Chapter 4 - WATER QUALITY

Figure 4-1. Pathway Recommendations for Water Quality

Water Quality Vision: Exceptional water quality provides restored clarity, environmental and human health, and human enjoyment of Lake Tahoe waters.

Proposed Desired Conditions

1. Lake Tahoe Clarity
Restore, and then maintain the waters of Lake Tahoe for the purposes of human enjoyment and preservation of its ecological status as one of the few large, deepwater, ultraoligotrophic lakes in the world with unique transparency, color and clarity.

2. Human & Environmental Health
Water quality conditions in the Lake Tahoe basin protect human and environmental health.

Proposed Indicators

Pollutant Loading Sources
Measurement of fine sediment, nitrogen and phosphorus loads from tributaries, storm water, stream channel erosion, ground water, and atmosphere. (Type III)

Pollutant Loading Effects
Secchi depth measurement in pelagic waters and turbidity in littoral waters of Lake Tahoe.
(Type I).

WQ Health Conditions Report
Summary of health-based water quality information and data from Tahoe Basin ground and surface waters. (Type II)

Index of Biological Integrity (IBI)
To be determined by Wildlife and Fisheries Technical Working Group.
(Type II or III)

Proposed Standards

Pollutant Load Reductions
An outcome of the TMDL is load reduction targets for major sources categories. Because targets will necessarily be refined over time based upon actual monitoring results and achievement of milestones, they should be considered as management standards as opposed to threshold standards.

Clarity
Secchi depth shall not be less than annual average of 29.7 m. Agencies will retain existing standards for turbidity and vertical extinction coefficient. Collaborative development of alternate nearshore aesthetic standard(s) will be addressed after 2008.

Compliance
Compliance with established federal, state and local health-based water quality standards and regulations.

IBI Index –
See standards for Index(es) of Biological Integrity, reference Wildlife and Fisheries Chapter.

4.0 Water Quality Overview

Lake Tahoe is one of the deepest and clearest lakes in the world. As such, it is a highly sought out destination for recreation, tourism and home ownership. Clarity and exceptional water quality are the basis of Lake Tahoe water quality goals. These important features give Lake Tahoe important designations. Both the federal government and California government have designated Lake Tahoe an "Outstanding National Resource Water". Nevada has designated Lake Tahoe a "Water of Extraordinary Ecological or Aesthetic Value". In addition to aesthetic enjoyment, the exceptional quality of water in the Lake Tahoe Basin supports a number of beneficial uses related to human and environmental health, including drinking water supply, water contact recreation, wildlife habitat, and aquatic life and habitat.

This water quality evaluation report summarizes the Pathway 2007 Water Quality resource group's analysis and recommendation for improving certain water quality regulations for the Lake Tahoe Basin:

- A common set of language and organizational structure to describe desired conditions relevant to the beneficial uses of Lake Tahoe Basin waters;
- Identification and prioritization of indicators of desired conditions based on current scientific knowledge and technical capability;
- Information about existing standards and proposed modifications;
- Discussion pertaining to the monitoring and trend analysis and, possible development of standards for new indicators (e.g. nearshore clarity and aesthetics);
- A recommendation to update and integrate specific water quality standards where they currently differ between the two states and TRPA.

The proposed desired conditions for water quality fall into three categories (categories which derive from official "Beneficial Uses" of Lake Tahoe Basin waters: 1) Lake aesthetic as related to the open water and nearshore environments; 2) Human health and 3) Environmental health. Human and environmental health are grouped under one desired condition statement. Indicators that measure progress toward attainment of desired conditions are proposed based on a prioritized evaluation of potential indicators utilizing best professional judgment of the Water Quality Core Group (WQCG) and Technical Working Group (TWG). Additionally, input was considered from members of the general public derived through Pathway 2007 outreach efforts. In general, public opinion collected during early 2005 reflects support for:

- A common set of standards among the agencies;
- Protection of human health; and
- Protection or restoration of Lake Tahoe clarity.

4.1 Water Quality Vision

The Pathway agencies share the goal of protecting water quality for the achievement of beneficial uses. The Nevada Division of Environmental Protection (NDEP) and California Regional Water Quality Control Board (Lahontan) are the delegated authorities for implementing the Clean Water Act and Porter-Cologne Act[1]. The Tahoe Regional Planning Agency (TRPA) is also responsible for implementing programs that protect water quality and ensure the protection of beneficial uses. The US Forest Service manages public lands under its jurisdiction in the Lake Tahoe Basin in accordance with local, state and federal regulations. Through the Pathway

[1] The Porter-Cologne Act applies to California only.

2007 process the following vision statement, as related to the need for regulation and management of Lake Tahoe Basin water quality, has been developed.

Water Quality Vision: Exceptional water quality provides restored clarity, environmental and human health, and human enjoyment of Lake Tahoe waters.

4.2 Need For Change

The Pathway agencies share this common vision for water quality in the Lake Tahoe Basin. However, mutual language describing the desired conditions for beneficial uses related to Lake Tahoe water quality is currently lacking. Moreover, inconsistencies exist amongst TRPA, and the states of Nevada and California for the indicators and standards used to evaluate desired conditions and beneficial use attainment status. This chapter presents indicator-standard packages identified as most appropriate for measuring progress towards achievement of the stated desired conditions. The Pathway agencies acknowledge that a common, comprehensive approach to managing and regulating water resources at the basin scale is desirable. As such an integrated approach is the most effective and efficient means to ensure the protection of these precious natural resources. Therefore, the need exists for the Pathway agencies to adopt the identified indicators and standards.

4.3 Desired Condition 1: Lake Tahoe Clarity

All Pathway Desired Condition statements for Water Quality appear in Figure 4-1. The Desired Conditions were crafted on the basis of water body relation to three different beneficial uses: 1) aesthetic enjoyment; 2) human health; and 3) environmental health. Although it is a goal to preserve the aesthetic enjoyment attributes of all Lake Tahoe Basin waterbodies, the Clarity Desired Condition specifically focuses on Lake Tahoe.

Lake Tahoe has been designated an Outstanding National Resource Water (ONRW) due to its famed clarity and exceptional water quality, which also serve as the basis for its worldwide popularity as a tourist and recreation destination. For these reasons the Pathway agencies agreed that a desired condition statement specific to the clarity of Lake Tahoe is warranted.

DC1. Lake Tahoe Clarity
Restore and then maintain the waters of Lake Tahoe for the purposes of human enjoyment and preservation of its ecological status as one of the few large, deepwater, ultraoligotrophic lakes in the world with unique transparency, color and clarity.

4.3.1 Proposed Indicators for Desired Condition 1: Lake Tahoe Clarity

4.3.1.1 Indicators for Pollutant Loading Effects

Secchi Disk

The portion of the lake deep enough that light does not reach the bottom is the pelagic (deep water) zone. Within Lake Tahoe's pelagic zone, the key indicator for clarity has been Secchi disk depth, for which TRPA as well as the State of California has established a standard. This indicator is a measurement of the depth to which an observer can see a white disk submerged in the water column. Traditionally, ecologists have used the Secchi depth to indicate the trophic status of waterbodies throughout the world. Secchi disk depth is a scientifically defensible, statistically valid measurement of status-and-trend. Moreover, the simplicity of the methodology facilitates public understanding and acceptability.

While annual Secchi disk measurements are commonly referred to as clarity, this measurement is actually defined as transparency in regulatory documents. Clarity is defined as vertical extinction of light in deep water and as turbidity in shallow water. Collectively, this report refers to all three measurements as clarity.

Vertical Extinction Coefficient

The vertical extinction coefficient (VEC) represents the fraction of light held back (or extinguished) in water per meter of depth by absorption and scattering. Thus, higher VEC values indicate less clarity. The vertical transmission or penetration of light down the water column extends beyond the depths where Secchi disks can be seen from the Lake surface. In Lake Tahoe, very small amounts of light can be measured at depths greater than 100 m (Swift 2004).

Though VEC measurements are relatively easy to perform, many VEC measurements must be taken to equal one Secchi depth reading. Secchi depth readings are more inclusive than multiple VEC measurements, and therefore, Secchi depth is the recommended key indicator for pelagic water clarity.

Turbidity

Measurement of clarity within the littoral (nearshore) zone of Lake Tahoe is important, because from the perspective of a person onshore, the clarity of the water near the shore is more obvious than clarity in the pelagic zone. The Secchi disk can not be used to measure near shore clarity, because the disk will still be visible when it is on the bottom. TRPA, Lahontan, and NDEP use turbidity as the preferred indicator of nearshore clarity for areas too shallow to reliably measure VEC.

Turbidity is a measure of the murkiness or cloudiness of the water. Technically, turbidity is a specific class of light scattering, as it is a measurement of the amount of light scattered at right angles to an incoming light source. Recent studies have documented limitations in measuring turbidity:

- Variety of methodologies available to conduct the measurement
- Variety of instruments utilize different designs, and may not be applicable to the method for which they are being applied
- Limited sensitivity and/or range of instruments
- Values are based upon an empirical relationship to a standard used to calibrate the instrument
- Measurements are made on discrete water samples as opposed to a column of water

These limitations suggest that perhaps a different indicator or indicators would be more valid and useful as an indicator of the aesthetic quality of the nearshore environment. Potential other indicators that could be employed include periphyton (attached algae) biomass, light transmission and/or remote sensing. No other indicator for nearshore water clarity is proposed at this time. Each agency should retain existing turbidity measurement as the nearshore clarity indicator until a better and more valid indicator is determined. However, pollutant loading effects in the nearshore are not well understood and it is not known whether additional research will produce conclusive recommendations for a better indicator. More information is available on each of the potential indicators evaluated in the Water Quality Technical Supplement document.

The indicators recommended for pollutant loading effects:

Proposed Indicator for Pollutant Loading Effects
Secchi depth measurement in pelagic waters and turbidity in littoral waters of Lake Tahoe.
(Type I).

4.3.1.2 Indicators for Pollutant Loading Sources

The Lake Tahoe Fine Sediments and Nutrients Total Maximum Daily Load (TMDL) project is a collaborative effort underway by Lahontan and NDEP to address the declining trend of Lake Tahoe's clarity. The goal of the project is to provide a scientific framework for the restoration of Lake Tahoe to the current State of California Secchi disk depth standard. TMDL development involves a three step process:

1. Determine the current pollutant loading to Lake Tahoe
2. Determine the needed load reductions to achieve the numeric target for transparency.
3. Develop and implement an effective and acceptable plan to achieve the numeric target.

Research indicates that fine sediment, nitrogen and phosphorus are the primary controls on clarity. Recent studies suggest that fine sediment less than 20 micrometers (µm) diameter is responsible for roughly 60% of the clarity loss. These fine particles affect the optical properties of the water by scattering light, reducing the depth to which it is able to penetrate. Due to the small size, the particles do not readily settle out of the water column. Algal productivity, or the concentration of algae existing within a waterbody, also

affects the clarity of the lake. Nitrogen and phosphorus are the primary nutrients that control algal growth.

To meet the needed load reductions, monitoring these three pollutant loads may be needed to determine if progress is being made toward attaining the clarity standards. Establishing a framework to monitor and track pollutant loads from each source category group is considered a priority by the Pathway agencies.

The recommended indicators for pollutant loading sources:

Proposed Indicators for Pollutant Loading Sources
Measurement of fine sediment, nitrogen and phosphorus loads from tributaries, storm water, stream channel erosion, ground water, and atmosphere. (Type III)

4.3.2 Current Condition and Trend Related to Lake Tahoe Clarity

4.3.2.1 Pollutant Loading Effects

Pelagic (Deep) Water
The Lake Tahoe Secchi disk depth has been measured on approximately a weekly to bi-weekly basis for the last 35 plus years. This extensive dataset facilitates long-term trend evaluation, which demonstrates Lake Tahoe water transparency has been decreasing for the period of record (Figure 4-2). The annual average Secchi depth was 102 feet (31 meters) in 1968. In 2004, the annual average was measured at 73.6 feet (22.4 m). This is approximately a 30 foot loss in Secchi depth for the period of record. A linear trend is displayed in Figure 4-2, but other trend curves through the data suggest the rate in transparency depth decrease may be slowing recently since 1987.

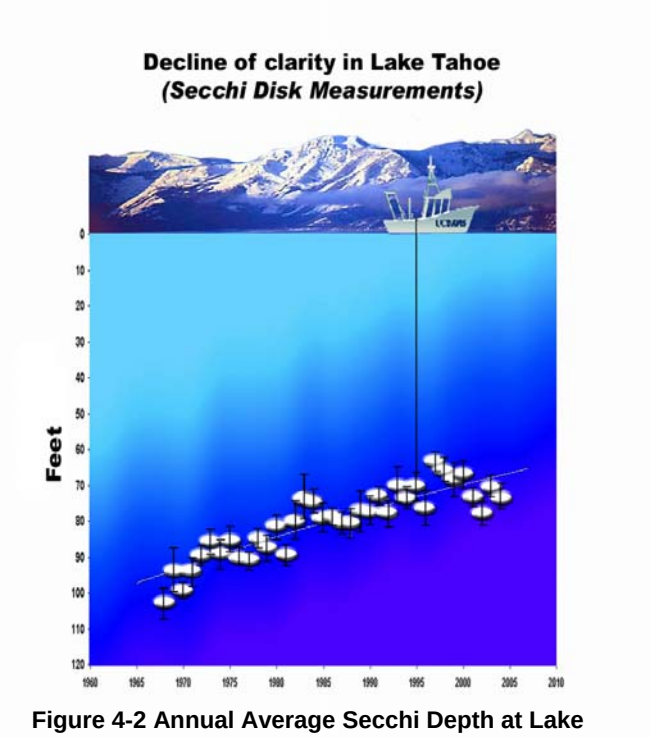

Figure 4-2 Annual Average Secchi Depth at Lake Tahoe 1960s to 2004

Nearshore (Shallow) Water
A study by Taylor et al. (2003) explored nearshore clarity by collecting field measurements of turbidity between September 2001 and August 2003. The field measurements showed that California's nearshore numeric clarity objective for turbidity was exceeded in several areas.

Figure 4-3 provides a synoptic view of near shore turbidity. The highest measurements coincided with spring snowmelt and runoff, and also had the highest ratios of mineral to algal particle content. Summer thunderstorms had a lesser but still discernable effect on near shore clarity. Areas associated with chronically elevated turbidity occur most frequently in proximity to urbanized areas during periods of surface water discharge.

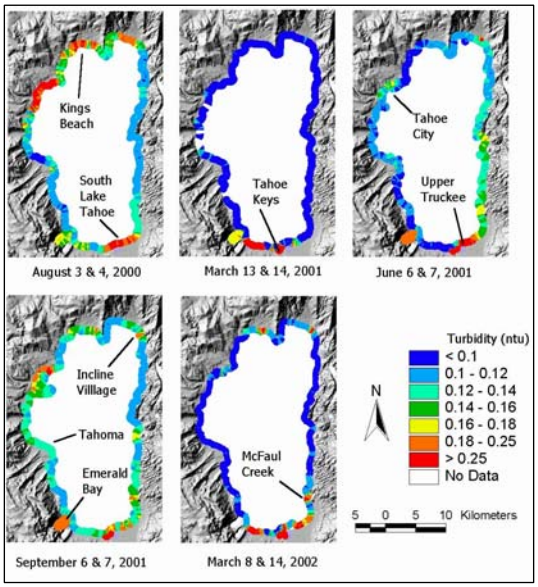

Figure 4-3. Synoptic monitoring of near shore turbidity in Lake Tahoe showing seasonal and spatial variation (Taylor et al. 2004).

4.3.2.2 Pollutant Loading Sources

To determine the current pollutant loading to the lake, a source analysis was conducted that included implementing a substantial research and monitoring program to fill in knowledge gaps. This analysis included detailed investigations for five major source categories: upland sources; groundwater; atmospheric deposition; stream channel erosion; and shoreline erosion. The outcome of the source analysis was an updated pollutant loading budget, as presented in Table 4-1.

Table 4-1. Updated Pollutant Loading Estimates (Metric Tons per Year)

Source Category		Total Nitrogen	Total Phosphorus	Total Fines*	% of Total number of particulates <20µm
Upland	Urban	63	18	4,430	72
	Non-Urban	62	12	4,670	9
Stream Channel Erosion		2	<1	3,800	4
Atmospheric Deposition	(wet plus dry)	218	7	750	15
Groundwater		50	7	NA	NA
Shoreline Erosion		2	2	550	<1
TOTAL		397	46	14,200	100%

* Fines are defined as particles ≤ 63 µm diameter for all sources except air. Air particles are ≤ 30 µm.

Along with climate data, the pollutant loading estimates served as inputs to the Lake Tahoe Clarity Model. Particulates larger than 16 µm have little direct affect on Lake clarity (Swift et al. 2006), and the total number of particulates less than 20µm are crucial inputs to the Model. The Clarity Model, a hydrodynamic/thermodynamic reservoir model that has been adapted to Lake Tahoe, predicts the Lake's annual average Secchi depth measurements over time based on these inputs. At the current annual pollutant loading rates, the Clarity Model indicates the Lake transparency will continue decreasing. If the pollutant loads are reduced by about 35% of current values, the Clarity Model predicts the Secchi depth measurements will increase gradually over 20 years to the historic transparency seen in 1967-71.

4.3.3 Technical Range of Feasibility for Lake Tahoe Clarity

The Clarity Model is being used to estimate the Lake's capacity for loading of fine particulates, nitrogen and phosphorus relative to the Secchi depth response. The Clarity Model will be used to help suggest interim Secchi depth milestones relative to loading of the three pollutants and the timeframe that might be required to reach such interim milestones.

By inputting different source load reduction scenarios, the Clarity Model indicates the time needed to reach the historic Lake transparency for each scenario. Source loads could be reduced individually or in combination to achieve the transparency standard. The Clarity Model demonstrates the theoretical possibility of achieving the historic Secchi depth with many different load reduction scenarios, over various timeframes.

Because the Clarity Model indicates the possibility of restoring the historic Lake transparency by reducing pollutant loading, the WQ Resource Group and the public conceptually agreed the historic Secchi depth annual average should remain as the primary achievable pelagic Lake transparency objective. There is no data or modeling to suggest the historic Secchi depth objective should be changed, either to a higher or lower value. Rather, the WQ Core Group suggests step-wise milestones should be set for gradually improving the Secchi depth to ultimately restore the transparency to historic values.

4.3.4 Proposed Standards for Lake Tahoe Clarity

4.3.4.1 Pollutant Loading Effects

Secchi Depth

Historic lake monitoring efforts performed by the Tahoe Research Group (TRG) enabled the State of California (through the Lahontan Water Board) and TRPA to each adopt individual Secchi disk transparency standards for pelagic Lake Tahoe:

> *Lahontan Water Board*
> *For Lake Tahoe, the Secchi disk transparency shall not be decreased below the levels recorded in 1967-71, based on a statistical comparison of season and annual mean values. The '1967-71 levels' are reported in the annual summary reports of the 'California-Nevada-Federal joint Water Quality Investigation of Lake Tahoe' published by the California Department of Water Resources.*
>
> *TRPA*
> *Winter (Dec-Mar) mean Secchi disk transparency: 33.4 meters.*

The State of California narrative transparency standard has been in effect since 1980 when the Lahontan Basin Plan was originally adopted, and until recently, was not tied to a specific numeric standard. TRPA's Secchi standard was adopted in 1982 as part of Attachment C in Resolution No. 82-11 for the Environmental Threshold Carrying Capacities for the Lake Tahoe Basin. An October 1982 TRPA staff report for the

Environmental Threshold Carrying Capacities suggested the annual mean Secchi disk transparency standard for pelagic Lake Tahoe should be 29.7 meters. To verify that value, the WQ Core Group worked with TRG scientists in July 2005 and confirmed the annual mean value recorded during the 1967-71 period was 29.7 meters.

Annual mean values were calculated from Secchi disk depth data collected at an approximate interval of every 12 days. However, the TRG began Secchi disk depth measurements in July 1967, so data collected during the first six month period through December 1967 was excluded from the annual mean value calculations. Therefore, the annual mean values of the "1967-71 levels" are actually based on the four-year dataset from January 1968 through December 1971. With regards to sample location, the TRG performed a synoptic survey to determine a statistically representative reference site.

TRPA's existing threshold standard uses the same four year dataset collected by the TRG, but it specifies a winter average (Dec. – Mar.) rather than an annual average. Members of the Water Quality Resource Core and Technical Working Groups agreed the Pathway agencies should use the same standard. Annual average Secchi Disk depth was selected as the most appropriate standard for the following reasons:

- Lake Tahoe's antidegredation policy (i.e., designation as Outstanding National Resource Water (ONRW)) is based upon the annual average Secchi disk depth of 29.7 m, and this value serves as the numeric target for the Lake Tahoe TMDLs.
- Winter average dataset only excludes that portion of the data coinciding with the time that the greatest loading of pollutants occurred (snowmelt season).
- Winter has a greater potential to reflect anomalous data due to upwelling events that occur only during winte.r
- Summer is when most persons experience the Lake.
- Lake Tahoe Clarity Model is based on annual average Secchi depth data.

Vertical Extinction Coefficient

While the Lahontan Water Board and TRPA each have a Secchi disk transparency standard, only the States of California and Nevada have adopted the same VEC standard for Lake clarity:

> *For Lake Tahoe, the vertical extinction coefficient shall be less than 0.08 per meter when measured below the first meter.*

VEC measurements are typically taken from 1 meter below the surface to 35 meters in depth, which is commonly called the photic zone. However, VEC can be measured accurately to depths that receive the smallest bit of light and may be as deep as 100 m in some instances.

To determine the most appropriate numeric target for the TMDL, it was necessary to determine the relationship between Secchi depth and VEC values and evaluate which is more protective. The difference between California and TRPA clarity objectives was also assessed.

The relationship between VEC and Secchi depth readings in Lake Tahoe was examined for the periods 1967-2002 (UC Davis-TERC unpublished data; Swift 2004). Between 1967 and 1971, the period upon which transparency objectives are based, annual average Secchi depths were in the range of 28.5-32.5 m and, in general, corresponded

to VEC values between approximately 0.045-0.065/m. During the period of 1967 to 1971, a VEC of ≥0.08/m was measured only three times in close to 100 observations. At no time between 1967 and 2002 did a VEC of 0.08/m correspond to a Secchi depth of 30 m. A more appropriate value for VEC that reflects actual conditions between 1967 and 1971 would be on the order of 0.5-0.6/m. These observations show the California water quality objective for transparency (i.e., Secchi depth) is more protective than the California and Nevada clarity objective (VEC). Therefore, an annual average Secchi depth of 29.7 m is the recommended standard for pelagic clarity in Lake Tahoe. Current VEC standards will remain and should be the objective for the water depths below the Secchi measurements but within the photic zone.

Nearshore Turbidity

As stated previously, TRPA, Lahontan and NDEP use turbidity to indicate nearshore clarity. This standard is relatively consistent between the agencies at a single value of less than 3 NTU[2]. Lahontan and TRPA standards include an additional provision that turbidity shall be less than 1 NTU at locations that are "not directly influenced by stream discharges". Because no guidance is provided as to the definition of "directly influenced", this standard remains subjective in nature.

Recent nearshore studies raised issues with the turbidity standards and suggest the standards may not be appropriate for protecting nearshore clarity. These studies have demonstrated that turbidity in the nearshore is temporally and spatially variable due to hydrologic events. Surveys during such events have observed turbidity levels at and exceeding 3 NTUs in various areas throughout the nearshore. However, it remains unclear whether the existing standards were meant to be measured during such events. Traditionally, turbidity measurements conducted for assessment purposes has been measured during hydrologic events. Surveys of the same areas during calm periods consistently measured turbidity less than 1 NTU. The studies concluded that modifications to the turbidity standard may be warranted. Furthermore, the protocol for its measurement must be specified to ensure consistency throughout the basin.

The associated complexities with the turbidity standard and measurement limitations led the studies to suggest the development of a more appropriate indicator and associated standard may be warranted. Periphyton biomass, or the amount of algae growing on rocks and other substrate in the nearshore, is considered by the public and researchers to have increased to an unacceptable level. Although not a specific measure of clarity, this indicator may be the most appropriate indicator of nearshore aesthetic quality because of its appearance, in addition to its direct connection to the quality of the recreational experience involving contact with the water (i.e., swimming, wading, etc.). However, developing appropriate numeric standards requires determining the desirable range for both developed and undeveloped portions of the nearshore, for which dedicated funding is unavailable at this time. Similarly, the desirable range for other potential indicators (light transmittance and remote sensing) would need to be determined. However, it is not known if or when those ranges could be determined with some accuracy.

The Pathway agencies expect that measures implemented to improve pelagic Lake clarity will likely translate into aesthetic improvements in the nearshore environment. It is recommended that current Agency turbidity standards be retained until the Lake Tahoe

[2] Nephelometric turbidity units

Fine Sediment and Nutrient TMDLs are completed. At that time, costs could be estimated for implementation of monitoring that will help inform the discussion regarding resource availability to develop and monitor an alternative nearshore indicator.

The recommended standard for Lake Tahoe clarity is presented below.

Proposed Standard for Clarity
Secchi depth transparency shall not be less than annual average of 29.7 m. Agencies will retain respective existing standards for turbidity and VEC. Collaborative development of alternate nearshore aesthetic standard(s) will be addressed after 2008.

4.3.4.2 Pollutant Loading Sources

Determining the necessary load reductions for fine sediment, nitrogen and phosphorous is the goal of Phase II of the TMDL project. The Lake Tahoe Clarity Model will serve as the primary tool for this evaluation. Preliminary results from the Clarity Model suggest that a 35% reduction of all constituents equally may achieve the 29.7 meters annual average Secchi disk depth target. However, because there are three variables in the equation, multiple solutions are probably equally capable of achieving the clarity standard.

At present, the TMDL has initiated a project entitled *Integrated Water Quality Management Strategy (IWQMS)*. It is the goal of this project to evaluate the effectiveness of various pollutant control options (PCOs), and through a stakeholder input process, develop several alternatives that are capable of meeting the necessary load reductions. It is envisioned that approximately three to five alternatives will be crafted, each of which will consist of a different set of PCOs or PCO packages. [Note: some alternatives may contain a subset of the same PCOs or PCO packages.] Stakeholders will be engaged to provide input that will be considered in the development of alternatives and the selection of the preferred alternative.

The alternatives will be analyzed in TRPA's Regional Plan Update Environmental Impact Statement. This analysis and the EIS certification process will provide key information to the Pathway Executives regarding the selection of a single strategy to achieve the clarity target. The selected IWQMS option will represent an agreed upon implementation framework that will serve as the basis for the development of regional policies and programs to meet the needed load reductions. Moreover, the IWQMS will serve as the basis for the establishment of milestones, or interim check-points established to evaluate if actual progress is keeping pace with anticipated progress as predicted through modeling.

Monitoring and research programs will be key elements of a continuous improvement cycle that will allow for testing of hypothesis and assumptions, provide for model refinement, and the incorporation of new information. Load reductions for each constituent will be updated regularly, based on this latest information. Thus, load reduction standards need to retain some flexibility. The recommended standard for Lake Tahoe pelagic clarity is presented below.

Proposed Standard for Pollutant Load Reductions
An outcome of the TMDL is load reduction targets for major sources categories. Because targets will necessarily be refined over time based upon actual monitoring results and achievement of milestones, they should be considered as management standards as opposed to threshold standards.

Adopting these management standards for pollutant load reduction will allow incorporation into necessary plans while providing flexibility to update the values as needed.

4.4 Desired Condition 2: Human & Environmental Health

Extensive development has occurred in the urbanized parts of the Lake Tahoe watershed which has contributed to the decline in Lake Tahoe clarity. However, the surface and ground waters of the Lake Tahoe Basin largely remain healthy for humans and the environment. In relation to human health, water quality is evaluated in relation to two beneficial uses: 1) municipal/domestic supply; and 2) water contact recreation. Within the Tahoe Basin, the majority of municipal drinking water suppliers in Nevada and some in California receive their supply directly from the Lake. Most of these municipal water suppliers have received an exemption to the Federal Surface Water Treatment Rule because Lake Tahoe water is exceptionally pure and meets all the mandated drinking water standards without being filtered and requires only mild disinfectant. In addition, waters of the Lake Tahoe Basin are used for a variety of recreational activities which involve direct contact with the water. Furthermore, environmental health of waterbodies is important to ensure that aquatic life requirements are supported. The following desired condition was developed by the WQ Core group to address the health aspects of water quality.

DC2. Human & Environmental Health
Water quality conditions in the Lake Tahoe Basin protect human and environmental health.

4.4.1 Proposed Indicators for Human and Environmental Health

Because of the differences in desired conditions for human health compared to environmental health, separate key indicators have been identified for these two attributes. The key indicator for human health will be based on water chemistry, whereas, the key indicator for environmental health will be based on measures of ecologic integrity. The environmental health component of water quality, including discussion of the key indicators, is more thoroughly discussed in the fish and wildlife section of this report.

4.4.1.1 Human Health

Water quality for consumption and recreation, both from ground sources and surface sources such as Lake Tahoe, is generally of exceptional quality in the Lake Tahoe Basin. No waters appear on either state's respective 303(d) list as being impaired for contact recreation. Occasionally, certain portions of the water supply have been affected by isolated contamination spills, such as sewage or gasoline, or by natural

contamination, such as arsenic and radioactivity. This has resulted in localized temporary threats to human and environmental health for which state authorities have regulated cleanup efforts.

Authorities for human and aquatic health-based standards and reporting lies with a variety of California and Nevada state agencies. This disaggregation of information has meant there is currently no basin-wide perspective on the status of health-based water quality for the Lake Tahoe Basin. As such, it is difficult to draw conclusions regarding overall status, conditions or trends. A periodic basin-wide assessment report would facilitate identifying pollutant sources drinking water sources and water contact recreation locations, analysis of trends pertaining to these constituents, and prioritizing management strategies to remediate any problems. Moreover, a comprehensive, coordinated monitoring program is needed for source water and recreational site pollutant risk.

The recommended indicator for human health:

Proposed Indicator for Human Health: WQ Health Conditions Report
Summary of health-based water quality information and data from Tahoe Basin ground and surface waters. (Type II)

4.4.1.2 Environmental Health

Numerous federal, state and local water quality standards exist to protect environmental health. Traditionally, these standards have been primarily based on water chemistry. However, water chemistry is only one component of ecologic integrity. The other two components are the biological and physical integrity of the aquatic ecosystem. In recent years, it has been demonstrated that the biological community which comprises a waterbody represents the integrated effects of habitat quality and water chemistry. Deleterious effects of either or both of these components will be manifest in the species types and abundances that subsist in the aquatic system. Therefore, the Water Quality Resource Group recommends using an Index of Biological Integrity (IBIs) as the key indicator(s) with regards to environmental health for the various water bodies in the Lake Tahoe Basin. This is consistent with the recommendations of the Fisheries and Wildlife Resource Area Groups.

The recommended indicator for environmental health:

Propose Indicator for Environmental Health: Index of Biological Integrity (IBI)
To be determined by Wildlife and Fisheries Technical Working Group. (Type II or III)

4.4.2 Current Conditions and Trend Related to Human and Environmental Health

The basin waters, including Lake Tahoe and all its tributaries and other water bodies in the basin, continue to be of exceptionally high quality. Anthropogenic pollutants, such as pesticides, sewage and petroleum hydrocarbons, generally have not been detected in the basin surface waters except in certain instances and locations where they have not been a chronic or persistent problem.

Source water protection is important in the Tahoe basin because the surface and ground waters are tapped for drinking water supplies. Most municipal drinking water suppliers on the Nevada-side of the Lake Tahoe basin and some of the California-side municipal water purveyors receive the majority of their supply directly from the Lake. Many of these municipal water suppliers have received an exemption to the Federal Surface Water Treatment Rule because Lake Tahoe's water is exceptionally pure and meets all the mandated drinking water standards without being filtered, though must still be lightly chlorinated as a disinfectant.

Water purveyors collect water quality data and report compliance annually to customers and to the California Department of Health Services and NDEP. The compliance reports and data are disaggregated and there has not been a Basin-wide compilation and evaluation of all the submitted data. Therefore, Basin-wide conditions and trends cannot be determined at this time.

4.4.3 Technical Range of Feasibility for Human and Environmental Health

Numerous water quality standards exist for human uses and for the environment (fish, wildlife, and aquatic ecosystems). The Federal Environmental Protection Agency recommends the water quality standards and the States and locals set and implement those standards.

The California Department of Health Services prescribes the drinking water standards for the California-side of the Tahoe basin, while the Nevada Division of Environmental Protection prescribes the drinking water standards for the Nevada-side of the Tahoe basin. Both states have similar standards that include Maximum Contaminant Levels for microorganisms, radionuclides, disinfectants, disinfection byproducts, inorganic constituents, and organic chemicals. The Lahontan Basin Plan contains human health-based water quality objectives for ammonia, coliform bacteria, biostimulatory substances, certain chemical constituents, total residual chlorine, dissolved oxygen, floating materials, oil and grease, pesticides, pH, radioactivity, sediment, taste and odor, toxicity, and turbidity.

4.4.4 Proposed Standards for Human and Environmental Health

4.4.2.1 Human Health

Although there are discrepancies between existing agency water quality standards for human health, it is beyond the ability of this Pathway effort to rectify all discrepancies

within a reasonable timeframe for plan development. In general, the Water Quality Resource Core and Technical Working Groups believe the current agency standards are protective of human health. Therefore, no changes to existing human health standards are proposed at this time. Rather, it is the desire to remain in compliance with the established federal, state and/or local health-based water quality standards and regulations. To facilitate a regional perspective on the status of health-based water quality for the Lake Tahoe Basin, the need exists to develop and maintain a periodic Water Quality Health Conditions Report as described previously, and the implementation of a coordinated, regional monitoring program that better integrates water contact recreation activities and localities.

The recommended standard for human health is:

Proposed Standard for Human Health: Compliance
Compliance with established federal, state and local health- based water quality standards and regulations.

4.4.2.2 Environmental Health

Water quality scientists and biologists are together developing IBIs as primary indicators of environmental health within the Lake Tahoe basin. The IBIs will include numeric criteria for species type and abundance requirements necessary to report environmental health condition. These indexes are proposed and discussed in detail in the Fisheries and Wildlife Chapter. The Water Quality Resource Group recommends basin-wide agency adoption of the standards for the IBIs proposed by the Fisheries and Wildlife Group.

The recommended standard for environmental health:

Proposed Standard for Environmental Health: IBI Index –
See standards for Index(es) of Biological Integrity, reference Wildlife and Fisheries Chapter.

4.5 Further Considerations Regarding Water Quality

Due to the sheer number of water quality standards amongst the Pathway agencies, the work conducted for this effort could not rectify all discrepancies within the allotted timeframe. The outcomes of this Water Quality chapter represent those indicators and standards that were determined as the highest priority, which have been termed the label *Pathway Indicators*. Lake Tahoe clarity pelagic clarity was considered the highest priority by the Water Quality Core Group (and subsequently confirmed by the TWG and public) because it is this attribute for which Lake Tahoe has become famous, and subsequently it drives the socio-economics of the region.

It is a goal of the Pathway agencies to continue to work together in the future to address those issues that were not resolved as a part of this effort. Efforts to further investigate

issues associated with Nearshore clarity have been initiated. Funding through the Nevada License Plate Grant has been awarded for a pilot project to deploy continuous monitoring of nearshore clarity using turbidity, light attenuation and phloresence. In addition, at the time of this publication, the nearshore environment was included as a Water Quality theme area for potential funding through the Southern Nevada Public Lands Management Act (SNPLMA).

Finally, one remaining issue surrounding the Pathway Indicators that must be resolved includes the development and establishment of a comprehensive monitoring plan to track progress toward achievement of recommended standards and support a continuous improvement system. These efforts have also been initiated as they are necessary for finalization of the TMDL effort.