Appendix 3. Cost/Benefit Analysis

Introduction

This appendix summarizes the costs and benefits associated with the three nutrient TMDLs for Calleguas Creek presented in this document. Estimated costs were developed based on literature values and costs incurred by the POTWs in the watershed that have begun installing treatment processes for nutrients. Benefits are much more difficult to quantify. For this reason, the benefits have been described in qualitative terms.

The costs of the TMDLs are divided among three different implementation measures: nitrification, denitrification, and agricultural BMPs. Treatment costs for POTWs are presented as capital, operation and maintenance, and present worth costs. Agricultural best management practice (BMP) costs were developed based on installation costs only, maintenance was not estimated. Benefits are discussed based on the beneficial use impacted by the TMDL implementation.

Costs

Because of the interconnection between the three nutrient TMDLs, the implementation measures overlap. For this reason, the costs are presented by implementation measure rather than by TMDL.

NITRIFICATION AND DENITRIFICATION

Nitrification is required to remove ammonia from wastewater treatment plant effluent by converting it to other nitrogen forms, such as nitrite and nitrate. Denitrification converts these oxidized nitrogen forms to nitrogen gas which is then released from the effluent. For most of the treatment plants in the Calleguas Creek watershed, two different categories of nitrification and denitrification processes can be employed. The first involves converting existing facilities to provide nitrification and denitrification. The second requires the construction of new facilities for nitrification and denitrification.

Conversion of existing facilities basically involves adjusting the existing activated sludge processes at the plant to provide nitrogen removal by adjusting the amount of aeration, the types of bacteria present in the sludge, and the solids residence time. Through this process, almost all of the ammonia in the influent can be removed and nitrate plus nitrite concentrations of 10 mg/L-N on average can be achieved. The benefits of this process are that it is very cost effective, does not involve new construction, and does not significantly change existing operations and maintenance costs. However, this process is harder to control than facilities specifically designed to remove nitrogen compounds. If a large amount of ammonia enters the treatment plant unexpectedly, it is possible that the ammonia will pass through the plant without being treated. As such, meeting instantaneous maximum effluent limits with this process could be difficult. Achieving consistent levels of nitrate and nitrite significantly below 10 mg/L-N is not possible with this process. And finally, this process adds some organic nitrogen to the effluent.

The construction of new facilities for nitrification and denitrification is significantly more costly than the conversion of existing facilities. However, the new facilities allow significantly more control over the nitrogen removal processes. Additionally, the new facilities can be designed to achieve significantly more overall nitrogen removal than the converted facilities.

Except for Simi Valley, the POTWs should be able to meet the ammonia and oxidized nitrogen TMDLs through the conversion of existing facilities. If the implementation of the algae/DO TMDL requires a significant reduction in TKN over those achieved through the ammonia TMDL or POTWs need to meet lower nitrate/nitrite concentrations, construction of new facilities will likely be needed at the Hill Canyon and Camarillo plants as well.

Simi Valley is the only treatment plant not already nitrifying/denitrifying or building nitrification and denitrification facilities. Simi Valley potentially has the capability to provide some nitrification with existing facilities, but not denitrification. Both Hill Canyon and Moorpark are in the process of converting their facilities. Hill Canyon converted its conventional activated sludge process to a high aeration facility. This process did not require the construction of any new facilities or tankage at the plant. They are currently able to remove all the ammonia typically entering the plant, but have to add ammonia back into the process to ensure adequate disinfection of the effluent. Moorpark is currently constructing new facilities that include nitrification and denitrification capabilities. Camarillo has already installed nitrification, but would need to install denitrification at its plant under the oxidized nitrogen TMDL. Denitrification may be able to be done in house with existing facilities.

Costs for nitrification and denitrification can vary significantly depending on the type of process used. For conversion of existing facilities, the costs are in the range of $100,000 to $150,000 for each POTW in the watershed. This value is based on the actual cost incurred by Hill Canyon to convert its existing facilities.

The estimated cost of the facilities being constructed for Moorpark is approximately $6,300,000 (KJC, 1995). This is the magnitude of costs that may be incurred if nitrification and denitrification facilities need to be built at any of the treatment plants. However, because Moorpark is a small treatment plant with percolation ponds and different processes from most of the other treatment plants in the watershed, the estimated costs for constructing new facilities were based on literature values from a study by the EPA (EPA, 1977). Estimated costs from this document were updated to March, 2000 costs using an ENR index of 6201 (from 2401 in 1976).

The following tables summarize the costs of nitrification and denitrification at each of the POTWs. The first table summarizes nitrification costs and the second presents denitrification costs if additional facilities need to be built. Total present worth costs were based on an interest rate of 7% over 20 years for a separate stage nitrification and denitrification facility with a clarifier. If additional facilities are not required and Simi Valley can find a way to perform denitrification in the existing facilities, the estimated watershed cost would be approximately $300,000 ($150,000 for each Simi Valley and Camarillo).

Table A3-1. Estimated Nitrification Costs

POTW	Present Worth Cost	Capital Cost	Annual O&M
Hill Canyon	$8,040,000	$6,000,000	$202,000
Simi Valley	$8,100,000	$6,000,000	$211,000

Table A3-2. Estimated Denitrification Costs

POTW	Present Worth Cost	Capital Cost	O&M
Hill Canyon	$14,020,000	$4,170,000	$930,000
Simi Valley	$14,700,000	$4,300,000	$980,000
Camarillo	$7,290,000	$3,180,000	$390,000

In summary, the costs of installing some degree of nitrification and denitrification at the POTWs in the Calleguas Creek watershed is not very significant with the possible exception of Simi Valley. However, additional control of the processes to meet stringent requirements for algae/DO and potentially the oxidized nitrogen TMDL would require the construction of much more expensive facilities and the addition of significant annual operations and maintenance costs.

AGRICULTURE BEST MANAGEMENT PRACTICES (BMPS)

To estimate the costs of agricultural BMP implementation, it is necessary to know to what extent BMPs have been implemented throughout the watershed and to what extent BMPs will be implemented in the future. Because this information is not readily available, several assumptions were made in the estimation of ag BMP costs. First, all agricultural land was assumed to have not implemented any of the BMPs presented in the implementation plan of this document. Although it is known that some farms likely employ some of these measures already, there is no way to estimate the number that do at this time. Secondly, each BMP listed was assumed to have been implemented separately from the other BMPs. In reality, some BMPs may be implemented together and therefore reduce the costs. Finally, implementation of the BMPs was assumed to occur concurrently and consistently across all of the agricultural acreage in the watershed.

The following table summarizes the estimated costs for each BMP. Using these costs and an estimated agricultural acreage of 57,500 acres in the Calleguas Creek watershed, estimated watershed costs were determined.

Table A3-3. Estimated Agricultural BMP Costs

Best Management Practice	Unit	Cost per unit [1]	Watershed Cost
Conservation Tillage (329)			
No Till	acre	($2.90)	($166,750)
Mulch Till	acre	$17.20	$989,000
Contour Farming (330)	acre	$61.90	$649,950
Contour Orchard and Other Fruit Area (331)	acre	$131.80	$1,383,900
Crop Residue Use (344)			
Chopping and Chopping Waste	acre	$48.75	$2,803,125
Mulching using min. Tillage	acre	$20.10	$1,155,750
Filter Strip (393)			
Filter Strip (10-20 ft wide)	acre	$7,377.75	$1,381,473
Filter Strip (20-40 ft wide)	acre	$7,377.75	$2,762,945
Filter Strip (40-60 ft wide)	acre	$7,377.75	$5,525,890
Buffer Strip (20-30 ft wide)	acre	$1,217.70	$456,025
Landscaping (20-30 ft wide)	acre	$2,263.45	$847,655
Grassed Waterway (412)	acre	$7,377.75	$6,907,363
Hillside Bench (192)	acre	$1,080.15	$11,341,575
Irrigation System: Sprinkler (442)	acre	$830.90	$47,776,750
Irrigation System: Trickle (441)			
Microspray System	acre	$2,320.80	$133,446,000
Drip Irrigation	acre	$3,123.00	$179,572,500
Irrigation System			
Tailwater Recovery (447)	each	$16,904.40	unknown
Irrigation Water Management (449)	acre	$458.40	$26,358,000
Runoff Management system (570)			
Sediment Basin (350)	each	$573,430.70	unknown
Infiltration Trench	per foot	$51.60	unknown
Sediment Trap, Box Inlet	each	$593.10	unknown

1. Based on average costs presented in "Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon", National Resources Conservation Service, May 1995.

Watershed costs for each BMP were determined based on the amount of acreage in the watershed to which the BMP could be applied. Tillage, crop residue, and irrigation systems were assumed to be implemented on all the agricultural acreage in the watershed. Contour farming, contour orchards, and hillside benches were estimated for agricultural acreage in hilly areas (estimated to be 10,500 acres). Filter strips were assumed to be installed along the main channel and tributaries in agricultural areas for a total of 157 miles in the watershed. For simplicity, grassed waterways were assumed to be applied to the same miles of the waterways as the filter strips. The number of sediment basins, infiltration trenches, and sediment traps depend greatly on the amount of space available to install these devices. This information was not readily available, so watershed costs were not estimated for these BMPs. Because the number of individual farms in the watershed was not known, it was not possible to estimate the watershed cost for tailwater recovery systems.

As shown in Table A3-3, the agricultural costs on a watershed basis could be very significant. However, most of these BMPs would provide treatment benefits for constituents other than just nitrogen compounds. The overall costs will depend on the extent of BMP implementation and the BMPs chosen.

OTHER COSTS

The costs presented in the previous sections are based on the development of an implementation plan for the nutrient TMDLs outside of the overall watershed management plan for the Calleguas Creek watershed. Therefore, actual costs for implementing these TMDLs may be higher or lower depending on the implementation measures chosen in the watershed plan. These measures could include reverse osmosis, zero discharge or reduced discharge options, blending, etc. Implementation of any of these measures could make nitrification and denitrification unnecessary.

In addition, other costs could be associated with implementation of the nutrient TMDLs. These costs include studies to refine the targets and additional costs beyond meeting the wasteload and load allocations required to achieve the beneficial use of the water. These costs could include:

1. Cost of conducting water effects ratio (WER) study for ammonia
2. Costs to use the water for municipal supply (storage, transportation, treatment, etc.)
3. Loss of nutrients in water used for agricultural irrigation and potential need for more fertilizer use

Because of the uncertain nature of these costs, these costs were not estimated as part of this analysis. However, they are identified in this section in recognition that there may be additional costs associated with implementation of these TMDLs that are not identified in the previous sections.

Benefits

As discussed in the introduction to this appendix, assigning numeric dollar values to the benefits associated with the nutrient TMDLs is an extremely difficult task. As such, the benefits have been described qualitatively. The benefits have been discussed based on the beneficial uses impacted by the improvement in water quality associated with the nutrient TMDLs.

AQUATIC LIFE AND HABITAT

Toxicity Investigation Evaluations (TIEs) conducted in the watershed have demonstrated that ammonia is a source of toxicity to aquatic life in the Calleguas Creek system. Therefore, removing ammonia in this system would provide environmental benefit in the form of reduced aquatic toxicity. The reduced toxicity may potentially manifest itself in increased numbers and diversity of aquatic life species. This potentially will increase the number and types of birds and other wildlife that will be present that feed on these aquatic species. In addition to the removal of toxicity due to ammonia, implementation measures associated with the dissolved oxygen/algae TMDL will reduce the likelihood of fish kills occurring due to depletion of oxygen in the creek system.

Although reduced toxicity and higher dissolved oxygen levels are inherent benefits to the watershed, it is unclear how much improvement in the aquatic life will be gained through these improvements. Aquatic life is more significantly impacted by sediment and temperature in this watershed than by ammonia toxicity or dissolved oxygen levels (California Department of Fish and Game, 1998). Hydrologic restrictions in the watershed, such as the lack of connected flow between the Arroyo Simi and Calleguas Creek during much of the year and warm water temperatures, restrict the types of aquatic life that can be present. Physical stream modifications and the character of the stream in many areas place habitat restrictions on aquatic and terrestrial wildlife that will not be remedied by improving the water quality. As a result, it is unlikely that removing ammonia toxicity or increasing dissolved oxygen levels will result in a significant increase in species numbers and diversity in the watershed.

It is not possible to quantify this benefit in monetary terms. The qualitative discussion above recognizes that there will be aquatic life benefits realized from the implementation of these TMDLs, however, the benefits will be tempered by the physical and hydrological characteristics of the watershed that have significant impacts on the potential for aquatic life and habitat in the watershed.

RECREATION

Decreased ammonia toxicity may also provide additional recreation benefits in the watershed. Fishing in accessible areas may be increased and increased aquatic and terrestrial wildlife may provide additional aesthetic recreational opportunities around the creek. In areas where reductions in nutrient levels impact algae levels, recreational opportunities around the creek may be enhanced.

In the Calleguas Creek watershed, the recreational benefits achieved through the nutrient TMDLs are restricted due to several factors outside of the water quality in the watershed. Much of the watershed is inaccessible for public use. Fences, steep, overgrown embankments, and private property prevent public access to many areas of the waterbody. Additionally, portions of the creek are dry during much of the year and low flows in other areas prevent fish from reaching these reaches of the watershed. Improving the water quality in these reaches is unlikely to improve the fishing because of other restrictions on the fish population. Physical habitat limitations in accessible areas, such as modified channels and lack of riparian vegetation, reduce the likelihood that improved water quality will increase the numbers and species of birds and terrestrial wildlife for viewing. Finally, although the reduction in algae throughout the watershed will provide increased aesthetic value, the existing physical modifications of the system in many places restrict the aesthetic value much more than the algae and cannot be improved by improving the water quality in the watershed.

Many different methods have been used to attempt to assign monetary values to enhanced recreational opportunities. Typically, these estimations have been done in areas where a valuable natural resource exists. For example, studies have been done in areas of high shorebird viewing for tourists, national parks, or large boating rivers and reservoirs. No information has been developed for effluent dependent waterbodies with limited access and significantly modified channels. Because the waterbodies in this watershed are not suitable for boating and access for swimming and fishing is limited, the monetary values determined in other studies are not applicable to this watershed.

MUNICIPAL SUPPLY

In and of themselves, the maintenance of adequate nitrogen levels in the Calleguas Creek system will not allow the use of the surface water as municipal supply water. The effluent-dependent nature of the waterbodies result in a perceived health risk that prevents the Department of Public Health from allowing the use of this water for a drinking water supply, regardless of the water quality (Collins, 2000). Additionally, there are significant costs associated with the use of this water. Storage and treatment facilities would have to be constructed, as well as diversion facilities. Any water used for municipal supply would take away from the amount of water available for other, in-stream uses, such as aquatic habitat and groundwater recharge. Finally, the relatively low constant flow in the watershed from the treatment plants and urban runoff is probably not sufficient to make use of the water economically feasible, so facilities would have to be built to capture, store, and treat stormwater runoff. Because of the fact that a reduction in nitrogen concentrations will not result in the surface water being able to be used for a municipal supply, no benefit was assumed for this beneficial use from these TMDLs.

GROUNDWATER RECHARGE

Groundwater recharge and the use of the groundwater for municipal supply may receive a benefit from the reduction of nitrogen compounds in the watershed. In areas where significant groundwater recharge occurs (i.e. Las Posas Basin), nitrogen compounds may have the potential to degrade the quality of the groundwater resources over time. By reducing the amount of nitrogen in the surface water recharging the groundwater, the groundwater resources will be maintained for use as a municipal supply and costs for treatment of the groundwater may be avoided in the future. Additional benefit will likely be achieved in agricultural areas where nutrient management BMPs reduce the amount of nitrogen potentially reaching the groundwater.

There have been no studies in the Calleguas Creek watershed to date that link nitrogen concentrations in the surface water to increased nitrogen concentrations in the groundwater. Observed "hot spots" of high nitrogen concentrations in the watershed appear to be linked to agricultural activity or septic tanks. Modeling studies in this watershed indicate that nitrogen concentrations are significantly reduced as the surface water passes through the vadose zone into the groundwater (Kendall, 1998). Therefore, it is unclear exactly how much groundwater recharge benefit will be achieved in this watershed through the reduction in surface water nitrogen levels. Because there is not a clear connection between surface and groundwater nitrogen concentrations, it is not possible to estimate a monetary benefit for direct impacts to groundwater recharge.

Comparison of Costs and Benefits

This section summarizes the estimated costs and benefits associated with each of the three nutrient TMDLs.

AMMONIA TMDL

Implementation of the ammonia TMDL could likely be achieved with watershed costs around $300,000. Depending on the control needed at each of the POTWs, implementation of this TMDL could cost close to $23,000,000. The implementation measures will potentially result in limited benefits to aquatic life due to reduced toxicity in the watershed and potential increased benefits for recreation in the watershed.

OXIDIZED NITROGEN TMDL

Implementation measures associated with the oxidized nitrogen TMDL could result in present worth costs to POTWs of approximately $35,000,000. Costs to agriculture will likely be in the hundreds of millions of dollars depending on the extent of the BMPs listed that are implemented at each site. The benefits of achieving this TMDL are not clearly defined because of the lack of information about the connection between nitrogen concentrations in surface water and nitrogen concentrations in groundwaters recharged by the surface water. Benefits to municipal water supply beneficial uses will not be achieved from this TMDL, but some aesthetic, recreation, and aquatic life benefits may be achieved to the extent that a reduction in nitrogen concentrations impacts algae and dissolved oxygen levels.

ALGAE/DISSOLVED OXYGEN TMDL

The costs associated with the algae/dissolved oxygen TMDL will depend on the impact achieved through implementation measures for the ammonia TMDL. If additional control of TKN is required, costs will be in the vicinity of $23,000,000. Aquatic life benefits will be achieved in the Conejo system to the extent that low dissolved oxygen levels are impacting aquatic life. Some recreation benefits may be achieved by reductions in algae concentrations that may result from implementation of this TMDL. However, it is unclear the extent of the benefit that will be achieved because the impairments resulting from algae in the watershed have not been quantified to date.

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