate, file a spill response report.
- Maintain and post information for appropriate responders based on the nature of the spill.
- Determine the conditions that define whether a spill must be reported (i.e. what quantity of chemical spilled requires reporting).

- If required, report spills to the National Spill Response Center (1-800-424-8802) or to the local state regulatory agency such as the Washington Department of Ecology, Spills Program (NW Region 425-649-7000, SW Region 360-407-6300, Central Region 509-575-2490, Eastern Region 509-329-3400). In Oregon, report the spill to the Oregon Emergency Response System (OERS) (800-452-0311) as required. If there are other public or private agencies in the area that deal with spill response, have their number in a location visible for all staff.
- Be ready to answer questions such as:
  - Where is the spill?
  - What spilled?
  - How much spilled?
  - How concentrated is the spilled material?
  - Who spilled the material?
  - Is anyone cleaning up the spill?
  - Are there resource damages?
  - Who is reporting the spill?
  - How can they get back to you about the spill?

2.6.7 Wellhead Protection

- Check to see if municipal wellhead protection, permits, or land use restrictions apply.
- Review laws pertaining to wellhead protection - federal, state, and local.
- Implement a wellhead protection program (refer to Section 5.0 in the *Guidelines*).
- Identify public and private sources of drinking water including wells.

- Identify areas of the golf course where groundwater may be most impacted (e.g., shallow water table, sandy soil profile) by golf course management activities. These areas would be considered potentially sensitive areas.
- Reduce pesticide use in sensitive areas.
- Reduce fertilizer use, especially those with groundwater advisory statements on the label, in sensitive areas, including areas such as turfgrass adjacent to waterways, particularly ponds, lakes, wetlands, and rough adjacent to natural areas.
- Create delineation boundaries.
- Select turfgrass varieties that grow much slower and require less fertilizer.
- Maintain buffer zones to help minimize erosion and runoff.
- Manage hazardous materials and petroleum products to prevent releases.

- Manage vehicle and equipment maintenance areas to prevent releases.

2.7 PEST MANAGEMENT

Integrated Pest Management (IPM) is a method of combining proper plant selection, correct cultural practices, the monitoring of pest and environmental conditions, and the judicious use of biological controls and pesticides to manage pest problems.

2.7.1 Integrated Pest Management

- Develop an Integrated Pest Management Plan (refer to the Integrated Pest Management section of the *Guidelines*).
- Use the Integrated Pest Management Plan as an operational reference for all golf course operations.
- Educate staff on the contents and utility of the Integrated Pest Management Plan.
- Revise the Integrated Pest Management Plan over time so that it remains a contemporary document reflecting the state of golf course management.

2.7.2 Weeds

- Define action thresholds.
- Monitor turfgrass regularly for presence of weeds.
- Optimize turfgrass vigor by mowing at the appropriate height and by proper application of fertilizer and water to prevent weed colonization and establishment.
- When possible, use mechanical means (i.e., hand pulling) to remove.
- Use selective herbicides only when thresholds have been exceeded, and when appropriate, limit applications to spot treatments.

2.7.3 Fungal Disease

- Define action thresholds.
- Understand disease symptoms and disease life cycle.
- Define and implement cultural practices designed to minimize injury from fungal pathogens.
- Monitor turfgrass regularly for disease symptoms.
- Monitor conditions (temperature, humidity, moisture, etc.) that favor disease development.
- Use fungicides with optimal efficacy and specificity.
- When possible, use targeted, spot applications of fungicides.
- Rotate chemical family of fungicides applied to prevent the development of fungal resistance.
- Document problem areas, disease activity, and treatment applied.

2.7.4 Insects

- Define action thresholds.
- Understand relevant insect life cycles and symptoms of infestation.

- Provide habitat for native insect predators where possible.
- Install bat and bird boxes near areas where insect infestations could be food sources for these animals.
- Encourage beneficial insects and consider impacts to beneficial insects prior to application of pesticides.
- Monitor turfgrass regularly for symptoms of infestation.
- Cultivate growing degree days to estimate insect activity.
- If infestation is detected, correctly identify the insect.
- Use target specific insecticides.
- When possible, use targeted, spot applications of insecticides.

2.7.5 Rodents

- Define action thresholds.
- Use mechanical traps when possible and local laws allow.
- Study the habits of the target rodent to enhance trap efficiency.
- Provide habitat for native rodent predators where possible.
- Install nesting or perching features (i.e., snags, nest boxes, etc.) for raptors that use rodents as a food source.
- Use rodenticides as a last resort.
- If possible, eliminate food sources or habitat.

2.7.6 Buffer Zones

- Follow appropriate buffer zone practices as described in Section 2.1.
- Separate action thresholds must be defined for application of pesticides within buffer zones.

2.7.7 Aquatic

- Define action thresholds.
- Consider pond function (habitat or irrigation) when defining damage/action thresholds.
- Keep ponds/lakes as deep as practical to minimize aquatic plant growth.
- Where possible, use mechanical means to remove undesirable aquatic plants.
- Where possible, use non-toxic blue or black dye to block sunlight from growing plants or algae.

- Use beneficial aquatic plants to out-compete undesirable plants and/or to remove nitrate from the water.
- Use aerators to agitate water; this practice increases oxygen content and reduces the growth of bacteria and algae.
- Prior to using aquatic herbicides, obtain appropriate permits, if necessary.

2.7.8 Cultural and Physical Controls

- Use certified pest-free plant material, if available.
- Use appropriate turfgrasses for areas being planted.

- Increase mowing height to reduce plant stress associated with nematodes, root-feeding insects, disease outbreaks, or peak weed seed germination.
- Stimulate or increase root growth if root-feeding pests are detected. Increase irrigation frequency (with smaller quantities) until roots recover.
- Manage irrigation to avoid excess moisture or drought stress. (See Irrigation Section of the *Guidelines*)
- Wash mowers to avoid spreading pathogens and weeds.
- Manage thatch by adjusting fertility levels, mechanical removal, top dressing, or other means.
- Divert traffic away from areas that are stressed.

2.7.9 Natural Controls

- Provide native flowering plants that can be nectar food sources for parasitic insects and pollinators.
- Encourage beneficial organisms in out-of-play areas.

2.7.10 Pesticide (Synthetic or Biological) Controls

The following is a brief list of important factors to consider when using pesticides on golf courses. More detailed pesticide BMPs are listed in Section 2.8.

- Choose Reduced Risk products as defined by the EPA when available.
- Choose products targeted at the pest of intent.
- Read and understand the pesticide label.
- Test new pesticides on a small area on the golf course before widely using them.
- Manage pesticide resistance by rotating pesticides with different modes of action, as appropriate.
- Consider the weather condition prior to the application of pesticides.
- For insecticides aimed at soil insects, irrigate turfgrass before and/or after an application, in accordance with the label.
- Avoid applying herbicides at times when they could contribute to plant stress and result in greater plant damage by a secondary pest problem.
- Honor buffer zones when applying pesticides.
- Maintain pesticide application records required by your state.

2.8 PESTICIDES

When using pesticides on golf courses, there are many important factors that come into play. These include minimizing potential hazards to human health and the environment, optimizing playing conditions at the golf course, utilizing effective monitoring to enable selective control of pest populations, minimizing pesticide use through targeted application while optimizing pesticide efficacy, sustaining high turfgrass quality, controlling operating costs, and maintaining the health of the landscape elements such as trees, shrubs, flower beds, and natural areas.

2.8.1 Selection

- Confirm identity of pest requiring pesticide treatment.
- Select pesticides based on efficacy, target specificity, the potential effect on non-target species, cost, site characteristics, and environmental compatibility.

- Rotate the chemical "family" of pesticides used for a specific pest to prevent the development of pesticide resistance. The Insecticide (http://www.irac-online.org) and Fungicide Resistance Action Committees (http://www.frac.info/frac/index.htm) provide excellent resources on pesticides resistance issues and guidelines.
- When possible, use pesticides labeled by the EPA as Reduced Risk Pesticides.

2.8.2 Application

- Follow appropriate state regulations regarding licensing of personnel who handle pesticides.
- Read and understand pesticide labeling before use.
- Use pesticides for labeled use only.
- "First in—first out" principle. Use the pesticides that have been stored at the golf course for the greatest length of time first.
- Mix pesticides for target pests at rates specified on the label.
- Mix pesticides in a dedicated area.
  - Have a properly designed and constructed area where the operator can perform all mixing operations.

  - Spills can be collected and managed.
  - Locate operations well away from groundwater wells and areas where runoff may carry spilled pesticides into surface water bodies.
  - Clean up spills immediately.
  - Properly rinse pesticide containers and put rinsate into spray tank whenever possible.
- Wear appropriate personal protective equipment (PPE) during pesticide mixing and application.
- Properly calibrate sprayer or spreader before use.
- Apply pesticides to target areas only. Do not apply pesticides in buffer zones. Follow application setbacks when specified on the label.
- Minimize pesticide drift by applying when winds are 5 mph or less, or use hooded booms.

- Select appropriate nozzles and use drift reduction technologies.
- Use curative applications only when pest action threshold levels have been reached.
- Use preventative applications only when conditions favoring outbreaks occur (e.g., summer stress favoring anthracnose, cool conditions favoring Microdochium patch (fusarium)).
- Use check plots to determine pesticide effectiveness (i.e. 2 x 2 foot square of plywood laid on turfgrass to block application and serve as an untreated control area.)
- Follow posting requirements according to state law.

2.8.3 Pesticide Spill Management

- Use appropriate personal protective equipment (PPE).
- Follow the 4 steps: control, contain, collect, and store.
- Comply with all applicable federal, state, and local regulations on spill response training, spill reporting requirements, spill containment, and cleanup.
- Dispose of waste in accordance with regulations.
- Refer to Spill Response (Section 2.6.6).

2.8.4 Storage

Proper handling and storage is important to avoid serious injury or death, fires, environmental contamination, cleanup costs, civil lawsuits, destruction of turfgrass, and wasted pesticide product. Specific storage and disposal guidelines/requirements for Oregon can be found at http://www.oregon.gov/ODA/PEST/disposal.shtml.

- Read the label for specific storage requirements.
- Store pesticides in a restricted access, lockable, dedicated room or cabinet.
- Apply placards to exterior of storage.
- Pesticide storage building should be separate from other buildings.
- Store liquid products below dry products.
- Avoid placing liquids above eye level.
- Store all products; especially dry bags, up off floor (i.e. on pallets).
- Ensure that the pesticide storage area meets OSHA requirements (i.e., dry, ventilated, temperature control, etc.)
- Store pesticides in original containers with original labels.
- Organize the pesticides: flammable/nonflammable, fungicides/herbicides/insecticides.
- Create a map showing pesticide storage areas.

2.8.5 Disposal

- Read the label for specific disposal requirements.
- Rinse pesticide containers as soon as they are empty. Triple rinse containers prior to disposal. Mix rinsate into batch for application according to label directions.
- Consult with local fire department for storage and reporting requirements.
- Inspect rinsed container to confirm that all visible residues have been removed prior to disposal.
  - If pesticide containers are not properly rinsed they could be classified as hazardous waste.
  - Under the Resource Conservation and Recovery Act (RCRA), a container is not empty until it has been properly rinsed.

- After cleaning, puncture the pesticide containers to prevent reuse.
- Contact a local pesticide distributor for container recycling instructions.
- If there is any question about the contents of a container, set it aside for proper disposal.
- Properly dispose of old or unusable pesticides.

2.8.6 Documentation

- Follow state regulations for proper documentation and reporting procedures.
- Record target of pesticide application.
- Record location, date, and type of pesticide applied.
- Record weather conditions.
- Record rate of application.
- Record method of application.
- Maintain current inventory of pesticides on hand.

2.9 PETROLEUM PRODUCTS

Petroleum products can be harmful when introduced to the environment including surface waters. These products can float on the water surface, sink to the bottom, evaporate into the air, or remain suspended in the soil and groundwater. Petroleum products have a low solubility and can be toxic to plants, animals, and people.

2.9.1 Fuel Storage

- Store bulk fuel in certified, double walled, self-contained steel tanks.
- Keep gas cans in a separate metal cabinet.
- Label fuel storage containers clearly and accurately.
- Store solvents and degreasers in lockable metal cabinets in an area away from ignition sources.
- Create a map of fuel and chemical storage areas.

2.9.2 Disposal

- Store used fluids in separate containers appropriate for specific fluid type.
- Maintain used fluid containers in an easy access, safe area that is out of the weather.
- Store used fluid containers on a non-corrosive secondary containment deck.
- Label used fluid containers clearly with fluid contents.
- Contact local petroleum company to arrange pick up of containers for disposal.

2.9.3 Fueling Areas

- Minimize the possibility of a discharge and the need for disposal.
- Cover fueling areas to minimize contact with storm water.
- Direct catch basins in fueling areas to an oil/water separator or a dead end sump that is tested and managed.

- Educate employees on the importance of handling petroleum products properly.
- Comply with regulatory requirements for aboveground and underground storage tanks.

2.9.4 Spill Response

- Refer to Section 2.6.6.
- A spill kit should be located in the fueling area.

2.9.5 Fuel Usage

- Choose fuel-efficient equipment.
- Reduce the number of two-cycle engines that are used.
- Develop mowing, spraying, bunker raking, and other maintenance activity routes that optimize the activity and reduce fuel use.
- Limit engine idling.
- Repair fuel, oil, and hydraulic leaks immediately.

2.10 WASTE MANAGEMENT

Waste management is the collection, transport, processing, recycling, or disposal of waste materials, usually ones produced by human activity. By managing wastes, golf courses can reduce their effect on human or ecological health or local aesthetics or amenities. Managing wastes allows golf courses to reduce the effects on the environment.

2.10.1 Compost

- Compost as much biomass as possible and reuse on golf course.
- Site compost areas away from surface waters or where groundwater may be impacted.

2.10.2 Wash Water

- Do not wash equipment unnecessarily. Equipment should be brushed or blown with compressed air before, or instead of, washing.
- Do not discharge wash water directly to natural surface water or groundwater.
- Wash water should be discharged into a sanitary sewer system or a closed-loop recycling system. If this is not possible, contact the state environmental regulatory agency to determine if discharge permits are required.
- A few options and alternatives for equipment wash stations include:
  - "Dog leash" system—wash over grass and move around to prevent discharge to groundwater or runoff to surface water.
  - Separation system—Intercept clippings and compost, return water to a bioswale that does not discharge to groundwater or runoff to surface water.
  - Onsite—Drain directly to a closed loop recycle system (recycle systems typically require discharge to a sanitary system for maintenance purposes).
  - Offsite—Drain directly to a sanitary system.

- Residue from rinsing of mowing equipment that is collected at the prescreening to the wash water disposal system can be collected and composted or spread on the golf course.
- Recycle system filters and sludge should be treated and disposed of as hazardous waste unless they have been tested to determine that they are not hazardous.
- Minimize the use of detergents.
- Minimize the amount of water used to clean equipment. For example, use a hose with a shutoff nozzle if washing all equipment and machinery with water.
- Do not conduct equipment wash operations on a pesticide mixing and loading pad.
- Do not wash equipment used to apply pesticides on pads with oil/water separators. Pesticide residues will contaminate the oil that is salvaged.
- Protect equipment maintenance areas from rainfall.
- Each piece of equipment should have an assigned parking area. This allows oil or other fluid leaks to be easily spotted and attributed to a specific machine so that it can be repaired.
- Protect drains from receiving inappropriate fluids. For example, do not allow rinse water into a storm drain, and do not allow oil to enter sanitary or storm drains.

2.10.3 Hazardous Waste

- Contact the state environmental agency to perform a hazardous waste audit through the agency's waste reduction assistance program.
- Oregon: http://www.deq.state.or.us/lq/hw/
- Washington: http://www.ecy.wa.gov/programs/hwtr/index.html
- Protect drains from receiving inappropriate fluids. For example, do not allow rinse water to a storm drain, and do not allow oil to enter sanitary or storm drains.
- Ensure that all waste containers are sealed, secured, and properly labeled.
- Use only approved, licensed contractors for disposal.
- Pesticide mixtures that cannot legally be applied to a site must be disposed of as hazardous waste.
- Antifreeze must be recycled or disposed of as hazardous waste.
- Lead-acid storage batteries are classified as hazardous waste unless they are recycled.

2.10.4 Recycling

- Implement a recycling program (cardboard, plastic, pop cans, etc.).
- Store all cracked batteries in a non-leaking secondary container to retain acid leaks and recycle them. Store batteries inside a covered area.
- Recycle used materials such as degreasers, used oil, oil filters, antifreeze, cleaning solutions, automotive batteries, used rags, and hydraulic fluid in properly marked containers.

2.11 SAFETY AND EDUCATION PROGRAM

Effective management of worker safety and health protection is a decisive factor in reducing the extent and the severity of work-related injuries and illnesses. Worker safety is important in ensuring protection from the potential hazards of working at golf courses.

2.11.1 Safety Meetings

- Create a safety committee consisting of maintenance crewmembers.
- Establish a regular meeting time (i.e., first Monday of the month).
- Keep accurate records of meeting discussions.
- Communicate Environmental Stewardship principles used by the golf course with all staff.

2.11.2 Safety Training

- Establish a safety training program to include the following topics:
  - CPR and first aid.
  - Eye protection.
  - Noise exposure and protection.
  - Hardhat use and head protection.
  - Personal protection equipment (PPE).
- Request free safety training videos from OSHA.
- Understand how to interpret a Material Safety Data Sheet (MSDS). Place MSDS documents in a file and store in a location accessible to all staff.
- Bomb threat response.
- Fire safety training, including pesticides and other hazardous materials.

2.11.3 Hazard Communication Training

- The golf course should have a hazardous communication program in place.
- Employees should be alerted to the environmental and health hazards of the various chemicals used at the golf course.
- The training program should include the safe handling, storage, waste management, and disposal for all chemicals used at the golf course.
- All MSDS should be stored in one location that is known and accessible by everyone employed at the golf course.
- Eyewash stations should be located in the maintenance shop and at other locations where chemicals are stored.

2.11.4 Equipment Training

- Establish an equipment training program to include the following topics:
  - Tool and accessory training.
  - Lightning safety and protection.
  - Emergency procedures.
  - Signage.
  - Fire extinguisher locations.
  - General use.
- Display signage appropriate for location or situation.

2.11.5 Safety Audits

- Have fire marshal perform an audit of fire safety.
- Have OSHA perform a “consultative” general safety audit.
- Contact the insurance company to determine if they will perform a safety audit.

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INTEGRATED PEST MANAGEMENT (IPM) PLAN 3.0

The broad objective of an Integrated Pest Management (IPM) strategy is to optimize turfgrass, ornamental, and tree health through the use of cultural methods as a means of minimizing the need to control pests with chemicals.

The states of Oregon and Washington define IPM as "a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner to meet institution programmatic pest management objectives" (Washington State, Interagency Integrated Pest Management Coordinating Committee, 2002 and Oregon Revised Statute 634.650). Legal Washington State definitions of IPM are located at www.ecy.wa.gov/programs/swfa/upest/legal_defs.html. The legal definition of IPM in Oregon is located at www.oregon.gov/ODA/PEST/ipm.shtml. Section 2.4 of the *Guidelines* provides the BMPs related to pest management.

The main goal of an IPM program is to protect the environment and maximize the quality of turfgrass by using a combination of tactics to control pests, including cultural, biological, genetic, and chemical controls. Many pest management practices do not involve the use of pesticides. By keeping the turfgrass healthy, the need for chemical treatment will be reduced. Other times, preventative pesticide applications can reduce the total amount of pesticides used on a given area over a given time. Many times pesticide applications are used after other IPM strategies have been either employed, or considered.

Pesticides can be applied as preventative or curative maintenance. Whether the pesticide application should occur prior to the pest becoming apparent or after the pest has began to establish itself may depend on the type of pest/disease and its characteristics, the action threshold set for the pest at the golf course, time of year, and the schedule of maintenance activities.

Pesticide resistance should also be considered when deciding on a course of action for a particular pest. Both the Insecticide Resistance Action Committee (IRAC) and the Fungicide Resistance Action Committee (FRAC) are technical groups of Croplife International designed "to provide pesticide resistance management guidelines to prolong the effectiveness of "at risk" fungicides and to limit crop losses should resistance occur. The main aims of both IRAC and FRAC are to:

- Identify existing and potential resistance problems.
- Collect information and distribute it to those involved with fungicide and insecticide research, distribution, registration, and use.
- Provide strategies, guidelines, and advice on the use of pesticides to reduce the risk of resistance developing, and to manage it should it occur.
- Recommend procedures for use in pesticides resistance studies.
- Facilitate communication and education on pesticide resistance.
- Stimulate open discussions and collaboration with universities, government agencies, advisors, extension workers, distribution, and farmers.

As referenced in Section 2.8.1, the approved FRAC and IRAC monitoring methods are located on the FRAC and IRAC websites.

Documented IPM plans have become important golf course assets, and provide a cornerstone for environmental stewardship programs. Pest management decisions and methodology are based on sound scientific information. An IPM plan can be viewed as the incorporation of the general policies and procedures of Best Management Practices into a written description of IPM-driven management practices.

Although the primary purpose of an IPM plan is to provide the golf course Superintendent and staff with a working reference document, the IPM plan has a variety of additional beneficial uses. The IPM plan can be used to inform greens committees, owners, regulatory agencies, and the public regarding the IPM strategies and practices at the golf course. A significant challenge is to develop a documented IPM plan that is understandable to a wide variety of readers. The plan should contain sufficient detail to define all aspects of IPM practices, yet should also be written so that readers with a variety of comprehension levels can easily understand specifics of the plan. Ideally, the plan should be written in outline form that has short, clear descriptions under each outline heading. In certain instances, the use of tables is recommended to provide a concise presentation of certain aspects of the plan.

The organization of the IPM plan has been synthesized from a variety of sources, which include the Portland Parks and Recreation Pest Management Policy (Portland Parks and Recreation, 2009); Best Management Practices for Golf Course Development and Operation (King County Environmental Division, 1993); the Audubon Cooperative Sanctuary Program for Golf Courses; and a collection of contemporary, turfgrass management references.

The Portland Parks and Recreation Pest Management Policy is in compliance with the 4d Rule under the Endangered Species Act. There have been updates to this policy, which can also apply to golf courses. Alternative weed management treatments are currently being studied. By keeping up to date with the results of these studies, golf courses will be able to develop the best practices. Another part of the current Pest Management Policy is to stem the invasion of non-native invasive weeds that displace the natural plants. This is necessary to restoring natural areas, in creating healthy habitats needed to support wildlife, and in enhancing storm water quality.

An IPM Plan development tool designed for Pacific Northwest golf courses is available at www.greengolfusa.com. This tool allows a Superintendent to enter golf course descriptive information, pest threshold information, and treatment approach. A formatted electronic document that reflects the selections will be emailed to the golf course Superintendent after data entry. The result is a formal IPM Plan tailored to meet the maintenance objectives of the golf course. The resulting IPM plan can be edited and made even more site-specific by the golf course Superintendent.

The following is a table of contents for a typical IPM plan. Because IPM plans are specific to each golf course, your IPM plan may vary from this example. The contents are described in more detail in later sections.

1. Introduction
2. IPM Definition, Objectives, Structure
3. Area Definition

3.1 Management Areas

3.2 Non-Turfgrass Areas

4. Turfgrass Cultural Practice

4.1 Cultural Practice

4.2 Pest Management

4.3 Nutrient Management

4.4 Irrigation

5. Tree Management

6. Composting and Organic Materials Management
7. Pest Population Definition
8. Pest Action Threshold Levels
9. Pest Monitoring and Pest Control
10. Pesticide Specifications
11. Facilities Description
12. References

3.1 AREA DEFINITION

The IPM Plan should include a description of the facility. More specifically, the individual management areas and the respective maintenance requirements should be defined. For example, the golf course may include 10 acres of fairways that have a medium level of irrigation requirement, a medium level of mowing frequency, and a low fertilizer requirement.

3.2 TURFGRASS CULTURAL PRACTICE

Turfgrass area maintenance is often the most labor-intensive element of the IPM program, requiring greater than 95 percent of resource allocation. The primary intent of the IPM program is to optimize turfgrass vigor utilizing sound cultural practices as a means of preventing and/or minimizing pest infestation. The primary practices of turfgrass maintenance include mowing, fertilization, and irrigation.

Cultural practices also include aeration, topdressing, thatch removal, and overseeding to promote a healthy turfgrass environment.

Pesticide applications may be used as part of IPM strategies.

3.2.1 Pest Management

The following are the basic steps for an IPM program:

- Identify the key pests (pests most likely to be encountered or those observed during scouting).
- Determine the pest's life cycle, and know which life stage to target.
- Use cultural, mechanical, or physical methods to prevent problems from occurring, reduce pest habitat, or promote biological control.
- Decide which pest management practice is appropriate and carry out corrective actions. Directly control where the pest lives or feeds. Use properly timed preventive chemical applications, while minimizing the economic and environmental costs.
- Determine if the "corrective actions" to act, reduce, or prevent pest populations, were economical, and minimized risks.

A critical component of a successful IPM program is monitoring. The turfgrass conditions need to be observed regularly. In order to track the

effectiveness of the treatments, results should be documented.

3.2.1.1 Invasives

Noxious and invasive weeds need to be controlled. These types of plants are a threat to the function, composition, and structure of native ecosystems. The U.S. EPA states that noxious weeds and invasive exotic (non-native) plants are a serious biodiversity issue of great significance to human and natural resource conditions.

In order to control invasive plants, the following objectives should be followed:

- Prevent the continued spread of aggressive, non-native plant species.
- Prevent the spread of established non-native noxious and invasive plants into uninfested or lightly infested areas.
- Eradicate new invaders before they become established.
- Eradicate or control known and potential non-native noxious and invasive plant infestations.

3.3 PLANT NUTRITION

Nutrient management is most effective when combined with IPM practices. The nutrient management plan is a guide for adjusting management practices to address variability throughout the golf course. It is a guide for managing the amount, sources, placement, form, and timing of application of nutrients and other soil amendments and should be applied as part of a conservation management system to efficiently use nutrient resources.

Nutrient management has a significant impact on plant health, soils, and the environment over time; therefore it is important to closely monitor the nutrient application rate, nutrient form, nutrient application method, and nutrient application timing.

The major nutrients required for turfgrass health are nitrogen (N), phosphorus (P), and potassium (K). Calcium, magnesium, and sulfur also contribute significantly to turfgrass health. Micronutrients include iron, boron, copper, manganese, and zinc. The availability of nutrients to turfgrass is influenced by the pH of the soil. Consequently, management of the appropriate pH is an important component of the fertilizer program. Controlled-release fertilizers should be used whenever appropriate, with adjustments being made for special needs and conditions.

A good nutrient management plan that is followed will reduce fertilizer costs, improve turfgrass quality, and protect water resources.

Three items that a good nutrient management plan should include are:

- Use a realistic plan for nitrogen requirement.
- Adjust the plan based on in-season soil and/or plant testing or monitoring.
- Manage irrigation efficiently to prevent leaching and runoff.

3.3.1 Nitrogen

Nitrogen is a major nutrient and is a key element in plant growth, but excess nitrogen will not be taken up by the plant.

The fate of residual nitrogen includes:

- Uptake by plants and soil microorganisms.
- Loss through denitrification and volatilization.
- Loss through leaching or runoff as nitrate.

When planning nitrogen management, consider the contribution from other nitrogen sources such as clipping, recycling, or microorganism release besides fertilizer as well as the efficiency of fertilizer nitrogen uptake by turfgrass. Soil factors, weather, and climate are also important considerations.

3.3.2 Phosphorus

Phosphorus is very persistent and should be managed efficiently. When managing phosphorus, take soil temperature into consideration. Phosphorus exists in water in either a particulate phase or a dissolved phase. Particulate matter includes living and dead plankton, phosphorus precipitates, phosphorus adsorbed to particulates, and amorphous phosphorus. The dissolved phase includes inorganic phosphorus and organic phosphorus.

The fate of residual phosphorus includes:

- Precipitation as insoluble or "slowly soluble" chemical forms.
- Loss in runoff or leaching.

Phosphorus in natural waters is usually found in the form of phosphates (PO_4^{-3}). Phosphates can be in inorganic form (including orthophosphates and polyphosphates), or organic form (organically-bound phosphates). Fertilizers generally contain phosphorus in the form of orthophosphate, which is the form used by plants. Orthophosphate is sometimes referred to as "reactive phosphorus." It is the most soluble form of phosphorous, although it is much less soluble than nitrogen, and therefore much less mobile. Soils can bind phosphorus, but once they become saturated, the excess phosphates can be carried into surface waters with storm runoff.

Phosphates are not toxic to people or animals unless they are present in very high levels. However, excess phosphorus in aquatic systems can promote algae growth and subsequent consumption of oxygen upon degradation. Depleted oxygen can lead to death of aquatic organisms.

Certain water bodies have been determined by state regulatory agencies to be water quality limited based on the presence of phosphorus. A golf course Superintendent should be aware of these designations and incorporate steps in the nutrient management plan to meet Total Maximum Daily Loads (TMDLs) for the water bodies.

In summary, apply phosphorus fertilizer only when soil tests show the need. Minimize phosphorus loss to the environment by tailwater elimination/containment and by erosion controls. Remediation efforts should be targeted on special areas based on the phosphorus sources and transport factors. Keep in mind, many organic sources of fertilizer have high ration levels of phosphorous in relation to other nutrients.

3.3.3 Potassium

Turfgrass requirements for potassium are intermediate in relation to nitrogen and phosphorus levels. Potassium is an essential component needed in plant growth. Although applied to maximize efficiency of uptake, potassium does not pose the extent of environmental risk that excess nitrogen and phosphorus levels represent. Proper levels of potassium are an important component of plant disease resistance and contribute to the ability of turfgrass to withstand wear and traffic stress.

3.4 LAKE AND AQUATIC PLANT MANAGEMENT

If lakes and/or ponds exist at a golf course, a comprehensive written lake/pond management plan should also exist for that golf course. Some of the challenges in maintaining the quality of ponds are:

- Low dissolved oxygen,
- Sedimentation,
- Excess nutrients,
- Changes in plant population,
- Nuisance vegetation,
- Aquatic life,
- Erosion Control, and
- Depth.

The Washington Department of Ecology provides a useful aquatic plant management plan at www.ecy.wa.gov/water.html titled "A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans" (Gibbons, M.V., Water Environmental Services, Gibbons Jr., H.G., and Sytsma, M.D., 1994). The manual uses an approach based on integrated management of land plants that considers such concerns as:

- How bad is the aquatic plant problem?
- At what level will plants become harmful and when should action be taken to control them?
- When is the best time of year to kill, remove, or suppress the nuisance plant species?
- What methods will best deal with the target species, and for how long?
- How will the treatment affect humans, native plants, and wildlife?
- Are the costs reasonable and affordable?

3.4.1 Aquatic Plant Control

A major piece of the lake/pond management plan is the aquatic plant control plan. In order to control the aquatic plants appropriately, the intended use of the water body must be known, as well as whether there are any invasive or weedy species present, the aesthetic purposes of the lake/pond, and any other environmental conditions. The comprehensive lake/pond management plan should include strategies to control the growth of nuisance vegetation that can negatively impact the water quality and treatment capacity of the ponds.

The general IPM principles should be applied:

- Proper turfgrass fertilization practices
- Unfertilized buffer strips
- Good pond design
- Hand removal of plants or mechanical harvesting
- Littoral shelf plantings of desirable plants
- Use of lake dyes and biological controls
- Aeration
- Aquatic herbicides

If herbicide applications are to be used, they should be used according to the label. Choose the aquatic herbicide according to:

- Target plant
- Water body type and uses
- Wind
- Temperature
- Water depth
- Efficiency
- Cost-effectiveness

It is important to consider the types of chemicals used in an aquatic environment. For example, copper is a concern because of its persistence in the environment and it is highly toxic to fish and other aquatic animals. The presence or absence and the

types of plants in ponds may affect the bird life that frequent ponds. If water from the pond is used for irrigation, waiting periods for using the water for irrigation required by the herbicide label must be followed.

The 4 zones in a lake/pond include:

1. Riparian (buffers)
2. Littoral (transition between upland and open water)
3. Limnetic (open water)
4. Benthic (bottom of pond—sediment)

Properly designed ponds with a narrow fringe of vegetation along the edge are much more resistant to problems than are those with highly maintained sod. This vegetation along the edge of the pond should be maintained in order to avoid degradation of the pond. Pond edges can often be overtaken by plant growth resulting in reduced water quality or eventual pond extinction. The aquatic plants growing in and around a pond provide many benefits-good water quality; cover for fish; shelter for birds; emergent vegetation serves as egg mass attachment sites for amphibians; cover and food for reptiles, amphibians, and birds; breeding sites for birds; etc.

3.4.2 Dissolved Oxygen

Dissolved oxygen in a lake or pond comes primarily from photosynthesis, wind action, or mechanical aeration devices. Aquatic organisms

require oxygen to survive—oxygen is important to all forms of life in the pond/lake and supports the food chain. The lack of dissolved oxygen causes a series of chemical reactions that further degrade the pond/lake water quality. For example, sulfide is converted to hydrogen sulfide and insoluble iron is converted to soluble iron. Natural decomposition processes in the aquatic ecosystem are oxygen dependent. Improper application for some aquatic herbicides can result in oxygen depletion. Treating aquatic weed infestations with herbicides in hot weather can be risky. Treating only part of the pond at a time can lower the risk of oxygen depletion. The most immediate reactions to oxygen depletion would be fish kills or odors. Long-term reactions include nutrient buildup, sludge accumulation, and chemical imbalance in the lake/pond.

3.4.3 Permitting Issues

Golf course superintendents need to be aware of the most current rules governing the application of pesticides to aquatic environments. The U.S. EPA rule adopted in 2006 to exempt aquatic pesticide applications from permitting requirements under the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) program was invalidated by the U.S. Court of Appeals for the 6th District in January 2009.

Beginning in April 2011, the U.S. EPA will require a NPDES permit for pesticide applications on, over, or near water. Oregon DEQ will not require a NPDES permit or other water quality permit for pesticide applications to water made in accordance with the label until that time. However, the Washington State Department of Economy (DOE) is requiring permits to control the use of aquatic pesticides in and around state waters. Therefore, golf courses should be aware of the current and upcoming legal requirements, and know that they may need to apply for a permit if they plan on treating ponds or lakes with pesticides.

Prior to pesticide applications in or over water, the golf course Superintendent should contact the state environmental regulatory agency regarding permit requirements.

3.5 TREE MANAGEMENT

Tree management includes inventorying the trees at the golf course and general tree planting, management, and removal practices.

3.5.1 Tree Selection

Trees considered for planting are selected based on ultimate size and type of growth appropriate for the planting location, compatibility with soil conditions and climate, and pest resistance properties. Select native species as appropriate. If non-native tree species are selected, select those that are not invasive in nature. Select a diversity of native tree species—a variety of species is better for wildlife (insects through mammals).

3.5.2 Planting Locations

Tree planting locations should be carefully evaluated prior to planting to anticipate the effect of mature trees on surrounding turfgrass and ornamental areas. Architectural features, engineering, aesthetics, and influence on playing characteristics of the golf course are important landscape functional considerations. Water requirements, shading, and influence on air circulation are the primary determinants of planting locations.

3.5.2.1 Tree Planting

Trees should be planted in planting holes appropriate for the root ball/root mass; and planting holes are backfilled with native material, except in certain situations where the existing soil is contaminated or filled with rubble. It is important to make sure the planting area is mulched and receives irrigation as required through the first three growing seasons. Planting should occur during the Fall. However, certain tree species, such as conifers, should be planted in the Spring.

3.5.2.2 Tree Maintenance

Trees should be routinely monitored for overall health, influence on playing characteristics, the presence of insects and diseases, influence on surrounding turfgrass and ornamentals, and hazard potential. In general, insect and disease pests can be tolerated. High-value specimen trees may require more consideration for IPM strategies. Established trees do not require supplemental watering except in situations of extreme drought. Trees should be pruned to optimize health, allow passage of light and wind, minimize hazard, and manage pests. A professional tree service should be consulted regarding trees that have disease and/or pest problems beyond the normal scope of golf course management practices.

3.5.3 Tree Removal

Tree removal may be required because of disease, age, wind or lightning damage, and hazard potential. At other times, trees may be removed to increase sunlight and air circulation to specific turfgrass areas to create better growing conditions for healthy turfgrass. Consider impacts to wildlife habitat and shading properties before trees are removed. The Superintendent will be responsible for determining if tree removal is necessary, and will consult with a professional tree service regarding tree removal that is beyond the scope of routine golf course management practices.

Consider removing only a portion of a tree and leaving the rest, e.g. “high stump” a hazard tree to eliminate the hazard but to provide some value on-site such as wildlife habitat. If possible, place cut/pruned material on-site when possible and where appropriate to provide values to wildlife.

Some communities have enacted ordinances requiring planting or protection of trees in rights-of-way, parking areas, or along property lines. Check with your city’s arborist or urban forestry program for ordinances affecting your location.

3.6 PLANT GROWTH REGULATORS

Plant growth regulators (PGRs) are chemicals that regulate plant growth. The objective of plant growth regulators is to increase turfgrass quality, and reduce maintenance costs. Plant growth regulators provide economical growth regulation of turfgrass. Because the vertical growth of the turfgrass is reduced, the frequency of mowing may

also be reduced. The use of plant growth regulators may also limit seedhead development.

3.7 HYDROPHOBICITY OR WATER REPELLANCY

Hydrophobic soils are soils that repel water as opposed to wetting easily under irrigation or rainfall conditions. Soil hydrophobicity commonly referred to as soil water repellency, is generally caused by a coating of long-chained hydrophobic organic molecules that accumulates on individual soil particles. Soil water repellency can be pronounced, with the soil obviously repelling the water, or slight where infiltration is disrupted but not prevented altogether. In either case, soil water repellency can lead to runoff, non-uniform wetting of soils, poor delivery of fertilizers and pesticides, plant stress and reduced quality, increased need for irrigation and water use, and increased risk of environmental contamination. The sources of the hydrophobic organic compounds have been found to include microbes, root exudates, fungi, and decomposing organic matter among other things.

To counteract hydrophobicity in soil, soil surfactants, a.k.a. soil wetting agents may be used. Wetting agents are nonionic substances that reduce the surface tension of water, and in many cases restore the wettability of the soil. When applied to water-repellent (hydrophobic) soils at rates recommended by manufacturers, surfactants can improve the ability of the water and solutes to penetrate the soil surface and more uniformly wet the entire root zone. Before using a wetting agent, be sure that slow infiltration is being caused by water repellency, not some other factor. This can be done by pulling a core after a few dry days, laying it on its side, and placing small drops of water along it at ½-inch intervals from the turfgrass at the top down side of the column. If there is any delay at all in the penetration of the drop, there is some level of water repellency present. Soil wetting agents will improve infiltration rates and water distribution only in soils that have some level of water-repellency present, regardless of their texture, tilth, and aggregation (North Carolina Cooperative Extension Service). Additional information can be found in the 2008 Soil Science Society of America publication Soil Science: Step-by-Step Field Analysis (S. Logsdon, D. Clay, D. Moore, and T. Tsegaye, 2008). The information can also be found on the website www.soils.org.

3.8 ECO-LAWN

One option for turfgrass in buffer zones where nutrients and pesticides are restricted or limited, or in out-of-play areas, may be an Eco-Lawn. As stated on the WSU Clark County Extension website, "an Eco-Lawn is an extensive use of ground cover plants to replace the traditional grass lawn. Once established, the Eco-Lawn is drought tolerant, self fertilizing, and requires no pesticides" (http://clark.wsu.edu/volunteer/mg/gm_tips/EcoLawn.html). Commercially packaged seed mixtures are blended with varieties well adapted to specific regions. Choose seed mixtures carefully as some packets contain seeds for noxious or nuisance weeds. It takes approximately 1-2 years for an Eco-Lawn to be fully established.

3.9 REGULATION AND LEGAL ISSUES

Federal and state agencies have numerous rules regarding pesticides. The rules address permitting, licensing, prohibited chemicals, and other regulatory issues. There are three general rules that apply to all pesticide applicators:

1. Pesticide products must be registered by both the EPA and by the state.
2. Restricted use pesticides (RUPs) can only be applied by licensed applicators.
3. Record keeping of the pesticides applied is required. The lists should be kept as part of the IPM program.

In Oregon, pesticide use reporting became a requirement beginning January 1, 2007; however as of July 1, 2009, Pesticide Use Reporting System (PURS) was suspended until funding becomes available, possibly until 2013. The PURS was administered through the Oregon Department of Agriculture (ODA). In Washington, pesticide application record keeping forms are available in the General Rules at: http://agr.wa.gov/PestFert/Pesticides/.

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WATER QUALITY MONITORING 4.0

Water quality monitoring is the foundation for evaluating the effectiveness of Best Management Practices and the environmental impacts of the IPM program. Water quality monitoring provides a data set that can be developed and evaluated over a long period of record for considering the effects on water quality from golf course management practices. By monitoring water quality, problems can be detected early and addressed before they become chronic. The water quality monitoring results provide the feedback loop for adaptive management; and changes in the BMPs or fertilizer/pesticide use patterns can be made on the basis of sound science and hard data.

While the primary objective of a water quality monitoring program is to evaluate whether the golf course is having an effect on the local surface, storm and/or groundwater, there are numerous other objectives and benefits possible for a water quality monitoring program. As described in the Connecticut BMP document, the evaluation objectives can focus more specifically on effects such as evaluating the frequency and timing of nutrient or pesticide applications and the effectiveness of the IPM program. Potential monitoring objectives might be to monitor golf course impact on sensitive areas, determine the extent and degree of a known problem, or to monitor the effectiveness of remediation or mitigation of a known problem. In addition, monitoring quality of water coming onto the golf course can provide important information for turf and soil management programs as well as provide a baseline for evaluating net effect of the golf course on water passing through the course.

4.1 WATER QUALITY MONITORING PLAN

The water quality monitoring program begins with development of a Water Quality Monitoring Plan for the golf course. Implementation of the water quality monitoring program should be based on site-specific conditions such as watershed, stream flows, soil type, topography, drainage, and vegetation as described in the Environmental Setting Section of the Environmental Stewardship Plan. The Water Quality Monitoring Plan documents the hydrologic conditions and drainage, objectives for monitoring, monitoring locations, and analytical program. An example of a map that might be included in a Water Quality Monitoring Plan to show water-sampling locations is shown on **Figure 3**.

There are various objectives a golf course may have for sampling various water bodies. Each water body on every golf course should be reviewed with respect to water quality monitoring objectives. Some water bodies may have a big effect on the surrounding environment and/or be more susceptible to contamination from nutrients and pesticides, while others may not.

Water quality monitoring locations at the golf course include surface water and groundwater. The types of surface water that may be included in the Water Quality Monitoring Plan include:

- Ponds—Lined and unlined;
- Wetlands;
- Lakes;
- Streams;
- Rivers;
- Storm Water; or

- Golf Course drainage systems.

Many golf courses use groundwater via water supply wells for irrigation purposes. The wells may be deep and completed in bedrock, or they may be shallow wells that are completed in more unconsolidated deposits. The water from these wells should be tested for water quality on a periodic basis. Baseline testing should include nutrients and pesticides. The monitoring program should include regular nutrient analysis of groundwater, and pesticide analyses at least every 5 years. In addition, monitoring of water to be used for irrigation will give the superintendent information regarding potential water quality impacts on soil chemistry and nutrient availability. From the information, additional management decisions can be made regarding soil and water quality and nutrient management programs.

The sampling objectives will vary from golf course to golf course. Prior to the sampling event, a complete survey of the golf course with respect to the surface and groundwater should be performed. During this survey, water bodies that may be affected by golf course maintenance practices should be noted on a map (**Figure 3**). The following is a list of details that the golf course should know about the water features:

- Groundwater or surface water
- Surface water type (pond, stream, etc.)
- Entry point and exit point
- Nearby features that may affect water quality (green, fairway, etc.)
- Which of these should be sampled
- What should be tested for—nutrients and pesticides or only nutrients

Ideally, the Water Quality Monitoring Plan should designate that samples be collected from all points where surface water enters and exits the course, as well as locations where golf course management practices may locally affect a water body.

Samples collected from water entry points serve to establish a baseline to determine the influence of golf course management practice on water quality by comparison of testing results with water exit point locations. The results from entry point samples also allow for the evaluation of influences from upstream locations (outside sources) on the quality of water entering the golf course. While a single sample or measurement may or may not be meaningful by itself, the results or measurements may be very meaningful if viewed as a trend over time.

The laboratory analytical program to be implemented at the golf course should be described in the Water Quality Monitoring Plan. The analytical program defines the chemicals to be tested in water samples collected from the golf course. Suggested approaches for applying analytical programs are presented in Section 4.2 Sampling Strategies.

Regulatory requirements related to water quality in the watershed in which the golf course is located should be identified in the Water Quality Monitoring Plan. These requirements may be

included in State water quality standards, permits issued to the golf course, municipal storm water permits issued to the city, listing of a nearby water body on the State 303(d) list, or total maximum daily loads (TMDLs) that have been applied to discharges in the watershed. A TMDL is the amount of a specified pollutant or associated pollutant measurement parameter that is "allowed" to enter the water body and is not expected to result in further degradation of water quality. TMDLs have been established for some constituents in some basins. Other water bodies have been determined to be water quality limited (i.e., listed on the 303(d) list) and are awaiting the development of TMDLs. These regulatory requirements may lead the golf course superintendent to implement specific water quality sampling strategies to monitor conditions and demonstrate improvements. In order to determine whether a TMDL has been conducted in the watershed where your golf course is located, state websites may be useful. The Oregon Department of Environmental Quality (DEQ) website contains links to TMDL and Water Quality Management Plan (WQMP) documents prepared for water bodies in Oregon designated as water quality limited on the 303(d) list: http://www.deq.state.or.us/wq/TMDLs/TMDLs.htm. The Washington Department of Ecology has a searchable database with a geographic interface listing 303(d) and TMDL information: http://www.ecy.wa.gov/programs/wq/wqhome.html.

4.2 WATER QUALITY SAMPLING STRATEGIES

The water quality sampling strategy should be developed to meet the objectives of the golf course Environmental Stewardship Program. A suggested program that provides important baseline data and results in a data set that can be evaluated to define an on-going monitoring program is presented in these *Guidelines*. This suggested program is broken into three phases:

- Baseline Water Quality Monitoring;
- On-Going Water Quality Monitoring; and
- Targeted Water Quality Monitoring.

4.2.1 Baseline Water Quality Monitoring

The monitoring plan at a golf course should begin with Baseline Water Quality Monitoring. Establishment of a baseline for comparing later results allows the golf course to recognize cause and effect between golf course management practices and water quality as well as to identify offsite sources of water quality influences. Offsite sources may include, but are not limited to residences and other businesses upstream, upgradient storm water drainage systems, and other turfgrass/park areas. As changes to the BMPs or IPM Plan are implemented, meaningful changes in water quality should be evident.

Baseline Water Quality Monitoring constitutes a rigorous testing program, which should include sampling waters from monitoring locations at the golf course defined in the Water Quality Monitoring Plan. These water samples should then be analyzed for all of the nutrients and chemicals that have been used on the golf course in the six months prior to the sampling event. Sampling should occur in the spring (generally April) and

fall (generally October) for each of the first three years. The Superintendent might consider using chemicals that are analyzed by the same analytical method to reduce analytical costs. A list of analytical methods and the chemicals analyzed by each of those methods is provided in Appendix C. Because methods may be modified or added, this list should be regularly updated. In addition to sampling for the pesticides that were used in the previous six months, laboratory analyses should also include those chemicals that were detected in the previous monitoring event, and nutrients. Presence of nutrients could be indicators of fertilizer runoff.

For the first year, in addition to orthophosphates and nitrates, ammonia should also be included in the analytical program. If the golf course is working towards certification in the Audubon Cooperative Sanctuary Program, it is recommended that testing be conducted quarterly for one year, generally the first year of the water quality monitoring program and twice annually after that. For certification, it is required that testing be done at least once per year.

4.2.2 On-Going Water Quality Monitoring

Once the baseline water quality has been established, the water quality monitoring program can move toward an On-Going Monitoring program. At this point, water quality monitoring will continue on a regular basis, but now some conditions will influence what chemicals are to be analyzed during a monitoring event as discussed below.

Many chemical properties and golf course-specific circumstances will be considered when determining which chemicals need to be analyzed, how often, and from which location(s). These include frequency of detection, persistence, physico-chemical properties of pesticides, water body types, existing Pacific Northwest-research data, and comparisons of application dates versus detections.

4.2.2.1 Historical Database Statistical Analyses

Since the *Guidelines* were established in 2000, there has been a significant amount of water quality data collected from golf courses in the Pacific Northwest. By studying these data, some changes to the baseline testing program may be justified, which may narrow the number of analyses that need to be run during a given sampling event while retaining a rigorous analytical program.

One important piece of information derived from the historical data is the frequency of detection of golf course chemicals.

Chemicals that have been previously detected at Pacific Northwest golf courses and used during the prior six months should always be included in the analytical program for a water quality monitoring event under these *Guidelines*.

The following chemicals have been used at golf courses within the past 5 to 7 years; however, have never been detected in water samples:

Chemical	Number of Samples	Chemical	Number of Samples
1-naphthol	4	isoxaben	20
bendiocarb	3	mancozeb	183
bifenthrin	2	MCPA	17
carfentrazone-ethyl	33	MCPP	91
chloroneb	14	myclobutanil	14
DCPA	13	oxadiazon	23
deltamethrin	3	paclobutrazole	9
dicamba	116	pendimethalin	37
dichlobenil	5	picloram	37
diquat	4	prodiamine	16
dithiocarbamate	1	pronamide	11
ethofumisate	59	pyraclostrobin	8
ethoprop	12	quinclorac	29
etridiazole	5	thiophanate-methyl	161
fenamiphos	23	thiram	12
fludioxanil	109	trifloxystrobin	22
flutolanil	33	trifluralin	6
glyphosate	169	trinexapac-ethyl	58
		turcam	11

For those chemicals where we have a significant number of samples to provide a reasonable picture of the likelihood of those chemicals entering the hydrologic system, the analytical program included in the ongoing monitoring can be modified to limit analytical costs.

4.2.2.2 Physico-Chemical Properties

The chemical's persistence (half-life) and other physico-chemical properties can help determine how long a pesticide might remain in the environment after it is applied. The published half-lives are based on a certain set of conditions used in conducting experiments to measure half-life. These conditions may not be applicable at a particular golf course, and as such these chemical properties should not be solely relied upon in determining the analytical program. However, for those chemicals in the database that have not been detected, application of the half-life in determining an analytical program that will provide adequate characterization of the golf course is reasonable. The following chart provides some guidance for how to decide which chemicals to include in the analytical program:

Chemical	Soil Half-Life (days)	# Days Before Sampling Event						
		15	30	60	90	120	150	180
Bendiocarb	3.5							
Carfentrazone-ethyl	0.6							
Chlorothalonil*	35.0							
Glyphosate	47.0							
Mancozeb	7.6							
MCPA	30.0							
Tetramethrin	12.0							
Thiophanate-methyl	2.0							
Triadimefon	26.0							
Trifloxystrobin	35.0							
Trinexapac-ethyl	13.0							

analyze do not analyze

* these chemicals have some regulatory limitations that may supersede the # of days prior to sampling method

The number of days since an application occurred is used in this chart to determine whether a particular chemical should be included in the analytical program. If an application was made within the indicated number of days before a sampling event, then the chemical should be tested. If the application was made more than the indicated number of days before sampling, then the chemical can be excluded from the sampling program. Only chemicals that have never been detected at Pacific Northwest golf courses should be considered for modified analytical programs, however the analytical history at an individual golf course can also be used to make these determinations.

As part of an on-going water quality monitoring program, a golf course may opt to perform annual water quality monitoring. Water samples could be collected in the Spring or Fall each year. The season in which samples are collected should alternate at times in order to ensure both are being represented in the database. However, if a chemical is detected, water quality monitoring should occur for at least the chemical detected the following season. Other options may include sampling for the chemical soon after to make sure it is no longer present or after the next time the chemical is used at the golf course.

4.2.3 Targeted Monitoring

As golf course Superintendents perform On-Going Monitoring, they may recognize a need to do more intensive studies on the fate and transport of chemicals considering the specific conditions and management of the golf course. These more intensive studies under the *Guidelines* are termed Targeted Monitoring events and may include alternative sampling locations, focus on a particular pesticide or nutrient application, or be designed to answer a number of other questions about fate and transport of chemicals at the golf course.

The Targeted Monitoring program can be used to supplement or replace an On-Going Monitoring program in a particular year. For example, if propiconazole has been detected periodically at the golf course in an exit sample, additional locations such as drainage systems or other locations in a creek may be sampled to try to pinpoint the source. These Targeted Monitoring events may be performed at times other than the Spring or Fall and may be timed to specific chemical applications. The results may help the golf course Superintendent to make changes to BMPs, adjust the IPM Plan for a particular green, or expand buffer zones in an effort to eliminate releases to surface water.

4.2.4 Analyses Suggested by Audubon International

Another benefit to water quality monitoring is recognition in the Audubon Cooperative Sanctuary Program (Audubon International). "Audubon International awards certification to recognize golf courses that protect the environment, conserve natural resources, and provide wildlife habitats. Achieving certification demonstrates a course's leadership, commitment, and high standards of environmental management" (Audubon International, 2007). In order to become certified, there are specific water monitoring requirements that must be followed. These include analyzing for nutrients including ammonia, and measuring pH, temperature, specific conductance, and dissolved oxygen on a quarterly basis. The *Guidelines* monitoring program is currently a semiannual program, therefore each course that is working towards Certified Audubon Cooperative Sanctuary status must include at least one quarterly monitoring as a part of their Water Quality Monitoring Plan. The Audubon International fact sheet for Environmental Management Practices for Golf Courses is included in Appendix D and on their website: www.audubonintenational.org.

4.3 CERTIFICATION PROGRAMS

Golf courses that implement the *Guidelines* may be eligible for certain certification programs. For instance, designation as a Certified Audubon Cooperative Sanctuary should be achievable for golf courses that have implemented the *Guidelines*. In addition, a group associated with the Puget Sound, Stewardship Partners, administers a certification program titled "Salmon-Safe." The Salmon-Safe standards are described in section 4.3.1.

To help promote the *Guidelines*, Audubon Cooperative Sanctuary, Salmon-Safe, and a group of local superintendents have formed the Northwest Golf Course Environmental Alliance (NWGCEA). The objective of the NWGCEA is to encourage, support, and recognize the environmental accomplishments of golf course superintendents in Oregon and Washington.

Criteria for certification will depend on the organization conducting the certification. During development of the *Guidelines*, it became apparent that the development of water quality benchmarks would be useful given the varying toxicity and environmental effects of the chemicals used on golf courses. Benchmarks would also be useful for allowing the water quality data to be put in perspective. Currently, adjustments to BMPs and the IPM Plan are made on the basis of detections and the toxicological evaluation made of those concentrations in the water body. However, the detections are purely instrument based and some chemicals detected may not be particularly toxic or damaging to the environment. As such, a "zero detections" policy as the basis for certification is too stringent to give proper recognition to golf courses that have made great improvements in their operations and the environment.

A certification of a golf course Superintendent's effort to improve the environment in the watershed can be useful. The environmental stewardship program and subsequent certifications can be communicated to the club membership, management, and community, or used in club marketing programs. However, certification comes with responsibility. A demonstrated record of proactive adaptive management (adjusting BMPs and the IPM Plan to alleviate environmental effects of golf course management) should be maintained in the Environmental Stewardship Plan binder.

4.3.1 Salmon-Safe Standards

Salmon-Safe promotes ecologically sustainable practices that promote water quality and aquatic biodiversity throughout the Pacific Northwest. The standards for certification are discussed further in Section 7. As noted by the *Guidelines*, the Salmon-Safe standards also state that certain pesticides are a serious threat to salmon and other aquatic life—chemicals can potentially kill fish, stress juveniles, alter swimming ability, interrupt behaviors, inhibit migration, and delay spawning. A list from the Salmon-Safe standards of commonly used pesticides that are considered to pose risk to salmon and aquatic life in urban streams is included in Appendix E.

4.4 WATER QUALITY SAMPLING PROCEDURES

The list of analytes to be tested will be determined by the Water Quality Monitoring Plan and whether the golf course is in a Baseline Water Quality Monitoring, On-Going Monitoring, or Targeted Monitoring mode. The procedures to be used to collect water samples are described in the following sections.

4.4.1 Sample Collection Methods

Proper sample collection methods are important in developing optimal testing information value. The less uncertainty about the sample will lead to less uncertainty about the result. The following are the basic principles of proper sample collection:

- Obtain the proper bottles from the analytical lab.
  - Water for nutrient testing should be collected in new, clean plastic bottles supplied by the laboratory.
  - Water for pesticide testing should be collected in new, clean amber glass bottles supplied by the laboratory. Currently these are 1-liter bottles although improvements in analytical techniques may allow for use of different size bottles in the future. Certain chemicals may require alternative bottles depending on the characteristics of the chemical.

- Obtain the samples from the same location at each sampling event. The sample locations should be marked on a map prepared in conjunction with the Water Quality Monitoring Plan.
- Label each sample collection bottle with the appropriate sample identifier as well as the date and time of collection.
- Triple rinse the clean sampling device with the subject water. The sampling device should be constructed of materials that will not affect the water sample.
- Lower the sampling device into the water column approximately 6 inches to collect a representative sample. Using the device, fill the bottles. If 2 bottles are necessary for one sample, be sure to fill the 2 bottles almost simultaneously by emptying half of the water from the sampling device into one bottle and the other half of the water sample into the second bottle.
- Once the samples have been collected, cap the sample bottles with clean lids and store in a cooler with ice. Samples should be kept at 4º Celsius (39º Fahrenheit).
- Deliver samples to the lab within the holding time. For example, samples for nutrient testing have a 48-hour hold time.
- As part of the sampling process, field parameters should be measured at the sampling location during sample collection. Four key parameters to measure for include pH, temperature, specific conductance, and dissolved oxygen. As mentioned previously, dissolved oxygen is required as part of the Audubon Cooperative Sanctuary Program certification and is an important indicator of stream health.

Samples should be tested using methods approved by the US Environmental Protection Agency (EPA).

4.4.2 Field Measurements

Prior to collecting the sample for laboratory analysis, field parameters should be measured. As mentioned above, these include pH, temperature, specific conductance, and dissolved oxygen.

1. **pH**
   pH is a measure of the acidity or basicity of a solution in terms of activity of hydrogen. Solutions with a pH less than 7 are considered acidic, while those with a pH greater than 7 are considered basic. pH 7 is defined as neutral because it is the pH of pure water at 25 °C. Natural fresh waters can have a pH range from 4.0 to 10.0, but normal pH for waters in the Pacific Northwest is between 5.5 and 8.5. Knowing the pH of the water body is important for several reasons including but not limited to: 1) high pH values tend to facilitate the solubilization of ammonia, heavy metals, and salts, 2) low pH levels tend to increase carbon dioxide and carbonic acid concentrations, and 3) lethal effects of pH on aquatic life occur below pH 4.5 and above pH 9.5.

2. **Temperature**
   Temperature is a measurement of the intensity (not amount) of heat stored in a volume of water. Surface water temperatures naturally range from 0º Celsius (C) (32º F) under ice cover to 40º C (104º F) in hot springs. Natural sources of heat include: solar radiation, transfer from air, condensation of water vapor at the water surface, sediments, precipitation, surface water runoff and groundwater discharge. Temperature is the primary influencing factor on water density.

   Temperature affects the solubility of many chemical compounds and can therefore influence the effect of pollutants on aquatic life. Increased temperature elevates the metabolic oxygen demand, which in conjunction with reduced oxygen solubility, impacts many species. Vertical stratification patterns that naturally occur in lakes affect the distribution of dissolved and suspended compounds. For all these reasons, it is important to measure the temperature of the water being sampled.

3. **Specific Conductance**
   Specific conductance is the measurement of the ability of water to conduct an electric current—the greater the content of ions in the water, the more current the water can carry. Specific conductance may be used to estimate the total ion concentration of the water, and is often used as an alternative measure of total dissolved solids. In general, golf course specific practices do not have an effect on specific conductance general levels, unless using reclaimed water.

4. **Dissolved Oxygen**
   Dissolved oxygen (DO) is a measure of the amount of oxygen dissolved in water. Typically the concentration of dissolved oxygen in surface water is less than 10 mg/L. The dissolved oxygen concentration is subject to diurnal and seasonal fluctuations that are due, in part, to variations in temperature, photosynthetic activity, and river or stream discharge. Natural sources of dissolved oxygen are derived from the atmosphere or through photosynthetic production by aquatic plants. Natural re-aeration of streams can take place in areas of waterfalls and rapids. Aeration devices may be used to increase dissolved oxygen in ponds.

These field parameters are measured using instruments designed for the task. The instruments must be calibrated regularly to make sure data collected are accurate and limit false readings.

4.4.3 Monitoring Documentation

Monitoring documentation includes records of field measurements, a chain of custody (COC), laboratory reports, interpretations of the laboratory analytical data, and any corrective action that has been taken. This information should be contained in the Water Quality Monitoring section of the

Environmental Stewardship binder compiled by the golf course.

COC forms are a formal means of documenting the handling of a sample from the time of sample collection until the time of sample delivery to the lab. The intention of the COC is to establish a "trail" that defines who was responsible for the possession and maintenance of the samples from start (sample collection) to the end (delivery to the lab) of the process. The COC form contains signatures and the date and time samples were transferred from one person to another. The lab should provide these forms.

Each round of the water quality monitoring program should be documented in a report presenting an interpretation of the results. The report should include a description of the sampling points, who conducted the sampling, when the sampling was conducted, comparison of entry point and exit point water quality, a discussion of the field parameter measurements, and interpretation of the overall water quality sampled at the golf course. If any chemicals were detected, the concentrations should be discussed in the context of the toxicology of potential ecological receptors and regulatory requirements. Humans may be potential receptors in some watersheds and the effects on human health need to be considered where this pathway is complete. The summary report should be prepared following each round of sampling.

If the results of the sampling event show that golf course management practices may potentially threaten to degrade water quality, it is important to document the best way to change practices to correct the situation. This may include a review of fertilizer and pesticide application records, a review of the IPM plan, documenting results of these reviews, and documenting a corrective action statement. It is important to take and document the corrective action as quickly as possible.

4.4.4 Sampling by Golf Course Representative

One way to save costs is for the golf courses to collect their own samples. Regulated industry typically collects samples for compliance with water quality permit conditions. The Superintendent and other staff who would be performing the water quality monitoring should participate in a water quality sampling training program to demonstrate that they have the training necessary to collect representative samples, make the field measurements, and prepare the appropriate documentation. Once training is completed, the staff member(s) would be "certified" and capable of performing the sample collection for the Environmental Stewardship Program under the *Guidelines* in accordance with State water quality monitoring guidance.

As part of water quality sampling at their own course, the golf course would need to acquire the proper field sampling equipment such as a pH, temperature, and conductivity meter and a dissolved oxygen meter. These can be either purchased or rented. Some golf courses may choose to share the equipment purchase with other nearby golf courses. A water-sampling device will also be necessary to perform the sampling and field measuring properly. Sample bottles and a cooler should be supplied by the analytical laboratory.

WELLHEAD PROTECTION PROGRAM 5.0

The objective of a Wellhead Protection Program is to protect groundwater resources for use by the golf course and the communities in which the golf course exists. A municipal wellhead protection program was established under the Federal Safe Drinking Water Act (SDWA) and developed to be an active groundwater contamination prevention program. There are at least six federal laws to help protect groundwater:

- Safe Drinking Water Act (SDWA)
  - Set maximum contaminant levels (MCLs) in drinking water and established flexible protection programs
- Clean Water Act (CWA)
  - Sets standards for allowable pollutant discharges to surface water or groundwater
- Resource Conservation & Recovery Act (RCRA)
  - Regulates transport, storage, treatment, and disposal of hazardous and solid wastes
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
  - Regulates cleanup of contamination from hazardous wastes
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
  - Regulates pesticide use
- Toxic Substances Control Act (TSCA)
  - Regulates manufactured chemicals

The Oregon Department of Environmental Quality (DEQ) and Washington State Department of Health (DOH) oversee the municipal wellhead protection programs from the State level. DEQ implemented Oregon's 1989 Groundwater Protection Act, which focuses on statewide prevention of groundwater contamination, conservation of the resource, and maintaining its quality for present and future beneficial uses. The Groundwater Protection Act specifically calls for DEQ and DOH to implement Wellhead Protection Programs. As with the federal program, the primary goal of the States of Oregon's and Washington's Wellhead Protection Programs is to be proactive and prevent/reduce the risk of groundwater contamination from potential contaminant sources.

The following information is summarized from DEQ's Oregon Wellhead Protection Program Guidance Manual and Washington State's Wellhead Protection Program Guidance Document. There are six general steps in implementing a municipal wellhead protection program at a golf course:

1. Prepare wellhead protection plan
2. Define staff responsibilities
3. Delineate protection area including offsite supply wells
4. Inventory potential sources of contamination
5. Develop management approach
6. Develop contingency plan

The general principle of a wellhead protection program is to consider capture zones around a municipal water supply well in terms of the travel time for a release to reach the well. Often, special ordinances are enacted by municipalities to protect groundwater and limit potential sources of contamination.

A golf course should develop a Wellhead Protection Plan to guide an analog of the municipal wellhead protection process. The groundwater flow direction, the location of nearby water supply

wells (municipal and private) or irrigation wells, and how the golf course fits in the watershed need to be determined to develop a Wellhead Protection Plan for the facility. The golf course should contact the local water department for information on the water source. Source Water Assessments were completed in 2005 for all public water systems in Oregon. Oregon golf courses/golf clubs that have their own drinking water well and are considered a public water supply should have a copy of this assessment or can obtain it by contacting the Oregon Department of Human Services drinking water program at 541-726-2587. In addition, golf course superintendents can identify if they are located within a source area for a public water system by using the resources on DEQ's website, www.deq.state.or.us/wq/dwp/results.htm. Source water assessment program maps and data are available on the Washington State Department of Health/Division of Environmental Health/Office of Drinking Water website: http://www.doh.wa.gov/EHP/dw/swaphome.htm.

BMPs should be evaluated in the context of nearby water supply wells and adjusted, if necessary. Appropriate BMPs implemented upgradient of a water supply well will help to limit the potential for the well to be affected by golf course maintenance activities.

Pesticide and petroleum storage areas may be subject to municipal wellhead protection ordinances. Specific BMPs related to wellhead protection, which could include prohibiting certain activities in the protection area should be considered, and a groundwater sample collected to establish a baseline groundwater quality. It may be useful to perform pumping tests at golf course wells to determine aquifer properties or calculate groundwater travel times.

The standard of practice for wellhead protection at a golf course developing an Environmental Stewardship Program would be to meet the requirements of the local ordinances. If no municipal ordinances are applicable to the golf course, concepts enumerated in the City of Portland Groundwater Protection Manual for the Columbia South Shore Wellfield (http://www.portlandonline.com/shared/cfm/image.cfm?id=54719) and/or the City of Vancouver (Washington) Water Resources Protection Ordinance (http://www.cityofvancouver.us/waterprotection.asp) should be considered to the extent practical.

The following are groundwater protection basics:

- Pollution Prevention / BMPs
- Regulatory Permitting / Project Review
- Land Use Controls or Restrictions

Pollution prevention is summarized as the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. A source is considered to be a location where there is any activity having the potential to release one or more contaminants into groundwater at a concentration of concern. Pollution prevention includes practices that reduce the use of hazardous and nonhazardous materials, energy, water, or other resources, as well as those that protect natural resources through conservation or more efficient use.

Wellhead protection BMPs for golf courses include:

- Reduce pesticide use in sensitive areas, especially if a pesticide poses a risk to groundwater as stated on a label's groundwater advisory statement.
- Reduce fertilizer use.
- Create delineation boundaries/buffers.
- Use grasses that have low fertility requirements.
- Maintain natural shore/lawn barriers, which can include using trees, ground cover and other plants to help minimize runoff and fertilizer loss.
- Store pesticides in a restricted access, lockable, dedicated room or cabinet.
- Mix pesticides in a dedicated area.
- Clean up spills immediately.
- Dispose of pesticide waste in accordance with regulations.
- Manage hazardous materials and petroleum products.
- Manage vehicle and equipment maintenance areas. For golf courses located in areas subject to regulatory requirements for wellhead protection, permits or land use restrictions may apply.

As part of the Wellhead Protection Plan, baseline and future periodic groundwater sampling should be performed at each golf course. In order to establish a baseline of groundwater quality, the water should be sampled and analyzed for all of the chemicals that have been used at the golf course in the last five years. Once the baseline groundwater quality is established, the well water should be sampled at least every five years. If chemicals are detected at levels of potential concern, then more frequent sampling for those chemicals may be necessary to understand fate and transport characteristics. An environmental risk evaluation should be performed if golf course chemicals are detected.

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WATER MANAGEMENT AND CONSERVATION 6.0

Water is a scarce resource, and most of it is appropriated or otherwise committed for specific uses. Golf courses may find that sufficient water is not available to irrigate in dry years or under emergency situations. And, according to the Golf Course Superintendents Association of America (GCSAA), the most difficult task in Superintendent's water management practices is determining irrigation amounts and intervals (Water Efficiency, March/April 2007).

The first step in protecting access to a water source is to develop a Water Management and Conservation Plan. This plan documents how the golf course functions as designed while conserving water where possible. The local Soil and Water Conservation District (usually organized by county) or watershed council may be able to help develop a conservation strategy. The Oregon Water Resources Department (WRD) has guidance for agricultural and municipal water conservation plans (http://www.wrd.state.or.us/OWRD/mgmt.shtml#Water_Conservation). Other guidance sources are the Washington State Department of Ecology, which has a guidance for developing a water conservation issue paper (http://www.ecy.wa.gov/biblio/9167.html) and the University of Georgia and GCSAA "Best Management Practices for Turfgrass Water Conservation" (http://www.commodities.caes.uga.edu/turfgrass/georgiaturf/Publicat/1650_BMP_H2O.htm). This Georgia Turf document provides guidance for golf courses to implement site-specific water conservation plans based on a best management practices approach. In addition, the Environmental Institute for Golf is another resource for developing a water management and conservation plan (http://www.eifg.org/water/default.asp).

Water conservation is defined as any action that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces the loss or waste of water, improves the efficiency of water use, increases recycling and reuse of water, or prevents the pollution of water. There are many positives associated with a water conservation program besides conserving water for a golf course. For example, as a result of conserving water, a golf course could see significant cost savings. Upgrading sprinkler nozzles, heads (including valve-in-head technology with optimum pressure and spacing), and controls (including individual head control) on an old irrigation system, can result in a 20% water usage reduction or more. A water conservation program can also result in public relations benefits—positive stories reported to the community, media coverage to enhance the public image of golf.

In general, a water conservation plan includes a description of the water system, identifies the source of the water used by the golf course, and explains how the golf course will manage and conserve supplies to meet future needs. As listed in a Water Conservation Guide for Commercial, Institutional, and Industrial Users (New Mexico

1999), there are 8 keys to successful water management:

1. Water management plans must be part of an integrated approach that examines how changes in water use will impact all other areas of operation.
2. Water conservation involves two distinct areas: technical and human. The technical side includes collecting data from water audits and installing water-efficient fixtures and procedures. The human side involves changing behaviors and expectations about water usage and "the way things should be done." Both areas must be addressed for a water conservation program to succeed.
3. A water conservation plan depends upon accurate data. Before water-saving measures are implemented, a thorough water audit should be conducted to determine where water is being used. Then, water use can be monitored to track conservation progress.
4. A successful water conservation plan follows a logical sequence of events. Implementation should be conducted in phases, starting with the most obvious and lowest-cost options.
5. An effective plan examines not just how much water is being used, but how it is used and by whom. When analyzing a water audit, ask the next question: "Can this process be done as well or better using less water?"
6. The quality of water needed should be matched with the application. Many commercial, institutional, and industrial applications do not require the use of potable water. Whenever possible, substitute recycled water used in one process for use in another.
7. The true cost of water must be considered when conducting a cost analysis. The true cost of water is the amount on the water bill PLUS the expense to heat, cool, treat, pump, and dispose of/discharge the water.
8. Life-cycle costing is the key to evaluating water conservation options. Don't just calculate the initial investment. Many conservation retrofits that appear to be prohibitively expensive are actually very cost-effective when amortized over the life of the equipment.

The New Mexico water conservation guide (1999), which has a link on the Oregon WRD website was used as an example for the water conservation section. The following lists were found in the New Mexico document.

Some actions that should be taken when initiating a water conservation plan include:

- Establish the major goals and priorities of the water conservation program.
- Appoint a water conservation manager.
- Issue an organization-wide directive announcing the appointment of the water conservation manager.
- Provide funding for the program. Initial funding will be necessary to launch the program, and continued funding will be required to implement water-saving infrastructure and process changes.
- Emphasize the importance of the water conservation program to all employees.
- Recognize and publicize achievements in conservation, both large and small.

The water conservation manager should:

- Research institutional and regulatory considerations and constraints that will have an impact on water use decisions.
- Review and evaluate the golf course's existing or previous water conservation programs. Rate previous conservation efforts and determine their overall effectiveness. Note areas that were successful and areas that were not effective.

- Establish a budget for the water conservation program. Secure the necessary funding.
- Schedule water audits of all water-using equipment and processes. Oversee the auditing process, both initially and during follow-up and routine inspections.
- Create the water conservation action plan. This plan should include establishing the goals of the program as well as the details for implementing specific water conservation measures.
- Establish the process by which the water conservation plan will be documented and evaluated.
- Establish and coordinate an employee communications program.
- Implement the water conservation program. Install water conservation equipment and begin water conservation measures.
- Evaluate the water conservation program on a regular basis. Make any needed modifications to improve water reduction efforts.
- Report water conservation progress to top management. Fine-tune the plan if necessary to make additional water-use reductions.

Water reduction goals should be specific, measurable, and achievable. The goals should be stated in terms of gallons saved and percentage of water saved. They should also include the time frame for achievement; the area of the facility where the water savings will be realized; and by what means the savings will be achieved.

6.1 WATER AUDIT

The first major step in initiating a water conservation plan is to conduct a water audit. A water audit is a detailed examination of where and how much water enters the system, and where and how much water leaves the system. By conducting a water audit, the golf course can assess the current water uses; retrieve data needed to reduce water and revenue losses; and forecast future demand. The audit should include a complete physical inspection of the facility, in which each water-use area was carefully examined and water-use data was recorded.

6.1.1 Irrigation System Audit

More specifically, while all water uses need to be investigated on the property, a golf course should focus on an irrigation audit. The irrigation audit is a detailed examination of how much water enters the irrigation system and where it is used on the golf course. As with the general water audit, the objective of the irrigation audit is to identify water waste and inefficiencies that can be immediately corrected. These include issues such as but not limited to leaks and broken pipes, broken or malfunctioning sprinkler heads, or areas of water overspray. The audit can also reveal landscape areas that, from a water conservation perspective, require redesign or retrofitting. Before performing the actual landscape irrigation audit, the Superintendent or water manager should:

- Consult with golf course maintenance personnel who are familiar with the landscape irrigation system.

- Compile irrigation system plans, landscape plans, and maintenance records pertaining to the facility's entire irrigation system.
- Assemble water-use records, including utility bills and meter readings, applicable to golf course watering for the past 1-2 years.
- Obtain a current watering schedule, listed on a zone-by-zone basis.
- If possible, take the Irrigation Association (IA) certified Golf Irrigation Auditor course. The IA's website is http://www.irrigation.org.

According to the IA, the five turf and landscape irrigation BMPs include:

- Assure overall quality of the irrigation system;
- Design the irrigation system for the efficient and uniform distribution of water;
- Install the irrigation system to meet the design criteria;
- Maintain the irrigation system for optimum performance; and
- Manage the irrigation system to respond to the changing requirement for water in the landscape.

The complete Turf and Landscape Irrigation BMPs as well as the Landscape Irrigation Scheduling and Water Management Document are located on the IA website. The following outlines the procedure for conducting a landscape irrigation audit and test.

- Turn on each watering zone individually. Identify and inspect all water-delivery devices.
- Compare your irrigation system plans and blueprints to the actual water-using equipment in each irrigation zone. Update the plans to show the actual equipment. If possible, record detailed information about each piece of equipment. (For example, record spacing, spray pattern, throw distance, and water-delivery-rate for each sprinkler head).
- During the walk-through survey, note the location of all faucets, shut off-on valves, flush valves, solenoids, booster pumps, timers, quick couplers, and other irrigation system components.
- Carefully record the landscape area served by each irrigation system zone. Include any relevant information such as terrain type and turfgrass type.

- Note problem areas where water is being wasted. Also observe areas where too little water delivery is causing the plant material to die or become stressed.
- Test the water pressure at several key points in each irrigation zone to ensure pressure is specific to the type of sprinkler installed on the golf course. Pressure must be regulated per the design of the sprinkler to ensure optimum coverage. Too much water pressure will result in overwatering and maybe poor irrigation distribution; too little water pressure can result in dead or stressed turfgrass/plants.
- Test sprinkler heads to make sure they are delivering consistent amounts of water over the entire area.
- Run each irrigation zone for its prescribed watering period. Then randomly choose areas for spot checks of irrigation depth to see if the turfgrass is receiving proper water for the root zones. Taking multiple readings with a hand held moisture probe can give an indication of how uniformly water is or is not being delivered to the root zone. Another simple option is to perform an above-ground "can test."

6.1.2 Water Audit Report

Once the golf course has completed the water audit, an audit report should be prepared. This report will provide the baseline by which your water conservation efforts will be measured. The report should include the following:

- An updated set of facility diagrams, blueprints, and water flow charts.
- A current list of all water-using equipment with manufacturers' recommended input/output flow rates and the actual flow rates recorded during the water audit.
- A list of repairs needed immediately to prevent additional water waste.
- Retrofit options that can be done in the short term to enhance water-use efficiency (e.g. replace older model sprinkler heads with newer, more efficient models).
- Long-term recommendations for water conservation, including soil management to ensure wettability and monitoring of soil moisture levels.
- Investigation of new technologies that could result in a more efficient irrigation system (i.e. soil moisture sensors and ET calculators).
- An irrigation watering schedule (by month and/or season).
- A water flow chart that shows the movement of water from the time it enters the facility until it is discharged.
- Water use figures. The total water cost, which includes both the water bill and the cost of pumping, pretreating, etc.
- Any additional water-use observations revealed by the walk-through audit and analysis.
- An evaluation of the total cost of water used by the entire facility.

6.1.3 Action Plan

Using the water audit report, the golf course can prepare a plan of action. The plan should be evaluated using the following guidelines:

- Potential pest pressure reductions, turfgrass playability, and healthier turfgrass stands
- Potential annual water savings (water volume and costs only)
- Potential annual savings from reduced water processing
- Implementation costs
- Ongoing operational costs (if any)
- Time required for implementation
- Payback period (time required for cost of the conservation measure to be paid for by the water savings)

The actions to be taken by the golf course can be classified into 3 potential actions:

1. Cost effective and practical: water saving measures that should be enacted as soon as possible.
2. Potentially viable: measures that need further evaluation. Additional data may need to be collected during a testing period.
3. Not recommended: Based upon current information, these measures are not currently cost effective. However, they could be implemented as a response to drought conditions or as cost/benefit ratios change.

The Action Plan should contain the following:

- A statement of the golf course's commitment to water conservation.
- The golf course's water conservation goals, including the time frame for realizing the goals.
- A list of the water conservation actions that will be taken, prioritized by effectiveness and implementation cost. Include the anticipated implementation dates.
- Recommendations for additional (future) measures for consideration, including new water saving equipment or process changes.
- Funding resources for specific measures that will require capital expenditures.
- Review and evaluation process. Schedule follow-up water audits of specific areas (especially high water-use areas) and report on water conservation results.

6.1.4 Implementation of Water Conservation Plan

After the audit, report, and plan have been performed and assembled; it is time to implement the water conservation plan. A checklist for monthly and seasonal irrigation system testing and maintenance is included in Appendix E. As listed in the water conservation guide (Schultz Communications, 1999), the best place to start is with the most obvious ways to save water. Many of these tasks are also included as part of the BMPs in Section 2.0 of this document.

- Leak Detection and Repair
  - Using the information in your water audit, locate and fix leaky nozzles, faulty fittings, sprinklers, emitters, and broken water lines.
  - Look for wet spots in the turfgrass to help locate the broken water lines, leaky sprinkler heads, etc.
  - Locate and clean any dirty sprinkler heads, drip emitters, clogged tubing, etc.
  - Use your water meter and water bills to help reveal the presence of hidden leaks.
- No-Cost Adjustments

  - Check your water audit for any changes that can be made quickly and at no cost—and make these modifications as soon as possible.
- Installing Automated Sprinkler Systems
  - Timers
  - Weather stations
  - Rain/Soil Moisture sensors
- Converting out of play areas to less water intensive plants.
- Efficient Irrigation
  - Adjust sprinkler heads to ensure only the turfgrass is being watered (not the pavement)
  - Water during the early morning hours to reduce evaporation
  - If irrigation system does not have rain sensors, manually adjust the irrigation timers to eliminate unnecessary watering after rainfall
  - Use hose nozzles that automatically shut off when not in use

Once the most obvious, lowest-cost water-savings procedures have been implemented, the next step is to implement the long-term measures that will result in the greatest water savings. These measures may include:

- replacing outdated equipment,
- making modifications to existing equipment,
- establishing more efficient operational procedures, and
- exploring new procedures that will use significantly less water without negatively impacting golf course quality.

The following approaches can be used along with the golf course's specific water conservation plan, to begin to generate significant long-term water reductions:

- Install meters and controls wherever water is not currently being measured.
- Adjust metered flow.
- Adjust or improve water pressure.
- Reuse and recirculate water.
  - To ensure that all quality specifications are met, test the quality of the water before it is reused, and treat wastewater.
- Switch from potable to nonpotable water where water use applications do not require potable water.
  - Reclaimed municipal water
  - Treated process water
  - Collected rainwater
- Incorporate new irrigation technology (soil moisture sensors, etc).
- Install low-flow or aerated faucet heads.
- Transition to turfgrasses requiring less water.
- Use soil surfactants to optimize efficiency of water delivery and availability in the root zone.

As suggested in the water conservation guidance for agricultural enterprises, there are multiple pieces that should be included as part of the plan (many of these overlap with those listed above).

- Irrigation scheduling.
  - Scientifically determine when to irrigate and how much to apply. Scheduling helps get the best use of the irrigation water.
  - Establish a weather station so that local data can be used to calculate evapotranspiration or install soil moisture sensors.
  - Work within limits of sustainable water yields.
  - Reduce irrigation rates in secondary rough areas and, where possible, eliminate irrigation of non-play areas.
- Apply the water uniformly:
  - Map water use, drainage, and water flow into and out of the property.
  - Inspect the sprinkler systems by making sure they have the correct nozzle sizes, sprinkler spacing, and system pressure.
  - Check all the nozzles for wear and replace the worn ones.
  - Avoid irrigation during periods of high wind and temperature.
  - During each application apply only the amount of water required to recharge the soil reservoir in relation to the rooting zone and plant water requirement.
  - Inspect for and repair leaks.
  - Do not water areas that are not in need of water—sidewalks, pathways, ponds, etc.
  - Use soil surfactants to improve soil moisture uniformity and availability.
  - Use the most water sensible turfgrass species possible for your location.
- Plants
  - Use landscape plants that need less water.
  - Use leaves, grass, and tree clippings as natural mulch or fertilizer.
  - Native plants can be excellent "low-water" or drought tolerant plant choices. Native plants can help golf course superintendents meet a broad array of water conservation, water quality, IPM, and wildlife habitat quality guidelines identified in this document.

The GCSAA urges its members to monitor water conservation as well as quality irrespective of water restrictions (Water Efficiency, 2007). The GCSAA's suggestions are similar to those listed previously:

- Replacing the rough with drought-tolerant plant materials and drafting landscape plans to cluster plantings around water needs
- Locating and quickly fixing irrigation system leaks and capping sprinkler heads in non-priority watering areas
- Monthly monitoring of water meters to compare usage from year to year against the backdrop of weather variances
- Checking for plumbing leaks and other problems and shutting down unnecessary flows
- Washing equipment with a hose equipped with a shutoff nozzle

6.2 WATER RIGHTS

Golf courses in the Pacific Northwest generally need a water right or a water-use permit to divert water for irrigation and/or water features unless a municipality or a quasi-governmental agency provides the water. Land owners with water flowing through, or beneath, their property do not have an automatic right to divert water from these sources. The permitting agencies for diverting water in Oregon and Washington are the Oregon Water Resources Department and Washington Department of Ecology (Ecology), respectively. Irrigation districts may also be involved with delivering the authorized water supplies, depending on location.

Certificated water rights are a vested property right and typically remain valid as long as the water is used at least once every 5 years in accordance with the provisions stated in the associated water-right certificate. Water resources regulatory agencies consider use at least once every 5 years to be proof that the water is being used and the water right can remain valid. If water is not used to the full extent of the water right in a 5-year period, it can be subject to cancellation by the agency. Pump and flow records, electric bills, or photographs showing the extent of use are all suitable proof of use of a water right.

In contrast, water-use permits are only authorizations to divert water for specific purposes, and the duration of time under which the approved water use(s) can occur is limited. Oregon and Washington both allow permits to be "perfected" into water rights. The "perfection" process involves fully applying water to the approved beneficial use and then having the use inspected by either a Certified Water Right Examiner (Oregon) or an Ecology representative (Washington). The resulting Claim of Beneficial Use or Proof of Appropriation forms the basis of the certificated water right.

Water rights and water-use permits generally contain terms and limitations on:

- The maximum rate at which water can be diverted on an instantaneous basis and/or the total amount of water that can be diverted annually for each acre (referred to as duty);
- The location where the diversion pump or well is to be installed;
- The location where the diverted water can be used; and
- The period of time each year when water can be diverted.

Other limitations to the approved water uses may also apply, depending on the type of use, water-supply source (surface water or groundwater), geographic location, and state regulatory constraints. These limitations (commonly referred to as conditions) can include, but are not limited to, measurement and reporting of the amount of water diverted, installation and maintenance of fish screens for surface water diversions, and an annual measurement of the depth to groundwater in wells.

Unauthorized changes to any term and limitations specified in a water right or a permit can create a potential for cancellation of all, or a portion, of the right or permit. As a result, periodic reviews of water uses at golf courses relative to any water rights or permits is recommended, especially if changes to the course configuration are contemplated or modifications to the course have occurred since the water right certificate or permit was issued to be sure new turfgrass areas are covered in the water rights. An example of a map that shows water rights is presented on **Figure 4**. A Change (WA) or Transfer (OR) application should be submitted to address inconsistencies that develop after a permit or water right is issued.

6.3 RECYCLED OR RECLAIMED WATER

Irrigating with recycled or reclaimed water provides an opportunity to conserve water and develop partnerships with the community. Municipalities in the Pacific Northwest are facing water challenges—both in terms of water supply and wastewater. With the appropriate infrastructure, deliveries of treated reclaimed water to a golf course can provide a reliable water supply while relieving the pressure on aquatic ecosystems. In Oregon, recycled water refers only to treated effluent from municipal wastewater treatment facilities. "Recycled Water" means treated effluent from a wastewater treatment system, which as a result of treatment is suitable for a direct beneficial purpose. Recycled water includes reclaimed water as defined in ORS537.131 [OAR 340-055-0010(13)].

Recycled water programs require a permit; the water must be treated to the appropriate level; and the use of the water is subject to conditions and limitations described in the permit and a recycled water use plan. Although the permit is (generally) held by the treatment facility, the water user (i.e. golf course) still must comply with the Recycled Water Use Rules (OAR 340-055), and manage the use of recycled water to protect public health and the environment. Information on Oregon's Water Reuse Program can be found at: www.deq.state.or.us/wq/reuse/reuse.htm.

Some general facts regarding reclaimed water include:

- Treated reclaimed water is relatively clean;
- It is generally economical, and reduces your facility's potable water use substantially;
- A small percentage of golf irrigation systems are supplied by potable water systems; and
- The cost of reclaimed water for golf courses may be economically more expensive than courses retaining their existing water rights.

Some of the significant challenges of using reclaimed water include:

- Reclaimed water typically contains more salts than potable water;
  - Watch for salt accumulation on the soil surface
  - High salinity can have an adverse effect on plant life
  - Conduct water tests to know what you have and use additional management practices to compensate
- If high salinity is a problem when irrigating turfgrass, blend reclaimed water with water from a cleaner source and use additional soil and water quality management practices to compensate;
- Public access and exposure restrictions may apply
- Signage/notification requirements may apply
- Plumbing requirements may apply
- Irrigation scheduling issues need to be considered

- Depending on the situation, the golf course may be required to use more water than necessary.

On the west side of the Cascade Range, precipitation outside the irrigation season is often sufficient to flush salts from surface soils.

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WILDLIFE HABITAT ENHANCEMENT 7.0

Implementation of the *Guidelines* is intended to promote enhancement of wildlife and wildlife habitat. Golf courses are a good source of open green space in urban areas, and often can function as the only sanctuary for wildlife in nearby urban areas. Golf courses provide significant habitat to a diverse population of birds, mammals, plants, insects, and other wildlife. Insect diversity is generally the basis of wildlife diversity. Because of their scale, golf course grounds provide excellent opportunities to improve landscape-scale connectivity in a watershed.

As part of the Environmental Stewardship Program developed at a golf course, a Wildlife Habitat Enhancement Plan should be prepared. The plan starts with documentation of current conditions using the golf course description maps that have already been developed. One example of the kinds of maps a superintendent may make showing habitat restoration activities for a golf course is shown on **Figure 5**.

The USGA and the National Fish and Wildlife Foundation created a list of steps that can be followed when implementing wildlife enhancement and conservation. This list is referred to as "The Front 9" and was documented in "Wildlife Links, Improving Golf's Environmental Game." The following are "The Front 9":

1. Take stock
2. Develop a game plan
3. Save what's left
4. Use what you have
5. Protect endangered species (and species of concern)
6. Establish corridors
7. Naturalize out-of-play areas
8. Start an IPM program
9. Engage golfers

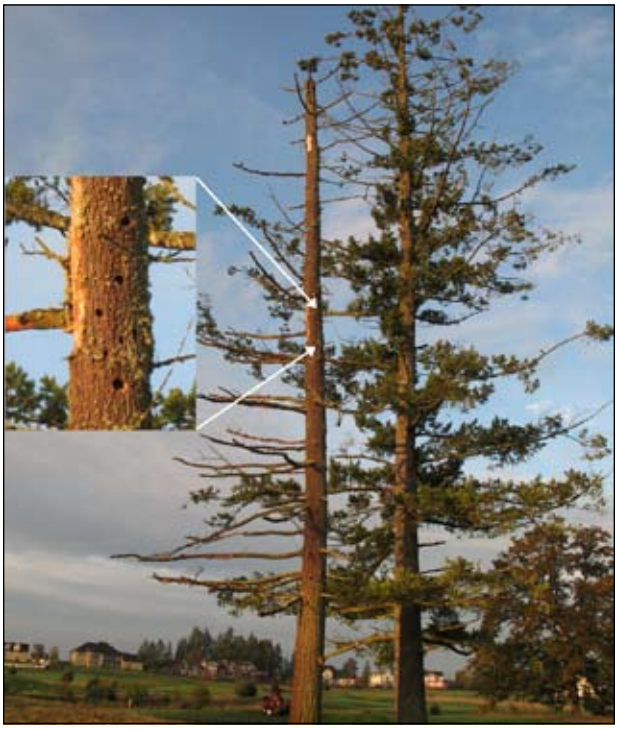
Areas of the golf course that are currently in a natural state or planted with native plants should be identified, evaluated for quality, and considered for the kinds of habitat (aquatic or terrestrial) they provide. Areas that are out-of-play or under-developed should be delineated to identify those areas that have potential to be restored as habitat. Each golf course must be managed with consideration for the unique conditions of its ecosystem.

Inventories of species present at the golf course will help to identify what fauna would benefit from an expanded or improved habitat. Golf course maintenance staff can conduct an informal inventory simply by having each person record sightings of birds and reptiles, amphibians, fish, mammals, or insects each day, as they might be recording diseases observed in turfgrass. Special note should be made of species of special management concern. These could be species that require extra management effort to control, such as Canada geese or Japanese knotweed. The inventory can be extended to include players and visitors by establishing a

board for them to record wildlife observed that day. An inventory is required for certification in the Audubon Cooperative Sanctuary Program.

The Wildlife Habitat Enhancement Plan provides documentation of the current habitat at the golf course and plans for improvement. Enhancing wildlife habitat at golf courses can be accomplished in numerous ways. The following are some examples:

- Maintain most of nonplay areas in varied types of native vegetation;
- Leave dead trees, or snags, if they are not a hazard to property or people; leave downed logs/woody debris/brush piles on the ground;



- When possible, remove only a portion of a tree and leave the rest as a high stump;
- Protect stream channels. No need to straighten, line, construct unnecessary bridges, remove down trees, or disconnect from wetlands or ponds;
- Wind natural areas through the golf course to provide movement corridors with shelter, concealment, and food;
- Restoration if necessary;
- Use sound integrated pest management (IPM), fertilization, and cultural maintenance practices;
- Maintain buffer zones surrounding all bodies of water where possible;
- Control golf cart traffic to avoid highly sensitive or erodible areas, to minimize turfgrass wear, and to minimize soil compaction;
- Know what species exist and can exist in the area;
- Provide nesting boxes for birds and bats. Refer to the Audubon International Fact Sheets on bat conservation and the Nest Box Project. Maintain boxes, observe that the correct species are using the boxes;
- Note ground nests during breeding season so they can be avoided by maintenance staff and golfers;
- Provide suitable habitat for wildlife species to use the golf course;
- Create additional habitats for priority species;
- Communicate to and educate golfers about wildlife conservation opportunities and initiatives.

As stated in "The Front 9", one of the best and easiest ways to upgrade the environmental quality of a golf course is simply to expand or enhance the existing natural amenities.

Presented in Appendix F is a guidance form to document terrestrial habitat. Information from the City of Portland's Terrestrial Environmental Ecology Strategy (TEES) committee was used as a basis for this form. The terrestrial habitat form includes a list of questions to ask when restoring/improving the habitat at a site such as a golf course. Some of the questions include the characteristics of the site, the status of the habitat, what species are involved in the habitat, etc. The document also includes general guidelines for "adding value" during project planning and implementation such as using natural processes to achieve ecological functions and project goals to the extent possible. Site considerations listed in the terrestrial guidelines include food, cover, water, disturbance, and other considerations such as creating urban habitat features (e.g. nest boxes and platforms). State Wildlife Action Plans (e.g. Oregon Conservation Strategy) can help golf courses identify priority habitats and priority species, plus recommended conservation actions for priority habitats and species. The list of species is available at http://www.dfw.state.or.us/conservationstrategy/document_pdf/b-habitat_1.pdf and http://www.dfw.state.or.us/conservationstrategy/document_pdf/b-species_2.pdf.

Observing the changes in macroinvertebrate populations with time as restoration activities are implemented is one metric that can be used to measure improvements.

One type of study that can be performed by an individual golf course and potentially combined with community watershed stewards is macroinvertebrate observation. Macroinvertebrates provide a food source to aquatic and terrestrial organisms. They are organisms that are large (macro) enough to be seen with the naked eye and lack a backbone (invertebrate). Examples of macroinvertebrates include crayfish, snails, and worms. Observing whether macroinvertebrates are present and of sufficient diversity at the golf course can be used as a good survey tool and can be as simple as compar-

ing numbers on and off the property. As stated by the U.S. EPA

(www.epa.gov/owow/monitoring/volunteer/stream/vms40.html), aquatic macroinvertebrates are good indicators of stream quality because:

- They are affected by the physical, chemical, and biological conditions of the stream;
- They can't escape pollution and show the effects of short- and long term pollution effects;
- They may show the impacts from habitat loss not detected by traditional water quality assessments;
- They are a critical part of the stream's food web; and
- They are relatively easy to sample and identify.

The basic principle behind the study of macroinvertebrates is that some are more sensitive to pollution than others.

As stated in the 2002 Tualatin Basin Macroinvertebrate Assessment (ABR, Inc., 2002) (www.trwc.org), macroinvertebrate communities are strongly influenced by physical differences among habitats, both naturally occurring and human-induced. A macroinvertebrate study evaluates the sampled community expected to occur in the absence of disturbance. Two types of approaches when studying macroinvertebrates are multimetric and multivariate.

Information to know when studying macroinvertebrates includes but is not limited to:

- The physical conditions,
- Human influence,
- Maps of riparian zone conditions if available,
- Maps of dominant stream substrate if available,
- Stream flow, and
- Water chemistry.

Macroinvertebrate studies can be incorporated into a watershed characterization plan. Attached, as Appendix G, is a 2002 guidance document from Oregon Department of Fish and Wildlife titled "Methods for Stream Habitat Surveys". Two examples of studies include the Tualatin Basin, Oregon, and the City of Lake Oswego, Oregon. The Tualatin Basin study examined high-gradient and low-gradient stream reaches independently and included physical habitat assessments. The study identified relationships between environmental conditions and macroinvertebrate conditions. The second study investigated physical conditions and macroinvertebrate communities in representative stream reaches as indicators of water quality and stream health throughout the City of Lake Oswego. Biological monitoring with fish and macroinvertebrate communities is widely used to determine the ecological integrity of surface waters (ABR, Inc., 2006).

As stated in "Making More Room" by the Xerces Society for Invertebrate Conservation (M. Shepherd, et al, 2006), pollinator conservation is another enhancement tool that is perfectly suited for golf courses. "The basic habitat needs for pollinator insects are simple to provide and can be integrated into current maintenance of any course, from expansive rural courses to compact urban

sites." Examples of pollinators include butterflies, hummingbirds, flies, and bees. "Pollinators are a fundamental component of a healthy environment and keeps plant communities healthy and able to reproduce." A variety of areas exist, or have the potential to exist at golf courses such as out-of-play areas, banks surrounding stormwater basins, or wood snags. Both this document and the document titled "Making Room for Native Pollinators" by the USGA and the Xerces Society (M. Shepherd, 2002) are excellent references for information on pollinator basics. The contents include everything from the history of bees to guidance on creating foraging habitat.

Storm water management often becomes the responsibility of golf courses either because storm water from upstream is routinely funneled through the golf course or because storm water is generated from the impervious areas and drainage systems at the golf course. If the golf course is generating storm water at its property, then the golf course should consider including a storm water management plan in its Environmental Stewardship Program. Storm water management can provide conjunctive opportunities to the Wildlife Habitat Enhancement Plan in that constructed wetlands and bioswales—two common storm water management features—can provide additional habitat to the inventory at the golf course.

The IPM Plan (Section 3) is closely tied to wildlife enhancement as well. The IPM Plan provides thresholds for invasive removal and natives planting.

Other wildlife monitoring types of ideas/activities to engage the community include:

- Amphibian egg mass surveys.
- Turtle surveys (visual)—easy when there is basking habitat present. This is a good way to figure out if native turtles are present versus non-native invasive turtles such as the red-eared sliders.
- Bird point counts—the points could be the playing holes. Golf courses could host a golf and bird day with possible assistance from ODFW and/or the local Audubon chapter.

Another consideration in implementing the Wildlife Habitat Enhancement Plan is to engage the community, such as local watershed groups and schools, in restoration activities. The following section of the *Guidelines* discusses community involvement in more detail. The golf course resides within a watershed, which is usually defined by natural hydrologic characteristics and may overlap municipal jurisdictions. A watershed is an area of land that drains into a given river, lake, or other water body.

At some scale, each watershed likely has a plan associated with it to provide direction and target resources for better management and restoration of the watershed and water quality. The local watershed and land use maps should also be included as part of the Environmental Setting Section 1.0. Watershed plans include wildlife habitat enhancement in that they serve as direction to improve water quality, reduce flood damage, and protect natural resources. Watershed plans aim to prevent existing watershed problems from worsening in the future as a result of pressures from land development. Additionally, watershed planning offers an opportunity for multiple parties to coordinate their efforts in watershed improvement.

The requirements of certification programs can be used to focus the wildlife habitat enhancement efforts and further engage the community. The Audubon Cooperative Sanctuary Program promotes wildlife habitat enhancement as one of its cornerstone principles. The *Guidelines* and the Audubon Cooperative Sanctuary Programs compliment each other. The preparation and implementation of a Wildlife Habitat Enhancement Plan under the *Guidelines* would generally allow golf courses to achieve basic requirements for Audubon Cooperative Sanctuary certification.

Another certification that the *Guidelines* generally allow golf courses to achieve the basic requirements for is Salmon-Safe. "In a general sense, compliance with Salmon-Safe certification standards is intended to promote landscape level conservation and protection of biological diversity. Salmon are a key species and an indicator species within the Pacific Northwest and their conservation is tightly intertwined with the health of the larger ecosystem" (Salmon-Safe Certification Standards for Golf Courses, Draft 1.0 (2009). Salmon-Safe addresses the overall land management and operations that directly and indirectly affect water quality and fish habitat with standards focusing on many of the key areas that the *Guidelines* also focus on:

- Water Quality
- Water Quantity
- In-stream Habitat
- Riparian Habitat

Integrated Pest Management (IPM) is also an important factor in the Salmon-Safe standards, which guide clients to develop an acceptable method of application through a comprehensive management program, such as an IPM. There are six habitat management categories listed in the Salmon-Safe standards:

- In-stream habitat protection and restoration
- Riparian and wetland protection and restoration
- Storm water management
- Water use management (irrigation activities)
- Erosion and sediment control
- Chemical and nutrient containment

When protecting and/or restoring the in-stream habitat, the stream channels should be in good condition for providing salmonids habitat, should have naturally protected stream banks, a meandering channel, and some wood structures present.

Riparian and wetland protection/restoration involves protecting areas in closest proximity to in-stream habitat, which are referred to as the riparian vegetation zones and any associated wetlands. As listed in the Salmon-Safe standards, it is important to make sure the riparian areas are in good condition, functioning to maintain and restore stream health, and provide shade, wood recruitment, leaf litter supply, stream bank stability and cover, and filtration of sediment. Natural vegetation should dominate these areas.

COMMUNITY OUTREACH 8.0

Golf courses are often significant features in local watersheds and play a leadership role in water quality. Golf courses are also often targets of citizen groups for the elimination/reduction of pesticide usage. Each community has several organizations or groups interested in improving the environment. These can include watershed councils, soil and water conservation districts, tribes, "Friends" groups, schools, business organizations, and activist groups. Municipalities often solicit ideas and opinions from citizen advisory committees. Golf course Superintendents can play an important role by offering to be a technical resource to the community and in the process, help shape the way golf is thought of by the community. Participating in local watershed councils, advisory committees, or other interest groups helps a Superintendent "tie-in" to current activities in the environmental arena. These types of activities will also help you become certified through the Audubon Cooperative Sanctuary Program for Golf Courses. A few sources of information about community involvement include:

- First Green: www.thefirstgreen.com
- Network of Oregon Watershed Councils: www.oregonwatersheds.org
- Oregon Department of Agriculture, Soil and Water Conservation Districts: www.oregon.gov/ODA/SWCD/index.shtml
- WA State DOE: http://www.ecy.wa.gov/apps/watersheds/wriapages/index.html
- Audubon Cooperative Sanctuary Program for Golf Courses

8.1 WORKING WITH THE COMMUNITY

A Community Involvement Plan that identifies the groups active locally, and how the golf course staff may interact should be prepared. Staff members, from maintenance technicians to club managers, can be canvassed for their interest in participating in community functions that may be beneficial to the golf course and the environment. The golf course should play an active part in the watershed planning and actions taken.

A local watershed council may be able to provide assistance with funding and volunteers for habitat enhancement or water quality improvements to a golf course. The watershed council may also be able to provide helpful suggestions and expertise on topics such as wetland restoration, wildlife habitat, and other environmentally related topics.

8.2 OPPORTUNITIES FOR COMMUNITY INVOLVEMENT

The term "Community Outreach" is used to refer to efforts to make contact and engage the community on environmental stewardship at the golf course.

Some ideas for community outreach activities include:

- Install signs around the golf course that explain the naturalized areas, turfgrass selection, and habitat preservation goals on the course.

- Conduct educational tours of the environmentally preserved and/or enhanced areas on the golf course to school classes, interested golfers, homeowners, and members of the surrounding community.

- Use wildlife web cameras that can be viewed by the public such as the bird cam at Royal Oaks Country Club in Vancouver, Washington: www.birdcam.royaloaks.net
- First Green of Washington has developed an educational program that encourages the use of the golf course as a laboratory for environmental education classes at local schools.
- Encourage volunteers to become involved with the environmental stewardship aspects of the golf course.
- Write articles for club newsletters or local publications on the progress of environmental stewardship at the golf course.
- Host a discussion forum for the community about the importance of managing an environmentally friendly golf course and progress in implementing the Guidelines.
- Develop a fact sheet for general distribution that describes environmental accomplishments of the golf course.
- Post an Environmental Stewardship Case Study on www.greengolfusa.com.
- Get involved in the Green Golfer Challenge on www.audubongreengolfer.com.

FIGURE 1

Go back

FIGURE 1

ENVIRONMENTAL SETTING

Demonstration Country Club

FIGURE 2

Go back

Explanation

Ponds

Pesticide & Nutrient Buffer Exclusion Zone

EnviroLogic Resources, Inc.

Note: This map is for demonstration purposes only and may not represent actual conditions.

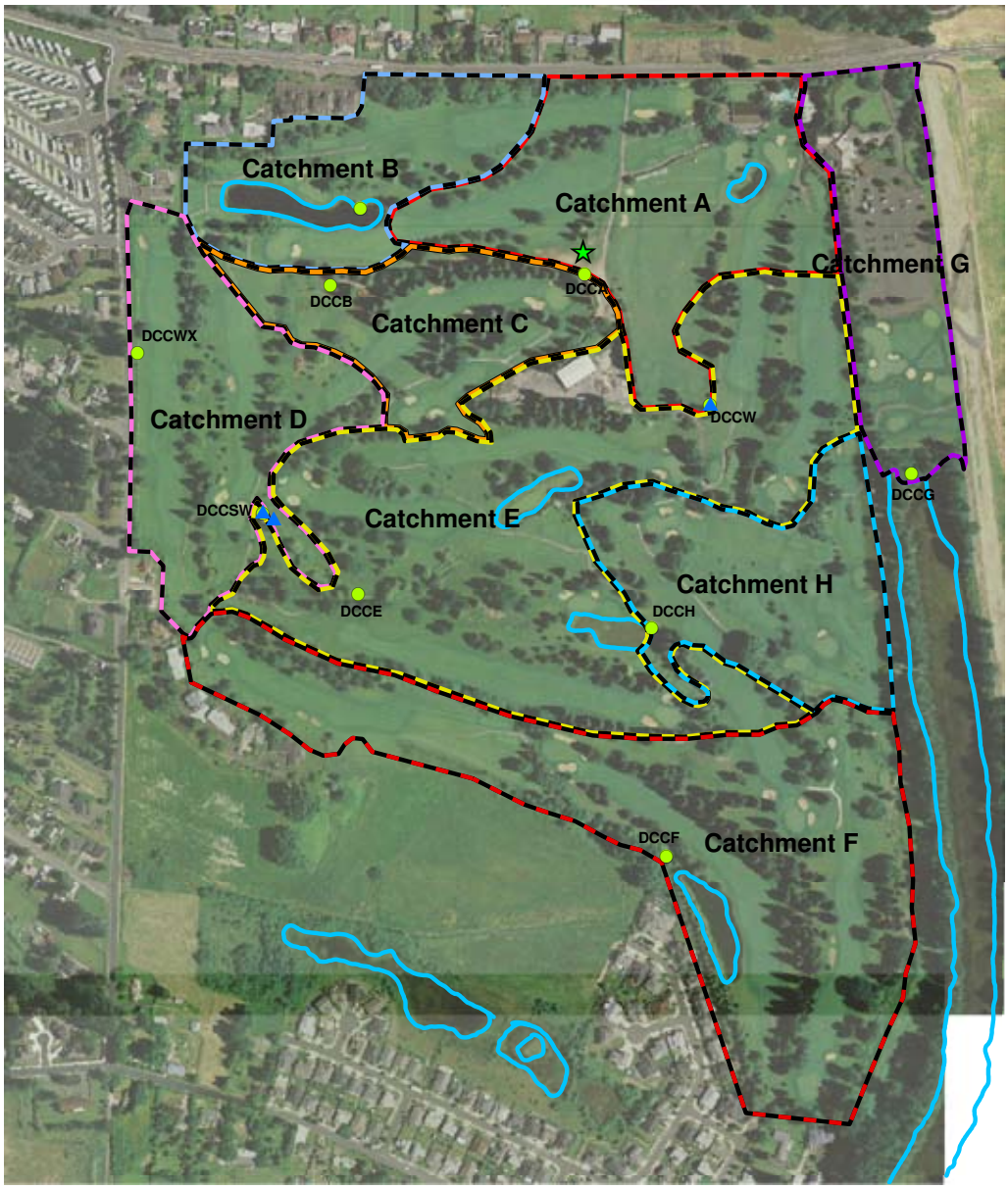
FIGURE 2

BUFFER ZONES

Demonstration Country Club

Go back

FIGURE 3



Explanation

DCCB — Sample Location & Designation

DCCSW — Well Location & Designation

Weather Station

Pond

Catchment Areas

- Catchment A
- Catchment B
- Catchment C
- Catchment D
- Catchment E
- Catchment F
- Catchment G
- Catchment H

Note: This map is for demonstration purposes only and may not represent actual conditions

EnviroLogic Resources, Inc.

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FIGURE 3

WATER QUALITY SAMPLING LOCATIONS

Demonstration Country Club

FIGURE 4

Go back

Explanation

Primary and Supplemental Water Rights

Note: This map is for demonstration purposes only and may not represent actual conditions.

FIGURE 4

WATER RIGHTS

Demonstration Country Club

EnviroLogic Resources, Inc.

FIGURE 5

Go back

Explanation

Potential Wildlife Habitat Enhancement Areas

Wildlife Habitats Restored Area

EnviroLogic Resources, Inc.

Note: This map is for demonstration purposes only and may not represent actual conditions

FIGURE 5

WILDLIFE & HABITAT MANAGEMENT AREAS

Demonstration Country Club

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APPENDIX A Rules and Regulations

The following is a list of federal and state (Oregon and Washington) rules and regulations that are pertinent to golf courses and golf course maintenance practices.

FEDERAL

4(d) Rules

Section 4(d) of the Endangered Species Act (ESA) directs NOAA Fisheries to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills or injures fish, and may include habitat modification. The ESA prohibits ANY take of species listed as endangered, but some take of threatened species that does not interfere with salmon survival and recovery can be allowed.

http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/Final-4d-Rules.cfm

Pesticides

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) FIFRA (109 pp, 288k, About PDF)] provides the basis for regulation, sale, distribution and use of pesticides in the U.S. FIFRA authorizes EPA to review and register pesticides for specified uses. EPA also has the authority to suspend or cancel the registration of a pesticide if subsequent information shows that continued use would pose unreasonable risks. Some key elements of FIFRA include:

- is a product licensing statute; pesticide products must obtain an EPA registration before manufacture, transport, and sale
- registration based on a risk/benefit standard
- strong authority to require data—authority to issue Data Call-ins
- ability to regulate pesticide use through labeling, packaging, composition, and disposal
- emergency exemption authority—permits approval of unregistered uses of registered products on a time limited basis
- ability to suspend or cancel a product's registration: appeals process, adjudicatory functions, etc.

The Pesticide Registration Improvement Act (PRIA) of 2003 establishes pesticide registration service fees for registration actions in three pesticide program divisions: Antimicrobials, Biopesticides and Pollution Prevention, and the Registration Divisions.

Endangered Species Act

The Endangered Species Act (ESA) of 1973 prohibits any action that can adversely affect an endangered or threatened species or its habitat. In compliance with this law, EPA must ensure that use of the pesticides it registers will not harm these species.

- Endangered Species Protection Program Under the Endangered Species Act, EPA must ensure that use of pesticides it registers will not result in harm to the species listed as endangered or threatened by the U.S. Fish and Wildlife Service, or to habitat critical to those species' survival. Find our more on the Endangered Species Protection Program

Clean Water Act

The objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), is to restore and maintain the

chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources, providing assistance to publicly owned treatment works for the improvement of wastewater treatment, and maintaining the integrity of wetlands.

Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority. The CWA regulates both direct and indirect discharges.

http://www.epa.gov/oecaagct/lcwa.html

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. Under SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

http://www.epa.gov/safewater/regs.html

OREGON STATE

Water Quality

The Oregon Administrative Rules, Department of Environmental Quality, Water Pollution, Division 41, Water Quality Standards: Beneficial Uses, Policies, and criteria for Oregon.

These rules set forth Oregon's plans for management of the quality of public waters within the State of Oregon.

http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html

303(d) and TMDL

CWA Section 303(d) requires identifying waters that do not meet water quality standards where a Total Maximum Daily Load (TMDL) needs to be developed.

This site contains links to Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) documents prepared for water bodies in Oregon designated as water quality limited on the 303(d) list. A TMDL is the calculated pollutant amount that a water body can receive and still meet Oregon water quality standards.

http://www.deq.state.or.us/wq/tmdls/tmdls.htm

Storm Water

National Pollutant Discharge Elimination System (NPDES) permits are required for storm water discharges to surface waters from construction and industrial activities and municipalities if stormwater from rain or snow melt leaves your site through a "point source" and reaches surface waters either directly or through storm drainage. A point source is a natural or human-made conveyance of water through such things as pipes, culverts, ditches, catch basins, or any other type of channel.

http://www.deq.state.or.us/wq/stormwater/stormwater.htm

Ground-Water Quality

The Oregon Administrative Rules, Department of Environmental Quality, Division 40, Ground-Water Quality Protection

The Rules within this Division establish the mandatory minimum groundwater quality protection requirements for federal and state agencies, cities, counties, industries, and citizens. Other federal, state, and local programs may contain additional or more stringent ground-water quality protection requirements. Unless specifically exempted by statute, groundwater quality protec-

tion requirements must meet or be equivalent to these rules.

http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_040.html

Water Rights

Under Oregon law, all water is publicly owned. With some exceptions, cities, farmers, factory owners and other users must obtain a permit or water right from the Water Resources Department to use water from any source—whether it is underground, or from lakes or streams. Landowners with water flowing past, through, or under their property do not automatically have the right to use that water without a permit from the Department.

http://www.wrd.state.or.us/OWRD/LAW/index.shtml

Removal/Fill

Oregon´s Removal-Fill Law (ORS 196.795-990) requires people who plan to remove or fill material in waters of the state to obtain a permit from the Department of State Lands.

The purpose of the law, enacted in 1967, is to protect public navigation, fishery and recreational uses of the waters. "Waters of the state" are defined as "natural waterways including all tidal and nontidal bays, intermittent streams, constantly flowing streams, lakes, wetlands and other bodies of water in this state, navigable and nonnavigable, including that portion of the Pacific Ocean that is in the boundaries of this state." The law applies to all landowners, whether private individuals or public agencies.

http://www.oregon.gov/DSL/PERMITS/r-fintro.shtml

Waste Pesticide Management

Environmentally sound management of pesticide wastes and empty pesticide containers is in everyone's best interest. Accidental release or indiscriminate discharge of pesticide waste into the environment can harm people and contaminate surface and groundwater. Pesticide-contaminated water poses a hazard to non-target organisms such as plants, beneficial insects, fish and other aquatic life.

For detailed information on the management of waste pesticides, refer to the Oregon Administrative Rule (OAR) Chapter 340, Division 109. Universal waste rules are found in the Code of Federal Regulations (CFR), Title 40, Part 273 and (OAR) Chapter 340, Division 113.

Fact sheets

The rules that apply to managing pesticide waste can be found in Oregon Administrative Rules, Chapter 340 in the following Divisions:

- Division 100—Hazardous Waste Management System: General http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_100.html
- Division 101—Identification and Listing of Hazardous Waste http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_101.html
- Division 102—Standards Applicable to Generators of Hazardous Waste http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_102.html
- Division 109—Management of Pesticide Wastes

The Oregon Administrative Rules, Department of Environmental Quality, Division 109, Hazardous Waste Management, Management of Pesticide Waste, General

http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_109.html

- Division 113—Universal Waste Management http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_113.html

- Division 142 - Oil and Hazardous Materials Emergency Response Requirements http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_142.html
- Underground Storage Tanks

The purpose of these rules is to provide for the regulation of underground storage tanks (USTs) (a) to protect the public health, safety, welfare and the environment from the potential harmful effects of spills and releases from underground tanks used to store regulated substances; (b) To prevent releases due to structural failure, system leaks, corrosion, spills and overfills for as long as an UST system is used to store regulated substances; (c) To promote the proper operation and maintenance of UST systems through training of UST facility personnel and expedited enforcement of violations; and (d) To obtain state program approval to manage underground storage tanks in Oregon in lieu of the federal program, as required by ORS 466.720.

http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_150.html

Drywells/Underground Injection Systems

Injection systems are any man-made design, structure or activity, which discharges below the ground or subsurface. Common uses include: stormwater discharge, industrial/commercial and process waste water disposal, large domestic onsite systems and cesspools, sewage drill holes, aquifer remediation systems, motor vehicle waste disposal, agricultural drainage, geothermal systems and aquifer storage and recovery (ASR). Common designs include drywells, trench drains, sumps, perforated piping, floor drains, drainfields and drill holes.

The intent of the program is to protect groundwater resources, primarily used for drinking water, from contamination. All groundwater aquifers in Oregon are considered suitable as drinking water. The program is implemented from headquarters and serves the entire state. There are numerous federal classes and types of injection systems. All classes and types are required to be registered with DEQ and approved either through rule authorization (in lieu of a permit), under a state permit or closed.

http://www.deq.state.or.us/wq/uic/uic.htm

Hazardous Substance Remedial Action

Any removal or remedial action shall address a release or threat of release of hazardous substances in a manner that assures protection of present and future public health, safety, and welfare, and the environment. In the event of a release of a hazardous substance, remedial actions shall be implemented to achieve:

Acceptable risk levels defined in OAR 340-122-0115, as demonstrated by a residual risk assessment; or numeric cleanup standards developed as part of an approved generic remedy identified or developed by DEQ under OAR 340-122-0047, if applicable; or in the event of a release of methane from a historic solid waste landfill, removal or remedial actions shall be implemented to prevent concentrations of methane exceeding or likely to exceed 1.25% by volume in confined spaces and structures, other than in equipment, piping, wells, or other structures designed for the collection and management of methane and approved by DEQ.

In the event of a release of hazardous substances to groundwater or surface water constituting a hot spot of contamination, treatment shall be required in accordance with OAR 340-122-0085(5) and 340-122-0090.

A removal or remedial action shall prevent or minimize future releases and migration of hazardous substances in the environment. A removal or remedial action and related activities shall not result in greater environmental degradation than that existing when the removal or remedial

action commenced, unless short-term degradation is approved by the Director under OAR 340-122-0050(4).

A removal or remedial action shall provide long-term care or management, as necessary and appropriate, including but not limited to monitoring, operation, maintenance, and periodic review.

http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_122.html

WASHINGTON STATE

Water Quality

Washington State's Water Quality Assessment lists the water quality status for a particular location in one of 5 categories recommended by EPA. This Assessment represents the Integrated Report for Sections 303(d) and 305(b) of the Clean Water Act.

http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html

Storm Water Quality Standards

Storm water is rain and snow melt that runs off surfaces such as rooftops, paved streets, highways, and parking lots. As water runs off these surfaces, it can pick up pollution such as: oil, fertilizers, pesticides, soil, trash, and animal waste. From here, the water might flow directly into a local stream, bay, or lake. Or, it may go into a storm drain and continue through storm pipes until it is released untreated into a local waterway.

http://www.ecy.wa.gov/programs/wq/stormwater/index.html#permits

Ground Water Quality Standards

Chapter 173-200 WAC: Water Quality Standards for Ground Waters of the State of Washington

Implementation Guidance for Ground Water Quality Standards

Ecology Publication 96-02, revised October 2005

Explains and interprets the standards providing clear direction to promote consistent statewide implementation for all activities which have a potential to degrade ground water quality.

Other Ground Water-Related Links

Critical Aquifer Recharge Area (CARA)

This ordinance provides local governments with a mechanism to protect the functions and values of a community's drinking water by preventing pollution and maintaining supply.

Water Quality Standards

The Water Quality Standards are the basis for protecting and regulating the quality of surface waters in Washington. The standards implement portions of the federal Clean Water Act by specifying the designated and potential uses of waterbodies in Washington State. They set water quality criteria to protect those uses and acknowledge limitations. The standards also contain policies to protect high quality waters (antidegradation) and in many cases specify how criteria are to be implemented, for example in permits.

The water quality standards are established to sustain public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife. This three-part approach was designed to set limits on pollution in our lakes, rivers and marine waters in order to protect beneficial uses such as aquatic life, swimming and fishing. They also support other water protection processes (such as total maximum daily loads, also known as TMDLs, and the biannual water quality assessment), and guide Washington citizens, businesses and other government agencies to the goal of sustaining clean water for current and future use. The three-part approach covers:

- Designated uses, such as fishing, swimming, and aquatic life habitat.
- Numeric and narrative water quality criteria limits to protect the uses.
- Policies, such as antidegradation, to protect higher quality waters from being further degraded.

Underground Injection Control Program

The Underground Injection Control Program (UIC) protects groundwater quality by regulating discharges to UIC wells. In other words, this program protects groundwater quality by regulating the disposal of fluids into the subsurface. UIC wells are used to manage storm water (i.e., drywells) and sanitary waste (large on-site systems), return water to the ground, and help clean up contaminated sites. The potential for groundwater contamination from injection wells depends upon well construction and location; quality of the fluids injected; and the geographic and hydrologic settings in which the injection occurs.

UIC Regulation (Washington State Legislature website)

Information on the UIC Program

Model Toxics Control Act

The Washington State Model Toxics Control Act, Chapter 70.105D RCW ("MTCA" or the "Act") creates a comprehensive regulatory scheme to identify, investigate, and clean up contaminated properties that are, or may be, a threat to human health or the environment.

The Washington State Department of Ecology ("Ecology") is the lead agency responsible for the implementation and enforcement of MTCA. Ecology has promulgated detailed regulations that supplement the Act. These regulations are found at Chapter 173-340 WAC. Ecology has also published various policy documents and technical memoranda that help explain how Ecology interprets and applies MTCA. These documents are available online at

http://www.ecy.wa.gov/programs/tcp/policies/tcp-poly.html

Two other useful websites related to MTCA are:

http://www.ecy.wa.gov/programs/tcp/regs/reg_main.html

http://www.ecy.wa.gov/biblio/9406.html

Underground Storage Tanks

http://www.ecy.wa.gov/programs/tcp/ust-lust/tanks.html

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APPENDIX B Pesticides Banned in Specific Buffer Zones

Washington Toxics Coalition versus EPA, January 22, 2004		
Active Ingredient	**Sample Trade Names***	**Typically Used on Golf Courses**
2,4-D	Various names	Yes
Azinphos-methyl	Guthion	No
Bensulide	Prefar	No
Bromoxynil	Buctril	No
Carbaryl	Sevin	Yes
Carbofuran	Furadan	No
Chlorothalonil	Bravo	Yes
Chlorpyrifos	Lorsban, Dursban	Yes
Dimethoate	Cygon	No
Disulfoton	Di-Syston	No
Diuron	Direx, Karmex	No
Ethoprop	Mocap	Yes
Fenbutatin-oxide	Vendex	No
Lindane	Lindane	No
Malathion	Various names	No
Methidathion	Supracide	No
Methomyl	Lannate	No
Methyl parathion	Penncap-M	No
Metolachlor	Dual	No
Naled	Dibrom	No
Phorate	Thimet	No
Prometryn	Caparol	No
Propargite	Omite, Comite	No
Triclopyr (ester)	Garlon 4	Yes
Trifluralin	Treflan	yes

* This table may not include every trade name for each active ingredient. Always check the active ingredient list on the label to verify presence of the above ingredients.

www.oregon.gov/ODA/PEST/buffers.shtml

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Methods Analyses

Method	Chemical Name	Trade Name
Modified EPA 608/Modified EPA 8081B		
	bifenthrin	Allectus
	chloroneb	Terraneb
	chlorothalonil	Daconil
	chlorpyrifos	Dursban
	cyfluthrin	Baythroid
	DCPA	dacthal
	deltramethrin	
	dichlobenil	Casoron
	dithiopyr	Dimension
	endosulfan	Thiodan
	etridazole	Terrazole
	fenarimol	Rubigan
	flutolanil	Prostar
	iprodione	Chipco 26019, 26GT
	oxadiazon	Ronstar
	oxyfluorfen	Goal
	PCNB	FFII, Terrachlor
	pendimethalin	Pendulum, Prowl
	prodiamine	Barricade
	pronamide	Kerb
	propiconazole	Banner, Tilt
	tetramethrin	neo-pynamin
	trifloxystrobin	Compass
	trifluralin	Treflan
	vinclozalin	Curalan
Modified EPA 625/Modified EPA 8270D	ethofumesate	Prograss
	fluazifop-p-butyl	Fusilade II
	flutolanil	Prostar

Method	Chemical Name	Trade Name
	metalaxyl	Subdue
	metalaxyl-M	Apron-XL
	myclobutanil	Eagle
	paclobutrazol	Bonzi
	propamocarb	Banol
	triadimefon	Bayleton
Modified EPA 8321B	azoxystrobin	Heritage
	bendiocarb	Turcam
	carbaryl	Sevin
	carfentrazone-ethyl	Speedzone
	clothianadin	Arena
	fludioxonil	Medallion
	imidacloprid	Merit
	isoxaben	Gallery
	oryzalin	Surflan, Snapshot
	pyraclostrobin	Insignia
	sulfentrazone	Quicksilver
	thiamethoxam	Meridian
	triticonazole	Trinity
Modified EPA 8321A	ethephon	Proxy
	fluridone	Sonar Q
	vinclozalin	Curalan
Modified EPA 8081	tetramethrin	
	deltamethrin	
	cyfluthrin	Tempo
Modified EPA 615/EPA 8321B ACIDS	2,4-D	Trimec, Millenium, Crossbow
	clopyralid	Confront, Stinger, Millenium
	dicamba	Trimec, Banvel, Clarity, Millenium, Power-zone
	MCPA	Trimec, Powerzone

Method	Chemical Name	Trade Name
	MCPP	Trimec, Powerzone
	picloram	Tordon
	quinclorac	Drive
	triclopyr	Confront, Garlon, Crossbow
EPA 8141B	ethoprop	Mocap
	fenamiphos	Nemacur
Modified EPA 630.1	mancozeb	Fore, Dithane
	maneb	
	nabam	
	thiram	
	vapam	
	zineb	
	ziram	
Modified EPA 547	glyphosate	Roundup
Laboratory In-House Method	thiophanate-methyl	Cleary 3336
EPA 549.1	diquat	Reward
Manufacturer's Method	trinexapac-ethyl	Primo Maxx

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Fact Sheet

GOLF AND ENVIRONMENT

AUDUBON INTERNATIONAL

Environmental Management Practices for Golf Courses

Golf courses provide extraordinary opportunities for nature conservation, when proper environmental management practices are followed.

Since its inception in 1992, the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP) has been assisting golf courses in their efforts to blend environmentally responsible maintenance practices into day-to-day golf course operations. Drawing upon the expertise and experience of golf course superintendents, golf industry experts, university researchers, and environmental professionals from diverse backgrounds, Audubon International has developed Standard Environmental Management Practices that are generally applicable to all golf courses. These practices form the basis for the ACSP's certification guidelines.

Environmental Planning

Evaluation and planning helps course managers to balance the demands of golf with their responsibility to the natural environment. An initial site assessment and environmental plan, followed by yearly review and goal setting, helps golf course superintendents and others to responsibly care for the land, water, wildlife, and natural resources upon which the course is sustained.

- Conduct a site assessment to evaluate current environmental management practices, and identify strengths and liabilities.
- Develop a map of the course that highlights wildlife habitats, water resources, and management zones to use for planning and project implementation.
- Set goals and priorities and assign responsibilities to staff.
- Evaluate progress toward goals and objectives at least once per year.
- Train employees regarding the importance of environmental performance and specific techniques for ensuring environmental quality.
- Communicate regularly to employees, customers, stakeholders, and community members about environmental goals, issues, project implementation, and progress.
- Document environmental activities and results to assist with planning and track progress.

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APPENDIX

List of Chemicals Not to Use Under Salmon-Safe

SALMON-SAFE

COMMONLY USED PESTICIDES THAT POSE HIGH RISK TO SALMON, OTHER FISH, AND AQUATIC LIFE IN URBAN STREAM

1,3-dichloropropene	captan	dichlobenil	linuron	paraquat dichloride
2,4-D	carbaryl	diflubenzuron	malathion	pendimethalin
acephate	chlorothlonil	dimethoate	metolachlor	permethrin
atrazine	chlorpyrifos	disulfoton	metribuzin	simazine
bensulide	cyhalothrin	diuron	naled	tebuthiuron
bentazon	cypermethrin	esfenvalerate	norflurazon	triclopyr
bifenthrin	diazinon	fenamiphos	oryzalin	trifluralin
bromoxynil	dicamba	iprodione	oxyfluorfen	

This list is based on EPA hazard level for fish and fish habitat. It is subject to change as pesticide registrations are updated and as more environmental data becomes available.

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BIRD OBSERVATION FORM

Facility Name _____

Date _____ Time _____

Species _____

Observer's Name _____

Phone/Email _____

Location/Hole _____

Type of Habitat the Bird was Found Occupying _____

_____

_____

_____

Describe the characteristics of the bird you found. Record relevant information such as size, color, shape/length of bill, legs, tail, voice, behavior, number of individuals, observed, sex, and how you eliminated look-alike species _____

_____

_____

_____

_____

_____

_____

Type of Plumage/Age _____

_____

Weather Conditions: Sunny _____ Stormy _____ Overcast _____

Optics used: Unaided Eye _____ Binoculars _____

Spotting Scope _____ Other _____

Number of Years Previous Experience with this Species _____

DAILY ENVIRONMENTAL ACCOMPLISHMENTS

Facility Name _____

Project/Activity/Event _____

Location _____

_____

Meeting Date _____ Time _____

Individuals Present _____

Meeting Coordinator(s) _____

Objectives of Project/Event/Activity _____

_____

_____

_____

_____

_____

Event Coordinator's Comments_____

_____

_____

_____

Individual Attendee Comments _____

_____

_____

_____

DAILY ENVIRONMENTAL ACCOMPLISHMENTS

(Continued)

Photos from Project/Event/Activity

(Place photos on this page with caption)

FERTILIZER APPLICATION RECORD

Facility Name _____

Date _____ **Time** _____

Applicator(s) Name & License _____

Area(s) To Be Treated_____**Time Applied** _____

Square Footage/Acreage_____**Temp & Conditions** _____

Wind Speed & Direction_____**Precipitation** _____

Fertilizers/Amendments

Common Name_____

Analysis_____

Other _____

Rate Per 1000 ft^2 N_____P_____K_____ Other _____

Total Product Used _____

Additives & Others

Name _____

Rate _____

Total Product Used _____

Calibrations

Equipment Used_____Nozzles_____

Total Gallons_____ Gallons Per 1000 ft^2 _____

Speed, RPM & PSI_____Setting (Spreader _____

Disposal Of Rinsate_____ Overlap (Spreader) _____

Comments _____

_____

_____

_____

IPM SCOUTING FORM

Facility Name _____

Date _____ Time _____

Observer's Name _____

Location/Hole _____

Symptoms observed at the plant _____

_____

_____

Signs of pest observed _____

Weather Conditions: Sun _____ Rain _____ Overcast _____

Other conditional factors _____

IPM SCOUTING FORM

Facility Name _____

Date _____ Time _____

Observer's Name _____

Location/Hole _____

Symptoms observed at the plant _____

_____

_____

Signs of pest observed _____

Weather Conditions: Sun _____ Rain _____ Overcast _____

Other conditional factors _____

IRRIGATION SYSTEM TESTING AND MAINTENANCE

Monthly checklist:

- Check for leaks. Inspect water lines, sprinklers, emitters, and other components.
- Replace broken parts.
- Locate and clean and dirty sprinkler heads, drip emitters, clogged tubing, etc.
- Use water/flow meter to help reveal the presence of hidden leaks.

NOTES:

IRRIGATION SYSTEM TESTING AND MAINTENANCE

Spring checklist:

- Set controller for watering times and durations.
- Replace back-up battery in controller.
- Test manual shut-off/isolation valve.
- Check the water pressure in each irrigation zone.
- Check and clean filters.
- Check and clean screen in sprinkler heads. Adjust pattern to eliminate water waste due to overspray.
- Test sprinkler heads to make sure they are delivering consistent amounts of water over the entire area.
- Inspect all drip emitters.

NOTES:

IRRIGATION SYSTEM TESTING AND MAINTENANCE

Summer checklist:

- Adjust controller for watering times and durations during the hottest months.
- Check and clean filters.
- Inspect all drip emitters and clean if clogged.

NOTES:

IRRIGATION SYSTEM TESTING AND MAINTENANCE

Fall checklist:

- Adjust controller to shorten watering times and durations as the weather cools.
- Test manual shutoff/isolation valve.
- Check and clean filters.
- Inspect all drip emitters and clean or replace if necessary.

NOTES:

IRRIGATION SYSTEM TESTING AND MAINTENANCE

Winter checklist:

- Adjust controller to further shorten or stop watering times and durations.

NOTES:

PESTICIDE APPLICATION RECORD

Facility Name _____

Date _____ **Time** _____

Applicator(s) Name & License _____

Area(s) To Be Treated_____**Time Applied** _____

Square Footage/Acreage_____**Temp & Conditions** _____

Wind Speed & Direction_____**Precipitation** _____

Pesticides

Name & EPA Number _____

Active Ingredient & Percentage_____

Rate Per 1000 ft^2_____

Total Product Used _____

Additives & Others

Name _____

Rate _____

Total Product Used _____

Calibrations

Equipment Used_____Nozzles _____

Total Gallons_____ Gallons Per 1000 ft^2 _____

Speed, RPM & PSI_____Setting (Spreader)_____

Disposal of Rinsate_____ Overlap (Spreader) _____

Comments _____

_____

_____

ENVIRONMENTAL STEWARDSHIP PLAN ADDENDUM

Facility Name _____

Date _____ Time _____

Describe the proposed modification: _____

_____

_____

_____

_____

Describe the reason for the modification: _____

_____

_____

_____

_____

Describe the actions to be taken as part of the modification: _____

_____

_____

_____

_____

Provide an implementation schedule for modifying existing procedures/conditions or implementing new procedures/conditions: _____

_____

_____

_____

_____

TERRESTRIAL ECOLOGY SITE ASSESSMENT FORM

Part 1: Background Information

Site Name	
Site Address or Nearest Intersection	
Total acreage/size of project area (if smaller)	
Watershed/Subwatershed	
Person(s) Conducting Site Visit	
Date and Time of Site Visit	

Part 2: Physical Parameters

General Topography of Area	Flat	Rolling	Steep	Ravine	Bluff	Other:
General Topography of Course	Flat	Rolling	Steep	Ravine	Bluff	Other:
General Climate	Average Rainfall:			Average Snowfall:		
	Average High Temp:			Average Low Temp:		
Elevation (feet above sea level)	Highest:			Lowest:		

Part 3: Site Visit Conditions

Wind	None	Light	Medium	Strong	Direction:	
Precipitation	None	Mist	Lt. Rain	Med. Rain	Hard Rain	Snow
	Other:					
Cloud Cover	0%	33%	66%	100%		
Temperature	_____ BF.		_____ B C.			

Part 4: Natural Features—Water

Water Features On Site	**Type** (e.g., pond, lake, river, stream, wetland, spring, seep)	**Number, size or extent**	**ODFW Stream Segment/ Reach Number**	**Condition** (e.g., pristine, degraded, water color, suspended solids)	**Isolated or connected to stream?** (if wetland)

Part 5: Natural Features—Vegetation and Habitat Types

Percent Cover (General Estimate)		< 5%	5 – 25%	26 – 50%	51 – 75%	76 – 100%
Cover Type	Turf					
	Natural Grass					
	Shrub					
	Canopy (Trees)					
	Buffer					

	Habitat Types Present On Site	Approximate Size (acres)	Condition
Special Status Habitats and Their Condition	Any wetland type		Poor Fair Good Excellent
	Upland prairie;grassland		Poor Fair Good Excellent
	Interior conifer-hardwood forest		Poor Fair Good Excellent
	Late successional conifer forest		Poor Fair Good Excellent
	Oak woodland		Poor Fair Good Excellent
	Bottomland hardwood forest		Poor Fair Good Excellent
	Open water—lakes, rivers and streams		Poor Fair Good Excellent
	Riparian/floodplain habitat		Poor Fair Good Excellent
Other Habitat Types	Mixed deciduous/conifer forest		Poor Fair Good Excellent
	Other:		Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent

	Species:	Height:	Comments
Large Individual Live Trees		DBH: (Diameter at Breast Height)	

	Abundance of Snags	Absent Low Med. High	Comments
Snags and Downed Materials	Snag Size	Small dbh (< 10”) Medium dbh (10” – 24”) Large dbh (> 24”)	
	Bark on Snag(s)?	Y N	
	Downed Wood Present?	Y N	
	Rootwads Attached to Downed Wood?	Y N	

		Present on Site (check all that are observed, and mark locations on maps and/or aerial photographs)	Percent Covering Site	Present on Adjacent Areas (check all that are observed)
Invasive Plant Species	English Ivy			
	Himalayan Blackberry			
	Reed Canarygrass			
	Japanese Knotweed			
	Diffuse Knapweed			
	Spotted Knapweed			
	Garlic Mustard			
	English Holly			
	Butterfly Bush			
	Morning Glory			
	English Laurel			
	Scot's Broom			
	Tree of Heaven			
	Robert's Geranium			
	Shiny Geranium			
	Giant Hogweed			
	Clematis (Traveler's Joy)			
	English Hawthorn			
	Canadian Thistle			
	Purple Loosestrife			
	False Brome			
	Daphne Laurel			
	Iris pseudocaris			
	Parrot Feather			
	Norway Maple			
	Money Plant			
	Other:			

Part 6: Other Natural Features (Non-Vegetation-Based)

	Feature	Present on Site	Used by Wildlife Species Using Feature	Feature
Key Non-Veg-based Features—Natural	Beach/mudflat habitat (seasonally-flooded shallow areas)	Y N	Y N Unknown	
	Rock outcrop	Y N	Y N Unknown	
	Butte	Y N	Y N Unknown	
	Riverine island	Y N	Y N Unknown	
	Waterfall	Y N	Y N Unknown	
	Other:	Y N	Y N Unknown	

Part 7: Other Wildlife Structures and Features—Human-made or Planted

Feature	Present on Site	Check if adjacent to, or within _ mile	Used by Wildlife	Species Using Feature
Bridge	Y N		Y N Unknown	
Chimney	Y N		Y N Unknown	
Channel marker	Y N		Y N Unknown	
Utility pole/tower	Y N		Y N Unknown	
Stormwater facility (e.g., ecoroof, planter, swale)	Y N		Y N Unknown	
Planted trees 8 **Native species** 8 **Non-native species** 8 **Large canopy** 8 **Small canopy**	 Y N Y N Y N Y N		 Y N Unknown Y N Unknown Y N Unknown Y N Unknown	
Semi-natural or cultivated landscapes (e.g., tree stands, vegetated areas or corridors, water features)	Y N		Y N Unknown	
Nest box, platform, bat boxes	Y N		Y N Unknown	
Wildlife crossing/corridor (e.g., between golf course and off site property, between holes, unused natural areas)	Y N		Y N Unknown	
Other:	Y N		Y N Unknown	

Part 8: Wildlife Species and Assemblages

Wildlife Species	Species	Observed or Known to be Present on Site	Vegetation or features they are using	Other Evidence	Potentially Present on Site?	Known to be Adjacent to Site	Special Status or Focal Species (check all that apply)
	Invertebrates						
	Amphibians						
	Reptiles						
	Birds						
	Mammals						

Species Groups Observed or Known to be Present	Species Group	Species Group Observed	Species Group Known To Use Site	What Are they Using?
	Migratory waterfowl	Y N	Y N Unknown	
	Shorebirds	Y N	Y N Unknown	
	Neotropical migratory songbirds (e.g. Barn Swallow, Ruby Throated Hummingbird)	Y N	Y N Unknown	
	Cavity-nesting birds (e.g., woodpeckers, owls)	Y N	Y N Unknown	
	Colonial-nesting birds (e.g., great blue heron)	Y N	Y N Unknown	
	"Iconic" species (species of cultural interest; e.g., great blue heron, Vaux's swift, osprey)	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	

Species of Management Concern (check all that apply)						
	Bullfrog		**House sparrow**		**Black bear**	
	Snapping turtle		**Virginia opossum**		**Common raccoon**	
	Red-eared slider		**Eastern cottontail**		**Striped skunk**	
	Canada goose		**Eastern fox squirrel**		**Western spotted skunk**	
	Domestic goose species		**Eastern gray squirrel**		**Cougar**	
	Mute swan		**American beaver**		**Domestic cat (feral)**	
	Domestic duck species		**Black rat**		**Roosevelt elk**	
	Rock pigeon		**Norway rat**		**Black-tailed deer**	
	European starling		**Nutria**		**Other:**	
	Brown-headed cowbird		**Coyote**		**Other:**	

Part 9: Human Disturbance

	Description, including Intensity (i.e., High, Medium, Low)	**Impacts on Wildlife and/or Wildlife Habitat**
Physical Disturbance (e.g., parking lots, development)		
Human Disturbance on Site (e.g., greens, tees, fairways, nonnatural areas)		
Barriers to Migration or Movement (e.g., fences, buildings, roads, significant vegetation gaps)		
Barriers, or Other Things Preventing or Inhibiting Safe Access to, Water or Other Important Habitat Features (e.g., paved pathways)		
Disturbance from Domestic Animals (e.g., dogs off leash)		
Proximity to Residential or Other Developed Areas (e.g., distances in all directions)		
Type and Intensity of Nearby Developments/Land Uses		
Trails (e.g., formal, informal, trails in floodplains)		
Other Management Issues (e.g., erosion, bridges, events, concerts)		

Part 10: Considerations for Wildlife

Functional Category		Current Conditions	Potential for providing or establishing (if conditions are poor of nonexistent)
Food Availability (A)	**1 Variety**—Diversity of food sources (e.g., native trees and shrubs), (as opposed to non-native species or maintained turf)	Excellent Good Poor Non-existent	High Medium Low None
	2 Quantity and Seasonality—Abundance of food sources (native trees, shrubs, wetlands) at the desirable season	Excellent Good Poor Non-existent	High Medium Low None
	3 Proximity to Cover—Proximity of cover to food sources identified above	Excellent Good Poor Non-existent	High Medium Low None
Cover (B)	**1 Structural Diversity**—Structural elements such as snags, live trees, downed trees of various sizes and types	Excellent Good Poor Non-existent	High Medium Low None
	2 Variety of cover—Diversity of cover (e.g., trees, shrubs)	Excellent Good Poor Non-existent	High Medium Low None
	3 Nesting—Presence of nesting habitat for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	4 Escape—Quantity of avenues of escape including lack of structures (e.g., fences) that might prevent escape or movement	Excellent Good Poor Non-existent	High Medium Low None
	5 Seasonality—Availability of cover throughout the year	Excellent Good Poor Non-existent	High Medium Low None
	6 Roosting—Presence of roost sites for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	7 Presence of large trees	Excellent Good Poor Non-existent	High Medium Low None
Water (C)	**1 Safe access to clean water**—Lack of barriers (e.g., fences)	Excellent Good Poor Non-existent	High Medium Low None
	2 Good water quality on site—Presence of streams, wetlands, ponds, or other water bodies	Excellent Good Poor Non-existent	High Medium Low None
Disturbance (D)	**1 Lack of habitat modification**—Minimal development, structures and other habitat modification	Excellent Good Poor Non-existent	High Medium Low None
	2 Lack of direct disturbance—Lack of paved trails, road noise	Excellent Good Poor Non-existent	High Medium Low None
Habitat Features (E)	**1 Downed wood, snags and old stumps**	Excellent Good Poor Non-existent	High Medium Low None
	2 Low percentage of nonnative plants	Excellent Good Poor Non-existent	High Medium Low None
	3 Mix of habitats	Excellent Good Poor Non-existent	High Medium Low None
	4 Other	Excellent Good Poor Non-existent	High Medium Low None

Part 11: Restoration and Enhancement Efforts and Opportunities

Possible Future Restoration or Enhancement Efforts	Possible Actions	Check all that apply, and note location on maps and/or aerial photographs	Function(s) Addressed (refer to categories from Part 10—e.g., A1, B2)
	Remove non-native plants/trees or natives suppressing other sensitive species		
	Remove native competing trees (e.g., firs encroaching on oaks)		
	Diversify tree/shrub/plant species and age class		
	Upland (non-streambank) native species plantings		
	Streambank native species plantings		
	Create snags		
	Increase amount of downed wood/large woody debris		
	Create brush piles		
	Conduct controlled burn		
	Slope stabilization		
	Trash or other cleanup		
	Remove fill from wetland		
	Land acquisition or easement		
	Daylight stream		
	Re-establish hydrologic conditions (e.g., flow, stream connectivity)		
	Culvert upgrade or conversion to bridge		
	Remove barriers or human site constraints (e.g., fences)		
	Establish wildlife corridor (e.g., vegetated area between habitat patches)		
	Establish wildlife crossing (e.g., between holes)		
	Reduce/remove human disturbance in natural areas		
	Erect nest box, platform, bat box or other structure		
	Maintain former restoration efforts (e.g., remove rodent barriers that are girdling trees)		
	Protect mature trees from beaver damage		
	Modify stormwater project (e.g., ecoroof, planter, swale) **to benefit wildlife**		
	Plant trees useful to wildlife		
	Other:		

Part 12: Opportunities To Connect People With Nature

Describe current or past restoration and/or enhancement efforts and apparent success or failure	

Opportunities	Location (note on maps)	Comments
Interpretive signs		
Viewing blind		
Trail		
On-site education		
Other:		

TERRESTRIAL ECOLOGY SITE ASSESSMENT FORM

Part 1: Background Information

Site Name	
Site Address or Nearest Intersection	
Total acreage/size of project area (if smaller)	
Watershed/Subwatershed	
Person(s) Conducting Site Visit	
Date and Time of Site Visit	

Part 2: Physical Parameters

General Topography of Area	Flat Rolling Steep Ravine Bluff Other:
General Topography of Course	Flat Rolling Steep Ravine Bluff Other:
General Climate	Average Rainfall: Average Snowfall: Average High Temp: Average Low Temp:
Elevation (feet above sea level)	Highest: Lowest:

Part 3: Site Visit Conditions

Wind	None Light Medium Strong Direction:
Precipitation	None Mist Lt. Rain Med. Rain Hard Rain Snow Other:
Cloud Cover	0% 33% 66% 100%
Temperature	_____BF. _____ B C.

Part 4: Natural Features—Water

Water Features On Site	**Type** (e.g., pond, lake, river, stream, wetland, spring, seep)	**Number, size or extent**	**ODFW Stream Segment/Reach Number**	**Condition** (e.g., pristine, degraded, water color, suspended solids)	**Isolated or connected to stream?** (if wetland)

Part 5: Natural Features—Vegetation and Habitat Types

Percent Cover (General Estimate)		< 5%	5 – 25%	26 – 50%	51 – 75%	76 – 100%
Cover Type	Turf					
	Natural Grass					
	Shrub					
	Canopy (Trees)					
	Buffer					

Special Status Habitats and Their Condition	**Habitat Types Present On Site**	**Approximate Size (acres)**	**Condition**
	o Any wetland type		Poor Fair Good Excellent
	o Upland prairie; grassland		Poor Fair Good Excellent
	o Interior conifer-hardwood forest		Poor Fair Good Excellent
	o Late successional conifer forest		Poor Fair Good Excellent
	o Oak woodland		Poor Fair Good Excellent
	o Bottomland hardwood forest		Poor Fair Good Excellent
	o Open water—lakes, rivers and streams		Poor Fair Good Excellent
	o Riparian/floodplain habitat		Poor Fair Good Excellent
Other Habitat Types	o Mixed deciduous/ conifer forest		Poor Fair Good Excellent
	o		Poor Fair Good Excellent
	o		Poor Fair Good Excellent
	o		Poor Fair Good Excellent
	o		Poor Fair Good Excellent
	o Other:		Poor Fair Good Excellent

Large Individual Live Trees	**Species:**	**Height:** **DBH:** (Diameter at Breast Height)	**Comments**

Snags and Downed Materials	**Abundance of Snags**	Absent Low Med. High	**Comments**
	Snag Size	Small dbh (< 10”) Medium dbh (10” – 24”) Large dbh (> 24”)	
	Bark on Snag(s)?	Y N	
	Downed Wood Present?	Y N	
	Rootwads Attached to Downed Wood?	Y N	

		Present on Site (check all that are observed, and mark locations on maps and/or aerial photographs)	Percent Covering Site	Present on Adjacent Areas (check all that are observed)
Invasive Plant Species	English Ivy			
	Himalayan Blackberry			
	Reed Canarygrass			
	Japanese Knotweed			
	Diffuse Knapweed			
	Spotted Knapweed			
	Garlic Mustard			
	English Holly			
	Butterfly Bush			
	Morning Glory			
	English Laurel			
	Scot's Broom			
	Tree of Heaven			
	Robert's Geranium			
	Shiny Geranium			
	Giant Hogweed			
	Clematis (Traveler's Joy)			
	English Hawthorn			
	Canadian Thistle			
	Purple Loosestrife			
	False Brome			
	Daphne Laurel			
	Iris pseudocaris			
	Parrot Feather			
	Norway Maple			
	Money Plant			
	Other:			

Part 6: Other Natural Features (Non-Vegetation-Based)

	Feature	Present on Site	Used by Wildlife	Species Using Feature
Key Non-Veg-based Features—Natural	Beach/mudflat habitat (seasonally-flooded shallow areas)	Y N	Y N Unknown	
	Rock outcrop	Y N	Y N Unknown	
	Butte	Y N	Y N Unknown	
	Riverine island	Y N	Y N Unknown	
	Waterfall	Y N	Y N Unknown	
	Other:	Y N	Y N Unknown	

Part 7: Other Wildlife Structures and Features—Human-made or Planted

Feature	Present on Site	Check if adjacent to, or within _ mile	Used by Wildlife	Species Using Feature
Bridge	Y N		Y N Unknown	
Chimney	Y N		Y N Unknown	
Channel marker	Y N		Y N Unknown	
Utility pole/tower	Y N		Y N Unknown	
Stormwater facility (e.g., ecoroof, planter, swale)	Y N		Y N Unknown	
Planted trees 8 **Native species** 8 **Non-native species** 8 **Large canopy** 8 **Small canopy**	 Y N Y N Y N Y N		 Y N Unknown Y N Unknown Y N Unknown Y N Unknown	
Semi-natural or cultivated landscapes (e.g., tree stands, vegetated areas or corridors, water features)	Y N		Y N Unknown	
Nest box, platform, bat boxes	Y N		Y N Unknown	
Wildlife crossing/corridor (e.g., between golf course and off site property, between holes, unused natural areas)	Y N		Y N Unknown	
Other:	Y N		Y N Unknown	

Part 8: Wildlife Species and Assemblages

Wildlife Species	Species	Observed or Known to be Present on Site	Vegetation or features they are using	Other Evidence	Potentially Present on Site?	Known to be Adjacent to Site	Special Status or Focal Species (check all that apply)
	Invertebrates						
	Amphibians						
	Reptiles						
	Birds						
	Mammals						

Species Groups Observed or Known to be Present	Species Group	Species Group Observed	Species Group Known To Use Site	What Are they Using?
	Migratory waterfowl	Y N	Y N Unknown	
	Shorebirds	Y N	Y N Unknown	
	Neotropical migratory songbirds (e.g. Barn Swallow, Ruby Throated Hummingbird)	Y N	Y N Unknown	
	Cavity-nesting birds (e.g., woodpeckers, owls)	Y N	Y N Unknown	
	Colonial-nesting birds (e.g., great blue heron)	Y N	Y N Unknown	
	"Iconic" species (species of cultural interest; e.g., great blue heron, Vaux's swift, osprey)	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	

Species of Management Concern (check all that apply)							
	Bullfrog		**House sparrow**		**Black bear**		
	Snapping turtle		**Virginia opossum**		**Common raccoon**		
	Red-eared slider		**Eastern cottontail**		**Striped skunk**		
	Canada goose		**Eastern fox squirrel**		**Western spotted skunk**		
	Domestic goose species		**Eastern gray squirrel**		**Cougar**		
	Mute swan		**American beaver**		**Domestic cat (feral)**		
	Domestic duck species		**Black rat**		**Roosevelt elk**		
	Rock pigeon		**Norway rat**		**Black-tailed deer**		
	European starling		**Nutria**		**Other:**		
	Brown-headed cowbird		**Coyote**		**Other:**		

Part 9: Human Disturbance

	Description, including Intensity (i.e., High, Medium, Low)	Impacts on Wildlife and/or Wildlife Habitat
Physical Disturbance (e.g., parkinglots, development)		
Human Disturbance on Site (e.g., greens, tees, fairways, nonnatural areas)		
Barriers to Migration or Movement (e.g., fences, buildings, roads, significant vegetation gaps)		
Barriers, or Other Things Preventing or Inhibiting Safe Access to, Water or Other Important Habitat Features (e.g., paved pathways)		
Disturbance from Domestic Animals (e.g., dogs off leash)		
Proximity to Residential or Other Developed Areas (e.g., distances in all directions)		
Type and Intensity of Nearby Developments/Land Uses		
Trails (e.g., formal, informal, trails in floodplains)		
Other Management Issues (e.g., erosion, bridges, events, concerts)		

Part 10: Considerations for Wildlife

Functional Category		Current Conditions	Potential for providing or establishing (if conditions are poor of non-existent)
Food Availability (A)	**1 Variety**—Diversity of food sources (e.g., native trees and shrubs), (as opposed to non-native species or maintained turf)	Excellent Good Poor Non-existent	High Medium Low None
	2 Quantity and Seasonality—Abundance of food sources (native trees, shrubs, wetlands) at the desirable season	Excellent Good Poor Non-existent	High Medium Low None
	3 Proximity to Cover—Proximity of cover to food sources identified above	Excellent Good Poor Non-existent	High Medium Low None
Cover (B)	**1 Structural Diversity**—Structural elements such as snags, live trees, downed trees of various sizes and types	Excellent Good Poor Non-existent	High Medium Low None
	2 Variety of cover—Diversity of cover (e.g., trees, shrubs)	Excellent Good Poor Non-existent	High Medium Low None
	3 Nesting—Presence of nesting habitat for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	4 Escape—Quantity of avenues of escape including lack of structures (e.g., fences) that might prevent escape or movement	Excellent Good Poor Non-existent	High Medium Low None
	5 Seasonality—Availability of cover throughout the year	Excellent Good Poor Non-existent	High Medium Low None
	6 Roosting—Presence of roost sites for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	7 Presence of large trees	Excellent Good Poor Non-existent	High Medium Low None
Water (C)	**1 Safe access to clean water**—Lack of barriers (e.g., fences)	Excellent Good Poor Non-existent	High Medium Low None
	2 Good water quality on site—Presence of streams, wetlands, ponds, or other water bodies	Excellent Good Poor Non-existent	High Medium Low None
Disturbance (D)	**1 Lack of habitat modification**—Minimal development, structures and other habitat modification	Excellent Good Poor Non-existent	High Medium Low None
	2 Lack of direct disturbance—Lack of paved trails, road noise	Excellent Good Poor Non-existent	High Medium Low None
Habitat Features (E)	**1 Downed wood, snags and old stumps**	Excellent Good Poor Non-existent	High Medium Low None
	2 Low percentage of nonnative plants	Excellent Good Poor Non-existent	High Medium Low None

	3 Mix of habitats	Excellent Good Poor Non-existent	High Medium Low None
	4 Other	Excellent Good Poor Non-existent	High Medium Low None

Part 11: Restoration and Enhancement Efforts and Opportunities

Describe current or past restoration and/or enhancement efforts and apparent success or failure	

Possible Future Restoration or Enhancement Efforts	Possible Actions	Check all that apply, and note location on maps and/or aerial photographs	Function(s) Addressed (refer to categories from Part 10—e.g., A1, B2)
	Remove non-native plants/trees or natives suppressing other sensitive species		
	Remove native competing trees (e.g., firs encroaching on oaks)		
	Diversify tree/shrub/plant species and age class		
	Upland (non-streambank) native species plantings		
	Streambank native species plantings		
	Create snags		
	Increase amount of downed wood/large woody debris		
	Create brush piles		
	Conduct controlled burn		
	Slope stabilization		
	Trash or other cleanup		
	Remove fill from wetland		
	Land acquisition or easement		
	Daylight stream		
	Re-establish hydrologic conditions (e.g., flow, stream connectivity)		
	Culvert upgrade or conversion to bridge		
	Remove barriers or human site constraints (e.g., fences)		

TERRESTRIAL ECOLOGY SITE ASSESSMENT FORM

PART 1: BACKGROUND INFORMATION

Golf Course Name	
Address	
Total acreage/size of project area	
Watershed/Subwatershed	
Person(s) Conducting Site Visit	
Date and Time of Site Visit	

PART 2: PHYSICAL PARAMETERS

General Topography of Area	Flat	Rolling	Steep	Ravine	Bluff	
	Other:					
General Topography of Course	Flat	Rolling	Steep	Ravine	Bluff	
	Other:					
General Climate	Average Rainfall:			Average Snowfall:		
	Average High Temp:			Average Low Temp:		
Elevation (feet above sea level)	Highest:			Lowest:		

PART 3: SITE VISIT CONDITIONS

Wind	None	Light	Medium	Strong	Direction:	
Precipitation	None	Mist	Lt. Rain	Med. Rain	Hard Rain	Snow
	Other:					
Cloud Cover	0%	33%	66%	100%		
Temperature	_____ °F.		_____ °C.			

PART 4: PROPERTY FEATURES—WATER

Water Features On Site	**Type** (e.g., pond, lake, river, stream, wetland, spring, seep)	**Number, size or extent**	**Condition** (e.g., pristine, degraded, water color, suspended solids)	**Isolated or connected to natural stream?**

PART 5: PROPERTY FEATURES—VEGETATION AND HABITAT TYPES

Percent Cover (General Estimate)		< 5%	5 – 25%	26 – 50%	51 – 75%	76 – 100%
Cover Type	Turf					
	Native Grass					
	Shrub					
	Canopy (Trees)					
	Buffer					

	Habitat Types Present On Site	Approximate Size (acres)	Condition
Special Status Habitats and Their Condition	Any wetland type		Poor Fair Good Excellent
	Upland prairie;grassland		Poor Fair Good Excellent
	Interior conifer-hardwood forest		Poor Fair Good Excellent
	Late successional conifer forest		Poor Fair Good Excellent
	Oak woodland		Poor Fair Good Excellent
	Bottomland hardwood forest		Poor Fair Good Excellent
	Open water—lakes, rivers and streams		Poor Fair Good Excellent
	Riparian/floodplain habitat		Poor Fair Good Excellent
Other Habitat Types	Mixed deciduous/conifer forest		Poor Fair Good Excellent
	Other:		Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent
			Poor Fair Good Excellent

Large Individual Live Trees	Species:	Height:	DBH*:	Comments

Attach Separate Sheet if Necessary
* Diameter at Breast Height

Snags and Downed Materials	**Abundance of Snags**	Absent Low Med. High	**Comments**
	Snag Size	Small dbh (< 10") Medium dbh (10" – 24") Large dbh (> 24")	
	Bark on Snag(s)?	Y N	
	Downed Wood Present?	Y N	
	Rootwads Attached to Downed Wood?	Y N	

		Present on Site (check all that are observed, and mark locations on maps and/or aerial photographs)	**Percent Covering Site**	**Present on Adjacent Areas** (check all that are observed)
Invasive Plant Species	**English Ivy**			
	Himalayan Blackberry			
	Reed Canarygrass			
	Japanese Knotweed			
	Diffuse Knapweed			
	Spotted Knapweed			
	Garlic Mustard			
	English Holly			
	Butterfly Bush			
	Morning Glory			
	English Laurel			
	Scot's Broom			
	Tree of Heaven			
	Robert's Geranium			
	Shiny Geranium			
	Giant Hogweed			
	Clematis (Traveler's Joy)			
	English Hawthorn			
	Canadian Thistle			
	Purple Loosestrife			
	False Brome			
	Daphne Laurel			
	Iris pseudocaris			
	Parrot Feather			
	Norway Maple			
	Money Plant			
	Other:			

PART 6: OTHER NATURAL FEATURES (NON-VEGETATION-BASED)

	Feature	Present on Site	Used by Wildlife Species Using Feature	Feature
KEY NON-Veg-based Features—Natural	**Beach/mudflat habitat** (seasonally-flooded shallow areas)	Y N	Y N Unknown	
	Rock outcrop	Y N	Y N Unknown	
	Butte	Y N	Y N Unknown	
	Riverine island	Y N	Y N Unknown	
	Waterfall	Y N	Y N Unknown	
	Other:	Y N	Y N Unknown	

PART 7: OTHER WILDLIFE STRUCTURES AND FEATURES—HUMAN-MADE OR PLANTED

Feature	Present on Site	Check if adjacent to, or within _ mile	Used by Wildlife	Species Using Feature
Bridge	Y N		Y N Unknown	
Chimney	Y N		Y N Unknown	
Channel marker	Y N		Y N Unknown	
Utility pole/tower	Y N		Y N Unknown	
Stormwater facility (e.g., ecoroof, planter, swale)	Y N		Y N Unknown	
Planted trees **8 Native species** **8 Non-native species** **8 Large canopy** **8 Small canopy**	 Y N Y N Y N Y N		 Y N Unknown Y N Unknown Y N Unknown Y N Unknown	
Semi-natural or cultivated landscapes (e.g., tree stands, vegetated areas or corridors, water features)	Y N		Y N Unknown	
Nest box, platform, bat boxes	Y N		Y N Unknown	
Wildlife crossing/corridor (e.g., between golf course and off site property, between holes, unused natural areas)	Y N		Y N Unknown	
Other:	Y N		Y N Unknown	

PART 8: WILDLIFE SPECIES AND ASSEMBLAGES

Wildlife Species	Species	Observed or Known to be Present on Site	Vegetation or features they are using	Other Evidence	Potentially Present on Site?	Known to be Adjacent to Site	Special Status or Focal Species (check all that apply)
	Invertebrates						
	Amphibians						
	Reptiles						
	Birds						
	Mammals						

Species Groups Observed or Known to be Present	Species Group	Species Group Observed	Species Group Known To Use Site	What Are they Using?
	Migratory waterfowl	Y N	Y N Unknown	
	Shorebirds	Y N	Y N Unknown	
	Neotropical migratory songbirds (e.g. Barn Swallow, Ruby Throated Hummingbird)	Y N	Y N Unknown	
	Cavity-nesting birds (e.g., woodpeckers, owls)	Y N	Y N Unknown	
	Colonial-nesting birds (e.g., great blue heron)	Y N	Y N Unknown	
	"Iconic" species (species of cultural interest; e.g., great blue heron, Vaux's swift, osprey)	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	
	Other (specify):	Y N	Y N Unknown	

Species of Management Concern (check all that apply)						
	Bullfrog		**House sparrow**		**Black bear**	
	Snapping turtle		**Virginia opossum**		**Common raccoon**	
	Red-eared slider		**Eastern cottontail**		**Striped skunk**	
	Canada goose		**Eastern fox squirrel**		**Western spotted skunk**	
	Domestic goose species		**Eastern gray squirrel**		**Cougar**	
	Mute swan		**American beaver**		**Domestic cat (feral)**	
	Domestic duck species		**Black rat**		**Roosevelt elk**	
	Rock pigeon		**Norway rat**		**Black-tailed deer**	
	European starling		**Nutria**		**Other:**	
	Brown-headed cowbird		**Coyote**		**Other:**	

PART 9: HUMAN DISTURBANCE

	Description, including Intensity (i.e., High, Medium, Low)	**Impacts on Wildlife and/or Wildlife Habitat**
Physical Disturbance (e.g., parking lots, development)		
Human Disturbance on Site (e.g., greens, tees, fairways, nonnatural areas)		
Barriers to Migration or Movement (e.g., fences, buildings, roads, significant vegetation gaps)		
Barriers, or Other Things Preventing or Inhibiting Safe Access to, Water or Other Important Habitat Features (e.g., paved pathways)		
Disturbance from Domestic Animals (e.g., dogs off leash)		
Proximity to Residential or Other Developed Areas (e.g., distances in all directions)		
Type and Intensity of Nearby Developments/Land Uses		
Trails (e.g., formal, informal, trails in floodplains)		
Other Management Issues (e.g., erosion, bridges, events, concerts)		

PART 10: CONSIDERATIONS FOR WILDLIFE

Functional Category		Current Conditions	Potential for providing or establishing (if conditions are poor of nonexistent)
Food Availability (A)	**1 Variety**—Diversity of food sources (e.g., native trees and shrubs), (as opposed to non-native species or maintained turf)	Excellent Good Poor Non-existent	High Medium Low None
	2 Quantity and Seasonality—Abundance of food sources (native trees, shrubs, wetlands) at the desirable season	Excellent Good Poor Non-existent	High Medium Low None
	3 Proximity to Cover—Proximity of cover to food sources identified above	Excellent Good Poor Non-existent	High Medium Low None
Cover (B)	**1 Structural Diversity**—Structural elements such as snags, live trees, downed trees of various sizes and types	Excellent Good Poor Non-existent	High Medium Low None
	2 Variety of cover—Diversity of cover (e.g., trees, shrubs)	Excellent Good Poor Non-existent	High Medium Low None
	3 Nesting—Presence of nesting habitat for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	4 Escape—Quantity of avenues of escape including lack of structures (e.g., fences) that might prevent escape or movement	Excellent Good Poor Non-existent	High Medium Low None
	5 Seasonality—Availability of cover throughout the year	Excellent Good Poor Non-existent	High Medium Low None
	6 Roosting—Presence of roost sites for desirable species	Excellent Good Poor Non-existent	High Medium Low None
	7 Presence of large trees	Excellent Good Poor Non-existent	High Medium Low None
Water (C)	**1 Safe access to clean water**—Lack of barriers (e.g., fences)	Excellent Good Poor Non-existent	High Medium Low None
	2 Good water quality on site—Presence of streams, wetlands, ponds, or other water bodies	Excellent Good Poor Non-existent	High Medium Low None
Disturbance (D)	**1 Lack of habitat modification**—Minimal development, structures and other habitat modification	Excellent Good Poor Non-existent	High Medium Low None
	2 Lack of direct disturbance—Lack of paved trails, road noise	Excellent Good Poor Non-existent	High Medium Low None
Habitat Features (E)	**1 Downed wood, snags and old stumps**	Excellent Good Poor Non-existent	High Medium Low None
	2 Low percentage of nonnative plants	Excellent Good Poor Non-existent	High Medium Low None
	3 Mix of habitats	Excellent Good Poor Non-existent	High Medium Low None
	4 Other	Excellent Good Poor Non-existent	High Medium Low None

PART 11: RESTORATION AND ENHANCEMENT EFFORTS AND OPPORTUNITIES

Possible Future Restoration or Enhancement Efforts	Possible Actions	Check all that apply, and note location on maps and/or aerial photographs	Function(s) Addressed (refer to categories from Part 10—e.g., A1, B2)
	Remove non-native plants/trees or natives suppressing other sensitive species		
	Remove native competing trees (e.g., firs encroaching on oaks)		
	Diversify tree/shrub/plant species and age class		
	Upland (non-streambank) native species plantings		
	Streambank native species plantings		
	Create snags		
	Increase amount of downed wood/large woody debris		
	Create brush piles		
	Conduct controlled burn		
	Slope stabilization		
	Trash or other cleanup		
	Remove fill from wetland		
	Land acquisition or easement		
	Daylight stream		
	Re-establish hydrologic conditions (e.g., flow, stream connectivity)		
	Culvert upgrade or conversion to bridge		
	Remove barriers or human site constraints (e.g., fences)		
	Establish wildlife corridor (e.g., vegetated area between habitat patches)		
	Establish wildlife crossing (e.g., between holes)		
	Reduce/remove human disturbance in natural areas		
	Erect nest box, platform, bat box or other structure		
	Maintain former restoration efforts (e.g., remove rodent barriers that are girdling trees)		
	Protect mature trees from beaver damage		
	Modify stormwater project (e.g., ecoroof, planter, swale) **to benefit wildlife**		
	Plant trees useful to wildlife		
	Other:		

PART 12: OPPORTUNITIES TO CONNECT PEOPLE WITH NATURE

Describe current or past restoration and/or enhancement efforts and apparent success or failure	

Opportunities	Location (note on maps)	Comments
Interpretive signs		
Viewing blind		
Trail		
On-site education		
Other:		

WATER SAMPLE LOG

Facility Name	
Date	
Sampled by	Locator ID
Time Sample Collected	Sample ID
Static Water Level	Time
Amount Purged	Weather
Sample Collection Method	
Discharge rate during sampling	
Color	Odor
Temperature	pH
ORP	Dissolved Oxygen
Specific Conductance	Other
Analyses Requested	
Comments	

WaterSampleLogForm.doc

WILDLIFE OBSERVATION FORM

Facility Name _____

Species _____

Date _____ Time _____

Observer's Name _____

Location/Hole _____

Habitat Type _____

Behavior _____

Total Number of Species _____

Number of: Males_____ Females _____ Unknown _____

Adults _____ Sub-adults _____ Juveniles (young of year) _____ Unknown _____

Observation Type: Sight _____ Track _____ Other _____

Confidence in ID: Definitely _____ Probably _____ Not Sure _____

Comments _____

_____

WILDLIFE OBSERVATION FORM

Facility Name _____

Species _____

Date _____ Time _____

Observer's Name _____

Location/Hole _____

Habitat Type _____

Behavior _____

Total Number of Species _____

Number of: Males_____ Females _____ Unknown _____

Adults _____ Sub-adults _____ Juveniles (young of year) _____ Unknown _____

Observation Type: Sight _____ Track _____ Other _____

Confidence in ID: Definitely _____ Probably _____ Not Sure _____

Comments _____

_____

APPENDIX G

Go back

Methods for Stream Habitat Surveys
Aquatic Inventories Project

Natural Production Program:
Oregon Department of Fish and Wildlife

INTRODUCTION

The Aquatic Inventories Project is designed to provide quantitative information on habitat condition for streams throughout Oregon. This information is used to provide basic information for biologists and land managers, to establish monitoring programs, and to direct or focus habitat restoration efforts.

Development of an Aquatic Inventories Project began within the Oregon Department of Fish and Wildlife (ODFW) in 1989 with sponsorship by the Restoration and Enhancement Program. Drafting of stream survey methods and implementation of field work began in 1990. The conceptual background for this work came from the experience of project staff and from interactions with Oregon State University, forest industry, and USFS PNW research scientists (Bisson et al. 1982, Grant 1986, Everest et al. 1987, Hankin and Reeves 1988, Moore and Gregory 1989, and Gregory et al. 1991). Significant contributions and review of these methods were provided by ODFW research staff, and from consultation with ODFW and United States Forest Service (USFS) biologists working on similar programs. Members of the Umpqua Basin Fisheries Restoration Initiative and the Oregon Forest Industry Council have provided additional review and consultation.

This methodology was designed to be compatible with other stream habitat inventories and classification systems (i.e., Rosgen 1985, Frissell et al. 1986, Cupp 1989, Ralph 1989, USFS Region 6 Level II Inventory 1992, and Hawkins et al. 1993). This compatibility is achieved by systematically identifying and quantifying valley and stream geomorphic features. The resulting matrix of measurements and spatial relationships can then be generalized into frequently occurring valley and channel types or translated into the nomenclature of a particular system. For example, information summarized at the reach level (valley width, channel type, slope, terrace height and width, sinuosity, width, depth, substrate, eroding banks, etc.) can be used to characterize the stream into one of the types described by Rosgen (1985) or to match the parameters collected in other quantitative (USFS) or historic (U.S. Bureau of Fisheries) surveys.

Version 12.1, May 2002. Kelly Moore, Kim Jones, and Jeff Dambacher. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Natural Production Program, Corvallis, OR, 97333. (541) 757-4263

The process of conducting a stream survey involves collection of general information from maps and other sources and the direct observation of stream characteristics in the field. This information is both collected and analyzed based on a hierarchical system of regions, basins, streams, reaches, and habitat units. Supervisors are responsible for collecting the general information on regions and basins and for directing the activities of the survey crews. Survey teams will collect field data based on stream, reach and channel unit characteristics. Region and basin data will primarily come from ODFW-EPA region and sub region classifications, and from map analysis.

The following instructions and definitions provide the outline for these activities and a description of the tasks involved in conducting ODFW's stream habitat inventory.

Each field crew is comprised of two people with each member responsible for specific tasks. The "Estimator" will focus on the identification of channel unit characteristics. The "Numerator" will focus on the counts and relative distribution of several unit attributes and will verify the length and width estimates for a subset of units. The "Estimator" and "Numerator" share the responsibility for describing reach characteristics, riparian conditions, identifying habitat unit types, and for quantifying the amount of large woody debris. Crew members may switch responsibility for estimator or numerator when they start a new stream. They <u>will not</u>, however, switch estimator and numerator jobs on the same stream.

BASIN INFORMATION

Basin information is gathered prior to and during the course of the survey. Some of this information (primarily map work and regional classification) must be collected in the office. Most of this information is not the responsibility of the field crews. However, relevant comments by the survey crews should be included in their Field Books and on the Data Sheets. These summaries are used to group and classify streams and to provide general information for the final stream reports.

1. Basin name. Use the name of the large river commonly used to describe a region. For example, use McKenzie R for Lookout CR, not Willamette or Columbia.

2. Stream name. Use a standardized system of the name followed by descriptors of forks etc. Examples: Alsea R, Drift CR, Lobster CR, E FK. Spell out descriptive or non standard types such as Branch, Slough, or Swale. Spell out compass direction only for larger streams and when the usage is common, such as North Umpqua. Use the same name format on all data sheets.

3. Stream order, drainage area, and drainage density of the study stream. Determined from blue line tributaries (perennial and intermittent) shown on U.S.G.S. 7.5 minute topographic maps.

4. Elevation (m) at the confluence with the receiving channel and at the end of the survey.

5. ODFW-EPA Regions and Sub regions, geology, and soils of the basin.

6. Stream Flow. Location of USGS or other gauging stations. The location and stage height at any gauging station, marked bridge, or staff gauge will also be recorded during the survey.

7. General community structure and size composition of riparian vegetation. Identified by separate census or sample in each basin.

8. Description of fish species and stocks present, management concerns, and linkage to other databases or research projects.

9. Flow Regulation: Description of existing or proposed dams and diversions influencing the basin and segment.

10. General description of land use and ownership in the basin (e.g. managed timber, rural residential, agricultural, livestock grazing).

11. Contacts. Names, addresses, and phone numbers of key people to contact with respect to survey. Include ODFW district biologists, interested private individuals, landowners contacted for access, etc.

EQUIPMENT

1. Maps - 7.5 minute quad (1:24,000 scale) USGS topographic maps of the stream and basin. Road map coverage by county or fire district. Oregon Atlas and Gazetteer (Delorme Mapping).

2. Recording Materials - Waterproof field book, survey forms for each portion of the survey, waterproof paper, and pencils.

3. Clothes - Neoprene chest waders, wading shoes, and/or hip boots (non-slip soles of felt, studded “corkers”, outdoor carpet or similar material is advised), rainwear, snag and thorn proof clothing appropriate for the weather.

4. Two-meter-long staff (marked in meters and tenths), compass, 60 meter fiberglass measuring tape, day pack, polarized glasses, thermometers, clinometer, clipboard, vest, flagging, permanent markers, and date-back camera, GPS unit.

See equipment page in appendix for a more complete description of survey equipment.

MAP WORK

Do not go into the field without a topographic map! Data that cannot be linked to the maps is essentially useless. Use the maps to orient to the stream and to identify the location of reach changes, named tributaries, roads, and bridge crossings. Mark all reach changes and important features on the map. Write the channel unit number on the map at the place that corresponds to the location of named tributary junctions, bridges, and other landmarks. Clearly mark where you start and end the survey.

A good correspondence between landmarks on the map and the data collected is an essential part of our survey effort. Information from the surveys will be utilized and integrated with Geographic Information System (GIS) analysis. Well documented and accurate maps are required for this process. In addition to a well marked map, it is essential that the habitat survey follow the USGS named stream on the topo map, regardless of the amount of flow.

An example of field entries on a topographic map is in the appendix (Page 32).

If using a GPS unit, record the Easting and Northing UTM coordinates at the beginning of the reach and at the end of all surveys. When reading the numbers from your GPS unit, the top number is the **Easting coordinate** and corresponds to small numbers along the top of your USGS quad map. The bottom number is the **Northing coordinate** and corresponds to similar numbers along the side of your USGS map. Your location should be where a vertical line from the Easting mark and a horizontal line from the Northing mark intersects.

FIELD BOOK

Maintain a succinct log of your activities in the field book. Each day, record the date and name of the stream where you worked. Enter the approximate distance covered and number of hours spent working on the stream. Keep track of your travel time separately.

Record relevant details about access to the stream, contact people from cooperating industry or agency groups, and people you contact to gain permission to survey. Record the names and phone numbers of people you may contact as you complete the survey.

Write a paragraph or so of general description for sections of each stream in the field book or on a separate stream report form. Pay particular attention to descriptions of the riparian zone, additional details concerning land use, or factors that influence the fish populations. This is the appropriate place to express your opinions. Other comments, sketches of complex features, suggestions, complaints, etc. are often useful.

PHOTOGRAPHS

A good photographic record of the stream survey provides additional information and documentation. Take pictures that typify reach changes, riparian zones, and other stream characteristics as described in the following sections of these instructions. Be sure that the date-back feature of the camera is functioning correctly and to turn off the flash. For each picture, record the channel unit number, date, time, and a description of the subject on the Photo Record sheet.

DATA SHEETS: REACH, UNIT-1, UNIT-2, WOOD, and RIPARIAN

REACH FORM

A reach is a length of stream defined by some functional characteristic. A reach may be simply the distance surveyed. More frequently, reaches are defined as: stream segments between named tributaries, changes in valley and channel form, major changes in vegetation type, or changes in land use or ownership.

Enter a new line on the reach data sheet at any significant change in any one of the reach variables (valley type, channel form, adjacent landform, valley width index, vegetation, or land use) *and/or* at the confluence with tributaries named on 7.5 minute topographic maps. When a new reach is identified by a named tributary, write the name in the Reach Note column. Also describe a new reach if an unnamed tributary contributes significant flow (approx. 15-20% of the total). Do not invent names for unnamed tributaries, instead identify them as Trib. 1, Trib. 2, etc. and record them on the data sheet and the map.

Changes in reach characteristics are used to verify survey location and to identify reach and stream segments within our basin classification system. Circle the variable that resulted in the new reach entry.

Flagging is used to mark specific points during a survey. Hang a strip of plastic flagging at each reach change, named tributary junction, and at riparian transects. Mark the flagging with the unit number, unit type, date, and "ODFW-AQ.-INV.". These flags will be used to locate specific reaches and units for fish sampling and to link units and locations for repeat habitat surveys. Randomly selected stream segments will be selected for repeat surveys during the field season. Results will be compared to check on variability between crews and for habitat changes at different stream flow.

The following sequence corresponds to the listing of variables on the data sheet:

1. **Date.**

2. **Reach.** The numbered sequence of reaches as they are encountered. Each reach is comprised of variable number of channel units.

3. **Unit Number.** Sequence number of the first unit recorded in a reach.

4. **Channel Form.** Determined by the morphology of the active channel, hill slopes, terraces, and flood plains. Identify the channel form and enter the appropriate two-letter code in this column. *Refer to Valley and Channel Classification in the appendix for definitions, allowable combinations, and examples.*

   First look at the ratio of the active channel width to the valley width to determine the **Valley Width Index** (see pg. 7, # 6). This ratio determines if you are in a broad or narrow valley floor type. If the VWI is 2.5 or less you have a narrow valley type and if the VWI is greater than 2.5 you have a broad valley type.

   Next, look at the types of land forms adjacent to the stream channel to characterize and complete your classification.

   The channel is constrained when adjacent land forms restrict the lateral movement of the channel. In constrained channels, stream flows associated with all but the largest flood events are confined to the existing channel configuration.

- Narrow Valley Floor Types (VWI ≤ 2.5)---Always constrained, defined by the characteristics of the constraining feature.

  CB **C**onstrained by **B**edrock (bedrock dominated gorge)
  CH **C**onstrained by **H**ill slope
  CF **C**onstrained by alluvial **F**an

- Broad Valley Floor Types (VWI > 2.5)---The valley is several times wider than the active channel. The channel, however, may be either unconstrained or constrained depending on the height and configuration of the adjacent landforms.

  1. Unconstrained Channel (terrace height is less than the flood prone height* and the floodprone width* is > than 2.5X active channel width). Low terraces, overflow channels, and flood plains adjacent to the active channel.

     US **U**nconstrained-predominantly **S**ingle channel.
     UA **U**nconstrained-**A**nastomosing (several complex, interconnecting channels)
     UB **U**nconstrained-**B**raided channel (numerous, small channels often flowing over alluvial deposits)

  2. Constrained Channel (terrace height is greater than the flood prone height*). Adjacent land forms (terraces, hillslopes) are not part of the active flood plain.

     CT **C**onstraining **T**erraces. (terrace height > floodprone height and floodprone width < 2.5 X active channel width).
     CA **C**onstrained by **A**lternating terraces and hill slope. Same rule for terrace height but the channel may meander across the valley floor. The stream channel is confined by contact with hill slopes and high terraces.
     CL **C**onstrained by **L**and use (road, dike, landfill)

* See page 20 for floodprone height and width definitions.

5. **Valley Form.** General description of the valley cross section with emphasis on the configuration of the valley floor. Divided into types with a narrow valley floor (valley floor width (VWI) ≤ 2.5 times stream active channel width (ACW) and types with a broad valley floor (VWI > 2.5 times ACW).

Narrow Valley Floor (VWI < or = 2.5)

SV **S**teep **V**-Shaped valley or bedrock gorge (side slopes ≥60°).
MV **M**oderate **V**-Shaped valley (side slopes > 30°, <60°).
OV **O**pen **V**-Shaped valley (side slopes ≤30°).

Broad Valley Floor (VWI > 2.5)

CT **C**onstraining **T**erraces. Terraces typically high and close to the active channel. Terrace surface is unlikely to receive flood flows and lacks water dependent (hydrophilic) vegetation.
MT **M**ultiple **T**erraces. Surfaces with varying height and distance from the channel. High terraces may be present but they are a sufficient distance from the channel that they have little impact.
WF **W**ide-Active **F**lood plain. Significant portion of valley floor influenced by annual floods, and has water dependent vegetation (mesic meadow). Any terraces present do not impinge on the lateral movement and expansion of the channel.

Valley Form and Channel Form are related and can only occur in certain combinations. Possible combinations are shown on page 31, Table 1.

6. **Valley Width Index.** Ratio of the width of the active stream channel to the width of the valley floor. The Valley Width Index (VWI) is estimated for the reach by dividing the average *active channel width* into the average *valley floor width* (see diagram on page 20). In practice, the number of active channels that could fit across the valley floor. Also entered on UNIT 1 sheet at verified units.

Do not start a new reach for minor changes in valley width index. However, always start a new reach when the channel changes from VWI < 2.5 to VWI > 2.5; or VWI > 5.

When the valley width changes repeatedly within a short distance, select an average value for the VWI. For example, when the valley floor gradually widens from a hillslope constrained reach to a broad valley reach, make one reach change, not new reach designations every few channel units.

It is possible to have an unconstrained channel but a VWI of 1. This may occur in some meadow reaches and other situations where the multiple channels and the floodplain spread across the entire valley floor.

Observations of valley floor surfaces and characteristics can be done as part of the riparian vegetation survey.

Getting out of the stream channel will help you to accurately estimate VWI, identify floodplain and terrace surfaces, and to classify reach types.

7. **Streamside Vegetation (Veg Class).** A two letter code based on the composition of riparian zone vegetation. Definitions of the riparian zone differ. Generally, we consider the vegetation observed in the area within one active channel width of either side of the channel to represent the riparian zone. The first letter identifies the plant community. The second part of the code will refer to the size of trees within identified dbh classes. Do not enter a size or age class for shrubs, brush, or grasses.

   Example: riparian zone with 15-30 cm diameter alder = D15.

   Separate entries are made for the dominant and subdominant plant communities as estimated from crown density. (Note: In some instances grass can be the dominant plant taxa).

   Example: C30 (dominant) and G (subdominant) in ponderosa pine/grass communities.

   Vegetation Type:

N	**N**o Vegetation (bare soil, rock)
B	Sage**B**rush (sagebrush, greasewood, rabbit brush, etc.)
G	Annual **G**rasses, herbs, and forbs.
P	**P**erennial grasses, sedges and rushes
S	**S**hrubs (willow, salmonberry, some alder)
D	**D**eciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.)
M	**M**ixed conifer/deciduous (approx. a 50:50 distribution)
C	**C**oniferous Dominated (canopy more than 70% conifer)

   Size Class. Use groupings for the estimated diameter at breast height (dbh) expressed in centimeters of the dominant trees. Estimate diameter of young conifers below the first whorl of branches. Enter just the first number(s) of any choice.

1- 3	Seedlings and new plantings.
3-15	Young established trees or saplings.
15-30	Typical sizes for second growth stands. West side communities may have fully closed canopy at this stage.
30-50	Large trees in established stands.
50-90	Mature timber. Developing understory of trees and shrubs.
90+	Old growth. Very large trees, nearly always conifers. Plant community likely to include a combination of big trees, snags, down woody debris, and a multi-layered canopy.

   These size classes correspond to dbh estimated in inches of: <1, 1-5, 6-11, 12-20, 21-35, and 36+ respectively.

8. **Land Use.** Determined from observations of terraces and hill slopes beyond the riparian zone. Code subdominant land use where appropriate. Separate entries for the dominant and subdominant land uses (i.e. PT (dominant) and HG (subdominant) = **P**artial cut **T**imber and **H**eavy **G**razing).

AG	**AG**ricultural crop or dairy land.
TH	**T**imber **H**arvest. Active timber management including tree felling, logging, etc. Not yet replanted.
YT	**Y**oung Forest **T**rees. Can range from recently planted harvest units to stands with trees up to 15 cm dbh.
ST	**S**econd growth **T**imber. Trees 15-30 cm dbh in generally dense, rapidly growing, uniform stands.
LT	**L**arge **T**imber (30-50 cm dbh)
MT	**M**ature **T**imber (50-90 cm dbh)
OG	**O**ld **G**rowth Forest. Many trees with 90+ cm dbh and plant community with old growth characteristics.
PT	**P**artial cut **T**imber. Selection cut or shelterwood cut with partial removal of large trees. Combination of stumps and standing timber. If only a few live trees or snags in the unit, describe in note column.
FF	**F**orest **F**ire. Evidence of recent charring and tree mortality.
BK	**B**ug **K**ill. Eastside forests with > 60% mortality from pests and diseases. Enter bug kill as a comment on the unit sheet when it is observed in small patches.
LG	**L**ight **G**razing Pressure. Grasses, forbs and shrubs present, banks not broken down, animal presence obvious only at limited points such as water crossings. Cow pies evident.
HG	**H**eavy **G**razing Pressure. Broken banks, well established cow paths. Primarily bare earth or early successional stages of grasses and forbs present.
EX	**EX**closure. Fenced area that excludes cattle from a portion of range land
GN	**G**ree**N** way. Designated Green Way areas, Parks (city, county, state).
UR	**UR**ban
RR	**R**ural **R**esidential
IN	**In**dustrial
CR	**C**onservation area or wildlife **R**efuge.
MI	**MI**ning
WL	**W**et**L**and.
NU	**N**o **U**se identified.
WA	Designated **W**ilderness **A**rea

9. **Water Temperature.** Stream temperature recorded at each reach change or a minimum of once per page of Unit 1 data. Record time. Note if temperature is ^{o}C or ^{o}F.

   At named tributary junctions record the stream temperature just above the tributary and in the tributary. Identify and record each temperature in the appropriate line of the Unit 1 Note column.

10. **Stream Flow.** Description of observed discharge condition. Best observed in riffles. If a gauging station is present, be sure to record the stage height.

    DR **DR**y
    PD **P**uddled. Series of isolated pools connected by surface trickle or subsurface flow.

    LF **L**ow **F**low. Surface water flowing across 50 to 75 percent of the active channel surface. Consider general indications of low flow conditions.
    MF **M**oderate **F**low. Surface water flowing across 75 to 90 percent of the active channel surface.
    HF **H**igh **F**low. Stream flowing completely across active channel surface but not at bankfull.
    BF **B**ankfull **F**low. Stream flowing at the upper level of the active channel bank.
    FF **F**lood **F**low. Stream flowing over banks onto low terraces or flood plain.

11. **Location.** Township, range, section and quarter at the start of the reach. Use the following example as the format: T10S-R5W-S22SE.

12. **Photo Number and Time.** Take a photograph that shows the stream and riparian zone at each reach change. Record the exposure number and the time shown on the camera on the reach sheet and the photo record sheet.

13. **Reach Note.** Additional space for comments, names of tributaries, land ownership, and reach start location. Abbreviate by ownership code or use names of forest, timber companies, ranches, etc. when known.

    P **P**rivate
    M **M**unicipal
    C **C**ounty
    T **T**ribal
    GN **G**ree**N**way
    FW Oregon Department of **F**ish and **W**ildlife
    BL **B**ureau of **L**and Management
    SF **S**tate **F**orest
    NF **N**ational **F**orest
    US **US** Fish and Wildlife Service
    WA **W**ilderness **A**rea

14. **Sketch.** Make a sketch of the channel and valley cross section for each reach in one of the boxes provided on the reach form. Identify the reach number in the box. Label and give approximate measurements and dimensions for important features. Record GPS UTM coordinates.

REACH SURVEY SHEET

PAGE: 1 OF: 1

STREAM: EXAMPLE CREEK

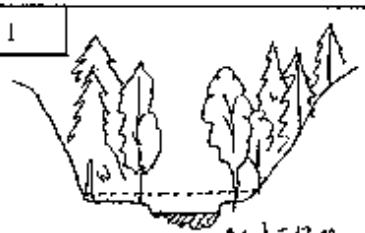
CREW: JANE DOE, JOHN DOE

BASIN: N. SOMEWHERE R.

USGS 7.5' MAP NAMES: CEDAR BUTTE

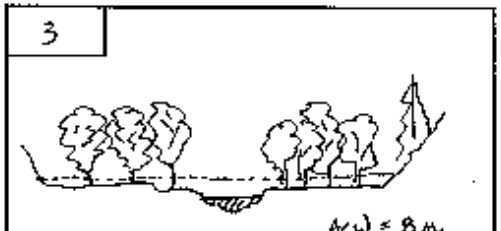
DATE	REACH #	UNIT NUMBER	CHANL FORM	VALLEY FORM	VWI	VEG CLASS DOM.	VEG CLASS SUB-DOM.	LAND USE DOM.	LAND USE SUB-DOM.	WATER TEMP	STRM FLOW	LOCATION TWN-RNG-SEC-1/4	PHOTO # /TIME	REACH NOTE
7/2/98	1	1	CH	MV	2	M30	D3	LT	YT	14°C	MF	T2S-R5W-20NW	10/09:12	BEGIN SURVEY @ CONFLUENCE W/ MAPLE CK.
7/2/98	2	97	CT	CT	3	M30	—	LT	RR	14°C	MF	T2S-R5W-20SE	15/11:30	TRIB JCT. - BLK CK.
7/3/98	3	180	US	MT	5	D15	S	YT	—	15°C	MF	T2S-R5W-29NE	16/10:15	
7/3/98	4	257	CH	MV	1.5	D30	S	ST	YT	15°C	MF	T3S-R5W-15E	20/13:10	COUNTY ROAD # 17A
7/7/98	5	391	CH	MV	1.5	D30	S	ST	YT	14°C	MF	T3S-R5W-15W	22/14:15	TRIB JCT. - BEAR CK.
7/7/98	6	440	CH	SV	1.0	C30	—	LT	—	14°C	MF	T3S-R5W-10NE	26/14:45	

1



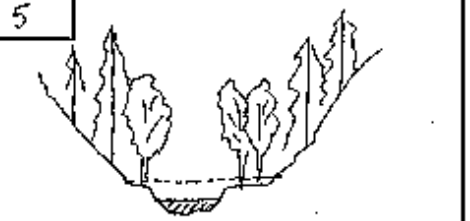
2

3



4

5



6

UNIT-1 FORM

This data sheet is completed by the "Estimator" member of the field crew.

- Crews work upstream, identifying and characterizing the sequence of habitat units.

- **At tributary junctions:**

  Tributary channel junctions (confluence with a tributary) are identified and noted by comment code on the Unit 2 data sheet. Record the active channel width and temperature of the tributary in the note column.

  At each channel junction, estimate the percent of total flow in each channel. Proceed up the named stream on the USGS topographic map regardless of flow. If neither channel is named, proceed up the channel with the greatest flow.

  Survey the portion of tributaries that flow across the active channel up to the bank full level. Tributary channel units will be numbered and sequenced from the point where the tributary enters the main channel. Be sure to use the proper channel type code. Survey and record a minimum of one unit for each tributary and additional units (if applicable) that would become part of the main channel at bankfull flow. Mark the topo map referencing the unit number of the unit into which the tributary flows.

- **In braided channels:**

  Continue upstream, always taking the channel with the greatest flow, until reaching the unit where the stream again forms a single channel. Backtrack, then survey the sequence of units in the secondary channel, then the sequence of units in the tertiary channel, etc.

  For particularly complex areas, make a simple sketch in the field book showing the sequence of channel units (type and number) and location of channels.

1. **Reach.** The number of the reach; links unit data to reach data.

2. **Unit.** The sequential number describing the order of channel habitat units. A reach is comprised of many channel units.

3. **Unit Type.**

The concept of a channel habitat unit is the basic level of notation for our survey methodology. We subdivide the stream into two general classes of unit types: channel geomorphic units and special case units.

Channel geomorphic units are relatively homogeneous lengths of the stream that are classified by channel bed form, flow characteristics, and water surface slope. With some exceptions, channel geomorphic units are defined to be at least as long as the active channel is wide. Individual units are formed by the interaction of discharge and sediment load with the channel resistance (roughness characteristics such as bedrock, boulders, and large woody debris). Channel units are defined (in priority order) based on characteristics of (1) bedform, (2) gradient, and (3) substrate.

Special case units describe situations where, because of stream flow level or a road crossing, the usual channel geomorphic unit types do not occur. Special case units include dry or partly dry channels, and culverts.

GEOMORPHIC CHANNEL UNITS

Characteristic water surface slopes are given for each group of habitat unit types. However, channel bed form and flow characteristics are the primary determinant of unit classification. Use the unit's slope to help make determinations when the other characteristics are ambiguous.

POOLS (water surface slope usually zero)

PP **P**lunge **P**ool: Formed by scour below a complete or nearly complete channel obstruction (logs, boulders, or bedrock). Substrate is highly variable. Frequently, but not always, shorter than the active channel width.

SP **S**traight scour **P**ool: Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross section.

LP **L**ateral scour **P**ool: Formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Asymmetrical cross section. Includes corner pools in meandering lowland or valley bottom streams.

TP **T**rench **P**ool: Slow flow with U or V-shaped cross section typically flanked by bedrock walls. Often very long and narrow with at least half of the substrate comprised of bedrock.

DP **D**ammed **P**ool: Water impounded upstream of channel blockage (debris jams, rock landslides).

BP **B**eaver dam **P**ool: Dammed pool formed by beaver activity. In most cases this will be preceded by a SD (step over beaver dam).

SUBUNIT POOLS

Alcoves, backwaters, and isolated pools are types of habitat subunits; generally not as long as the full channel width. They are, however, generally easy to identify and are important habitat types. Alcoves, backwaters, and isolated pools are formed by eddy scour flow near lateral obstructions.

AL **AL**cove: Most protected type of subunit pool. Alcoves are laterally displaced from the general bounds of the active channel. Substrate is typically sand and organic matter. Formed during extreme flow events or by beaver activity; not scoured during typical high flows.

BW **B**ackwater **P**ool: Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble.

IP **I**solated **P**ool: Pools formed outside the primary wetted channel, but within the active channel. Isolated pools are usually associated with gravel bars and may dry up or be dependent on inter-gravel flow during late summer. Substrate is highly variable. Isolated pool subunits do not include pools of ponded or perched water found in bedrock depressions.

GLIDES

GL **G**lide: An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1 % slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity. There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993).

RIFFLES

RI **R**iffle: Fast, turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross section. Low gradient; usually 0.5-2.0% slope, rarely up to 6%.

RP **R**iffle with **P**ockets: Same flow and gradient as Riffle but with numerous sub-unit sized pools or pocket water created by scour associated with small boulders, wood, or stream bed dunes and ridges. Sub-unit sized pools comprise 20% or more of the total unit area.

RAPIDS

RB **R**apid with protruding **B**oulders: Swift, turbulent flow including chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Moderate gradient; usually 2.0-4.0% slope, occasionally 7.0-8.0%.

RR **R**apid over Bed**R**ock: Swift, turbulent, "sheeting" flow over smooth bedrock. Sometimes called chutes. Little or no exposed substrate. Moderate to steep gradient; 2.0-30.0% slope.

CASCADES

CB **C**ascade over **B**oulders: Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. Fast, turbulent, flow; many hydraulic jumps, strong chutes, and eddies; 30-80% white water. High gradient; usually 3.5-10.0% slope, sometimes greater.

CR **C**ascade over Bed**R**ock: Same flow characteristics as Cascade over Boulders but structure is derived from sequence of bedrock steps. Slope 3.5% or greater.

STEPS

Steps are abrupt, discrete breaks in channel gradient. Steps are usually much shorter than the channel width. However, they are important, discrete breaks in channel gradient with 10->100% slope. Steps can separate sequential units of the same type.
Low steps (<0.3m high) in moderate to high gradient reaches formed by gravel and small cobbles on the face of transverse bars can usually be included in the next fast water unit upstream. However, small steps (<0.3m high) that separate pools may be important features in very low gradient reaches and should be recorded as individual habitat units.

Steps are classified by the type of structure forming the step.

SR **S**tep over Bed**R**ock (include hardpan and clay steps)
SB **S**tep over **B**oulders
SC **S**tep over face of **C**obble bar
SL **S**tep over **L**og(s), branches
SS **S**tep created by **S**tructure (culvert, weir, artificial dams)
SD **S**tep created by Beaver **D**am

⇨ Record the estimated height of the step in the note column and take a picture of any steps that are potential barriers to fish passage. (Note: always record a step height in the note column for the **SS** unit type regardless if a passage problem cannot be determined).

SPECIAL CASE UNIT TYPES

DU **D**ry **U**nit: Dry section of stream separating wetted channel units. Typical examples are riffles with subsurface flow or portions of side channels separated by large isolated pools. Record the length, active channel width, and all other variables for the dry areas.

PD **P**uddled: Nearly dry channel but with sequence of small isolated pools less than one channel width in length or width.

DC **D**ry **C**hannel. Section of the main channel or side channel that is completely dry at time of survey. Record all unit data, use active channel width for width.

CC **C**ulvert **C**rossing. Stream flowing through a culvert. Record all data for metal bottom culverts. However, record the substrate of the surrounding fill material when estimating the composition of substrate material.

⇨ *Record the height from the culvert lip to the stream surface (drop), diameter, material, and shape of culvert in the note column. Take a picture of any culvert that is a potential fish barrier. If possible, have a depth staff or person in the photo to reference the step height.*

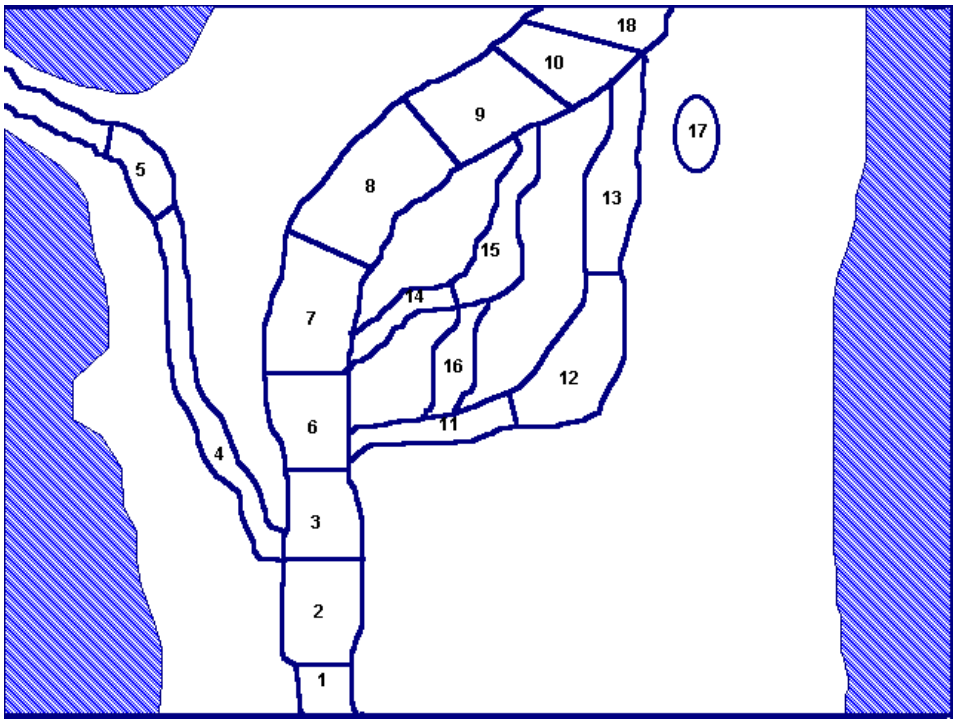
⇨ *All Culvert Crossing unit types should have a Step Structure unit type immediately preceding it unless there is absolutely no drop to the water below. If a drop exists, record a step height in the note column regardless of the height. Write "no drop" in the note column if a drop does not exist.*

4. **Channel Type.** Channel ordering code based on channel by size and location. Orders the sequence of single, multiple, and side channels.

    00 No Multiple Channels (all flow in one channel)
    01 Primary Channel (of multiple channel reach or in the unit where a tributary enters the channel)
    02 Secondary Channel (of multiple channel reach)
    03 Tertiary Channel (of multiple channel reach)
    Continue pattern for 04, 05, 06 level channels.

    10 Isolated Pools, Alcoves, or Backwater Pools.

    11 Primary channel of valley floor tributary. If the tributary has a name, write it in the note column.
    12 Secondary channel of valley floor tributary.



UNIT NUMBER	UNIT TYPE	CHANNEL TYPE	% FLOW
1	RI	00	100
2	LP	00	100
3	RB	01	90
4	RI	11	10
5	PP	11	10
6	RI	01	90
7	CB	01	80
8	RB	01	80
9	RI	01	90
10	LP	01	90
11	RI	02	10
12	LP	02	10
13	RB	02	10
14	RI	03	10
15	RP	03	10
16	RI	04	5
17	IP	10	0
18	CB	00	100

It is very important that the primary channel be identified with the proper code. This information is used in a critical step of the data analysis to calculate channel length and sinuosity.

The inventory considers the stream as the system of all channels that transport water down the drainage. The intention is to survey and quantify all aquatic habitats located within the valley floor. All active channels and unit types will be classified with a channel code and an estimate of the percent of total flow carried in each channel.

5. **Percent Flow.** Visual estimate of the relative amount of flow in the channel, in each channel where multiple channels occur, or the contribution to total flow from a tributary. Record 0% for alcove, backwater, and isolated pool unit types.

   This is difficult to measure accurately. In the past, crews have tended to overestimate the contribution from tributaries. Don't be concerned about balancing your totals for flow to 100 percent. The information is used only to identify the relative contribution or distribution of flow. Record the active channel width (ACW) of the tributary in the note column as well.

6. **Unit Length.** Length of each unit in meters. The length is estimated every unit; it is estimated and verified every 10th unit.

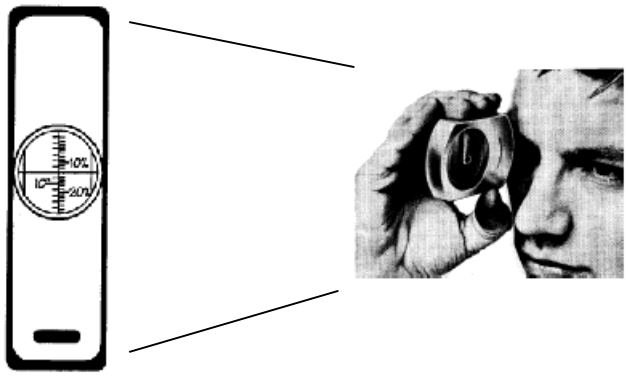
   To estimate the length of very long units, subdivide into lengths you are comfortable estimating and add them together. Do not pace the length of the unit. Except in very rare cases, no unit should be more than 100 to 150 meters long (with Oregon Plan surveys the maximum length of a unit will be 25m. for the 500 meter sites and 50m. for the 1000 meter sites).

   Long units can usually be divided at points where the stream changes direction. When long units turn corners of the stream, create a new unit before the upstream member of the crew disappears from view. Back-to-back units of the same type are acceptable when following this "line of sight" rule. Use gradient changes to identify breaks in unit lengths.

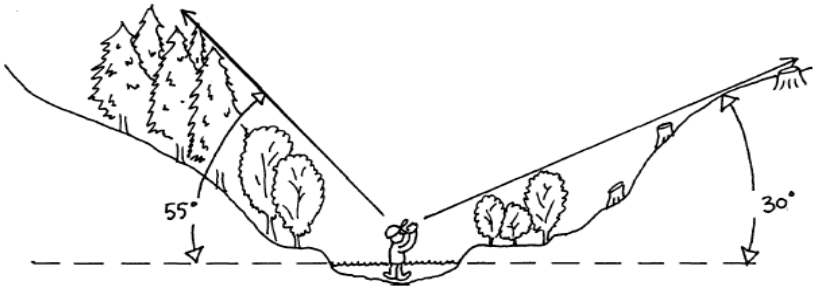
   ⇨ *Use equal effort to make good estimates on all units. Use the same technique on all units. Do not try to estimate more carefully on units you know will be verified.*

7. **Unit Width.** Width of wetted channel (estimated every unit; estimated and verified every 10th unit). Measure the average width of the entire unit. On multiple wetted channel units, such as steps over bedrock where there are several wetted slots carved into the rock, record the sum of the wetted widths.

8. **Slope.** Gradient of water surface in the unit. Expressed as the **<u>percent</u>** change in elevation over the length of the unit. Estimated with a clinometer using the scale on the right side in the viewfinder.



9. **Channel Shade.** (Shade Left and Shade Right on data sheet). Measured with the clinometer as the **<u>degrees</u>** (left side in the viewfinder) above horizontal to the top of riparian vegetation or land forms ($\leq 90^{o}$). Measured perpendicular to the channel unit on the left and right banks (see diagram below and on page 30). This variable requires integration of topographic shading and canopy closure.



10. **Active Channel Height.** Vertical distance from the streambed to the top of the active channel. Determined by measuring the average water depth of fast water units or at pool tail crest of pools and adding the distance from water surface to the top of the active channel. Measure the height at every 10th unit <u>and</u> at change in reach type.

11. **Active Channel Width.** Distance <u>across channel</u> at "bank full" flow. Bankfull flow is the level the stream flow attains every 1.5 years on average. The boundary of the active channel can be difficult to determine; use changes in vegetation, slope breaks, or high water marks as clues. Sum the width of all active channels in multichannel situations. <u>Measure</u> the active channel width every 10th unit when verifying estimates <u>and</u> at start of new reaches.

Refer to the diagrams below and in the appendix for illustrations of active channel, floodprone, and terrace measures.

12. **Floodprone Height.** The floodprone height is determined by doubling the active channel height. The floodprone height is the maximum depth in the channel during a flood event occurring approximately every 50 years. Record twice the active channel height as the floodprone height, to the nearest 0.1 meter. Measure the floodprone height every 10th unit when verifying estimates and at start of new reaches.

13. **Floodprone Width.** Distance across the stream channel and/or unconstraining terraces at floodprone height. The floodprone width is the width of the valley floor inundated during a flood event occurring approximately every 50 years. Measure the floodprone width every 10th unit when verifying estimates and at start of new reaches.

    If the floodprone width is less than 2.5 times the active channel width at that location, measure to the nearest 0.1 meter. If the floodprone width is greater than 2.5 times the active channel width at that location, simply estimate the floodprone width. The ratio of floodprone width to active channel width is necessary to determine the reach type and entrenchment ratio.

14. **Terrace Height.** The height from the streambed to the top of the high terrace. A high terrace is defined as the first terrace you encounter above the floodprone height. Measure every 10th unit and at reach changes.

15. **Terrace Width.** This is the inter-terrace distance measured from the first high terrace lip, across the stream channel, to the corresponding terrace lip on other side of the stream (TW in diagram below). Measure a terrace width and height if the following two conditions exist:

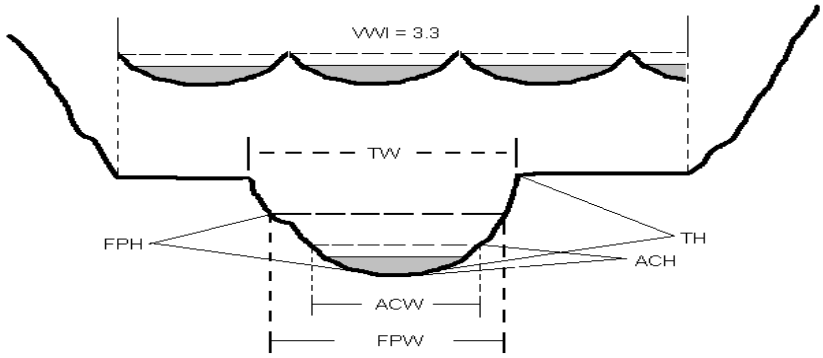
    1) The terrace height is greater than the floodprone height

    AND

    2) The terrace width is less than 4 times the active channel width.

    In multichannel situations, sum the inter-terrace width of all channels. Measure at every 10th unit (except for Oregon Plan surveys – see Appendix 1) and at start of new reaches.

16. **VWI** Valley Width Index. Same method as on the reach sheet (page 7). Additional estimates improve accuracy of average value.



17. **Note.** Any pertinent additional information or items of interest (fish or wildlife observed, evidence of pollution or illegal dumping, description of channel structure, names of roads or tributaries, etc.).

UNIT-2 FORM

Information recorded by the "Numerator" member of each field crew.

1. **Unit Number.** Corresponds to number on "Estimator" sheet.

2. **Unit Type:** Corresponds to same type on "Estimator" sheet.

3. **Depth.** Maximum depth in pools, modal or typical depth in glides and fast water units. Measure to the nearest 0.05 meter as accurately as possible in pools. Probe the bottom with the depth staff to find the deepest point. Small differences in pool depth are significant.

4. **Depth at Pool Tail Crest:** Measure the maximum depth to the nearest 0.01 meter at the pool tail crest for every pool habitat unit, with the exception of subunit pools (BW, AL, IP). This location is at the point where the water surface slope breaks into the downstream habitat unit. This point is the deepest point along the hydraulic control feature that forms the pools. For beaver ponds unit type (**BP**) that have no water flowing over the top of the dam yet there is subsurface flow through the sticks and logs of the dam, record the PTC depth as 0.01 meter.

5. **Verified Length and Width.** The measured length and width of the habitat unit. Taken at every 10th unit and called "verified units" because the actual measurements are used to calibrate the estimates made on each unit. Where a particular unit type is rare, additional measurements may be necessary; simply write in the values over the shaded part of the data sheet.

   Remember to hang a flag at every third channel metric. These correspond with the riparian transect.

6. **Substrate.** Percent distribution by streambed area of substrate material in six size classes: silt and fine organic matter, sand, gravel (pea to baseball; 2-64mm), cobble (baseball to bowling ball; 64-256mm), boulders, and bedrock. Estimate distribution relative to the total area of the habitat unit (wetted area). Round off each class to nearest 5 percent

   Do not worry about totaling your estimates to 100 percent; this will be done during analysis. Be sensitive to the difference between surface flocculants and other fine sediment. Fine sediment that <u>covers and embeds</u> gravel and cobble should be part of your estimate. A thin layer of low density fine material over bedrock or boulders should not be included.

   SL (step over log) and CC (culvert crossing) unit types can create confusion. Estimate the distribution of the <u>surrounding</u> and/or <u>supporting</u> substrate to the best of your ability. For open bottom culverts, estimate the substrate as you would a normal habitat unit.

7. **Boulder Count.** Count of boulders greater than 0.5 m in average diameter. Within this size class, include only the boulders that have any portion protruding above the water surface and those at the margin of the wetted channel. In dry units and dry channels, estimate the boulder count by including boulders with sizes and orientation similar to those counted in wetted units of the same stream.

8. **Percent Actively Eroding Bank.** Estimate the percent of the lineal distance of both sides of the habitat unit that is actively eroding at the active channel height. Active erosion is defined as actively, recently eroding, or collapsing banks and may have the following characteristics: exposed soils and inorganic material, evidence of tension cracks, active sloughing, or superficial vegetation that does not contribute to bank stability.

9. **Percent Undercut Bank.** An estimate of the percent of the perimeter of the habitat unit composed of undercut banks. Estimate at the margins of the wetted channel as an index of cover habitat.

   Look for areas that provide good hiding cover for fish. Typically, if the undercut portion extends along the bank for a meter or more, include it in your estimate. Include areas undercut beneath root wads.

10. **Comment Codes.** Comments identifying important features. Enter as many codes as appropriate. Separate items that apply to the left bank (looking upstream) from those for the right bank using a slash (/). *If a code does not exist for an observation, do not invent a code. Write a description in the note column if necessary.*

    BC **B**ridge **C**rossing. Record road name or number in note.
    BD **B**eaver **D**am. Helps to identify steps created by beavers.
    BK **B**ug **K**ill. Patches of insect or disease tree mortality.
    BV **B**ea**V**er Activity (beaver den, cut trees, etc.)
    CC **C**ulvert **C**rossing. Same as Bridge Crossing except the stream passes through a culvert. Record road name or number.
    CE **C**ulvert **E**ntry. Tributary entering through culvert. Record diameter, length, slope, and height of drop.
    CS **C**hannelized **S**treambanks. Rip-rap or other artificial bank stabilization and stream control.
    DJ **D**ebris **J**am. Accumulation of large woody debris that fills the majority of the stream channel and traps additional debris and sediment.
    FC **F**ence **C**rossing.
    GS **G**auging **S**tation.
    HS Artificial **H**abitat **S**tructure. Describe type: gabion, log weir, cabled or uncabled LWD, etc. in note. If a habitat structure spans across several habitat units record it only once. Put the comment code in the unit that is most affected by the habitat structure.
    MI **MI**ning
    PA **P**otential **A**rtificial Barrier. Potential artificial or human created barrier to upstream or downstream migration of fish. Document height, take photos and notes.

Comment Codes (continued)

PN **P**otential **N**atural Barrier. Potential natural barrier to upstream or downstream migration of fish. Document height, take photos and notes.

(Note: Barriers are relative to stream size and fish species encountering them. Consider these variables when using this comment code).

RF **R**oad **F**ord. Road that crosses within the active channel of the stream (no bridge).

SD **S**creened **D**iversion (pump or canal). Give some indication of size or capacity.

SS **S**pring or **S**eep. Usually small amounts of flow (<5% of total flow) directly entering from hillslope. For large springs, estimate the contribution to flow.

TJ **T**ributary **J**unction with named and unnamed tributaries. Use the **TJ** class only for tributaries with clearly developed channels.

UD **U**nscreened **D**iversion (pump or canal). Give some indication of size or capacity.

WL **W**ild**L**ife use of stream or riparian zone (note species) This code refers to anything except fish species. Record fish observations only in the note column. Identify species if possible.

Mass Movement: Use a two-part code. The first letter identifies the type of mass movement failure. The second letter evaluates the apparent activity of the failure. (Example: AI = inactive debris avalanche.)

Type:

E **E**arthflow: general movement and encroachment of hill slope upon the channel. These can be identified by groups of unusually leaning trees on a hillslope

L **L**andslide: failure of locally adjacent hill slope. Usually steep, broad, often shaped like a half oval, with exposed soils.

A **A**valanche: failure of small, high gradient, tributary. Often appear "spoon shaped" looking upslope. Water may flow in these intermittent or ephemeral channels that contribute alluvial soils and debris.

Condition:

A **A**ctive: contributing material now.

I **I**nactive: evidence of contribution of material during previous winter or high flows.

S **S**tabilized: vegetated scars, no evidence of recent activity.

11. **Note.** Additional information that describes the habitat unit, comment code, riparian vegetation, fish species present, measurements of steps, culverts, barriers, etc.

WOOD FORM

Objective of this effort is to apply a standardized and consistent methodology to obtain quantitative estimates of wood volume and distribution within stream reaches. Information will be used to evaluate effects on fish habitat and channel structure and to make quantitative comparisons between streams.

- Minimum size to consider is 15 cm diameter by 3 m length. Exception is root wads with cut ends which may be less than 3 m long.
- Collect data for all wood that meets the minimum size criteria. Do not attempt to evaluate its effectiveness as fish habitat.
- Count all dead pieces that are within, partially within, or suspended over the active channel, regardless of height above channel. Any live woody material is not counted.
- Estimate the entire length of all pieces; include portion outside the active channel.
- Use additional lines for each unit when more than one configuration, type, or size class of wood is present.
- Indicate grouping of pieces in individual accumulations and jams by drawing brackets around the appropriate rows in the note column.
- Location of all wood pieces within a jam is identified by the primary location or function of the jam.
- Make no entry for units where woody debris is absent.

1. **Unit Number.**

2. **Unit Type.**

3. **Debris Configuration.**

   S **S**ingle piece.
   A **A**ccumulation. Two to four pieces.
   J **J**am. More than four pieces.

4. **Debris Type.**

   N **N**atural. Broken ends or whole tree.
   C **C**ut end.
   A **A**rtificial. Part of man-made structure
   RN **R**oot wad attached to **N**atural bole.
   RC **R**oot wad with opposite end **C**ut.

5. **Debris Location.**

   S **S**ide of the channel.

   M **M**id-channel

   I **I**sland. At upstream end of mid-channel island.

   F **F**ull channel. Completely across channel within active channel. Pieces may be above the wetted channel at the time of the survey. When part of a jam, include all pieces regardless if they are touching the water, piled up, or submerged.

   O **O**ver channel. Suspended over the active channel with the ends above the active channel. Include debris with suspended bole but with branches in water.

6. **Diameter Class.** Estimate diameter of each piece at 2 meters above the base of the stem. Assign each piece or group of pieces to the closest size class (0.15, 0.30, 0.45). For pieces greater than 0.60 diameter be as accurate as possible when determining diameter and length. Measure diameter in meters.

7. **Length Classes.** Count and tally the number of pieces within each length class. Root wad less than three meters long (usually with a cut end) is a special case.

8. **Wood Note.** Note the tree species if known and any other information or assessments of the source, influence, or character of the woody debris.

   When estimating very large amounts of wood in debris jams, visually group it into length and diameter classes then count and tally onto the data sheet. Assign all jams to one unit number. Indicate in the note column if the jam spans more than one unit. Do not try to evaluate one piece at a time. ***Record and tally*** *all countable pieces.*

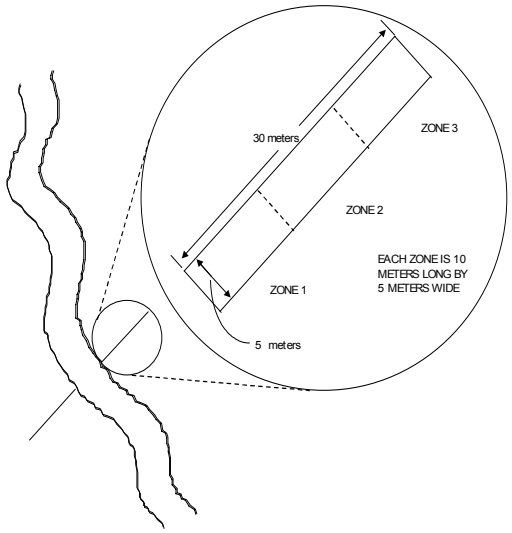
RIPARIAN FORM

Purpose: The riparian inventory is designed to provide additional quantitative information on the species composition, abundance, and size distribution of riparian zone vegetation.

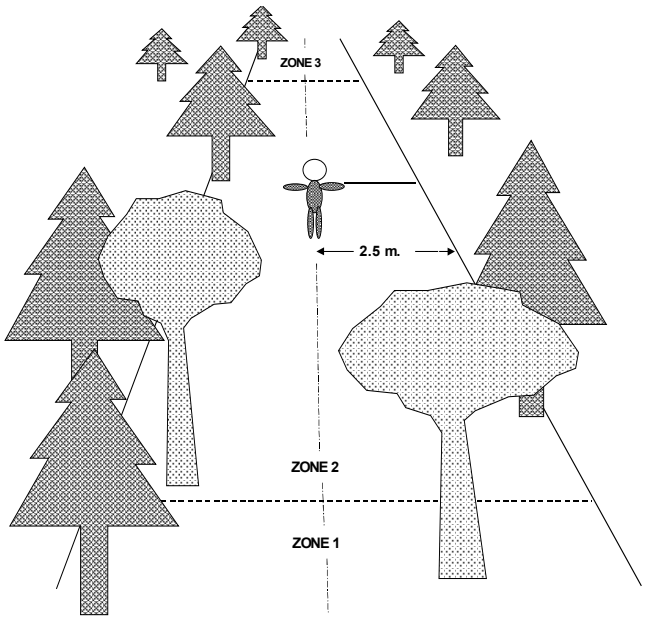
The riparian inventory will consist of a type of belt transect extending across the riparian zone perpendicular to the stream channel on each side.

Frequency: Transects will be conducted at least once every thirty units (once per unit page – except for Oregon Plan surveys – see Appendix 1) and at the beginning of all reaches. **Every** identified reach has to have at least one riparian transect. Begin the transect exactly where the new unit or new reach starts. Do not select starting point elsewhere in the unit because of ease of access or to get a "better" sample. **The location of each transect must be marked on the 7.5 minute topo map. Transects must occur at least every 1 kilometer.** Discuss transect spacing with your field supervisor if you are surveying a large stream.

Transects will begin at the margin of the active channel or where the initial band of riparian trees starts, whichever comes first. The transects will be perpendicular to the main axis of the stream and extend 30m as measured on the ground. The transects will be 5m wide and will be subdivided into three 10 meter long sections or zones (see the following diagrams).



One member of the survey crew will extend the tape measure out from the stream channel. The other crew member will follow and use the depth staff to determine if trees are within the area to be counted. Any tree that can be touched with the depth staff extended from either side of the body (practice the amount of reach you require to measure a 5m band) should be counted.



After the crews become very familiar with the method, particularly the dimensions of the sections and the size classes of trees they may visually estimate and count in difficult situations. There is no need, for example, to try and walk through 30m of blackberry bramble to measure the diameter of one or two alder trees. Likewise, it is not necessary to climb steep slopes to measure tree diameters.

Complete the following entries on the Riparian form:

1. **Unit Number.** The unit that begins where the transect is established.

2. **Side.** Left or right side of the channel, looking upstream.

3. **Zone.** Subdivision of the transect.

   1 0-10 meters
   2 10-20 meters
   3 20-30 meters

4. **Surface.** Geomorphic surfaces observed within the zone. If more than one surface is observed, record the more dominant feature and make a note of the other feature in the note column. Note length of each feature. Explain any ambiguous observations in the note column.

   FP **F**lood**P**lain
   LT **L**ow **T**errace (height is < Flood Prone Height)
   HT **H**igh **T**errace (height is > Flood Prone Height)
   HS **H**ill**S**lope

   SC **S**econdary **C**hannel
   TC **T**ributary **C**hannel
   IP **I**solated **P**ool or unconnected valley wall channel.
   WL **W**et**L**and bog or marsh with no obvious channel.

   RB **R**oad **B**ed (indicate surface type in note column i.e. paved, rock)
   RG **R**ailroad **G**rade
   RR **R**ip **R**ap

5. **Slope.** Measure the **percent** slope (NOT degrees) of the dominant surface in the zone.

6. **Canopy Closure.** The percent canopy closure estimated by looking up while standing in the middle of the zone. Include the influence of both conifer and hardwood species. Estimate within broad categories (20% increments).

7. **Shrub Cover.** The percentage of ground cover provided by shrubs. Include blackberry, salmonberry, devils club, willow, sage, etc. Small trees (seedlings and samplings less than 8 feet high) should be included in shrub cover. Estimate within broad categories (20% increments).

8. **Grass and Forb Cover.** The percentage of ground cover provided by grasses, ferns, moss, herbs, sedges, rushes, etc. Estimate within broad categories (20% increments).

9. **Tree Group.** Conifer or hardwood.

10. **Count.** Tally of trees by diameter class. Measured in centimeters as: 3-15, 15-30, 30-50, 50-90, or 90+.

11. **Riparian Note.** Optional comments that describe tree species or the plant community, large woody debris, or characteristics of snags or old stumps. Note presence or absence of large down wood in riparian zone. Record the riparian photo number and time in this column as well.

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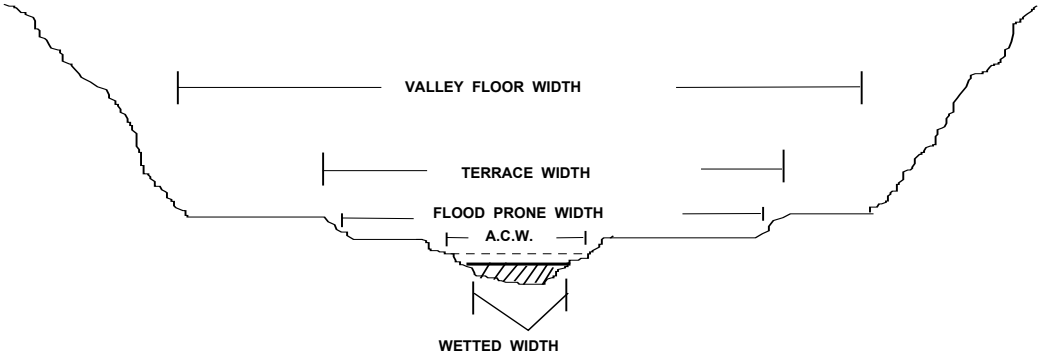
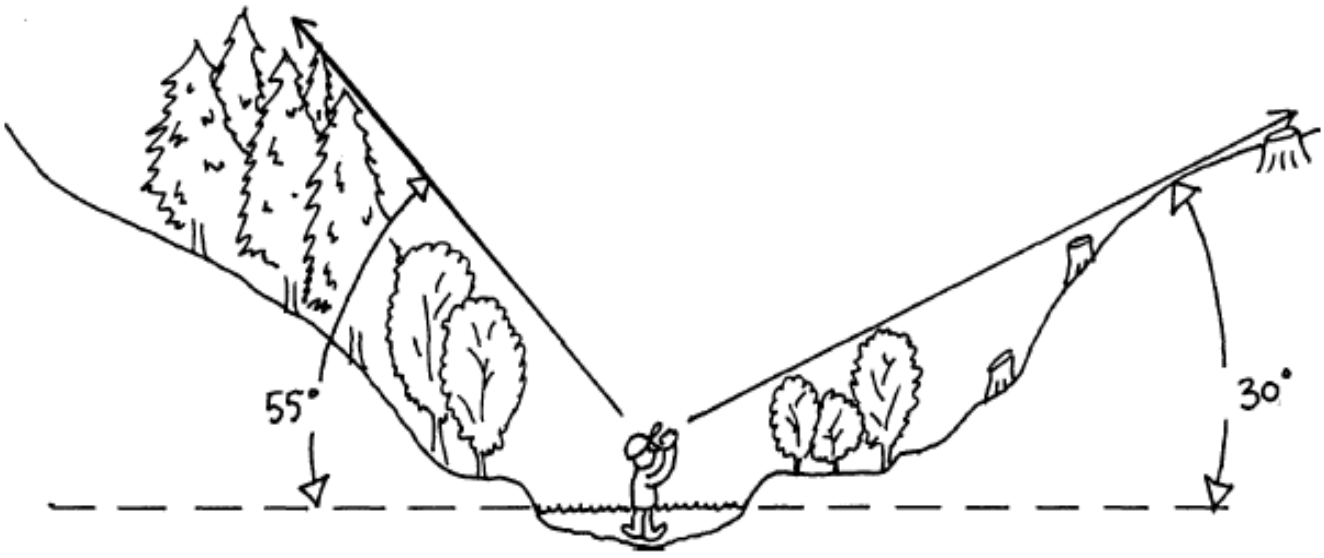
APPENDIX 1: MEASUREMENTS AND MAP EXAMPLE

ACTIVE CHANNEL, FLOOD PRONE, TERRACE, AND VALLEY FLOOR WIDTHS

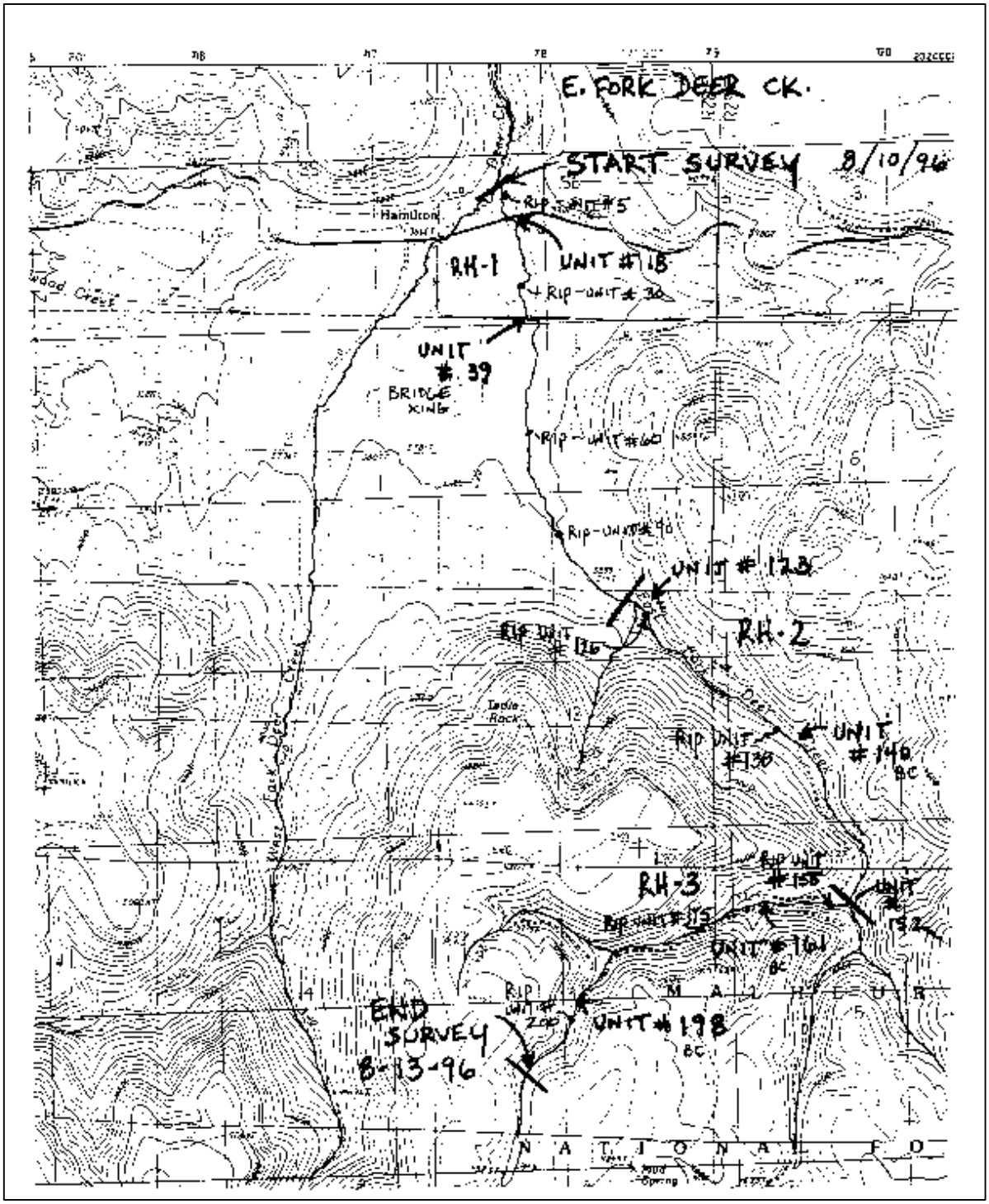


CHANNEL SHADE

Use of the clinometer to estimate topographic and vegetative shading.



EXAMPLE OF MAP DETAIL



APPENDIX 2: CHANNEL AND VALLEY FORM SUMMARIES

TABLE 1: POSSIBLE REACH – CHANNEL – VALLEY COMBINATIONS

CHANNEL FORM	VALLEY FORM					
	VWI < 2.5			**VWI > 2.5**		
CHANNEL	**NARROW VALLEY FLOOR**			**BROAD VALLEY FLOOR**		
CONSTRAINED:	STEEP V	MOD. V	OPEN V	HIGH TERRA	MULT. TERR	FLOODPLAIN
BEDROCK	CB - SV	CB - MV	CB - OV			
HILLSLOPE	CH - SV	CH - MV	CH - OV			
ALT. HILLSLOPE TERRACE				CA - CT	CA - MT	
HIGH TERRACE				CT - CT	CT - MT	
LAND USE				CL - CT	CL - MT	CL-WF
CHANNEL UNCONSTRAINED:						
SINGLE CHANNEL					US - MT	US - WF
ANASTOMOSING					UA - MT	UA - WF
BRAIDED CHANNEL					UB - MT	UB - WF

Check the valley form description against the Valley Width Index.
If it does not match, is it because the reach was not described properly,
or was the ACW determined incorrectly?

Does the terrace height work with the channel and valley form calls?
Remember that a high terrace more than one ACW away from the channel on both sides is not considered constraining.

Streamside terraces are frequently present within narrow valley floors, however, remember that when VWI <2.5, it is the hillslope or bedrock that constrains the channel.

In rare cases, notably flooded bogs, multiple channel wetlands, or flooded valley bottoms due to beaver activity, the VWI = 1 but the channel is actually unconstrained. Make a note and explain.

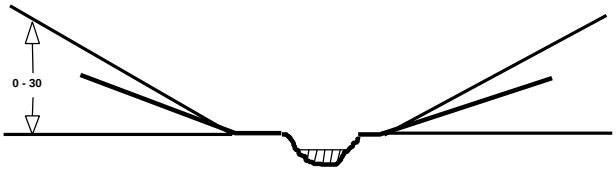
Use the spaces on the reach form to make diagrams of the reach cross section.
Label your drawings so that ambiguous or exceptional reach types can be understood.

VALLEY FORM

NARROW VALLEY FLOOR
VWI < 2.5

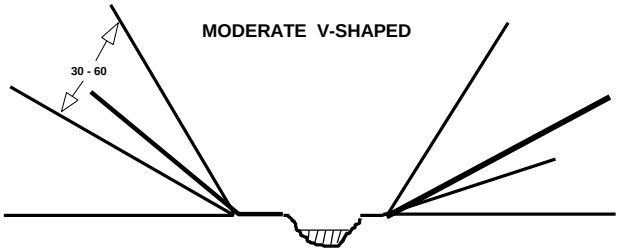
OV

OPEN V-SHAPED

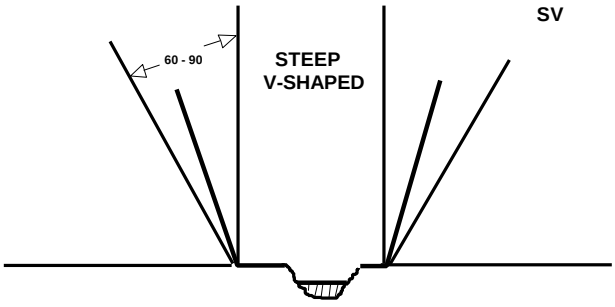


MV

MODERATE V-SHAPED



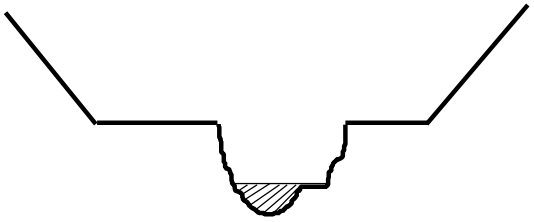
SV



BROAD VALLEY FLOOR
VWI > 2.5

CT

CONSTRAINING TERRACES

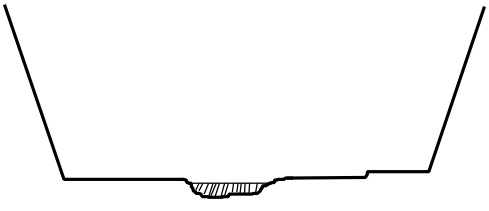


MT

MULTIPLE TERRACES

WF

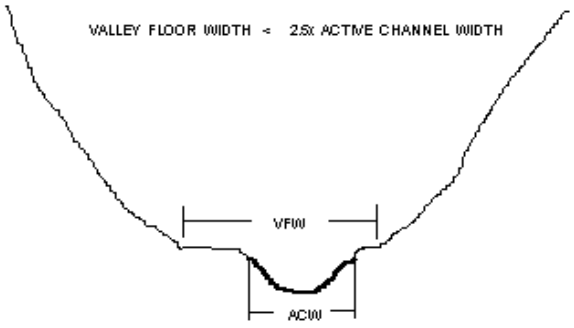
WIDE - ACTIVE FLOODPLAIN



CHANNEL FORM

HILLSLOPE CONSTRAINED

VALLEY FLOOR WIDTH < 2.5x ACTIVE CHANNEL WIDTH



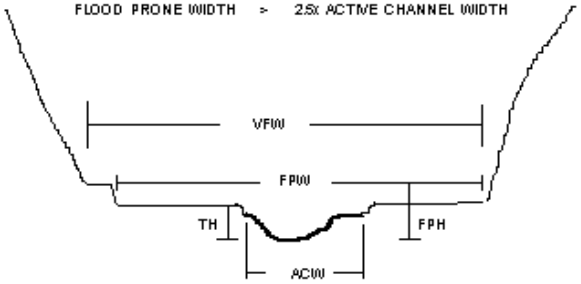
CH

US

UNCONSTRAINED

VALLEY FLOOR WIDTH > 2.5x ACTIVE CHANNEL WIDTH

FLOOD PRONE WIDTH > 2.5x ACTIVE CHANNEL WIDTH



UA

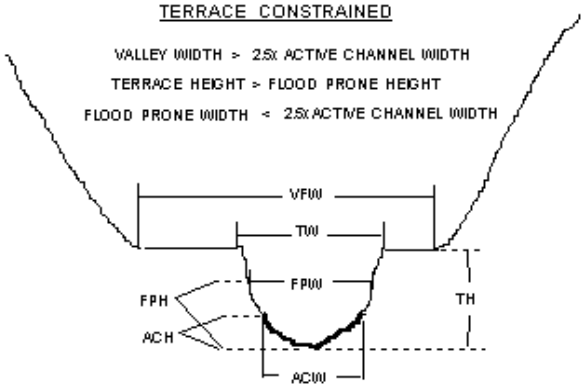
UB

TERRACE CONSTRAINED

VALLEY WIDTH > 2.5x ACTIVE CHANNEL WIDTH

TERRACE HEIGHT > FLOOD PRONE HEIGHT

FLOOD PRONE WIDTH < 2.5x ACTIVE CHANNEL WIDTH



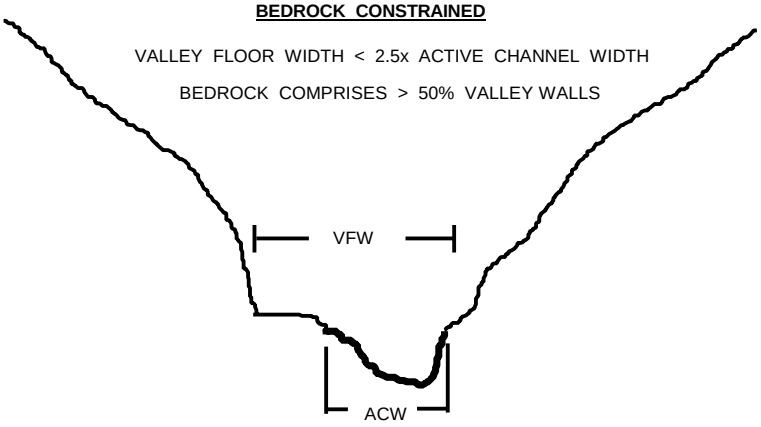
CT

CHANNEL FORM (cont.)

BEDROCK CONSTRAINED

VALLEY FLOOR WIDTH < 2.5x ACTIVE CHANNEL WIDTH

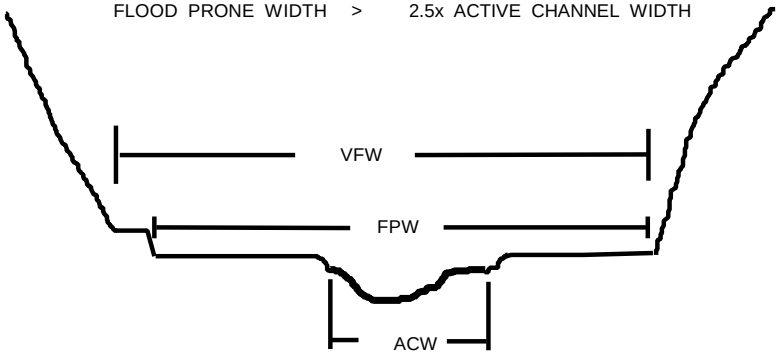
BEDROCK COMPRISES > 50% VALLEY WALLS



UNCONSTRAINED

VALLEY FLOOR WIDTH > 2.5x ACTIVE CHANNEL WIDTH

FLOOD PRONE WIDTH > 2.5x ACTIVE CHANNEL WIDTH



APPENDIX 3: EQUIPMENT CHECK LIST

IN STORAGE BOX:

- ☐ ATLAS (Oregon Atlas and Gazetteer. DeLorme Mapping $14)
- ☐ AMPHIBIAN FIELD IDENTIFICATION GUIDE ($14.95)
- ☐ USGS TOPOGRAPHIC MAPS (must have for each stream)
- ☐ CAMERA / FILM / MAILER ENVELOPES (Olympus Dateback $225) (color slide film and mailers $90 nine rolls)
- ☐ CLINOMETER (Sunto instruments $125)
- ☐ CLIPBOARDS (fiberback $2, and/or metal $20)
- ☐ COMPASS ($20)
- ☐ GPS unit (recommended $175 - 300)
- ☐ DATA FORMS / FILE BOX (forms from ODFW, box $5)
- ☐ FIBERGLASS MEASURING TAPE (60m metric Kesson $65)
- ☐ FIELD BOOK ("Rite in the Rain" Line Rule or Level $3)
- ☐ FLAGGING TAPE (four rolls blue and white stripe $8)
- ☐ SURVEY METHODS AND INSTRUCTIONS
- ☐ THERMOMETER (Pocket Celcius scale $10)
- ☐ VESTS (optional Filson Cruiser Vest $45 each)
- ☐ STORAGE BOX (Rubbermade Action Packer $20)
- ☐ CB RADIO (optional for some crews)
- ☐ PENCILS, SHARPIE WATERPROOF MARKER ($3)
- ☐ FIRST AID KIT ($45)

OTHER:

- ☐ DEPTH STAFF (2m long marked every 5cm)
- ☐ HATS AND UNIFORM SHIRTS (ODFW personnel only)
- ☐ HIP BOOTS ($60-90 x2)
- ☐ WADERS ($70-110 x 2)
- ☐ WADING SHOES ($45-75 x 2)
- ☐ RAINGEAR ($45-75 x 2)

All equipment must be checked in at the end of the field season. You supervisor will replace hip boots, wading shoe felts, and other equipment that may become worn out during the summer. Keep your supervisor informed of your equipment needs.

APPENDIX 4: EXAMPLES OF COMPLETED DATA FORMS AND BLANK DATA FORMS FOR COPYING

REACH

PAGE:_____OF:_____

STREAM:_____

CREW:_____

BASIN: _____

USGS 7.5' MAP NAMES:_____

DATE	REACH #	UNIT NUMBER	CHANL FORM	VALLEY FORM	VWI	VEG CLASS DOM.	VEG CLASS SUB-DOM.	LAND USE DOM.	LAND USE SUB-DOM.	WATER TEMP	STRM FLOW	LOCATION TWN-RNG-SEC-1/4	PHOTO # /TIME	REACH NOTE
													/	

UTM_____
_____

UTM_____
_____

UTM_____
_____

UTM_____
_____

UTM_____
_____

UTM_____
_____

UNIT-1

PAGE:________OF:_________

STREAM:____ DATE:______________________ ESTIMATOR:_________________________________

REACH	UNIT	UNIT	CHANL	%	UNIT	UNIT	SLOPE	SHADE (0-90)		ACTIVE CHANNEL		FLOOD PRONE		TERRACE			NOTE
#	#	TYPE	TYPE	FLOW	LENGTH	WIDTH	%	LEFT	RIGHT	HT.*	WIDTH	HT.	WIDTH	HT.	WIDTH	VWI	

* MEASURE FROM THE STREAMBED TO THE TOP OF THE ACTIVE CHANNEL . TAKE THE MEASUREMENT AT POOL TAIL CREST ON POOL UNITS.

UNIT-2

PAGE:________ OF:________

STREAM:____ DATE:______________________________ NUMERATOR:____________________________

UNIT	UNIT	DEPTH*	DEPTH**	VERIFIED		PERCENT SUBSTRATE						BLDR	% ACTIVE	% UNDER	COMMENT	NOTE
#	TYPE		PTC	LENGTH	WIDTH	S/O	SND	GRVL	CBLE	BLDR	BDRCK	COUNT	EROSION	CUT	CODES	
V																
V																
V																

AX DEPTH POOLS - MODAL DEPTH IN FAST WATER UNITS

** ONLY MEASURED @ POOLS (EXCEPT OFF-CHANNEL POOLS)

WOOD

PAGE:_____ OF:_____

STREAM:_____ DATE:_____ NAME:_____

UNIT NUMBER	UNIT TYPE	DEBRIS CONFIG	DEBRIS TYPE	DEBRIS LOCAT	DBH CLASS	LENGTH CLASS (m) RW <3	3	6	9	12	15	18	21	24	28	32	36+	WOOD NOTE

RIPARIAN

PAGE:_____ OF:_____

STREAM:_____ DATE:_____ NAME:_____

UNIT					CANOPY	SHRUB	GRASS/FORB	COUNT (DBH in CENTIMETERS)						RIPARIAN NOTE
NUMBER	SIDE	ZONE	SURFACE	SLOPE	CLOSURE	% COVER	% COVER	TREE	3-15	15-30	30-50	50-90	90+	
	LEFT	1						CONIFER						
								HARDWOOD						
		2						CONIFER						
								HARDWOOD						
		3						CONIFER						
								HARDWOOD						
	RIGHT	1						CONIFER						
								HARDWOOD						
		2						CONIFER						
								HARDWOOD						
		3						CONIFER						
								HARDWOOD						
	LEFT	1						CONIFER						
								HARDWOOD						
		2						CONIFER						
								HARDWOOD						
		3						CONIFER						
								HARDWOOD						
	RIGHT	1						CONIFER						
								HARDWOOD						
		2						CONIFER						
								HARDWOOD						
		3						CONIFER						
								HARDWOOD						

APPENDIX 5: METHODS FOR RANDOM HABITAT SURVEYS

Oregon Plan Monitoring Surveys
Aquatic Inventories Project

Introduction:

An important objective of the Oregon Plan for Salmon and Watersheds was to determine current salmon habitat conditions and track trends in habitat over time. In order to accomplish this goal a long-term monitoring program incorporating coordinated stream habitat surveys, juvenile snorkeling inventories and spawning salmon surveys was developed. All field surveys encompass a point randomly selected using a GIS. Methods for the habitat survey portion of the monitoring effort are similar to the basin surveys that have been conducted by the ODFW Aquatic Inventories Project since 1990. Due to the standard survey length of the monitoring sites, some measurements are taken at increased frequency while others are omitted. These survey modifications are specific to the monitoring surveys, not to a comprehensive basin survey.

Site Set-up

It is crucial that the field surveys are set-up correctly. Some sites will be shared by all Oregon Plan monitoring programs during the same survey season and between years. There are some specific guidelines that need to be followed for site set-up to be successful.

- ✓ Surveys need to encompass the point identified for the site.
- ✓ Spawning survey signs may NOT be crossed when setting up a survey. If a spawning survey sign occurs before the point has been surveyed move the survey up to the spawning survey sign. If the spawning survey sign occurs after the point has been surveyed then move the start of the survey further down stream.
- ✓ Include only one homogenous reach in survey (see reach section below)
- ✓ Coordinate with Juvenile Snorkel survey crews to survey common sites together. If it is not possible to coordinate with them, make sure to share survey set up information.
- ✓ If you have questions about the set-up of a site contact your field supervisor or Becky.
- ✓ Clearly mark sites and take GPS readings at start and end points whenever this is possible.

Site Marking

GPS coordinates will be taken at the start and end of the survey and will be recorded on the reach sheet. They will also be saved on the GPS unit with the site code and S for start or E for end. The GPS units will be downloaded at the end of the season to extract stored information.

GPS GCA codes:

N – North Coast

M – Mid Coast
U – Umpqua
C – Mid-south coast (based out of Charleston)
S – South Coast

Example: the GPS unit coding for site Mid-coast 345 should be: start point M345S and end point M345E

Yellow site tags and flagging will be placed at the start and end point of the survey with an aluminum nail. Tags will be marked with stream name, site #, and START or END. Location of the tags will be noted on the reach sheet (e.g. large conifer stump on right). Site tags and flagging should be placed on repeat surveys only when they are missing.

Photos

Photos will be taken at the start of the survey. Other photos may be taken of outstanding features of interest (such as significant barriers, debris flows, large log jams or blow down).

Reach Information

It is the goal of the habitat survey to describe stream conditions that are representative of the point selected in the original sampling design. Therefore, it is best for only one reach to be documented in the field survey. There are instances in which the beginning or end of a survey may be moved in order to accommodate a reach break.

Example: On a 1km survey, if a reach break occurs 100 meters into a survey and the survey point has not been reached move the start of the survey to the beginning of the new reach. If the same condition occurs but the point is surveyed in the first 100 meters then move the survey below your initial survey point and restart the survey so that it ends at the reach break. If you modify the survey reach make sure that the new survey does not cross a spawning survey start or end sign.

While some modification may allow the maintenance of only one reach there are instances when a reach break occurs mid-survey. If a major reach change does occur during the survey, the reach will be recorded as a separate reach and the survey will continue for the full length. Only major changes in channel and valley constraint or major tributary junctions are a reason to call additional reaches.

Habitat Unit 1 form

Flood Prone Width, Flood Prone Height, Active Channel Width, and Active Channel Height will be measured 5 times per survey. It is not necessary to break a unit at exactly these distances if it does not happen naturally. Instead, conduct these measurements at the beginning (or end) of the unit closest to the desired distance.

- For 1 km sites these will be taken at 0, 250, 500, 750 and 1000m
- For 0.5 km sites these will be taken at 0, 125, 250, 375 and 500m

All unit lengths and widths will be measured. Unit length will be measured up the center of the channel or following the thalwag in pools. The thalwag is defined as the portion of the stream carrying the most flow. In lateral pools this may be to the right or left of the center of the

stream. Unit width will be measured at the point of average unit width. In highly variable or long units, multiple widths will be measured and averaged together. If unit lengths or widths are estimated they must be noted.

In order to ensure an adequate number of habitat units, maximum lengths are:

- The maximum length of fast-water units for 1 km sites is 50m(+5m).
- The maximum length of fast-water units for 0.5 km sites is 25m(+5m).
- There is no maximum length for slow water units (pools).

If a unit will naturally end within 5 m of the maximum unit length the unit may be extended to the natural end.
Example: In a 1 km survey, if a rapid that is 55 m long is followed by a lateral scour pool, there is no need to break the rapid unit into 2 units one 50 m in length and one 5 m in length. If the rapid unit is 60m in length, 2 units would need to be identified and recorded.

Riparian Survey

Riparian transects will be conducted at three (3) points along each survey. As with channel metrics, it is not necessary to break a unit at these measurements. Conduct the transect at the beginning of the unit closest to the desired distance.

- For 1 km sites these will be taken at approximately 250, 500, and 750m.
- For 0.5 km sites these will be taken at approximately 125, 250, and 375m.

APPENDIX 6: FISH INVENTORY PROTOCOL

Oregon Plan Monitoring Surveys
Aquatic Inventories Project

Introduction

In 1998, the Oregon Plan for Salmon and Watersheds (OPSW) mandated that the Oregon Department of Fish and Wildlife (ODFW) establish annual surveys to monitor stream habitat and fish populations in Oregon coastal streams. At sites upstream of the known distribution of coho, fish are sampled with electrofishing gear to assess species composition and distribution.

The Effect of Pulsed Direct Current on Fish

Electroshocking surveys are conducted with Smith-Root backpack electrofishers that discharge direct pulsed current. When the button on the probe (anode) is pushed, an electrical circuit is completed through the water when the current flows from the negative cathode (rattail) through the water and then to the positively charged anode (probe). Fish that are on the periphery of a weak electrical current experience mild nerve excitation but still retain control of swimming ability and will escape from the field. Those under a strong electrical field experience a progressive series of reactions that culminate in immobilization. The polarized nature of body musculature often causes fish to curve toward and face the anode, but the initial orientation of fish in the electrical field results in varied directional responses. Spasmodic undulations of the musculature induced by the electrical field may also result in involuntarily swimming (electrotaxis) towards the anode probe. As fish move closer to the anode probe, they experience increased intensity of electrical current. Above a certain intensity, body muscles become cramped and fish are immobilized.

Fish close to the anode probe are quickly immobilized and may not exhibit electrotaxis. Larger fish are more easily immobilized than smaller fish because they present a greater amount of nerve tissue to the electrical field at a given distance from the anode probe. In addition to voltage the frequency and wavelength of pulsed direct current has different effects on muscles depending on fish size, species, water temperature and conductivity. Smaller fish generally require higher pulse frequencies to become immobilized. A minimum frequency exists below which fish will not be immobilized.

Fish recover the ability to swim quickly after electroshocking if the applied current is not too strong and the amount of time they are exposed to the electrical field is short. However, the fish may experience physiological stress for several days following shocking. Injury (damage to swim bladders, muscles, and skin; fractured vertebrae; and bleeding have been reported) or death can result if excessive current is applied.

The zone of potential fish injury is 0.5 m from the anode. Care should be taken in shallow waters, undercut banks, or where fish can be concentrated because in such areas the fish are more likely to come into close contact with the anode (NMFS, 2000).

Crew members should carefully observe the condition of sampled fish. Dark bands on the body and longer recovery times are signs of injury or handling stress. When such signs are noted, the settings for the electrofishing unit should be adjusted. *Sampling should be terminated if injuries or abnormally long recovery times persist even after shocker settings have been reduced.*

Safety

The use of electrofishers can be dangerous. Some fatalities have occurred with older electrofishers that lacked tilt switches. Common sense will eliminate most of the potential for injury. Prevent exposure to the electrical field. Use nets with insulated metal handles. Wear standard weight waders or boots that have no leaks.

Rubber gloves are required to be worn while electrofishing. Replace ripped or overly worn gloves. Never place bare hands in the water unless it is completely understood that the electrical current is off and the probe is removed from the water.

Stunned fish frequently need to be extracted from crevices in the streambed. Before attempting to pick up a fish, have a well understood convention with the electrofisher operator, such as the netter saying "off" and having "off" repeated by the operator after the current is stopped and the probe lifted from the water. Resume electrofishing only after both parties give an "on" command. When reaching into crevices, use only one hand and keep the other arm well out of the water. This prevents passing an arc of current through your chest. Also, there is a chance of shock if you touch the probe in the "on" position at the same time you are touching the box on the backpack.

Electrofishing methods

Technique

Electrofishing has the potential to harm or to cause direct mortality of fish. Electrofishing can also be hazardous to the survey crew if not performed correctly. Use the least amount of voltage and lowest frequency pulse that effectively immobilizes fish (see section below on Electrofishing Methods). This decreases stress and chance of injury to the fish. It also extends the amount of time on the battery charge. Increase voltage when target fish are small or when the conductivity of the water is low. Decrease the voltage and frequency if large fish are observed in the habitat unit. *Do not sample if adult salmon are observed in the unit.*

Sample at least 3 pools and 3 fastwater units totaling a minimum of 60 meters stream length. Record the fish collected in the first pool by species and size. Sample at least 15 meters of the fastwater unit immediately above the pool and record the fish captured. Walk upstream to the next pool and sample it and the fastwater unit above. Consecutive sampling is preferred. Continue sampling until 3 pool – fastwater sequences have been sampled. If a fish species or life history stage not observed in the first 4 units is captured in the 5^{th} or 6^{th} unit, sample another pool and fastwater unit. In small streams with low flow, you may have to walk a considerable distance to locate pools. In larger streams with long habitat units, you may need to subsample within unit types as well as sample a variety of unit types. If you detect a potential fish barrier in the habitat survey, electrofish above and below the barrier to determine if it impedes fish passage.

Release netted fish far enough downstream to be outside the electrical field. Carefully release fish back into the water; fish should not be exposed to air for more than a few seconds or latent mortality will likely occur.

If you are unable to identify the fish, take a close-up photo or preserve a few individuals in ethanol for later identification. Write the date, stream name, sample site code, and name of the sampling crew members on the label in the jar or ziplock. Note on the data form that a collection was made at that site.

Survey Guidelines

(Information in this section taken from Rodgers 2001 unless otherwise cited)

Do not shock when water temperatures are above 18 C (65F) or expected to be above this temperature prior to completing the electrofishing. If water temperatures are appropriate in the morning, but you anticipate that they will increase later in the day, electrofish before you complete the habitat survey.

Measure the water conductivity and record it on the Fish Survey data form. High conductivity (over 2,000 microSiemens/cc) allows the electric current to spread throughout the water, decreasing the risk to fish health because most of the current flows through the water and not the fish. With higher conductivity readings use low voltages. Water conductivity may be higher in agricultural areas due to chemicals applied to fields and associated runoff. Conductivity of water also increases with increasing water temperature (Smith-Root 1998)

Smith Root electrofishers allow for adjustment of voltage, waveform, and frequency. Start with a setting of H-4 and 200 volts if in shallow pools; H-4 and 300 volts if sampling in deeper pools (>0.8m). Note that a pool for shocking may be smaller than pools identified in a standard habitat survey. If damage to fish (visible burn marks, extended spasms or long recovery periods) is occurring, decrease voltage to 100V. If fish continue to be injured, change settings to G-3 and 100V. If damage continues, try F-3 and 100V.

Increase voltage to 300V at H-4 if only small fish are being netted and larger fish are observed swimming away from the probe or fish are not stunned long enough to net. If either of these conditions continue, increase settings to I-4 and 200V. If this isn't catching fish, increase voltage to 300V and I-4. **Do NOT increase voltage beyond 300V.** Make sure to record shocker settings on the Fish Survey form.

The preferred method to prevent accidental mortality is to "attract" fish to the ring rather than actually "rolling" them. Keep the trigger on while "attracting" or "pulling" fish and netting them. Release trigger if you are rolling fish before you are able to net them.

The best way to get fish within an effective radius of the anode probe is to "surprise" them. Position the probe in a new area while it is turned off, turn it on only after it is in place. Sweeping a live probe about the stream merely introduces the weak border of the electrical field to new areas and fish will easily detect and escape the field. The stream should be covered systematically, moving the anode in a herringbone pattern through the water. Do not electrofish one area for an extended period. Continue shocking the habitat unit until the first pass is completed OR until at least one juvenile coho has been captured. Electrofishing of a stream must be terminated once a coho has been captured and positively identified.

Tips about the anode:

- *Do not use a net on the end of the ring.*
- *Wrapping the ring with cording may reduce damage to fish. Be sure to check the wrapped ring periodically for corrosion.*
- *Larger rings are better than smaller rings, they reduce the power gradient near the ring.*
- *Keep ring clean using a Scotch-brite pad suitable for Teflon. Do not use steel wool. Ring are fragile so be careful not to break them when cleaning.*

Tips about the cattode:

- *Add more area effected by electrical current by keeping the tail behind you in the same unit you are shocking. Be careful the cathode is not close to the anode and do not allow them to touch.*

Fish Survey Data Form

(most of the information in this section taken from "Methods from Stream Fish Inventories" 1998)

Header Information

Crew: Names of surveyors.

Stream name: Spell out the complete name of the stream being surveyed. Include the site identification number and monitoring area (MA) code.

USGS Map: Name of the USGS. 7.5 minute topographic quad.

Basin: Use the name of the large river commonly used to describe a region. For example, use McKenzie R as the basin name when sampling Lookout CR, not Willamette or Columbia.

Date: MM/DD/YY.

Notes: Additional information concerning sample site location (particularly relative to culverts or other potential barriers), type of ownership, and access roads or trails. Comments on the weather, cloud cover or precipitation, visibility and habitat condition can also be made.

UTM Start: Record the UTM coordinates at the beginning point of the fish survey.

UTM End: Record the UTM coordinates at the end point of the fish survey.

Map Code: Record the site's code including monitoring area and site id number (such as U1556 – for Umpqua site #1556). Be sure to mark all sites on topo maps and be as accurate as possible in marking sample sites on maps.

Active Channel Width: Distance <u>across channel</u> at "bank full" annual high flow estimated from change in vegetation, slope break, or high water mark. Sum the width of all active channels in multichannel situations.

Active Channel Height: Vertical distance from the stream bottom to the top of the active channel.

Stream Flow:

DR DRy
PD Puddled. Series of isolated pools connected by surface trickle or subsurface flow.
LF Low Flow. Surface water flowing across 50 to 75 percent of the active channel surface.

MF Moderate Flow. Surface water flowing across 75 to 90 percent of the active channel surface.
HF High Flow. Stream flowing completely across active channel surface but not at bankfull.
BF Bankfull Flow. Stream flowing at the upper level of the active channel bank.
FF Flood Flow. Stream flowing over banks onto low terraces or floodplain.

Water Temp: Degrees Centigrade or Fahrenheit; indicate scale used.

Gear/Method: Indicate method of sampling (i.e. snorkel, seining, or electrofishing). When electrofishing, indicate voltage setting of electroshocking unit.

Photo number and time: Take a photograph that shows the stream and riparian zone typical of the reach sampled. Record the exposure number and the time shown on the camera back. This can be the same photo used for the habitat survey.

Location: Township, range, and 1/4 section at the start of the fish survey site. Use following format: T10S R5W S22 SE. Draw a rough sketch of the stream as it appears in the topo map section in the upper right corner of the data form (see example).

Site Detail and Fish Species Information

Survey Number: The number of the unit sampled during habitat survey (if known). Not particularly important for Oregon Plan sites.

Sequence Number: The sequential number describing the order that channel units were sampled. Sample a minimum of 6 units and at least 60 meters.

Unit or Channel Type: Use the habitat types listed in the physical habitat survey methods.

Unit Length: Estimated length of each habitat unit or channel type sampled.

Depth: Maximum depth in pools, modal or typical depth in glides and other fast water habitat unit types.

Fish Code: Use the standard codes for the following species. For species not on the list, a code should be invented and an explanation of the code must be given in the note column and on every data form the invented code is used on.

standard abbreviations:

BG	bluegill	LAM	lamprey
BLB	black bullhead	MSU	mountain sucker
BR	brown trout	OC	Oregon chub
BRB	brown bullhead	PK	pumpkinseed
BSU	bridgelip sucker	PM	peamouth
BT	brook trout	PS	pink salmon
BUT	bull trout	RB	rainbow trout
CC	channel catfish	RSS	redside shiner
CH	chinook salmon	RT	redband trout

CLM	chiselmouth	SB	smallmouth bass
CO	coho salmon	SS	sockeye salmon
CS	chum salmon	ST	steelhead
CSU	largescale sucker	SU	sucker
CT	cutthroat trout	WF	mountain whitefish
D	dace		

non-standard abbreviations:

AM	ammocoetes	PGS	pacific giant salamander
AS	Atlantic salmon	RTS	reticulate sculpin
ATF	adult tailed frog	RO	roach
BD	black dace	RSN	rough skin newt
BTH	brook/bull hybrid	SH	shiner spp.
C	crappie	SKB	stickleback
CF	crayfish	SR	sandroller
COT	sculpin	SPD	speckled dace
CP	carp	SQ	northern squawfish
CTH	cutthroat hybrid	SNF	sunfish
FRG	frog (species unknown)	SF	salmonid fry (age 0+)
JSU	Jenny lake sucker	SAL	salamander
LB	largemouth bass	TC	tui chub
LND	longnose dace	TF	trout fry (age 0+)
MF	western mosquitofish	TFT	tailed frog tadpole
MMS	Malheur mottled sculpin	UT	unknown trout
MS	mottled sculpin	US	unknown salmonid
X	no fish found	YP	yellow perch

Count: Tally of the number of fish grouped by species and size class.

Note: Indicate whether length was estimated (E) or measured (M) in comments column. Write measured lengths in all columns as needed. Also indicate pass number when separate passes are made within a single habitat unit (ie: E-1 for estimated 1st pass).

Electrofisher Troubleshooting

Malfunction of the electrofishing system may occur in the field and can be very frustrating. The following tips can help to resolve problems with the equipment.
Problem: Unit won't shock fish.

Possible Solutions:

1. Dirty anode ring. Clean ring with wire wheel or abrasive pad. DO NOT USE SANDPAPER!
2. Broken wire in anode pole. Try a different pole. See section on ANODE TESTING for testing anode poles.
3. Broken cathode (tail). Try a different cathode. See section on CATHODE TESTING for testing tails.

4. Battery weak or dead. Check voltmeter on front of unit with output activated. Replace battery if necessary.
5. Loose connection at battery terminals. Tighten connection if possible. If connection is broken or burned return for repair.
6. No output. Return unit for repair.
7. Unit is tilted at too steep an angle. Tip over switch is turning off unit. Make sure to stand upright when shocking.
8. Rattail is not in water. Both the probe and rattail must be in the water for a circuit to be completed.

Problem: Unit overloads.

Possible Solutions:

1. Output voltage set too high. Reduce output voltage setting.
2. Pulse width or frequency control set too high. Reduce setting.
3. Anode and cathode too close together. Increase distance between electrodes.
4. Metallic object in the water or stream bed near the shocker.

Problem: Relay clicks on and off when output activated.

Possible Solutions:

1. Broken wire in anode pole curl cord. Try a different pole.
2. Weak battery. Replace.
3. Bad connection at battery terminals. Tighten connection is possible. If connection is broken or burned return for repair.

Problem: On/Off circuit breaker trips when unit is turned on.

Possible Solution:

1. Battery connected backwards. Return unit for repair.

Anode Testing

1. Disconnect pole from shocker.
2. Connect red lead of ohmmeter to pin A in plug on end of curl cord.
3. Connect black lead of ohmmeter to anode ring or bottom of pole.
4. Set ohmmeter to read 200 ohms full scale.
5. The ohmmeter should read near zero ohms regardless of pole switch position if not the pole is bad. Shake the curl cord during this test. If the reading changes the pole is bad.
6. Connect the red lead of the ohmmeter to pin B in the pole connector.
7. Connect the black lead of the ohmmeter to pin C in the pole connector.
8. The ohmmeter should read infinite resistance until the pole switch is pressed. if not the pole is bad. Shake the curl cord during this test, if the reading changes the pole is bad.
9. Press the pole switch. The ohmmeter should read near zero ohms. If not the pole is bad. Shake the curl cord during this test, if the reading changes the pole is bad.
10. Test between each pin in the plug and the metal shell of the plug. The ohmmeter should read infinite resistance, if not the pole is bad.

Cathode Testing

1. Disconnect cathode from shocker.
2. Connect red lead of ohmmeter to pin A in plug on end of cathode.
3. Connect black lead of ohmmeter to bare cathode cable.
4. Set ohmmeter to read 200 ohms full scale.
5. The ohmmeter should read near zero ohms. If not the cathode is bad. Pull on the cable, if the reading changes the cathode is bad.
6. Connect the red lead of the ohmmeter to pin B in the cathode plug.
7. Connect the black lead of the ohmmeter to pin C in the cathode plug.
8. The ohmmeter should read near zero ohms, if not the cathode is bad.
9. Test between each pin in the plug and the metal shell of the plug. Ohmmeter should read infinite resistance, if not the cathode is bad.

Batteries

Our Smith-Root backpack electroshockers are powered by a 24 volt gel cell battery. Following some simple procedures can prolong a battery's service life. For instance:

1. Recharge batteries after every use.
2. Protect batteries both in use and in storage by periodically charging them during cold weather. Cold temperatures reduce the amount of cranking capacity a battery can offer so it is best if batteries are not left in the cold.
3. Always place batteries on a wood surface when in use or in storage. If left set directly on the ground, the battery will discharge.

References

Methods for Stream Fish Inventories. 1998. Oregon Department of Fish and Wildlife-Aquatic Inventories Project, Natural Production Section, Corvallis Oregon. Version 7.1, July 1998.

NMFS Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. 2000. National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Rodgers, Jeff. 2002. Protocols for Conducting Juvenile Coho Salmon Surveys in Oregon Coastal Streams. Oregon Department of Fish and Wildlife, Corvallis Oregon.

Rodgers, Jeff. 2001. Personal Communication.

Smith-Root Backpack Electrofishers. 1998. Smith-Root, Inc. Vancouver, WA Rev. 03.

Glossary

303(d): Section 303(d) of the Clean Water Act (CWA) establishes that states are to list (the 303(d) list) waters for which technology-based limits alone do not ensure attainment of applicable water quality standards (WQS). The 303(d) list is to be submitted by the states to EPA on April 1 of each even numbered year. The 303(d) list includes priority rankings set by the state for the listed waters. Once the impaired waters are identified, Section 303(d) requires that the states establish total daily maximum loads (TMDLs) that will meet water quality standards for each listed water, considering seasonal variations and a margin of safety (MOS) that accounts for uncertainty. EPA's regulations for implementing Section 303(d) can be found in the Codified Federal Register (CFR) for Water Quality Planning and Management at 40 CFR Part 130. The regulations define terms used in Section 303(d) and otherwise interpret and expand upon the statutory requirements.

4(d) Rules: Section 4(d) of the Endangered Species Act (ESA) directs NOAA Fisheries to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills or injures fish, and may include habitat modification. The ESA prohibits any take of species listed as endangered, but some take of threatened species that does not interfere with salmon survival and recovery can be allowed.

Aquifer: a saturated bed, formation, or group of formations which yields water in sufficient quantity to be economically useful. Water-bearing formations and ground-water reservoirs are synonyms for the word aquifer.

BMPs: Best Management Practices. General policies and practices that are generally applicable to the golf course management industry. BMPs are generally not regulatory or enforcement based.

Buffer Zone: A corridor of land of a specified width adjacent to a surface water body in which there are special management restrictions to protect and restore aquatic habitats.

Carbon Footprint: a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide. An alternative definition of the carbon footprint is the total amount of carbon dioxide attributable to the actions of an individual (which includes emissions through their energy use, but other unforeseen emissions as well) over a period of one year.

Cultural practices: Practices including mowing, fertilizing, irrigation, as well as aerification, verticutting, and top dressing. It includes any practice that focuses on maintaining healthy turfgrass, even problem solving.

Evapotranspiration (ET): a term used to describe the sum of evaporation and plant transpiration from the earth's land surface to atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and waterbodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): The basic U.S. system for

the regulation of pesticides to protect applicators, consumers, and the environment. Under FIFRA, the EPA sets the minimum standards concerning the distribution, use, and disposal of pesticides and their containers. State standards may be more stringent. It is administered by the EPA and the appropriate environmental agencies of the states.

Groundwater: The subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

Half-life: The amount of time needed for half of a chemical to degrade.

Hydrology: The study of the movement, distribution, and quality of water throughout the Earth, and thus addresses both the hydrologic cycle and water resources.

IPM: Integrated Pest Management. A coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner to meet institution programmatic pest management objectives.

MSDS: Material Safety Data Sheets. A form containing data regarding the properties of a particular substance. An important component of product stewardship and workplace safety, it is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill handling procedures.

NPDES: National Pollutant Discharge Elimination System. NPDES permits are required for storm water discharges to surface waters from construction and industrial activities and municipalities if storm water from rain or snow melt leaves your site through a "point source" and reaches surface waters either directly or through storm drainage. A point source is a natural or human-made conveyance of water through such things as pipes, culverts, ditches, catch basins, or any other type of channel.

Oregon Ground-Water Quality Protection Act of 1989: (ORS 468B. 150-190). An act that sets a broad goal for the State of Oregon to prevent ground-water contamination while striving to restore and maintain the high quality of Oregon's ground-water resources for present and future uses. DEQ has primary responsibility for implementing Oregon's ground-water protection program.

Personal Protective Equipment (PPE): OSHA requires the use of personal protective equipment (PPE) to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective in reducing these exposures to acceptable levels. Employers are required to determine if PPE should be used to protect their workers.

If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance, and use of PPE; the training of employees; and monitoring of the program to ensure its ongoing effectiveness.

Pesticide: A general term for any substance used to control pests including weeds, insects, disease organisms, rodents, and burrowing mammals. Pesticides include insecticides, herbicides, fungicides, and other natural or synthetic substances used to kill pests.

Plant Growth Regulator (PGR): A chemical that regulates plant growth.

Poa annua: An annual bluegrass that is a widespread low-growing plant in temperate climates. It is a common weed of cultivation. It occurs as a

common constituent of turfgrass, where it is also often treated as a weed. However, it is sometimes the most suitable lawn grass for many sites, and can form most of the entire grass sward in some lawns.

Recycled Water: Treated effluent from a wastewater treatment system, which as a result of treatment is suitable for a direct beneficial purpose (Oregon DEQ).

RCRA: Resource Conservation and Recovery Act. Nation's primary law governing the disposal of solid and hazardous waste.

Riparian Zone: An ecological zone of varying width adjacent to a waterway or wetland that, in a natural condition, provides critical wildlife habitat and is essential for maintaining the healthy functioning of the adjacent stream, pond, or wetland.

Safe Drinking Water Act (SDWA): The main federal law that ensures the quality of Americans' drinking water. Under SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

Sheet flow: Movement of water from impermeable to permeable areas

Storm Water: Water that originates during precipitation events. It may also be used to apply to water that originates with snowmelt or runoff water form over watering that enters the storm water system. Storm water that does not soak into the ground becomes surface runoff, which either flows into surface waterways or is channeled into storm sewers.

Surface Water: Water collecting on the ground or in a stream, river, lake, wetland, or ocean.

TMDL: Total Maximum Daily Load. A calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. TMDLs are established for water bodies on the 303(d) list.

Top Dressing: The act of adding a material to a turfgrass surface to enhance its quality and appearance such as a fertilizer spread thinly on the surface of soil or a lawn.

Verticutting: The thinning of turfgrass grasses by blades or wire tines, which cut perpendicular to the soil surface.

Water Drop Penetration Time (WDPT) Test: A method of measuring the water repellency of soil.

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Resources

Audubon Cooperative Sanctuary System

- Audubon Cooperative Sanctuary Program for Golf Courses
- Guide to Environmental Stewardship on the Golf Course, 2nd Edition
- www.golfandenvironment.org

Audubon International: www.audubonintemational.org

Center for Watershed Protection: www.cwp.org

City of Portland Parks and Recreation Division

City of Vancouver, Water Resources Protection Program: www.cityofvancouver.us/waterprotection.asp

Conservation Summaries for Strategy Habitats: www.dfw.state.or.us/conservationstrategy/document_pdf/b-habitat_1.pdf and www.dfw.state.or.us/conservationstrategy/document_pdf/b-species_2.pdf

Croplife International

Eco-Lawn: www.clark.wsu.edu/volunteer/mg/gm_tips/EcoLawn.html

Endangered Species Act: www.nmfs.noaa.gov/pr/laws/esa

Environmental Institute for Golf: www.eifg.org

First Green Foundation: www.thefirstgreen.com

Fungicide Resistance Action Committee (FRAC): www.frac.info/frac/index.htm

Golf Course Superintendents Association of America: www.gcsaa.org

GreenGolfUSAtm: www.grrengolfusa.com

Insecticide Resistance Action Committees (IRAC): www.irac-online.org

Irrigation Association: www.irrigation.org

Macroinvertebrates: www.epa.gov/owow/monitoring/volunteer/stream/vms40.html

National Resources Conservation Services (NRCS): www.nrcs.usda.gov

Network of Oregon Watershed Councils: www.oregonwatersheds.org

Northwest Turfgrass Association (NTA): www.nwturfgrass.net

Oregon Agricultural and Municipal Water Conservation Plans:
www.wrd.state.or.us/OWRD/mgmt.shtml#water_conservation

Oregon Drinking Water Protection Program: www.deq.state.or.us/wq/dwp/results.htm

Oregon Golf Course Superintendents Association (OGCSA): www.ogcsa.org

Oregon Conservation Strategy: http://www.dfw.state.or.us/conservationstrategy

Oregon Department of Agriculture (ODA): http://www.oregon.gov/ODA/index.shtml

Oregon Department of Agriculture (ODA), Soil and Water Conservation Districts:
www.oregon.gov/ODA/SWCD/index.shtml

Oregon Department of Fish and Wildlife (ODFW)

Oregon definition of IPM—Oregon Revised Statute 634.650: www.oregon.gov/ODA/PEST/ipm.shtml

Oregon Pesticide Use Reporting System

Oregon State Department of Environmental Quality

Oregon State University

Oregon Specific Storage and Disposal Guidelines/Requirements:
www.oregon.gov/ODA/PEST/disposal.shtml

Oregon Waste Reduction Assistance Program: www.deq.state.or.us/lq/hw

Oregon Water Reuse Program: www.deq.state.or.us/wq/reuse/reuse.htm

OSHA

Pacific Northwest Interactive Mapper: www.streamnet.org

Portland Parks and Recreation, Integrated Pest Management Program

Port of Portland Vegetation Management Plan

Puget Sound Partnership

Salmon-Safe

Soil and Water Conservation District (SWCD)

Total Maximum Daily Load (TMDL)
Oregon: www.deq.state.or.us/wq/TMDLs/TMDLs.htm
Washington State: www.ecy.wa.gov/programs/wq/wqhome.html

Tualatin River Watershed Council: www.trwc.org

United States Environmental Protection Agency

US Department of Agriculture (USDA)

United States Golf Association (USGA): www.usga.org

Washington State Department of Agriculture General Pesticide Rules (WA 16-228):
www.agr.wa.gov/Pestfert/Pesticides/

Washington State Department of Ecology: www.ecy.wa.gov

Washington State Department of Health: www.doh.wa.gov

Washington State legal definitions of IPM: www.ecy.wa.gov/programs/swfa/upest/legal_defs.html

Washington State Source Water Assessment Program: www.doh.wa.gov/EHP/dw/swaphome.htm

Washington State University

Washington State University—Clark County Extension

Washington State, Interagency Integrated Pest Management Consulting Committee

Washington State Waste Reduction Assistance Program: www.ecy.wa.gov/programs/hwtr/index.html

Web Soil Survey: www.websoilsurvey.nrcs.usda.gov/app/

Western Washington Golf Course Superintendents Association: www.wwgcsa.org

Xerces Society for Invertebrate Conservation: www.xerces.org