CLEAN WATER SERVICES

REVISED TEMPERATURE MANAGEMENT PLAN

February 28, 2005

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INTRODUCTION

The Tualatin River Watershed faces water quality management challenges that reflect a complex web of land uses, pollution sources and management agencies. The eastern, urbanized portion has experienced steady growth since World War II and now has a population approaching half a million. All urban streams exhibit the water quality impacts of runoff from streets, parking lots, lawns and other features of the urban landscape. The eastern portion also has two facilities that provide wastewater treatment for the majority of the population. During the late summer, the effluent from these facilities constitutes a substantial portion of the flow in the Tualatin River.

The central portion of the watershed is largely agricultural, and streams that flow through this area are affected by farm runoff and other impacts, especially in places that lack adequate vegetated buffers. In the western portion, which is dominated by forests, runoff from logging activities affects streams that contain sensitive spawning habitat for cutthroat trout and steelhead.

Reflecting the different land uses, jurisdictional boundaries and water quality impacts, the watershed has several agencies ("designated management agencies" or DMAs) that manage water quality.[1] Many streams, including the Tualatin River, run though areas managed by several of these agencies.

After an investment of several hundred million dollars during the 1990's, the wastewater treatment facilities operated by Clean Water Services are now considered state-of-the-art, and treat wastewater to some of the highest levels in the nation. They also have an exemplary record of compliance with regulatory permits. This has resulted in significant water quality improvements in the mainstem Tualatin River. Despite these achievements, much work to improve watershed health remains to be done. The Tualatin River and most of its tributaries have been designated water quality limited under Section 303(d) of the Clean Water Act, and in 2001 the Oregon Department of Environmental Quality issued TMDL requirements for bacteria, dissolved oxygen, phosphorus and temperature (2001 TMDL).[2]

Traditional water quality regulation has relied on regulating discreet, easily identifiable pollution sources, such as industrial facilities or sewage treatment plants. While this approach has resulted in significant water quality improvements, it has not addressed diffuse sources, such as runoff from farms, lawns, working forests, roads and parking lots, which are a major cause of water pollution. The traditional approach has also failed

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[1] Clean Water Services, Washington County, Clackamas County, Multnomah County, Portland, Lake Oswego and West Linn are the DMAs for the urban portion of the watershed; the Oregon Department of Agriculture is the DMA for agricultural activities, and the Oregon Department of Forestry is the DMA for forestry activities.

[2] The Clean Water Act requires that total maximum daily load (TMDL) requirements be issued for pollutants that cause streams to be water quality limited. A TMDL specifies how much of a pollutant a river can receive on a daily basis and still meet water quality standards.

to foster sufficient coordination among water quality management agencies. This has resulted in solutions that have limited scope and effectiveness.

Recognizing that many areas of the nation have reached the limit of what can be accomplished under the traditional approach, the Environmental Protection Agency recently took steps to encourage a holistic, watershed-level approach to water quality regulation and stewardship. The watershed approach looks at potentially all of the activities that impact water quality within a watershed. In furtherance of this policy, the EPA issued grants to selected water quality agencies for developing watershed-based NPDES permits[3]. Clean Water Services received one of these grants, and was recently issued a watershed-based permit by the Oregon Department of Environmental Quality.

The EPA also recently took steps to encourage "water quality trading," a means of regulatory compliance that reflects the watershed approach. The EPA describes water quality trading as follows:

> Water quality trading is an innovative approach to achieve water quality goals more efficiently. Trading is based on the fact that sources in a watershed can face different costs to control the same pollutant. Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost.
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> While trading can take many different forms, the foundations of trading are that a water quality goal is established and that sources within the watershed have significantly different costs to achieve comparable levels of pollution control.[4]

To encourage water quality trading, the EPA issued grants to state regulatory agencies for developing water quality trading programs. The Oregon Department of Environmental Quality received one of the grants and used a portion of the funds to make water quality trading a part of Clean Water Services' watershed-based NPDES permit (referred to here as "the Watershed Permit"). The Watershed Permit allows temperature credit to be traded, provided that Clean Water Services develops a Revised Clean Water Services Temperature Management Plan (Revised TMP), subject to public review and DEQ approval, which describes the measures that will be used to reduce river temperatures and explains how temperature trading will be conducted.[5] The permit also contains a list of

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[3] Under the National Pollution Discharge Elimination System, discharge permits are issued for point-sources of pollution.

[4] "Frequently Asked Questions about Water Quality Trading (EPA website, March 15, 2004 ed.) (http://www.epa.gov/owow/watershed/trading/tradingfaq.html)

[5] NPDES Watershed-Based Waste Discharge Permit issued to Clean Water Services, February 26, 2004, Schedule C, pp. 26-27.

required contents for the Revised TMP, including a Thermal Load Credit Trading Plan (TLCTP).

This document contains the Revised TMP. The original TMP was completed during October of 2003, while EPA and CWS were negotiating the Watershed Permit. It was intended as a temporary plan that would be updated following the implementation of the Watershed Permit. The Revised TMP replaces the original TMP. A copy of the original TMP, which contains a discussion of the various temperature management approaches reviewed by CWS, is contained in Appendix A.

The Revised TMP contains a summary of the applicable water quality criteria, TMDL allocations, a list of methods for reducing stream temperatures that were considered but not selected, and a list of such methods that were selected. Among the latter are two that involve water quality trading: flow augmentation and the creation of stream shade. Much of the Revised TMP concerns how these two methods will be handled for trading purposes. To simplify the organization of the document, the TLCTP has not been separately identified. Each of the required TLCTP elements has been addressed however.

The use of flow augmentation and shade to meet temperature requirements will eliminate the need for more burdensome alternatives, such as the installation of refrigeration equipment at wastewater treatment facilities, or piping treatment facility effluent to another river basin. Either of these options would be very expensive. Moreover, they would contribute to other environmental problems. Shade, on the other hand, costs several times less and benefits the environment in a number of ways, including providing species habitat, reducing flooding and erosion, and keeping sediments and other pollutants out of streams.

Finally, it should be noted that the Revised TMP and the Watershed Permit break new ground. Clean Water Services will be the first NPDES permit holder in the State of Oregon to engage in water quality trading, and the first in the country to trade temperature credit.

CHAPTER 1

WATER QUALITY CRITERIA

A. Temperature Standard

Allowable stream temperatures under the federal Clean Water Act reflect the most sensitive beneficial uses. For the lower Tualatin River, where the Durham and Rock Creek advanced wastewater treatment facilities are located, the most sensitive beneficial use is salmonid fish rearing, which occurs throughout the year. Accordingly, the temperature water quality standard for the Tualatin River is 64º F[6]. When this standard is exceeded, no measurable temperature increase resulting from anthropogenic (i.e., human-caused) activities is allowed, unless specifically authorized under a DEQ-approved surface water temperature management plan. Tualatin River temperatures during the hottest part of the summer often exceed the temperature standard, as does the temperature of the effluent from the wastewater treatment facilities, which is typically 70-72º F.

Since the time the Tualatin TMDL and the CWS NPDES permit were issued by DEQ, the Oregon temperature standard has been revised. This TMP has been written to meet the requirements as specified in the NPDES permit and thus is tailored to the former temperature standard. When the permit is revised, appropriate changes will be made to the permit and TMP to reflect the requirements of the new standard.

B. Allowed and Excess Thermal Loads

The primary function of a TMDL is to allocate allowable maximum daily pollution loads among pollution sources. The 2001 Tualatin Basin TMDL bases thermal load allocations on preventing increases in river temperature above "system potential temperature." System potential temperature is generally defined as a condition without human activities that disturb or remove vegetation.[7] The use of system potential temperature approach results in the 64º F water quality standard being achieved at the mouth of the river. Consequently, the system potential temperature is 58.5º F at the Rock Creek facility and 63.3º F at the Durham facility.

Under the 2001 TMDL, the Allowable Thermal Load for each treatment facility is that which will cause no measurable increase in river temperature above system potential temperature. "No measurable increase" is defined as no more than a 0.25º F. increase at the edge of the mixing zone. The excess thermal load ("Thermal Load to Offset") for each wastewater treatment facility is the amount of thermal load that exceeds the Allowable Thermal Load. The values in the 2001 TMDL for the Allowable Thermal Load and for the Thermal Load to Offset were calculated using a particular set of effluent and river flow/temperature conditions. The TMDL specifies that these values are subject

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[6] OAR 340-41-445(2)(b)(A)
[7] 2001 TMDL, p. 21.

to modification at the time wastewater permits are renewed if there is a change in the conditions included in the calculation.[8] Accordingly, a different set of conditions was used to calculate the thermal loads for the Watershed Permit.[9] Like the TMDL, the Watershed Permit also provides that the thermal loads can be changed if the values and assumptions used in the calculation change.

To better reflect actual conditions, the Thermal Load to Offset under the Revised TMP will be based on average daily temperature and flow conditions from July 1 through August 31 of each year and it will be calculated with respect to the system potential temperature defined by the TMDL for temperature. July 1 through August 31 was selected as the thermal measuring period because it is the temperature trading credit reconciliation period under the Watershed Permit,[10] and is the time of year when river temperatures are most likely to exceed the temperature criterion. The results of the reconciliation process apply to the entire temperature season of May 1 through October 31. Hence, if the Thermal Load to Offset is completely offset between May 1 through October 31, then Clean Water Services thermal loads will be considered completely offset for the entire temperature season.[11]

C. Temperature Reduction Methods Reviewed but not Selected

A number of approaches for reducing thermal loads were examined in preparing the Revised TMP. Those which were not selected for the Plan are listed in Table 1. Each is briefly described and a summary of the reasons why it was not selected is provided. Further detail concerning some of the approaches is provided in Appendix A.

Table 1

Method	Reasons not Included in Plan
1. Evaporative Cooling—includes cooling towers, spray ponds and cooling ponds.	Because of local climate, would not be sufficient to lower effluent temperatures to required levels.
2. Mechanical Cooling—includes refrigeration, heat pump.	Heat pump has practical limitations; high energy usage and cost; environmental problems associated with energy generation; expensive.
3. Wetlands Treatment.	Little data exists on using this option for temperature management; most likely it is only a partial solution; very large land area required.

[8] 2001 TMDL, p. 47, footnote 8.
[9] An expanded data set was available when the Watershed Permit was negotiated.
[10] Watershed Permit, Schedule D, paragraph10 (p. 45). The methodology for temperature trading is described in Section C of Chapter 1 and Section B of Chapter 2.

[11] Ibid.

4. Export Effluent Out of Basin—Rock Creek to the Columbia River; Durham to the Willamette or Columbia.	Tualatin River water quality would suffer due to flow reduction; environmental problems associated with energy generation; expensive; high energy usage (due to pumping requirements) and cost.
5. Removal of in-stream ponds.	CWS has worked with landowners to do this in the past and will continue to do so in the future. This would be a partial solution at best because in-stream ponds are not numerous.
6. Recharge groundwater with effluent	Limited application in Tualatin Basin because of local geology; environmental restrictions on underground injection of treated wastewater.

D. Selected Temperature Reduction Methods

A summary of the temperature reduction methods included in the Revised TMP is contained in Tables 2 and 3. The methods are divided into two categories: those which will be used for thermal load credit trading and those which will not. The methods that will be used for thermal load credit trading are discussed at length in Chapters 2-4. Discussion of the other methods is limited to this section.

Table 2

Selected Temperature Reduction Methods that do not Involve Trading

Method	Description
1. Reuse	Use reclaimed water for irrigation in lieu of withdrawals of water from Hagg Lake or area streams; this approach decreases thermal loads while maintaining stream flows, and will be used when it can be accomplished in a cost-effective manner.
2. Treatment Facility Improvements	The primary clarifier units at the Rock Creek and Durham wastewater facilities were recently covered. This eliminates heating by solar radiation. CWS will conduct feasibility analyses of other potential temperature reduction measures

	and will implement additional measures when it is cost-effective to do so.[12]
3. Source Control	Each industrial facility that is subject to pre-treatment requirements will be required to conduct a feasibility analysis concerning thermal reduction measures; measures that can be implemented cost-effectively will be required.

Table 3

Selected Temperature Reduction Methods that Involve Trading

Method	Description
1. Flow Augmentation	The release of stored water from Scoggins and Barney Reservoirs into the Tualatin River during the summer months
2. Shade	The creation of shade in degraded stream corridors.

Each of the methods in Table 2 above would directly reduce the thermal loads attributed to the Durham and Rock Creek facilities. This contrasts with the thermal load trading approach (Table 3), in which temperature reduction measures offset, rather than directly reduce, thermal loads. To ensure the effective and efficient use of resources, a feasibility analysis will be conducted prior to implementing any of the above measures.

Of the three methods described in Table 2, reuse has the greatest potential to reduce thermal loads. Currently, three golf courses and three athletic fields are irrigated with reclaimed water from Clean Water Services' Durham facility. Approximately 100 million gallons of water are used annually for this purpose. In addition, up to 190 million gallons of reclaimed water from Clean Water Services' Forest Grove and Hillsboro facilities are used annually to fill storage ponds. The ponds provide wildlife habitat and irrigation water for the native plant holding facility at Clean Water Services' Stream Operations Center.

Clean Water Services recently hired a new staff member to manage the development of the Clean Water Services Reclaimed Water Master Plan. The Plan will address future reuse needs and opportunities for expansion. It is expected that major consideration will be given to approaches that avoid reductions in stream flows, because flow reduction would cause additional water quality problems. Possibilities include supplying reclaimed water for irrigation in exchange for water rights leases, or in exchange for irrigation water stored in Hagg Lake. The stored water would then be used to augment stream flows.

[12] Actions that measurably reduce the temperature of the effluent will reduce the thermal load. Covering clarifiers is expected to result in only a very small reduction in the thermal load.

Expansion of reuse is hindered by the high cost of infrastructure, which includes the cost to install pipelines, storage ponds and pumping facilities, and the cost to acquire easements. Since 1990, Clean Water Services has required reclaimed water customers to pay a substantial portion of infrastructure costs. This policy has probably resulted in a slower expansion of the reuse program than would have occurred if infrastructure costs were heavily subsidized. The policy will be reviewed in the forthcoming Reclaimed Water Master Plan. Regardless of whether the policy remains in place or is changed, the utilization of existing infrastructure offers the potential to increase stream flows without large capital costs. Accordingly, Clean Water Services is currently studying the feasibility of using the pipeline owned by the Tualatin Valley Irrigation District to provide water from Hagg Lake to tributary streams for flow augmentation. Flow augmentation would occur during the late summer and fall months following the peak of the irrigation season, when the pipeline would have excess capacity.

CHAPTER 2

FLOW AUGMENTATION

As indicated in the Introduction, flow augmentation is one of two ways in which Clean Water Services will obtain tradable thermal load credits. In addressing the subject, this chapter contains a brief summary of the science of stream temperature, indicates how flow augmentation reduces stream temperature, describes the approach used to calculate thermal load trading credit for flow augmentation, and concludes with a discussion of long-range plans to increase in-stream water supply.

A. The Science of Stream Temperature

Temperature is an easily measured property of matter that indicates how warm or cold a substance is. It is a useful property because it enables the measurement of energy transfer. When two substances have different temperatures (a stream and the air above it, for example), thermal energy in the form of heat will flow from the warmer substance to the cooler one. Thermal energy transfers and temperature differences are mathematically related and one can be calculated from the other if the appropriate factors are known.

One of the most basic laws of physics is the conservation of energy, which states that energy cannot be created or destroyed. When energy changes from one form to another or is transferred from one object to another, the total amount of energy stays the same. Using this principle, it is possible to construct a “thermal energy budget” that accounts for energy transfers between a stream and its surroundings. Stream temperature changes can then be calculated from these thermal energy transfers. To summarize, the temperature of a stream is determined and can be calculated from the thermal energy that is gained and lost by the stream.

Streams gain thermal energy by a variety of processes including radiation from the sun, infrared radiation from the atmosphere, inputs of warm water, and the conduction of heat from warmer air or earth. Similarly, streams lose thermal energy from evaporation, infrared radiation from the stream, inputs of cool water, convection currents, and the conduction of heat to cooler air or earth. These processes occur simultaneously and continuously, so the temperature of a stream is constantly changing as thermal energy is gained and lost.

B. The Effect of Flow Augmentation on Stream Temperature

Stream flow plays an important part in determining stream temperature. The most obvious effect of stream flow is its influence on the relationship between energy transfers and temperature change. If two streams gain the same amount of thermal energy, the temperature of the stream with lower flow will increase more than the temperature of the one with higher flow. This is because the thermal energy gain in the higher flow stream is distributed over more water, and therefore, the temperature change is smaller.

Stream flow also affects temperature in another way that is less obvious, but often more important, than the one just described. For many streams, including the Tualatin River, a large part of the thermal energy budget is the heat gained from solar radiation. Heat gains from solar radiation are directly related to the length of time the river surface is in sunlight. The slower the water moves, the longer it is in sunlight and the more solar energy it absorbs. Water in streams with low flow moves more slowly, and therefore gains more thermal energy from the sun, than water in streams with higher flows. Consequently, it will tend to have a higher temperature.

Streams in the Tualatin Basin usually have low flows during the summer months. This occurs naturally because the summer season in Western Oregon tends to be dry. Summertime stream flows, however, are probably lower than they would be naturally because water is removed for a variety of uses, such as municipal use and irrigation, and because of other factors. Low flows in the Tualatin River are associated with higher temperatures and poorer overall water quality. To solve this problem, watershed managers have been looking for ways to restore adequate stream flows. One way to do this to release additional water from another source; this is called “flow augmentation.”

Flow augmentation from Scoggins and Barney Reservoirs during mid-summer in the Tualatin River can account for more than half of the flow in the 20-mile stretch of river between the Springhill Pump Plant (where water is pumped out for municipal and irrigation uses) and the Rock Creek WWTP (where effluent enters the river). River temperatures are several degrees cooler as a result of this flow augmentation.

C. Calculating Credit for Flow Augmentation

As previously described, flow augmentation will consist of stored water releases from Scoggins and Barney Reservoirs into the Tualatin River. The releases will occur during the summer months when large thermal energy gains from long sunny days coupled with low seasonal river flows result in high river temperatures. The decrease in river temperature caused by flow augmentation will be determined using a mathematical model of Tualatin River heat dynamics called Heat Source. Heat Source is the same model that was used by DEQ for the 2001 Tualatin Basin TMDL. To estimate the amount of shading needed, for planning purposes CWS has used several values of flow augmentation. The thermal credits from these flow augmentation values have been calculated using a refined version of the Department’s *Heat Source* model. These refinements included corrected river widths and depths and the light extinction function. This refined model was run to determine river temperature and thermal credits associated with selected flow augmentation rates, based on system potential conditions without augmentation and point source flows present but with nonpoint sources at the TMDL allocations (i.e., thermal potential riparian shading). Appendix B describes this modeling and the results obtained in more detail. Appendix B also lays out how the thermal credit associated with flow augmentation will be calculated and reported on an annual basis throughout the permit cycle.

D. Long Range Plans to Increase In-Stream Water Supply

Background

Scoggins Dam, a Bureau of Reclamation (BOR) project that created Scoggins Reservoir (Hagg Lake), was completed in 1975. At that time Clean Water Services signed a long-term contract with BOR to provide water for flow augmentation on an annual basis. The purchased water was released from the dam during the summer months and entered the Tualatin River via Scoggins Creek, a Tualatin River tributary and the conveyance channel for all water released from the dam. Clean Water Services pursued this course to ensure that there would be sufficient water in the Tualatin River to meet the requirements of its NPDES permits. Beginning in 1993, however, water releases were no longer required. Nevertheless, Clean Water Services has continued the program because of its water quality benefits.

Current Status of Flow Augmentation

The water storage capacity of Scoggins Reservoir is 53,640 acre feet. Stored water is used for municipal, recreational and industrial purposes, as well as agricultural irrigation and river flow augmentation. Clean Water Services portion, which is used entirely for flow augmentation, is 12,618 acre feet annually. An additional 1,700 feet in nearby Barney Reservoir is also available for this purpose. Barney Reservoir, which is on the Trask River, was completed in 1999 and discharges water directly to the Tualatin River.

Clean Water Services has developed flow targets for the Tualatin River which are based on managing dissolved oxygen levels. As measured at the Farmington Bridge, the flow targets are 120 cfs during early summer (May-June), 150 cfs during mid-summer (July-August), and 180 cfs during the late summer and fall (September-October). Water is released from Scoggins Reservoir at a rate that varies based on river and anticipated weather conditions. Water from Barney Reservoir is usually released at a constant rate because of operational limitations.

Currently enough stored water is available to meet the flow targets during years with normal rainfall, but not during dry years. For example, during 1992, a particularly dry year, 12,500 additional acre-feet of flow augmentation water would have been needed to reach the flow targets. Clean Water Services can request an additional 3,000 – 6,000 acre feet from the Bureau of Reclamation when current supplies are inadequate. Such purchases were made during 1992 and 2000. During 2001, another dry year, Clean Water Services purchased additional water from the Tualatin Valley Water District (TVWD) because it was unavailable from the Bureau of Reclamation. This water came from the City of Portland's Bull Run Reservoir. TVWD water is also subject to availability, and will be an increasingly less reliable source as population growth within the Portland area continues.

Long-Range Planning

In 1997, Clean Water Services, several local water management agencies, and other stakeholders commenced work on a project to determine the major water supply issues facing the Tualatin River Watershed. This work was completed in 2001. The results identified potential water supply deficits during a planning horizon that ended in the Year

2050. Additional water for flow augmentation made up a significant portion of the potential deficits.

A follow-on study completed during 2003 estimated that an additional 50,000 acre-feet of water will be needed by the Year 2050. Of this amount, 15,000 acre-feet was earmarked for flow augmentation. This would approximately double the amount currently used, and would provide enough water to meet the river flow targets for both dissolved oxygen and for temperature management, even during dry years, without requiring the purchase of additional water. During years of normal rainfall, the flow targets would be increased in order to further reduce river temperatures.

An Environmental Impact Statement is currently being prepared to evaluate alternatives for increasing the local water supply. Options being studied include increasing the size of Scoggins Reservoir by raising the height of Scoggins Dam. Following the EIS, the project partners, which include Clean Water Services, will determine whether to construct one of the supply options. Project completion, including the EIS, permitting, design and construction is expected to take six to eight years.

Additional Planning
Clean Water Services may consider additional measures for increasing in-stream water supply. These would focus on the tributaries to the Tualatin River, which, like the River itself, experience low flows during the summer months that are associated with poor water quality and poor habitat for aquatic species. Options for increasing tributary flows include the acquisition of water rights on a willing seller basis, the use of reclaimed water for irrigation in place of water withdrawn from streams, and increasing tributary flows using Scoggins Reservoir water and the current Tualatin Valley Irrigation District pipeline. As discussed in Chapter 1, Clean Water Services will study the feasibility of pursuing the latter option.

CHAPTER 3

SHADE

As indicated in the Introduction, shade is the second way in which Clean Water Services will obtain thermal load trading credits. In addressing the subject, this chapter contains a brief summary of the science of how shade affects stream temperature, lists benchmarks and a timeframe for establishing shade, describes shade programs, explains the methods that will be used to prioritize and calculate credit for shade, and describes how temperature management would be conducted during a typical year.

A. The Effect of Shade on Stream Temperature

As described previously, streams gain thermal energy from many processes, including solar radiation, infrared radiation from the atmosphere, inputs of warm water, and the conduction of heat from warmer surroundings. In the summer, the largest thermal energy input to the Tualatin River (more than 50% of the total) is infrared radiation from the atmosphere. Infrared radiation is a natural phenomenon that cannot be controlled or effectively blocked. The second largest input is solar radiation, which accounts for about 40% of the thermal energy input to the Tualatin River. Unlike infrared radiation, sunlight is easily blocked by vegetation. If Tualatin Basin streams were better shaded, total thermal energy inputs would be smaller, and streams would be cooler.

B. Calculating Credit for Shade

Shade prevents stream heating by blocking sunlight. The amount of energy that is blocked by shade along a particular stream is a function of stream width, tree height and vegetation density. All of these factors will be taken into account when determining shade credit. To account for the fact that shade can take a significant amount of time to establish, particularly on larger streams (defined as more than 7 feet across), a trading ratio of 0.5 will be applied when determining the amount of credit associated with a particular project. The use of this trading ratio effectively means that at 20 years, CWS will be offsetting twice as much heat via shading as their treatment plants add to the Tualatin. Appendix B discusses the use of trading ratios in more detail, and explains how they will be modified for streams less than 7 feet across.

The shade for which credit has been established will be monitored during the twenty-year shade establishment period to determine whether unforeseen events, such as floods, fires or landowner activities, have resulted in a significant reduction in shade. If a reduction occurs, Clean Water Services and DEQ, with public input, will develop an action plan that addresses possible credit reduction or efforts to offset or mitigate the loss of shade.

The twenty-year shade establishment period will provide time for vegetation to grow to a height where it will provide substantial shade. It will also provide an upward limit on the amount of shade credit that can be generated. Vegetation can continue to grow after twenty years, and in many cases, especially on wider streams, it will provide increasing amounts of shade. Nevertheless, the credit is due to expire after twenty years.

It should be noted that the vegetation that exists after 5 years will not be of a sufficient height or maturity to offset CWS' excess thermal load. However, the 2:1 trading ratio described previously ensures that within 20 years, the solar radiation that is offset will exceed CWS' excess thermal load. Allowing CWS to offset their thermal load via shading means that in the long run, the overall reduction in thermal load to the Tualatin will be significantly greater than it would have been via other means.

The shade credit will be used in a thermal energy budget that accounts for Clean Water Services' activities in the Tualatin Basin. The energy budget will be calculated and reported on each year, along with progress relative to the 5 year timeframe for achieving compliance with the thermal load to offset defined in the permit.

The amount of shade that must be created after 5 years via riparian restoration will be referred to as the Shade Credit Goal. As explained in the summary of Appendix B, CWS estimates that about 35 miles of stream restoration will be required to meet the Shade Credit Goal.

The thermal load budget calculated in the fifth year of the Watershed Permit will determine compliance with the permit's temperature requirements. If flow augmentation, the cumulative total of shade created, and all other DEQ-approved temperature management measures combine to offset the excess thermal load, the temperature requirements will be met. Prior to the five-year mark, compliance will be established with respect to the shade benchmarks described in Section F and listed in Table 4. From 5 years to 20 years, growth and shade will be monitored as described in Table 5 which is found in Chapter 4, Section D.

C. Credit for Shade Creation

This section explains the basis for allowing credit for creating shade. Water quality trading, like all forms of environmental trading, is based on the principle that environmental performance which exceeds regulatory requirements has economic value and can be traded in the marketplace. A corollary of this principle is that mere compliance with regulatory requirements produces nothing of value that can be traded. In a water quality trading system, then, measures that generate tradable credit must exceed those required by regulations.

In the Tualatin River Watershed, landowners in some areas are required to maintain vegetated buffer areas. Specifically, forest landowners are required to do so under the Forest Practices Act, agricultural landowners are required to do so under the local water quality management rules developed by the Oregon Department of Agriculture (also known as SB 1010), and property developers are required to do so under Clean Water Services' Design and Construction Standards.

To remain consistent with the basic principles of trading, credit for creating shade will be confined to activities that go beyond regulatory requirements. This means that re-vegetation projects will need to exceed the minimum requirements established in the above-mentioned regulations. Below are examples of shade-producing activities that will generate temperature credit:

- Landowner incentive programs, such as those described in Section E of this chapter, where shade is regenerated in agricultural areas as a direct result of active management measures aimed at increasing shade. These go beyond the minimum SB 1010 requirements, which give landowners the option of allowing shade to regenerate naturally.[13]
- Landowner incentive programs where shade is created in forested areas under circumstances where the amount of shade either exceeds the requirements of the Oregon Forest Practices Act or the Act does not require shade.
- Shade created under other Clean Water Services programs that furthers Clean Water Services' environmental stewardship mission, but is not required by law. For example, shade created under a program that focuses on public land would be in this category.

An example of a shade-producing activity that would not generate temperature credit is the re-vegetation and protection of near-stream areas carried out by property developers under the Clean Water Services' Design and Construction Standards. These regulations, which apply within Clean Water Services' service area, require that streams be protected from new development by buffer areas that have prescribed widths. The regulations also require re-vegetation of buffer areas under certain circumstances.

D. Shade Programs

Clean Water Services will develop and implement programs aimed at increasing riparian shade. Collectively, the programs will apply to most of the areas in the watershed where streams exist. Programs intended primarily for use on private land will be incentive-based. Most projects on public land will be conducted under Clean Water Services' Urban Stream Enhancement Program.

Incentive Programs
Incentive programs are intended to induce landowners to create shade by providing benefits in the form of cash payments, contributed labor, donated materials, or a combination of these. They are an alternative to regulatory programs that can bring superior results by generating win-win outcomes for landowner and management agency alike. Incentive programs are also one of the few management options available to Clean Water Services for use outside of its service area, where it has no regulatory authority.

Agriculture occupies approximately one-third of the land in the watershed, and much floodplain land in farming areas has been cleared for growing crops. Hence, these areas present significant opportunities for increasing shade, and Clean Water Services will implement two programs for the purpose of creating and protecting shade there. The programs are a modified version of the U.S. Department of Agriculture's Conservation Reserve Enhancement Program (Enhanced CREP) and Vegetated Buffer Areas for Conservation and Commerce (VEGBACC). The programs are complementary—each

[13] "Stream Temperature: By January 1, 2005, agricultural activities along a perennial stream must allow for the natural or managed regeneration and growth of vegetation, consistent with the site capability, that is adequate after sufficient growth, to provide erosion control, stream bank stability, and minimization of direct solar heating. " (OAR 603-095-0140 (4))

has a unique set of benefits and requirements, and is intended for landowners with particular needs and preferences. Program descriptions are in Appendix C (Enhanced CREP) and Appendix D (VEGBACC).
It should be noted that the Enhanced CREP and VEGBACC programs do not specifically require landowners to keep riparian buffer areas in a vegetated state for the agreed-upon 20 year credit period, though the removal of vegetation from a buffer area would decrease benefits payable under Enhanced CREP.

CWS designed both programs with input from the farming community. It was clear from this input that requiring 20 years' of "no touch" would reduce participation rates in both programs significantly. CWS explored the various disincentives that already exist for landowners to clearing riparian areas prior to 20 years and found them to be as follows:

- The Oregon Administrative Rules that implement the Tualatin River Subbasin Agricultural Water Quality Management Plan require vegetated buffers that provide erosion control, streambank stability, and the minimization of solar heating.[14]
- The removal of vegetation could jeopardize a farmer's ability to qualify for benefits available under certain agricultural programs. For example, farmers in Washington County will soon be able to enroll in the USDA's Conservation Security Program, which pays them for following certain conservation practices. The removal of vegetation from a stream buffer would result in a reduction in payments under this program.
- Buffers are part of the floodplain, which can only support a dwindling number of crops, such as grains, hay and grass seed that have low profit margins. Historically, floodplain areas could be used to grow vegetables, which can be profitable, but following the closure of the local packing plants during the 1980's, vegetable production declined considerably. The crops that bring the highest returns—nursery stock, nuts and berries—can only be grown in upland areas.
- Besides low profit margins for riparian area crops, there is the cost to remove vegetation from a buffer area and prepare it for crop production, which can be high, especially when the buffer area contains trees and shrubs. According to a study performed by the Economic Research Service of the USDA[15], it is much less likely that areas planted with forest will be returned to crop production than areas planted with grasses, legumes and other cover crops. The study concludes that this reflects the higher cost of removing forest vegetation.
- It is now generally recognized that a well-vegetated buffer area not only helps the environment, but also benefits farm production by slowing the erosion of top soil.

Based on these disincentives, CWS decided that its best opportunity for success would be to design programs so as to maximize landowner participation. If some landowners do in fact clear planted areas prior to 20 years, CWS will have to re-plant to compensate. In an effort to avoid this expense, CWS has included in both programs the option of a conservation easement, which is less expensive than mitigation, and provides the farmer

[14] OAR 603-095-0140(4).
[15] "The Conservation Reserve Program: Economic Implications for Rural America," Agricultural Economic Report No. AER834, October 2004.

with significant financial incentives to keep vegetated buffer areas intact. Clean Water Services intends to explore other approaches as well.
The risk remains that not all planted areas will be in a mature vegetated state at the end of 20 years. This risk will need to be re-evaluated with each permit renewal to ensure that the incentive programs designed by CWS are sufficient to accomplish the necessary objectives.

Clean Water Services intends to develop and implement at least two additional shade programs. One will be geared toward forested areas, and the other will focus on developed areas.

The Urban Stream Enhancement Program
Clean Water Services will also increase and retain shade through its existing Urban Stream Enhancement Program. Shade creating projects implemented under this program will be part of ongoing efforts to reduce pollution from nonpoint sources and improve habitat for aquatic species. Most projects will take place on public land in urban areas where gaining access is not difficult. Some projects will occur on private land and in rural areas also. The scope of the Urban Stream Enhancement Program, including a list of projects and a schedule for completing them, will be contained in the Healthy Streams Plan.

It is difficult to estimate the relative contribution each of the shade programs will make to the total amount of shade created. Uncertainties such as popularity with landowners, amounts of land available, and other factors make this a difficult task. With several programs in place, however, Clean Water Services will have the flexibility needed to take maximum advantage of the available opportunities for creating shade.

E. Program Implementation Time Frame/Benchmarks

The following time frame will apply to the use of programs to create and protect shade:

Program Development
The development and authorization of shade creating programs will take a maximum of one year; all landowner incentive programs will be developed by the Stream Protection Opportunities Technical Advisory Committee (SPOTAC), a stakeholder group representing diverse interests and expertise. All landowner incentive programs will be evaluated by the Clean Water Advisory Commission, Clean Water Services' citizens' advisory commission. Finally, all programs will be subject to the approval of the Clean Water Services Board of Directors and the governing bodies of partner agencies and organizations.

Program Implementation
The implementation of developed and authorized shade creating programs will take a maximum of one year; implementation includes negotiating contracts with partners, awarding contracts to outside vendors and contractors, program marketing and outreach, enrolling landowners, and beginning the development of site plans; implementation does not include site work.

Site work
Site clearing and planting will occur during a one to three year period, depending on the site and the program. The approach to this work is explained in Section A of Chapter 4.

Benchmarks for Determining Progress
The incentive-based shade programs are new, which makes their popularity with landowners difficult to predict. In view of this, Clean Water Services will need to be flexible: programs that turn out to be unpopular will need to be modified or discontinued, and popular programs may require additional resources. Annual benchmarks will be used to determine Clean Water Services' progress toward meeting the Shade Credit Goal (defined in Chapter 3, Section C), as indicated in Table 4 below. Each benchmark will apply to all shade programs collectively. This will allow Clean Water Services to meet the benchmark using whatever combination of shade programs is optimal.

A benchmark is defined as the annual increase in the percentage of the average excess thermal load that is offset by shade after accounting for flow augmentation and any other DEQ-approved temperature management measures. Progress toward achieving the benchmarks will be evaluated annually. Benchmarks are a means of measuring progress but are not requirements.

Table 4

Shade Benchmarks

Permit Year	Annual Shade Credit Benchmark	Estimated Stream Miles Planted[16]
2004	10%	3.5
2005	20%	7.0
2006	30%	10.5
2007	20%	7.0
2008	20%	7.0
Shade Credit Goal	100%	35

In the event the shade credit created in any year is less than 50% of the benchmark for that year, Clean Water Services will prepare and submit to DEQ a written memorandum that contains a list of measures that will be undertaken to meet benchmarks in subsequent years. The measures described in the memorandum will be subject to DEQ's approval and may include any of the following:

- Changes to landowner incentive programs

[16] These estimates are based on the estimate made on page 19 of Appendix B. Actual miles will depend on the conditions that exist during the measuring period and the temperature management measures used. For example, the amount of water released for flow augmentation will have a substantial effect on the amount of shade needed. See Appendix B or a further discussion of this issue.

- Increased program marketing efforts
- Additional program staff/contractor resources
- Purchase/release of additional flow augmentation water
- Increased effluent reuse

F. Prioritizing Shade

The watershed permit requires a system for prioritizing areas where shade creation and protection will occur. The permit also requires that prioritization be based on protecting the most sensitive beneficial uses. According to the 2001 TMDL, the most sensitive beneficial uses in the Tualatin River Watershed are salmonid spawning and rearing. This section describes the prioritization system, which emphasizes the improvement of spawning and rearing areas.

Clean Water Services and its partners will increase marketing and outreach efforts in priority areas, and will provide expedited service to landowners as well

The RESTORE Model
The RESTORE model will be used to prioritize stream reaches. The model, which was developed by Oregon State University, is a decision support tool designed to assist watershed planners in the use of scientific data to make decisions and set priorities. RESTORE analyzes GIS-based data using user-defined rules. In customizing the model for shade prioritization, Clean Water Services emphasized salmonid spawning and rearing. Data was collected from the entire watershed except for areas downstream from Clean Water Services' Durham wastewater treatment facility, which are not considered appropriate for temperature credit trading. The following data was entered into the model:

- Effective impervious area
- Reach type (i.e., steep or flat headwaters, moderate gradient, or low gradient)
- Percentage of tree canopy cover
- Salmonid fish spawning habitat
- Salmonid fish rearing habitat
- Streambed material
- Land ownership – public vs. private

Prioritization System
As indicated above, RESTORE enables the user to define the rules by which it operates. Clean Water Services will program the model so that it places each stream reach into one of three prioritization categories: high, medium and low. To be placed in the high or medium category, a reach must meet all of the criteria within the category. The categories and criteria are listed below.

High Priority:

--spawning habitat for salmonids
--percent tree canopy: > or = 42%

--high or medium gradient area
--bed material: cobble, gravel or bedrock
--effective impervious area: <20%

Medium Priority:

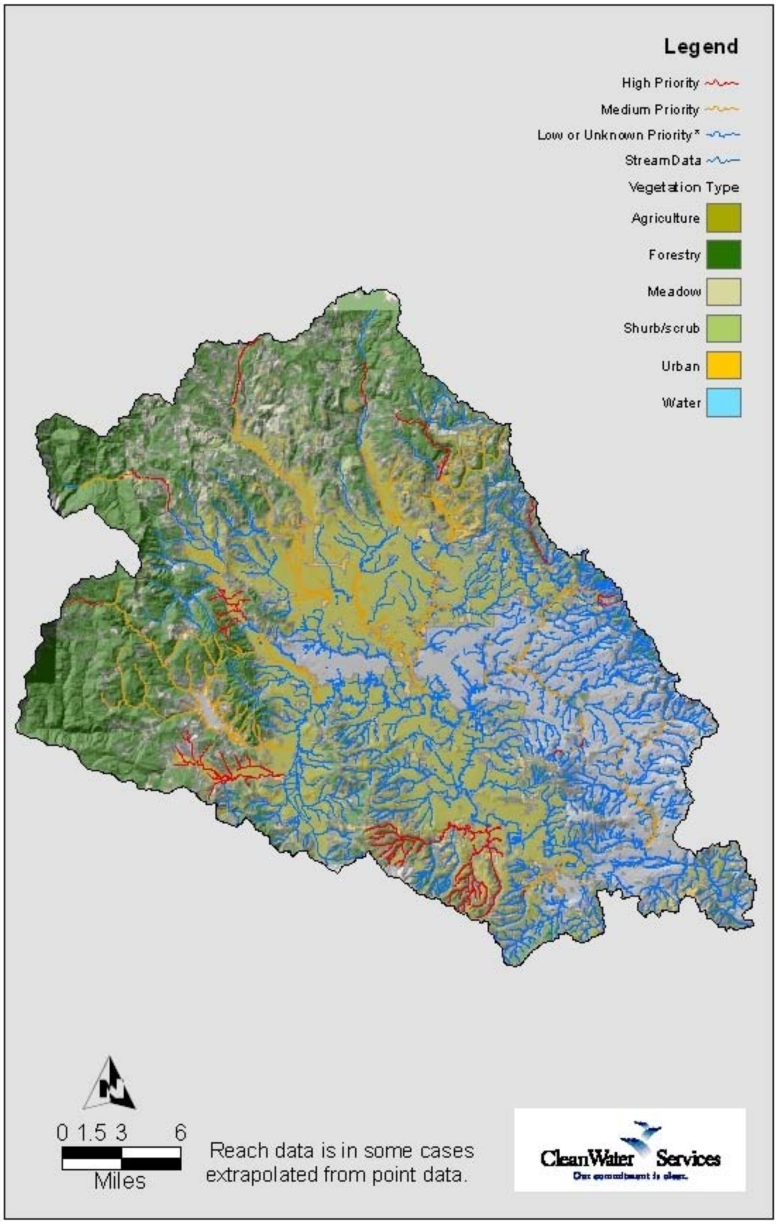
--spawning ***or*** rearing habitat for salmonids
--percent tree canopy > or = 11%
--effective impervious area < 20%

Low Priority:

--failure to meet each of the “medium” or “high” priority requirements

After stream reaches have been placed into one of the above categories, CWS will apply an additional criterion—land ownership. Because land in public ownership can usually be protected or re-vegetated more easily and more quickly than land in private ownership, land in public ownership will have priority over land that is privately owned within the same category.

The map below identifies stream reaches according to priority level. Using vegetation types as surrogates, it also provides a general indication of land use. Most of the high and medium priority stream reaches are in agricultural and forested areas.



During the first year the Revised TMP is in effect, no special effort will be made to create shade in priority areas. Instead, the emphasis will be on implementing shade programs and achieving initial success in enrolling landowners. During the second and subsequent years, marketing efforts will be directed toward landowners in priority areas.
This will include contacting individual landowners and holding meetings with groups of landowners. In addition, landowners in priority areas will be given precedence over other

landowners in the event interest in the programs exceeds the available resources. If necessary, Clean Water Services will also provide financial incentives to the Tualatin Soil and Water Conservation District, its shade program contractor, for enrolling landowners in priority areas.

RESTORE and Urban Stream Enhancement Program Projects
RESTORE was previously used to prioritize the Clean Water Services Urban Stream Enhancement Program projects. For this use, the model was programmed differently because several factors besides shade and the protection of the most sensitive beneficial uses were considered important. In addition, more information concerning stream conditions was available because of a previous field study. To accommodate the goals of the Revised TMP, the stream reaches that were considered a high priority for re-vegetation under the Urban Stream Enhancement Program will be prioritized for shade also using the approach described in this section.

Increased Shade Credit
Streams in High Priority areas are typically quite narrow. Some are only three or four feet wide during the summer months. As indicated by the graph in Appendix B, it takes several times more shade area, and a corresponding increase in resources, to achieve an equivalent reduction in thermal energy blocked along these streams than it does along wider streams, such as lower portions of major tributaries or the Tualatin River mainstem, which are typically at least 15-20 feet wide and sometimes much wider. In recognition of the fact that narrow streams achieve maximum shade much sooner than wide streams, High Priority area streams that are seven feet wide or less will not be subject to the .5 contingency factor. For these streams, shade credit will be calculated on a 1:1 basis.

As with estimating the relative contribution of each shade program, it is difficult to estimate the amount or percentage of shade that will be created in priority areas—too much depends on landowner interest in programs and other factors that affect shade opportunities.

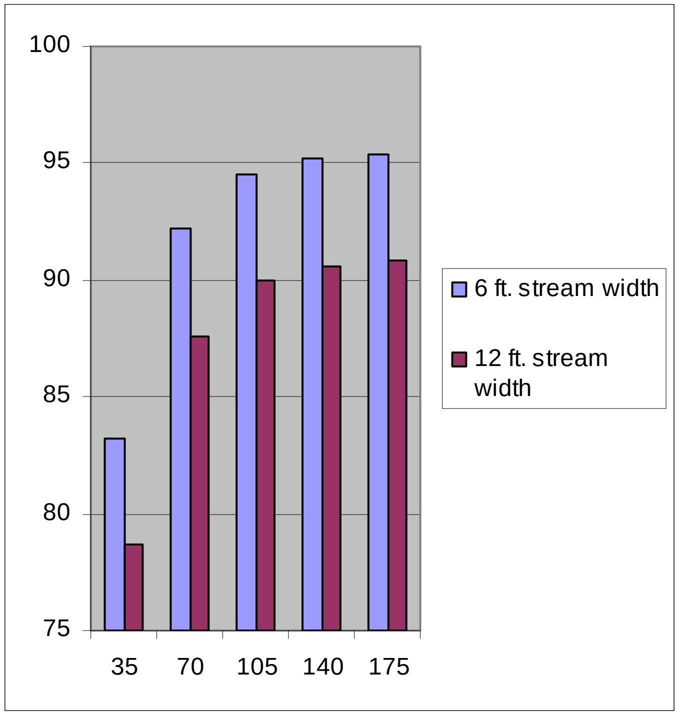
G. Calculating Shade Credit for a Typical Project

Shade credit for each project will be calculated using a computer model developed by DEQ called “Shade-A-Lator.” To run the model, site-specific data must first be collected, including the size of the site, width of the stream, orientation of the site to the sun, and the estimated canopy height and density twenty years after planting. The model uses this data to determine the effective shade produced by the project. “Effective shade” is a measure of the amount of sunlight blocked by shade. The blocked sunlight is then converted to kilocalories per square foot of stream surface.

A more detailed description of how the Shade-A-Lator operates is contained in Appendix B.

The graph below shows effective shade for a typical project. The bottom of the graph shows various buffer widths in meters. The side of the graph shows percentage effective shade. Note that stream and buffer width are significant factors in determining shade.

Although the graph doesn't show it, the orientation of the site to the sun and the amount of vegetation overhanging the stream are less important. [17]



H. Temperature Management during a Typical Year

As indicated in Chapter 2, flow augmentation has occurred in the Tualatin River since the 1970's. In the past, flow augmentation was mainly intended to address dissolved oxygen needs. During a typical summer, dissolved oxygen levels begin to decline during July, and the problem gradually worsens over the course of the summer and into the fall until the fall rains begin. Accordingly, flow augmentation began during July and steadily increased in response to river conditions. The highest flow augmentation rates were usually in September and October. During a typical year, average flow augmentation during July and August was about 30 cubic feet per second (cfs); during September and October it was about 40-50 cfs. The entire allotment of flow augmentation water was used each year.

Under the Revised TMP, the flow augmentation regime will be adjusted to serve both the goal of maintaining dissolved oxygen levels and the goal of developing thermal load credits. As described above, the critical period for dissolved oxygen is September and October, when stream flows are at their lowest. The critical period for temperature, however, is during July and August when the hottest weather occurs. Because these time periods do not overlap, it is possible that in some years there will not be enough water available to fully meet both temperature and dissolved oxygen needs. For example, if

[17] The graph assumes a five foot overhang and a tree height of sixty feet after twenty years.

more flow augmentation water is used during July-August than in the past, then the amount of flow augmentation water available for September-October will be less. When shortages occur, thermal load credit needs will be balanced with oxygen needs and flow augmentation will be optimized to produce the greatest overall environmental benefit.

Clean Water Services' approach to temperature management each year will be based on the flows in the Tualatin River and the availability of flow augmentation water. Because higher stream temperatures are associated with lower flows, flow augmentation rates will generally be higher for low flow years than for high flow years. In addition, the amount of shade created through re-vegetation and protection projects will be assessed annually to determine if the pace of these projects is on-track to meet the Shade Credit Goal. Flow augmentation rates will be aimed at meeting, insofar as possible, both thermal load offset and dissolved oxygen needs. In general, flow augmentation is expected to vary between 30 and 40 cfs during the measuring period. This would mean that between 20 and 40 miles of stream shade would be needed to reach the Shade Credit Goal.[18]

[18] Details concerning how the shade estimate was derived are in Appendix B.

CHAPTER 4

SHADE PROGRAM IMPLEMENTATION

This chapter addresses how shade programs will be implemented. The subjects covered include a planting plan that addresses planting methods and plant species, explains how a reliable plant supply will be secured, and describes how shade will be monitored. The chapter also contains a plant monitoring and maintenance plan, and describes shade credit reporting requirements.

A. Planting Plan

The Planting Plan addresses how the planting work will be performed on riparian area re-vegetation projects that qualify for temperature credit trading. It contains the following elements: planning sources, work task responsibility, plant species selection, and planting methods. The Planting Plan is based on two fundamental principles: 1) the unique nature of each project site requires a site-specific approach to planting; and 2) because of the unpredictable nature of re-vegetation projects, adaptive management will be emphasized. The upshot of these principles is that it is not possible to create a uniform plan that addresses the challenges associated with all projects. The Planting Plan must, therefore, address planting issues on a general level, and leave the specifics to site planning efforts for individual projects.

Planning Sources
Existing planning sources make up most of the Planting Plan. For incentive programs, these include planting standards used by partner agencies such as the NRCS and ODF. For Urban Stream Enhancement Program projects, the planning source is the Clean Water Services Design and Construction Standards, relevant portions of which are in Appendix F. These standards apply to all near-stream development in the Clean Water Services service area.

Planting Densities and Buffer Widths
Species-specific planting densities will be in accordance with guidelines described in the technical literature, which are as follows:

Species		Spacing (feet apart)
Hardwoods:		
	Shrubs (general)	1-3[19]
	Shrubs - high erosion risk sites	1-1.5[20]
	Trees (general)	6-15[21]
	Trees - harsh conditions sites	3-4[22]
Softwoods:		

[19] *Coastal Oregon Riparian Silviculture Guide* (Coos Watershed Association 2003), citing Hoag, J.C., *How to Plant Willows and Cottonwoods for Riparian Rehabilitation* (USDA 1993)
[20] Ibid.
[21] Ibid.
[22] Ibid.

Douglas fir	10-12[23]
Ponderosa pine	13-14[24]

The above densities do not include non-woody plants such as forbes, which will be planted where moisture is sufficient to permit their survival. Following the planting of new trees and shrubs, sites will be monitored to determine plant health and maintenance needs. In the event that planting densities are determined to be a contributing cause of poor plant health or the need for extra maintenance, densities will be adjusted for future projects. If there is more than 20% plant mortality at a site, the site will be replanted.

Overall, it is anticipated that planting densities for incentive program projects will range from 700 stems per acre to 1500 stems per acre. This is less than the planting densities for Urban Stream Enhancement Program projects, which range from 1500-2500 stems per acre. The main reason for the difference is that conditions in rural areas are more favorable to the growth of new plants. Rural area streams tend to experience less down-cutting from storm events because there is less impervious surface area. As a result, water tables near streams are higher, and there is less drying out of the soil during the summer months. In addition, rural areas tend to have fewer invasive species, so competition from weeds is lower. With more favorable conditions, fewer plants are needed because there is lower plant mortality.

The selected planting density for a given incentive program site will depend on a number of factors, including the expected level of competition from weeds and the kinds of species planted. Competition from weeds will generally be higher at sites near urban areas and sites where weeds are abundant prior to planting.

Minimum buffer widths for projects performed under Enhanced CREP will be 35 ft. The “No Touch” zone for projects performed under VEGBACC will be 20 ft.

Work Task Responsibility

A site plan will be developed for all re-vegetation projects. The site plan will serve as a blue print for all site work. For incentive program projects, the site plan will be developed by partner agencies or their contractors. For Urban Stream Enhancement Program projects, the site plan will be developed by Clean Water Services or its contractors.

Partner agencies or their contractors will provide technical assistance concerning planting issues for incentive program projects. Clean Water Services or its contractors will provide the same for Urban Stream Enhancement Program projects.

For some incentive program projects, landowners will either be required to be responsible for planting work, or may choose to be responsible at their option. For other incentive program projects, partner agencies or their contractors will be responsible for planting work. For Urban Stream Enhancement Program projects, CWS, landowners, volunteers, or contractors will be responsible for planting work.

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[23] *Conservation Practice General Specifications, Tree/Shrub Establishment* (NRCS 1997)
[24] Ibid.

Plant Species Selection
The list of plant species eligible for Urban Stream Enhancement Program is in Appendix G. The list is part of Clean Water Services' Design and Construction Standards, and includes many species of trees, shrubs, herbs and grasses, and is organized according to plant community. Each project site will be planted with a particular plant community or communities. The list shows the species that must be planted within each plant community (i.e., minimum species composition). All species on the list are natives that are known to grow in the Tualatin River Watershed.

Most incentive program projects will involve a subset of the plant species used for Urban Stream Enhancement Program projects. Hence, the incentive program plant list will likely be a subset of the Urban Stream Enhancement Program list. Plant species will be selected for incentive program projects using the following criteria: a) site conditions; b) hardiness; c) diversity; and d) availability.

Planting Methods
For incentive program projects, plant specimen type (whether containerized, plug, bare root or pole cutting) will be selected using the following criteria: a) site conditions; b) season; c) availability; and 4) cost. For example, pole cuttings are usually the least expensive planting material and are well suited to moist, streamside areas where erosion is a concern because they can be planted without digging. In drier areas where erosion is less of a concern, bare root or containerized plants are often the best choice. Bare root plants are best suited for winter planting, however, and containerized plants are best for planting during other times. For Urban Stream Enhancement Program projects, the species list (Appendix G) specifies plant specimen type.

For Urban Stream Enhancement Program projects, planting densities will vary with site conditions, and the species list, which contains instructions regarding planting density, will serve as a guide. For incentive program projects, planting density will also vary with site conditions, but on the whole is expected to be less than for Urban Stream Enhancement Program projects because of lower expected levels of plant mortality.

Plant placement at each site will facilitate a successional trajectory that approximates natural conditions during the years after planting.

The watershed is known for large numbers of mice, nutria, beaver, deer and other herbivores that consume or damage newly-planted trees and shrubs. For this reason, tree and shrub protection measures will need to be implemented at many sites. The measures selected will depend on the expected species of herbivore. In addition, areas near the base of trees and shrubs will be cleared of vegetation to prevent damage by rodents, which tend to fear open spaces.[25]

Because Himalayan blackberry, reed canary grass and other non-native invasive species may compete with newly planted native species, site preparation will include controlling

[25] This material is discussed in more detail in Appendix H.

invasive species before planting work begins. On some sites, grass seed will be planted between trees and shrubs to discourage the growth of invasive species.

Mulch/wood chips may be placed around the base of newly-planted trees and shrubs to help retain soil moisture and discourage weed growth.

B. Plant Supply

Securing a Reliable Plant Supply
Clean Water Services will be responsible for purchasing all of the plant material needed for shade programs. Given the high level of need and the ability to forecast it on a multi-year basis, Clean Water Services has determined that the best approach is to enter into multi-year contracts with commercial growers. Under these contracts, growers will agree to propagate, grow and supply an agreed number of plants during the five-year planting window established in the time frame for shade program implementation (see Section F of Chapter 2). When compared with other approaches, such as making spot purchases on an as-needed basis, contract growing offers a measure of certainty and results in lower prices paid for plant material.

Clean Water Services has researched the contract growing market and has determined that there is adequate capacity to meet its needs. Although some potential contract growers are not located in the Tualatin Basin, all are capable of growing plants from seed produced in the Tualatin River Watershed to ensure that plants are genetically adapted to local growing conditions. A competitive process will be used to select contract growers. Clean Water Services expects to meet a significant portion of the need for plant cuttings by purchasing them from local landowners enrolled in the VEGBACC program. The prices Clean Water Services will pay for cuttings are competitive with those paid for crops grown in areas where re-vegetation will occur.

It is likely that Clean Water Services will purchase nearly all plant material other than cuttings in bare root form. Bare rooted plants are less expensive than containerized plants and are easier to transport. Growers will be responsible for delivering the plants to the Clean Water Services Stream Operations Center, which is located adjacent to its Forest Grove wastewater treatment facility. To minimize the risk of supply shortages, the Operations Center will be used to maintain an inventory of planting material that can be available whenever needed. The Operations Center will also be used to increase the size of certain plants prior to planting at re-vegetation sites, and to grow plants in containers when needed. The planting area at the Center covers 18 acres, and has its own supply of irrigation water.

C. Maintenance and Monitoring Plan

Overview
Because sites where re-vegetation has occurred need protection from a variety of threats, including invasive plant species, herbivores and dry weather, site monitoring and maintenance will play a critical role in creating shade. This section of the Revised TMP explains how monitoring and maintenance will be addressed, and does so by focusing on the following elements:

- planning sources
- work task responsibility
- monitoring
- control of invasive plant species
- control of herbivores
- irrigation
- plant replacement

Like the Planting Plan (Section A of this Chapter), maintenance and monitoring require a site-specific approach that emphasizes adaptive management. Accordingly, this section describes a general approach to the subject. Details will be contained in individual site plans.

As with the Planting Plan, incentive program projects are treated differently in some respects from Urban Stream Enhancement Program projects.

Planning Sources
Several existing planning sources will be used. For incentive programs, these include practice standards and other guidance produced by partner agencies such as the NRCS, ODF and TSWCD, as well as Clean Water Services' Integrated Vegetation and Animal Management Guidance (IVAMG) (Appendix H). Any conflicts between the IVAMG and partner agency planning sources will be resolved in favor of partner agency sources. As explained in the Planting Plan, this approach respects existing partner agency procedures. For Urban Stream Enhancement Program projects, the IVAMG will serve as the primary planning source, since these will be managed by Clean Water Services.

Work Task Responsibility
As stated in the Planting Plan, a site plan will be developed for all re-vegetation projects. The site plan will serve as a blue print for all site work, including maintenance and monitoring. For incentive program projects, the site plan will be developed by partner agencies or their contractors. For Enhanced CREP and VEGBACC projects the partner agency is the Tualatin Soil and Water Conservation District. For Urban Stream Enhancement Program projects, the site plan will be developed by Clean Water Services or its contractors.

Partner agencies or their contractors will provide technical assistance concerning maintenance issues for incentive program projects. Clean Water Services or its contractors will provide the same for Urban Stream Enhancement Program projects.

For some incentive program projects, landowners will either be required to be responsible for maintenance and monitoring or will choose to be responsible at their option. For other incentive program projects, partner agencies or their contractors will be responsible for maintenance and monitoring. For Urban Stream Enhancement Program projects, CWS or its contractors will be responsible for maintenance and monitoring.

Monitoring

Site monitoring will occur in two ways. First, maintenance crews will be required to monitor sites in conjunction with performing maintenance work, and to inform project managers of any conditions warranting remedial measures or a change in maintenance procedures. Second, each site will be monitored on a detailed basis at least once annually by CWS. DEQ staff may participate in the annual monitoring, at DEQ's discretion. This effort will result in a written monitoring report that describes site conditions and contains recommended changes in maintenance or other measures when appropriate. Site conditions noted in the report will include the following:

- plant growth and mortality
- colonization by invasive plant species—type and extent
- effectiveness of/need for measures to protect plants from herbivores
- additional factors that limit plant growth, including excessive or inadequate water, soil problems, disease, and too much or too little sunlight

Monitoring will occur for the duration of any agreements that require a site to remain in vegetated buffer status. If there is no agreement[26], monitoring will occur until the land changes status or for twenty years, whichever occurs first.

Invasive Plant Species

Invasive plant species will be controlled in accordance with the instructions included in the site plan. Control methods will include the following:

- mechanical/manual methods, such as weed whipping, mowing, tilling and hand grubbing
- cultural methods that rely on natural processes, such as mulching, solarization and shade
- pre- and post-emergent chemical controls.

Control methods will be adjusted as needed during the monitoring period. Species-specific guidance contained in the IVAMG (Appendix H) will be followed as needed. Chemical controls will be used only when alternatives are impractical or ineffective. All chemical controls will be used in accordance with regulatory requirements.

Maintenance to control invasive species will be performed at least once annually for as long as invasive species present a chronic problem, and as-needed thereafter for the duration of the monitoring period.

Herbivore Control

As indicated in the Planting Plan, herbivores are expected to be a significant problem in certain areas. The Planting Plan also indicates that plant protection devices will be installed as needed during planting. If herbivores continue to be a problem despite the use of protection devices, additional measures will be taken, including planting different species, installing more robust protection devices and, as a last resort, removing

[26] Under the VEGBACC program, agreements concerning the minimum amount of time land will remain in vegetated buffer status are not required. However, incentives such as conservation easements and cuttings contracts are available to keep land in vegetated buffer status.

herbivores. Species-specific guidance concerning animal control is contained in the IVAMG, and will be followed as needed.

Irrigation
The need for irrigation will be determined during the preparation of the site plan. Some sites will need irrigation during the driest part of the summer until vegetation has become established. Because irrigation may be more difficult to implement in rural areas, plant hardiness will be one of the criteria used to select species to plant, thereby minimizing the need for irrigation.

Where irrigation is needed, water and irrigation equipment will be supplied by the landowner if the landowner irrigated the site prior to its conversion to vegetated buffer. If the landowner did not irrigate the site prior to conversion, water and equipment for incentive program projects will be supplied by partner agencies or their contractors. For projects under the Urban Stream Enhancement Program, these items will be provided by Clean Water Services or its contractors.

It is expected that the primary means of supplying water to sites that lack a water source will be by water truck.

Plant Replacement
All re-vegetation projects involve some plant mortality. Where Clean Water Services or its partners are responsible for planting work, plants will be replaced as needed during the monitoring period. It is expected that some plants will need to be replaced each year during the early years of a re-vegetation project. Replacement will not occur when plant mortality occurs on an isolated basis or is the result of natural succession. Where repeated replacement is necessary, an adaptive management approach will be taken, including changes in species composition when warranted.

Landowners may be responsible for planting work under some incentive programs. When this is the case and plants are furnished to the landowner without charge, there will be a limit on the number of times free replacement plants will be made available. Under VEGBACC, for example, replacement plants will be offered without charge once each year during the first two years following planting.

Appendix I contains a sample planting and maintenance schedule for a particular site. The schedule shows an intensive approach that would be typical for a site that is difficult to re-vegetate. Less difficult sites will involve less intensive efforts.

D. Shade Monitoring

Clean Water Services will monitor shade levels at the start of each riparian restoration project, and then monitor changes in stream shade at regular intervals to determine progress toward meeting the Shade Credit Goal established in Section B of Chapter 3. This section explains how shade will be monitored.

Monitoring Frequency
In selecting a monitoring frequency, CWS considered the following factors:

- The length of time required to establish significant increases in shade; and

- The need to determine progress toward meeting the Shade Goal, and to make timely programmatic changes if progress falls short of expectations.

Shade at re-vegetation and shade protection sites will be monitored as indicated in Table 5 below. The monitoring intervals contained in the table will apply to each site separately. This means that shade monitoring is expected to occur at various locations every year.

Table 5

Shade Monitoring Schedule

Monitoring Year (After Shade Credit Established)	**Purpose**
5	Assess growth and shade
10	Assess growth and shade
15	Assess growth and shade
20	Determine if Shade Credit Goal has been achieved

Monitoring Method
Several method have been used to monitor shade. The most common are:

- densiometer — measures canopy cover rather than shade
- clinometer — measures angle of open sky
- solar pathfinder — hand-drawn diagram analyzed to measure shade
- hemispherical photography — photo of sky that is computer analyzed to determine shade, canopy density and other measures
- photo point monitoring— photos of riparian area from same location over time

In selecting a method for measuring shade, it is desirable to find one that directly measures effective shade, rather than a related parameter. In the past, this was relatively difficult. The solar pathfinder was the only method that did so, but it was, and still is, prone to user error. Recently, however, hemispherical photography has become available. It is the first and only method that measures shade directly while practically eliminating the possibility of user error.

In hemispherical photography, a photograph is taken of the sky from the stream using a fisheye lens. This produces an image up to 180º wide with a 360º field of view. To minimize user error, the camera is attached to a "self-leveling" device, and North-South orientation is shown on the final image by a feature built into the camera mount. Once the image is collected, it can be computer-analyzed in a variety of ways. Among the analyses commonly performed are:

- analysis of both direct and diffuse radiation above and/or below canopy
- shade over the course of the day
- canopy cover
- canopy gap as a function of time of day
- sunfleck frequency and duration

No other method supports such a broad range of analyses. Moreover, the digital image is a permanent record that can easily be shared with others and re-analyzed as better algorithms for analyses become available. A GPS can be used to identify monitoring locations. The user can then return to the exact spot where previous monitoring was conducted, and thereby create a robust record over time.

Because of its obvious advantages, Clean Water Services intends to use hemispherical photography to monitor stream shade. Given the timeframe for monitoring shade, however, it is possible other methods will become available that offer additional advantages. If this occurs, Clean Water Services will change methods and provide justification for doing so.

CHAPTER 5

MONITORING, MEASURING AND REPORTING

A. In-Stream Temperature Monitoring

Clean Water Services currently monitors 54 sites on the Tualatin River and its tributaries. The monitoring, which is done on a continuous basis, includes five sites on the River above the Rock Creek wastewater treatment facility, two sites between the Rock Creek facility and the Durham wastewater treatment facility, and three sites below the Durham facility. Clean Water Services will continue to monitor stream temperatures on a continuous basis for the duration of the Watershed Permit, but may change some sites during bridge and road construction, or to meet changing data needs. After five years, a report will be prepared that contains a review of the temperature data.

B. Effluent Temperature Monitoring

Effluent temperature will be monitored before discharge at both the Durham and Rock Creek treatment facilities. Appropriate temperature sensors will be deployed in a well-mixed location between the final stage of wastewater treatment (chlorination/de-chlorination) and the outfall. The exact location will depend on accessibility and the physical layout of the treatment facility.

Clean Water Services cannot guarantee uninterrupted collection of effluent temperature data. Temperature sensors will be monitored to ensure that they are properly functioning and, in the event of equipment failure, new equipment will be deployed to minimize the interruption of data collection.

The continuous temperature monitors used for effluent monitoring will be maintained in accordance with the procedures described in the *DEQ Procedural Guidance for Water Temperature Monitoring, Rev. May 6, 1997*.

C. Reporting Requirements

The Watershed Permit calls for an annual report that addresses compliance with the Revised TMP and an annual report that summarizes the results of its thermal load credit trading activities. These reports will be combined because both have the same due date and concern related material.

The Watershed Permit requirements for the report content regarding thermal load credit trading[27] will be followed. In addition, the report will describe the activities that Clean Water Services undertook to meet the requirements of the Revised TMP. It will contain a cumulative summary and an annual summary of Clean Water Services thermal impacts to the Tualatin Basin, including calculations of

[27] Watershed Permit, Schedule D, paragraph i (p. 34)

- the average daily thermal loads discharged by the Rock Creek and Durham wastewater treatment facilities;
- the allowed thermal loads for the Rock Creek and Durham wastewater treatment facilities;
- the thermal load credits for flow augmentation;
- and the thermal load trading credit for shade.

To support these calculations the following information will be included:

- the average daily effluent flow from the Rock Creek and Durham wastewater treatment facilities for the period July 1 – August 31;
- the average daily temperature of the effluent from the Rock Creek and Durham wastewater treatment facilities for the period July 1 – August 31;
- the average daily Tualatin River flow at the Farmington Bridge (River Mile 33) for the period July 1 – August 31;
- the average daily flow augmentation rate from Scoggins and Barney Reservoirs for the period July 1 to August 31;
- a description of each shade project including the site location, program used to create shade, length, width and acreage of re-vegetated area, and the shade credit expressed in kilocalories per day of thermal energy blocked.
- Results of vegetative monitoring with reference to performance standards.

In addition, the following information will be included if applicable:

- the volume of effluent that was reused rather than discharged directly to the receiving stream;
- a discussion of other temperature management measures, including wastewater treatment facility changes and source control management measures;
- a discussion of proposed program changes, if any, including an explanation of why changes are necessary.