Supplement to Technical Staff Report for Draft Total Maximum Daily Load, Indian Creek Reservoir, Alpine County

California Regional Water Quality Control Board
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May 2002

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Introduction

Indian Creek Reservoir (ICR) is a manmade reservoir in eastern Alpine County. It is eutrophic, largely because of internal loading of phosphorus from the sediment. Most of the phosphorus in the sediment is a legacy of past wastewater disposal to the reservoir. .Under the federal Clean Water Act, California is required to adopt strategies called Total Maximum Daily Loads (TMDLs) to ensure attainment of standards in impaired surface water bodies. A TMDL is required for ICR because of violations of water quality objectives and impairment of aquatic life and recreational uses by eutrophic conditions.

In November 2000, the California Regional Water Quality Control Board, Lahontan Region (Regional Board) released public draft amendments to its *Water Quality Control Plan for the Lahontan Region* (Basin Plan) and supporting documents including a technical staff report. The draft amendments contained a TMDL and TMDL implementation plan to reduce the loading of phosphorus to ICR from internal and external sources. Responsibility for implementing the TMDL was assigned to the South Tahoe Public Utility District (STPUD), the U.S. Bureau of Land Management (USBLM) and other public and private land owners in the watershed.

The Regional Board was unable to consider adoption of the Basin Plan amendments (originally scheduled for January 2001) due to lack of a quorum. The draft amendments and environmental document have been revised and will be recirculated for public review in May 2002. Regional Board approval will be considered in July 2002. These documents include changes in response to public comments on the November 2000 drafts. A revised version of the Regional Board's November 2000 technical staff report on the TMDL was sent to the U.S. Environmental Protection Agency, Region IX (USEPA) in August 2001 as a TMDL grant work product. This supplement to the 2001 staff report updates information on the setting for the TMDL and summarizes the background for staff's decision to change or not to change certain provisions of the Basin Plan amendments.

Watershed Update

Since the TMDL was developed, a number of changes have been proposed in the water quality planning and land use and water rights management status of the Indian Creek and West Fork Carson River watersheds. These changes could affect the implementation of the TMDL and could eventually require update of the TMDL calculations. They are summarized below.

Stakeholders' Plans

In January 2002, STPUD released a draft Environmental Impact Report (EIR) for its proposed *Recycled Water Facilities Master Plan.* The primary purpose of the master plan is to address the disposal and reuse of treated wastewater (recycled water) in Alpine County, California (and possibly in Douglas County, Nevada). However, the master plan also includes several components related to improvement of water quality in ICR. These

components are summarized below as additional potential implementation measures for the TMDL. The master plan is not expected to be completed and adopted until after Lahontan Regional Board action on the TMDL. The TMDL implementation schedule allows time for STPUD to report to the Regional Board on the specific implementation measures it plans to use. Information from STPUD's draft EIR is also being used to update the environmental and socioeconomic information in the Regional Board's revised (2002) draft environmental document for the proposed Basin Plan amendments.

The U.S. Bureau of Land Management (USBLM) is continuing to seek funding for land management planning for the watershed directly tributary to ICR. This planning would address implementation of Best Management Practices (BMPs) among other issues. To date, no funds for such planning are available (Arthur Callan, USBLM, personal communication, March 18, 2002). Regional Board staff's revised economic analysis for TMDL implementation on BLM land, contained in the revised environmental document, includes a "worst case" estimate of implementation costs on USBLM lands. If the reservoir is maintained at a higher level, as proposed under STPUD's master plan, there will be a smaller terrestrial disturbed area requiring BMPs.) The revised TMDL implementation schedule calls for the USBLM and other landowners to identify specific sites needing BMPs by one year after final TMDL approval and to implement BMPs for all problem areas by 2013.

In 2001, the Alpine County Board of Supervisors entered into an agreement with the Carson Water Subconservancy District (Subconservancy) to facilitate water resources coordination for the Carson River watershed has a whole. The Subconservancy is a multicounty agency that participates in the management of water resources within the entire Carson River watershed in Nevada. The Subconservancy is pursuing changes in the use of 219 acre-feet per annum (afa) of agricultural water rights for the Lost Lakes (at the headwaters of the West Fork Carson River) to allow municipal use of the water in Carson City. There is a possibility that the water could be routed through ICR to provide additional dilution and flushing.

A more active Alpine County stakeholder group for the Carson River watershed has been formed as a subgroup of the Upper Carson River Coordinated Resource Management Plan (CRMP) group. This group has recently obtained grant funding for a fluvial geomorphology study of the West Fork Carson River. The Alpine County group will be among the stakeholders invited to participate in planning for implementation of the TMDL.

Section 303(d) Listing

Under Section 303(d) of the Clean Water Act, States must periodically update their lists of surface water bodies requiring TMDLs**.** In 2001, Lahontan Regional Board staff reviewed water quality monitoring data for the West Fork Carson River collected by STPUD between 1981 and 2000, and determined that several water quality objectives expressed as annual "means of monthly means" were being exceeded. In particular, the objective for total phosphorus (0.02 milligrams per liter or mg/L) was exceeded at the

Woodfords monitoring station (near the STPUD's diversion point for the tributary inflow to ICR). A "mean of monthly means" is a rolling average incorporating all historical data for a given monitoring station. The means of monthly means in recent years were as follows: 1997, 0.09 mg/L; 1998, 0.03 mg/L; 1999, 0.02 mg/L; and 2000, 0.03 mg/L. Means of monthly means since 1997 have obviously been strongly influenced by short term high phosphorus concentrations at Woodfords as a result of the January 1997 flood event. (The flood was greater than a 100 year event for this reach of the river.) In January 2002, the Lahontan Regional Board recommended that the State Water Resources Control Board (State Board) place the segment of the West Fork Carson River from the headwaters to Woodfords on the 2002 Section 303(d) list for violation of the water quality objectives for total phosphorus and other pollutants. TMDLs, if needed, would be developed for these pollutants after 2015. Stakeholders have expressed interest in developing a cooperative monitoring program, and Regional Board staff will consider revisions in water quality objectives when additional data, including data for stations above Woodfords, become available. In particular, objectives should be revised to be expressed as annual means so that compliance is evaluated in terms of the most recent data.

Because of the proposed listing, Regional Board staff's assumption in the TMDL analysis that the West Fork Carson River is "background" quality could be challenged. The reasons for continued use of this assumption are outlined later in this staff report supplement.

Nutrient Criteria Development

Since development of the ICR phosphorus TMDL began, the USEPA has proposed numerical nutrient criteria for surface waters of "aggregate ecoregions" within California and Nevada. The USEPA has directed states to adopt these criteria or to develop their own scientifically defensible nutrient criteria for surface waters by 2004. The recommended USEPA criteria for total phosphorus in the "Mountainous West" ecoregion (Ecoregion II) including the Sierra Nevada are 10.00 ug/L for rivers and streams and 8.75 ug/L for lakes and reservoirs, expressed as annual medians. The "rivers and streams" number is more stringent than the current water quality objective for the West Fork Carson River; the "lakes and reservoirs" number is more stringent than the proposed TMDL target for Indian Creek Reservoir. Regional Board staff are participating in a state/federal process to develop more precise nutrient criteria for smaller ecoregions in California and Nevada. Protection of aquatic life uses is a major consideration. This process may result in recommendations for revised phosphorus objectives for the West Fork Carson River and Indian Creek Reservoir and, eventually, revisions to the TMDL target.

Rationale for Proposed Changes to Basin Plan Amendments

Changes to the draft Basin Plan amendments include:

- Addition of less stringent interim targets for total phosphorus and dissolved oxygen, to be attained by 2013.

- Removal of total phosphorus target for tributary inflow to reservoir (the load allocation to this source would remain).

- Increased emphasis that a change from eutrophic to mesotrophic conditions, necessary for support of aquatic life and recreational uses, is the desired outcome of the TMDL.

- Revisions to the implementation program and schedule. Changes include extension of the deadline for implementation of controls for external sources to 2013 and additional reference to the Rangeland Water Quality Management Plan as a mechanism for implementation.

- Recognition of increased dilution and flushing as a potential implementation measure.

- Miscellaneous editorial changes including citations of references.

Changes to TMDL targets and indicators.

During the earlier public review period, a number of stakeholder comments questioned the feasibility of attaining the proposed targets for phosphorus and dissolved oxygen and urged that less stringent targets be adopted. Regional Board staff's recommendation is that the more stringent targets should be kept as long term targets (to be attained by 2024) but that less stringent interim targets should be added (to be attained by 2013). If monitoring shows that beneficial uses can be adequately supported at higher phosphorus and/or lower dissolved oxygen concentrations, the long term targets may be revised to be less stringent. Revisions could also be justified if other scientific evidence (such as the California nutrient criteria development process outlined above) results in revisions in applicable water quality standards.

The interim phosphorus target (0.04 mg/L as an annual mean) is similar to the current water quality objective for phosphorus in ICR. (The latter is expressed as a mean of monthly means.) Regional Board staff's scientific literature review (summarized in the earlier technical staff report) and the scientific peer reviewer's comments (Johnston, 1999) indicate that this level will maintain eutrophic conditions. The long term target (0.02 mg/L) is based on a large body of scientific evidence. However, some potential reservoir management measures, such as oxygenation, could enhance aquatic life and recreational uses at phosphorus concentrations higher than the long term target. Regional Board staff are willing to evaluate progress toward water quality improvement under the implementation measures selected and to consider revisions in targets based on beneficial use support. If oxygenation is used in combination with dilution and flushing, as may be the case under STPUD's proposed master plan, progress toward attainment of the interim

and long term phosphorus targets could be more rapid than with use of either management measure alone.

To complement the addition of interim targets, reference to mesotrophic conditions as the desired outcome of the TMDL has been added to the Basin Plan amendment language. Attainment of oligotrophic conditions (involving lower nutrient concentrations and algal productivity than mesotrophic conditions) is probably not feasible even if internal phosphorus loading is drastically reduced, since the "background" phosphorus concentration of the West Fork Carson River is higher than the threshold concentration (0.01 mg/L total phosphorus) between mesotrophic and oligotrophic lake conditions. (Thresholds from the scientific literature are summarized in USEPA, 1999.)

The TMDL's long-term dissolved oxygen target is set at the level of the current water quality objective for Indian Creek Reservoir The objective is based on the regionwide water quality objective for dissolved oxygen in the 1975 *Water Quality Control Plan for the North Lahontan Basin*. The TMDL target and water quality objective for ICR are more stringent than the current regionwide dissolved oxygen objective (in the 1995 Basin Plan) for waters with the same aquatic life use designations as ICR. The difference between the 1975 and 1995 regionwide objectives is due to changes in federal dissolved oxygen criteria over time. It is probable that attainment of the 1995 regionwide criteria would provide adequate support for aquatic life uses in ICR. However, TMDLs must provide for the attainment of existing water quality standards, and the more stringent long-term target is necessary unless and until the dissolved oxygen standard for ICR is revised. Both the interim and final dissolved oxygen targets are set at levels much higher than the near-zero levels measured near the bottom of ICR during summer stratification, and similar measures would probably be required to attain both targets.

During the earlier public review period, some stakeholders expressed concern that the target for total phosphorus in the tributary inflow might not be attainable due to seasonal variations in phosphorus concentrations in the West Fork Carson River and constraints under existing water rights on the time when water can be diverted to Indian Creek Reservoir. In response to this concern, Regional Board staff decided to drop the target and indicator for the tributary inflow. (The TMDL load allocation for this source will be retained.)

TMDL targets are not enforceable in themselves, but are means of interpreting compliance with water quality standards, including protection of beneficial uses. (TMDL targets and indicators <u>are</u> considered "regulatory" in that they must be approved by the California Office of Administrative Law.) The tributary target for the TMDL was included to facilitate evaluation of water quality improvements due to implementation of Best Management Practices in the watershed tributary to Snowshoe Thompson Ditch No. 1; however, it is not essential for evaluation of the overall success of the TMDL. Dropping the target will reduce the perception that violations are occurring due to variations in background water quality related to spring runoff. Water quality in the tributary inflow will continue to be measured whether or not a numerical target is included. The TMDL includes a variety of other targets for Indian Creek Reservoir itself

that will allow evaluation of progress toward attainment of mesotrophic conditions, the desired state for protection of beneficial uses. The in-reservoir phosphorus target is expressed as a ten-year rolling average in order to account for seasonal and annual variations.

Implementation schedule

The implementation schedule for the TMDL has been revised to include somewhat different deadlines. In particular, the deadline for implementation of all Best Management Practices necessary to control external sources of phosphorus loading has been changed to 2013, the same year as the previous deadline for implementation of controls for internal phosphorus loading. The earlier proposed deadline for external controls (2003) resulted from a misunderstanding on Regional Board staff's part of the compliance schedules in a draft version of the statewide Nonpoint Source Plan. The 2013 compliance date is appropriate for control of internal sources, since potential control measures are likely to be expensive (see the economic analysis in the Regional Board's revised draft environmental document) and time will be required for acquisition of funding, engineering design, project specific environmental analysis, and (in the case of water rights changes) legal agreements. Since the TMDL analysis indicates that internal loading contributes the greatest amount of phosphorus to ICR, it is equitable to allow later implementation for external sources.

Dilution and flushing as a potential implementation measure

The Basin Plan amendments do not mandate any specific implementation measures, but rather establish performance standards. (The Regional Board is prohibited by Section 13360 of the California Water Code form specifying the manner of compliance with its orders.) In the earlier staff report, Regional Board staff summarized the results of a literature review on lake restoration methods and identified dredging (to remove sediment) and chemical treatment (with alum or other compounds) to prevent phosphorus release from the sediment as in-lake restoration methods capable of meeting the performance standards within the existing water rights/water management regime. (As the earlier staff report explains, STPUD's water rights are limited and there is almost no inflow to the reservoir during the critical summer period.)

In its 2002 master plan Environmental Impact Report, STPUD has proposed to acquire additional water rights and to reach agreement with the owners of other water rights in order to allow significant increases the amount of West Fork Carson River water routed through or stored in ICR. These changes are summarized in Table 1. They could allow inflow of up to 4,700-11,200 acre-feet per year of water into Indian Creek Reservoir, in addition to the maximum of 555 acre-feet per year allowed under STPUD's existing water rights from the West Fork and Indian Creek. (Due to the limited capacity of the inflow ditch, STPUD is currently unable to make full use of its existing water rights. Current water inflows are used to maintain the level of the reservoir and do not provide significant dilution and flushing.) The Carson Water Subconservancy District (2002) is also considering a water rights scenario that could provide for an additional 219 acre feet

per year inflow to the reservoir. The potential maximum new inflow amount is more than three times the inflow estimated by STPUD's consultants to provide for good reservoir quality. In 1981, STPUD's consultants (Porcella *et al*., 1981) estimated that if the wastewater inflow occurring at that time were replaced with a 3,552 afa inflow of West Fork Carson River water, the concentration of total phosphorus in ICR would reach 0.005 mg/L by 1985 and would be maintained at that level through 1990. (This estimate did not take significant internal loading of phosphorus from the reservoir sediment into account.)

Since the waters of the West Fork Carson River are fully adjudicated, the acquisition of additional water for Indian Creek Reservoir will require court consent as well as legal agreements with other water rights owners. In addition to the uncertainty associated with these agreements, no detailed information is currently available on management of the "new" water (e.g., on the amount of water that would be flowing through or stored in ICR at any given time of year). Significantly higher summer lake volumes would affect the degree of stratification and the release of phosphorus from the sediment. Because of these factors, Regional Board staff did not attempt to calculate how the ambient phosphorus concentration in ICR would be affected by a given inflow amount. Significantly increased inflows and outflows would change the TMDL phosphorus budget for the reservoir, and TMDL calculations will need to be revised if and when a new flow regime is certain.

The scientific literature indicates that flushing with low nutrient water can be effective in reducing nutrient concentrations and algae blooms in eutrophic lakes, depending on the amount and timing of inflows. Increased inflow reduces the concentration of nutrients and washes algal cells out of the reservoir. If the flushing rate during the growing season is high in relation to the algal growth rate, washout of cells can significantly reduce algal biomass. To the extent that fresh water inflow mixes and cools the water column, it may slow algal population growth and offset the competitive advantage that blue-green algae enjoy by being more buoyant than other kinds of phytoplankton. If mixing maintains oxygenated conditions near the sediment, phosphorus release from the sediment will be reduced. Cooke *et al.*(1993) stated that a flushing rate on the order of 10 to 15 percent of the lake volume per day should provide some control of algal growth through washout. In two case studies cited by Cooke *et al.,* water quality (expressed as chlorophyll a, Secchi depth, and phosphorus concentration) improved significantly with dilution and flushing, but deteriorated in years when water was in short supply. Dilution "achieved substantial control " of internal phosphorus loading in case studies where such loading was a factor. The effects may be complex. In one lake in the Netherlands, dilution decreased summer internal loading by reducing the winter blue-green algae concentration. This decreased the effects of early season algal blooms on lake pH; lower early summer pH reduced the release of P from the sediment. In some cases dilution may increase phosphorus release from the sediment by creating a diffusion gradient. Once additional water supplies for ICR are assured, the effectiveness of dilution and flushing, and the optimal amount and timing of inflows, will need to be determined through monitoring and modeling.

STPUD's draft master plan EIR includes additional optional components such as oxygenation that could complement increased dilution and flushing to enhance aquatic life uses. Oxygenation would also reduce the release of phosphorus from the sediment.

Rationale for continued use of TMDL calculations based on water quality data for 1999.

The TMDL source analysis and load allocations are based on water quality monitored in Indian Creek Reservoir and its tributary inflow in 1999. During that year, the mean annual concentration of total phosphorus in the West Fork Carson River was 0.02 mg/L, roughly equivalent to the water quality objective (the latter is expressed as a mean of monthly means). The river water quality was assumed to be background for purposes of the TMDL. The load allocation for the tributary inflow assumed that Best Management Practices to control phosphorus loading would be applied in the watershed tributary to the inlet ditch downstream of the diversion point from the river and to the upper Indian Creek watershed.

It could be argued that the TMDL analysis should be updated to reflect the most recent water quality data available for the tributary inflow and for the reservoir. Because of the Section 303(d) assessment summarized above, and the seasonal variability of phosphorus concentration, it could also be argued that the West Fork Carson River should not be considered background quality, and that the tributary load allocation should include the West Fork watershed above the diversion point. Regional Board staff have chosen to retain the TMDL analysis based on 1999 conditions for the following reasons:

During 1999, the tributary inflow to the reservoir, estimated from reservoir volume changes shown by staff gage height, was 593 acre-feet, slightly higher than the maximum amount of water available under STPUD's current water rights. 1999 was a "wet" year, and phosphorus loading in natural runoff from the ICR's immediate watershed was presumably relatively high. 2000 and 2001 were relatively "dry" years, and inflow was probably atypical. Data provided by STPUD show that the mean total phosphorus concentration in near-surface (0.5 foot depth) samples from the reservoir in 2000 was 0.063 mg/L in 2000, and 0.034 mg/L in 2001. The 2001 surface phosphorus concentration is in attainment of the proposed interim TMDL target, and surface concentrations in May and July (0.022 and 0.033 respectively) approached the long term target. However, the mean phosphorus concentrations from the deepest part of the reservoir were 0.105 mg/L in 2000 and 0.076 mg/L in 2001, indicating that high levels of phosphorus are still present in the system. The reason for the improved surface water quality in 2001 unknown; it may reflect reduced phosphorus loading due to low runoff, changes in wind-related stratification and mixing patterns during the summer, and/or increased phosphorus uptake by large algal colonies or multicellular aquatic plants that were not collected or analyzed.

The discussion of the Section 303(d) list assessment, above, notes that the recent violations of the "mean of monthly means" standard in the West Fork Carson River were influenced by high phosphorus concentrations resulting from the 1997 flood event.

Calculation of annual means shows that the 0.02 mg/L phosphorus value used as background for the TMDL has historically been attained more often than not. Annual means calculated from the data summarized in Table 6 of the TMDL technical staff report for years with 10 or more samples (1984-1998) were equal to or less than 0.02 mg/L in eleven of 16 years (69%). More frequent sampling, including additional sampling at upstream stations, might show that the quality of the West Fork at Woodfords is not truly "background." The forthcoming fluvial geomorphology study may identify specific eroding areas where restoration would reduce phosphorus loading as well as sediment loading. However, for the present, the continued use of the 1999 base year, with a 0.02 mg/L phosphorus background level, in TMDL calculations for Indian Creek Reservoir seems to be reasonable.

Other TMDL Issues

Need for a TMDL.

During the earlier public review period, some stakeholders questioned whether a TMDL is needed to protect beneficial uses of ICR, since they are satisfied with the fishery maintained by annual stocking. The 2001 technical staff report and response to comments document provide evidence that aquatic life and recreational uses of the reservoir are indeed impaired, and that the current reservoir management program is not adequate to protect and enhance them. In addition to the earlier evidence, Regional Board staff have recently become aware of literature on the public health implications of blue-green algal toxins for recreational users of eutrophic lakes and reservoirs. Toxins are not produced by all strains of a given species of blue-green algae. However, if blue-green algae are present at "bloom" densities, there is a greater risk that toxins will be present. The following information is from a recent (2002) literature review by L.C. Backer (2002) of the National Center for Environmental Health.

Toxins produced by freshwater blue-green algae belong to one of two groups, neurotoxins and hepatotoxins. Routes of human exposure include drinking water or accidental contact with cells and/or toxins by swallowing or inhalation during recreational activities. Exposure can also occur through the use of untreated water for irrigation or lawn watering. "People swimming in contaminated lakes have experienced conjunctivitis, earache, swollen lips, allergic dermatitis, and a hayfever-like syndrome." People with existing asthma or allergies may be particularly sensitive. Gastrointestinal disorders have been reported after accidental ingestion of water with blue-green algae blooms during recreational use. Symptoms include stomach cramps, headache, nausea, and diarrhea. Chronic exposure to blue-green algal toxins in drinking water may increase the risk of digestive system and liver cancers, and may possibly affect fetal development. In a survey (published in 2001) of 24 drinking water sources in the United States and Canada, microcystins (one category of blue-green algal toxins) were present in the majority of source waters, although they were removed during treatment.

The USEPA has included blue-green algae and their toxins to its drinking water Contaminant Candidate List. There is an international effort to develop drinking water

limits for algal toxins and guidance for public health authorities to use in response to blooms in recreational waters. Backer summarizes one series of guidelines developed by authorities including the World Health Organization and the USEPA:

> *"If cyanobacterial [blue-green algal] scum forms in bathing areas, acute poisoning, short-term effects (e.g., skin irritation and gastrointestinal illness) and possibly for [sic] long-term illness could occur. Public health officials should immediately employ procedures to control contact with cyanobacterial scums. Other appropriate actions include informing the public and relevant authorities. When there are 100,000 cyanobacteria/mL or 50 ug chlorophyll-a/L (primarily from cyanobacteria), both acute effects (e.g., skin irritation, gastrointestinal illness) and chronic effects could occur. Response actions include discouraging bathing, monitoring scum development, posting advisories, and informing the relevant authorities. When there are 20,000 cyanobacteria/mL or 10 ug chlorophyll-a L (primarily from cyanobacteria), risk exists for short term adverse effects (e.g., skin irritation, gastrointestinal illness). Response action should include posting advisory signs and informing relevant authorities. Aggravation of dermal reactions from accumulated cyanobacteria between skin and wet bathing suits may occur even at cell densities below those described above, and appropriate advisories should be posted."*

This guidance is relevant to the Indian Creek Reservoir TMDL because blue-green algae cell counts and chlorophyll a levels monitored in the reservoir have exceeded the cited levels warranting advisories in the past. For example, cell counts of *Anabena* ranged from 20,800 to 999,999 in 1997, and the near-surface chlorophyll a concentration was 41.0 mg/cubic meter (equivalent to ug/L) in August 2000. It is not known whether the chlorophyll a in the reservoir comes primarily from blue-green algal sources. If this is ever determined to be the case, it might be appropriate to revise the TMDL target for chlorophyll a to be more stringent. The currently proposed target is a maximum of 10 micrograms per liter (ug/L) chlorophyll a during the summer months, representing the threshold between mesotrophic and eutrophic conditions. (As discussed in the earlier Regional Board staff report, blooms of blue-green algae are an indicator of eutrophic conditions. Reductions in phosphorus loading will allow other kinds of algae to compete with blue-green algae, and reduce the risk of blooms.)

The public health information summarized above provides additional evidence that eutrophic conditions in ICR do constitute beneficial impairment that warrants a TMDL.

<u>BMP Efficiency.</u> The proposed load allocations were developed with the assumption that Best Management Practices with at least 75% efficiency in removing phosphorus will be used to reduce loading from external sources in the watershed directly tributary to ICR and in the watershed tributary to the inlet ditch. During the earlier public review period, some comments questioned whether the assumption of efficiency was justified. In the 2001 "response to comments" document, Regional Board staff provided additional references to show that BMPs with this degree of phosphorus removal efficiency are available. Table 2 provides further data on phosphorus removal efficiency from the

USEPA's NPDES stormwater webpage. The reported efficiencies are from studies of urban stormwater BMPs, and efficiency can vary with a number of factors such as soil, climate, etc. However, similar practices might be used to treat runoff from disturbed areas in the ICR watershed. Combinations of different BMPs with different phosphorus removal efficiencies can be expected to provide higher removal efficiencies (Maine Department of Environmental Protection, no date.).

If the STPUD's plans to improve Snowshoe Thompson Ditch No. 1 by converting it to a pipeline or a larger engineered open ditch are implemented, there will be a reduced need for implementation of agricultural BMPs on grazing lands currently tributary to the inflow to ICR. (An improved open ditch could be designed to exclude pasture runoff.) Improving the ditch would eliminate existing erosion problems near the diversion point; this may provide the greatest improvement to water quality for the tributary inflow. Land ownership maps in STPUD's 2002 master plan EIR show that STPUD owns most of the grazing land tributary to the ditch.

BMPs might still be needed on public and private lands in the upper Indian Creek watershed. Site inspection will be needed to determine whether BMPs are needed for the Indian Creek watershed and which BMPs are most appropriate. The high phosphorus removal efficiency cited in Table 2 for grassed buffer areas indicates that pasture and meadow vegetation should be capable of removing large amounts of phosphorus from surface runoff. If the stream channel and riparian vegetation are in good condition, extensive additional BMPs may not be necessary.

Table 2. Phosphorus Removal Efficiency of Certain Best Management Practices

Practice	**Reported Efficiency**	**Comments**
Submerged gravel wetland	64% (Total P)	
Pond/Wetland System	56 +/- 35%	
Wet Ponds	18-91%	9 of 34 studies found greater than 75% efficiency; 14 of 34 found greater than 60% efficiency.
Infiltration trench	60-70%	For facility designed to treat 1 inch storm
Infiltration basin	60-70%	For facility designed to treat one inch storm.
Sand and organic filters	80-84%	For multichamber treatment train.
Porous Pavement	65% (Total P)	Same efficiency in 2 different sites.
Bioretention areas (runoff treatment by soil/vegetation strips surrounding parking areas)	65-87%	
Grassed buffer zone near water body (4.6-9.3 meters wide)	78%	

Correction to 2001 Staff Report

In Section 3.2.D.2.1, the units in the numeric target for chlorophyll a should have been ug/L rather than mg/L.

Summary

The May 2002 draft Basin Plan amendments include a number of changes in the previously proposed TMDL such as including interim targets, a revised implementation schedule, and recognition of dilution and flushing as a possible means to reduce internal loading of phosphorus to the reservoir water column over time. This supplement to the staff report provides background for the proposed changes, and additional justification for the portions of the TMDL analysis that are not recommended for change.

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