LAKE TAHOE NUTRIENT AND SEDIMENT TOTAL MAXIMUM DAILY LOAD

WINTER 2004-05 NEWSLETTER

Nevada Division of Environmental Protection Lahontan Regional Water Quality Control Board

The Lake Tahoe Total Maximum Daily Load (TMDL) newsletter is back after a break last fall when Lahontan Regional Water Quality Control Board (RWQCB) and Nevada Division of Environmental Protection (NDEP) staff focused on the TMDL Symposium to present our research results to date and our upcoming studies and planning efforts. Thanks to all who attended and provided interesting discussion and challenging questions! We briefly report on the meeting and provide a link to symposium presentations and materials in the final article in this edition. Our primary focus below is on just one effort among the many covered in presentations on TMDL Phase 1 research: representing land use in Lake Tahoe Basin.

TMDL PHASE 1 LAND USE LAYER COMPLETED

Land use serves as the framework for computing the quantity and quality of surface runoff that enters Lake Tahoe. The Spring 2004 Newsletter (http://ndep.nv.gov/bwqp/file/tahoe06.pdf) featured an overview of how the Watershed Model will use land use and other land characteristics to model pollutant loading within the Lake Tahoe watershed. This article describes the approach taken to represent land uses in a manner suitable for water quality modeling, an unprecedented effort in Lake Tahoe Basin. Various data layers or maps describing physical characteristics of the watershed were compiled in a Geographic Information System (GIS), or computerized mapping program, for spatial analysis and to generate other model inputs. Developing the composite land use layer was an involved process that took much more effort and time than originally anticipated. The TMDL Development team (D-Team, see following article) is happy to announce that, after a year-long effort, the Lake Tahoe TMDL Land Use Layer has finally been completed and is shown in Figure 1.

Lake Tahoe Basin GIS Data Applied to the Watershed Model

The main objectives of the effort to create a composite land use layer were: (1) to locate and compile the most current and representative GIS layers available on each land use category, (2) to identify the advantages and limitations inherent in each data source, and (3) to layer and combine the various data sources in such a way as to maximize their overall accuracy in representing land use areas in the Tahoe Basin. The watershed model's composite land use layer was derived using the best GIS data available at the time from the Tahoe Regional Planning Agency (TRPA), the U.S. Forest Service Lake Tahoe Basin Management Unit (LTBMU), the Desert Research Institute (DRI), the University of California at Davis, and various California and Nevada state agencies. Before compiling the GIS maps, the D-Team had to determine a manageable number of the most important land uses present in the Basin (from a water quality modeling perspective) and to identify spatial information available for each type. Separate but related approaches were taken for the urbanized areas as distinct from the undeveloped or vegetated portions of the basin. While the D-Team focused its efforts on impacts to vegetated areas, Watershed Model developers Tetra Tech, Inc. (see http://ndep.nv.gov/bwqp/tahoew2.pdf) assisted in compiling the latest data sources on urban land uses, as detailed below.

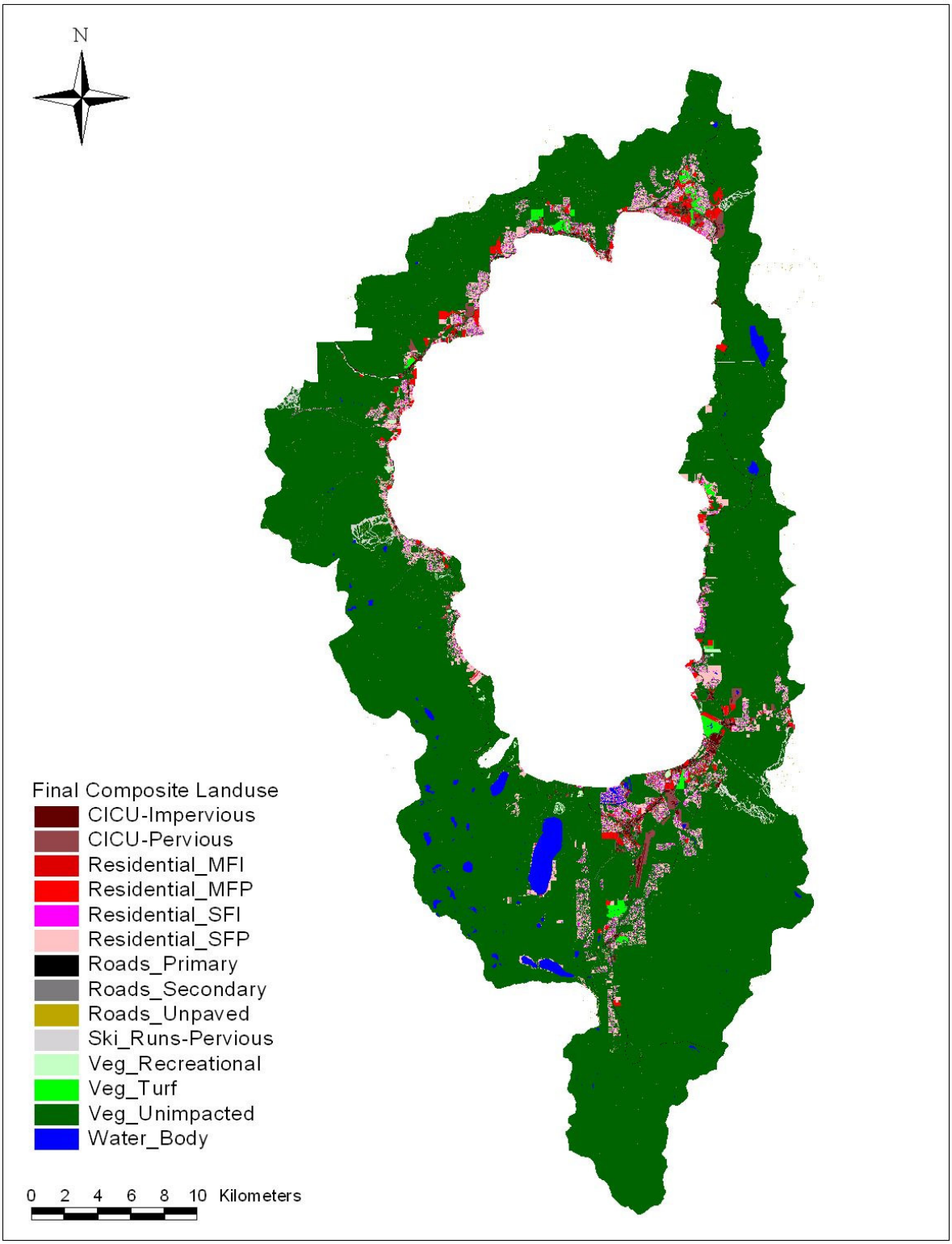

Figure 1. Final composite land use layer for Lake Tahoe's watershed. See Table 1 for full name of each land use category. Two categories of vegetated land uses—fire and timber harvest—are too detailed to be included here but are available upon request. Overall composite land use layers may be viewed in greater detail with ArcView 3.X or more recent GIS software. Contact Jack Landy at jlandy@waterboards.ca.gov for downloading instructions.

Representing Land Uses in Developed Areas

The Lake Tahoe TMDL land use layer relies on two primary sources of spatial data to represent urbanized or developed areas: (1) an updated parcel boundaries layer depicting ownership and classifying land uses of over 60,000 lots in the Basin, and (2) a Hard Impervious Cover (HIC) layer of the Lake Tahoe Basin. A number of agencies comprising the Tahoe Basin GIS Users Group funded the acquisition of an updated parcel boundaries layer. This highly accurate GIS "coverage" (another word for 'map') is useful for a variety of planning purposes and was badly needed, as the old parcel layer was developed using antiquated technology and had inaccurate parcel boundary information (in some places by as much as 800 feet!). The fundamental advantage of the new parcel layer is the high resolution with which the parcels are classified and the accuracy of their boundaries (within 10 feet). As a result, this new parcel coverage was used by TRPA to revise their land use coverage for the Lake Tahoe Basin.

The other primary GIS layer used to develop the final Watershed Model land use layer is the HIC. Developed by DRI using IKONOS satellite images from 2002 (Minor and Cablk, 2004)[1], the HIC layer is a one-meter resolution grid coverage of all anthropogenic impervious surfaces throughout the watershed (see Figure 2).

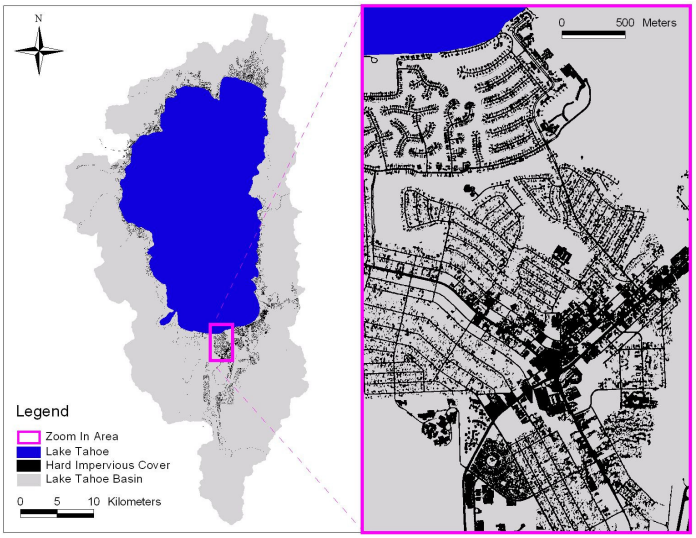

Figure 2. IKONOS Hard Impervious Cover (HIC) layer for the Lake Tahoe Basin, left, with magnification of South Lake Tahoe's "Y" area.

This high-resolution layer provides an exceedingly detailed spatial representation of impervious surfaces in the watershed, including rooftops and paved road surfaces in both urbanized and rural or vegetated areas. Because perviousness significantly affects runoff volume, timing, and pollutant load, it is desirable to accurately quantify the amount and location of impervious cover in the Watershed Model. Combining the HIC layer with the TRPA parcel layer provided a highly accurate representation of land uses likely to impact runoff water quality for the developed portion of Lake Tahoe Basin, once urban land use categories were narrowed to a manageable number.

TRPA's land use coverage classifies properties into over a hundred categories, primarily for the purpose of land-use planning. The classification system was never intended for water quality modeling purposes. It was neither practical nor possible to gather the hydrologic and pollutant loading information to represent each of the land use types individually. The wide variety of land uses needed to be condensed into major land use categories existing within the basin for which local or national pollutant runoff values are available. Therefore, under Tetra Tech's

[1] Minor, T. and M. Cablk. 2004. Estimation of Hard Impervious Cover in the Lake Tahoe Basin Using Remote Sensing and Geographic Information Systems. Desert Research Institute, January 2004.

direction, the D-Team reached consensus on reclassifying the 140 TRPA parcel codes into one of the following general categories:

- Single-family residential (SFR)
- Multi-family residential (MFR)
- Commercial/Institutional/Communications/Utilities (CICU)
- Transportation, and
- Vegetated

Representing Vegetated Land Uses

Vegetated areas comprise over 80 percent of Lake Tahoe Basin, yet they are hardly uniform from a water quality modeling standpoint. They include natural variations in ground cover and vegetation type, which are captured by other, non-land-use-specific GIS layers, but they also include a variety of human and natural impacts or disturbances that can have significant effects on water quality. Importantly, these impacts are also potentially manageable as part of TMDL implementation to achieve necessary pollutant load reductions. They include different land uses (such as ski or other recreational areas), management activities (such as harvesting to control overgrowth and fire hazard), and/or natural conditions (such as intentionally or naturally burned forests) that have differing hydrologic and pollutant loading characteristics. The process of classifying and delineating these areas was iterative and subject to revision based on both data availability and the team's judgment concerning the significance of each disturbance for water quality. As a result, the D-Team's initial list of land uses (see Spring 2004 newsletter) was modified slightly to drop grazing (a practice that has almost disappeared within the basin, and whose historical or 'legacy' impacts were not considered significant for water quality) and to further refine the open space "recreational" category into turfed and non-turfed vegetated areas. Six sub-classifications of vegetated land use were defined:

(1) Unimpacted: forested areas that have been minimally impacted in the recent past;
(2) Turf: land use types with large turf areas and little impervious coverage, such as golf courses, large playing fields, and cemeteries;
(3) Recreational: lands that are primarily vegetated and are characterized by relatively low-intensity uses and small amounts of impervious coverage. These include the unpaved portions of campgrounds, visitor centers, and day use areas.
(4) Ski areas: lands within ski resorts that have been cleared to create a "run."
(5) Burned: lands that have been subject to

Land Use Description	Pervious/ Impervious	Subcategory Name
Single Family Residential	Pervious	Residential_SFP
	Impervious	Residential_SFI
Multi Family Residential	Pervious	Residential_MFP
	Impervious	Residential_MFI
Commercial/Institutional/ Communications/Utilities	Pervious	CICU-Pervious
	Impervious	CICU-Impervious
Transportation	Impervious	Roads_Primary
	Impervious	Roads_Secondary
	Impervious	Roads_Unpaved
Vegetated	Pervious	Ski_Areas-Pervious
	Pervious	Veg_Unimpacted
	Pervious	Veg_Recreational
	Pervious	Veg_Burned
	Pervious	Veg_Harvest
	Pervious	Veg_Turf

Table 1: Final land use classification in the Watershed Model.

controlled burns and/or wildfires within the recent past, and
(6) Harvested: lands that management agencies have been thinned within the recent past for the purpose of reducing fire risk, improving wildlife habitat and increasing ecosystem resiliency.

Once the classifications were agreed upon by the D-Team, team members used their best judgment and knowledge of the basin to identify and categorize each parcel (see Table 1). Coverages that did not exist, or could not be identified from the other supporting GIS layers, were ground-truthed and hand-drawn by GIS technicians from the USFS LTBMU, the California Tahoe Conservancy (CTC), and NDEP. During this process, the D-team identified a troublesome issue: the TRPA Parcel Layer identifies ownership rather than the actual land usage occurring within those parcel boundaries. To address this problem, legal or jurisdictional boundaries had to be corrected or modified to translate parcels into actual land uses. The primary modifications were as follows:

(1) Because the impact from ski areas stems from the disturbance (clearing) of steep slopes, a new GIS layer of ski runs was developed and used instead of the ski resort boundary. Fully vegetated (in most cases, forested) lands within the resort surrounding ski runs are considered unimpacted (see Figure 3).

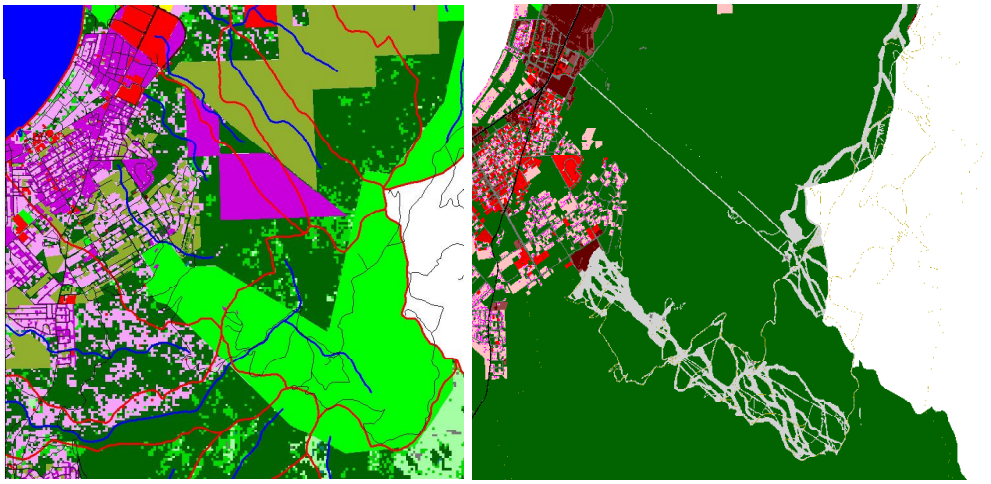

Figure 3: Part of Heavenly Ski Area before and after revision of previously-utilized land use GIS layers. The old layer on the left shows (among other things such as streams, watershed boundaries, and roads), jurisdictional limits including the edge of the ski area, in bright green. It does not include, however, the most important physical attributes of the area itself, i.e., cleared runs vs. naturally forested areas. The final land use layer, on the right, shows the cleared runs and other significant attributes of the ski area (from a water quality perspective), such as parking areas, but no longer includes the ski area boundary.

(2) Campsites were hand-delineated based on a USFS estimate that camping occurs within approximately 80 feet of roads inside camping areas such as California and Nevada State Parks and USFS campgrounds. Supplemental site-specific information was obtained from campground brochures. This land use type was categorized as Vegetated-Recreational.

(3) Parking areas within highly trafficked recreational facilities, beach areas and ski resorts were hand-delineated and classified as commercial or institutional (due to the intensity of usage).

(4) Primary and secondary roads contained in the TRPA parcel coverage delineate the jurisdictional right-of-way, a much wider area than is occupied by the paved road surface. These categories were more accurately represented using the IKONOS impervious layer (see Figure 4), by means of a GIS layering and intersecting process.

Additional Work Needed to Refine Land Use Layer

The work described above produced what the TMDL Development Team believes is the best possible representation of land uses within Lake Tahoe Basin given our time limitations and the availability of data during this effort. At the same time, the process also generated valuable suggestions for further improvements and refinements that future iterations of the Watershed Model might incorporate. New spatial information is continually being gathered by basin science and management agencies and should be adapted for use by the model as soon as practicable. Examples include an update of the 1974 Lake Tahoe Basin soil survey by the Natural Resources Conservation Service and new vegetation maps, also based on the 2002 IKONOS satellite images, which have recently been produced for TRPA.

During development of the roads layers described above, the D-Team noticed that numerous secondary (i.e. city and county) roads on existing TRPA and USFS land use maps are not shown on the IKONOS impervious surface layer (Figure 2), indicating that they were never built. However, as many basin residents including D-Team members know, some roads that were once planned may have been initiated without ever being completed, leaving scars on the land or forest that could still experience significant erosion. Finally, the current, initial version of the Watershed Model is not capable of representing land use change over time, for purposes of varying the distribution of existing land uses during the extended period that we anticipate Lake Tahoe water quality restoration to require. To more accurately model the environmental changes we expect to occur in the future, it would be very desirable if the model could dynamically represent land use change over time.

Lahontan RWQCB has developed a work plan for our watershed modelers, Tetra Tech, to address these and other issues even as they are producing the 'first generation' Watershed Model. We will report on the progress of this work in subsequent editions.

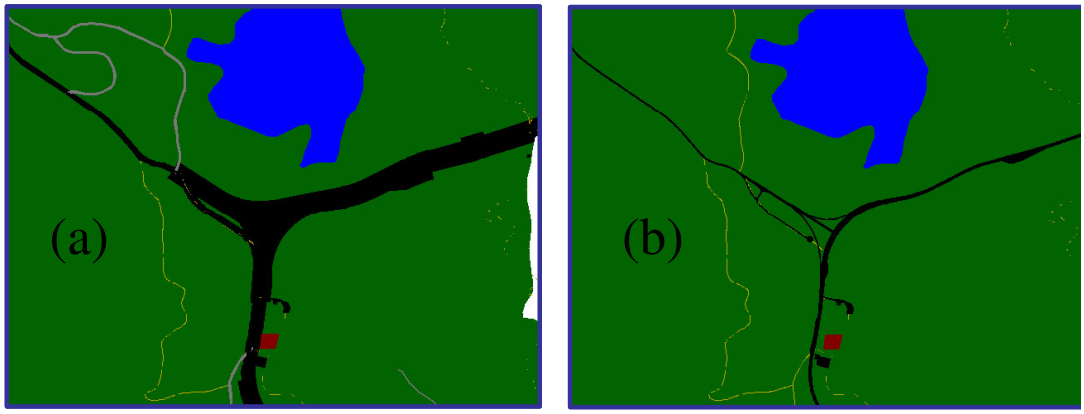

Figure 4. Roadways in the vicinity of Spooner Lake: (left) as represented in the original TRPA parcel boundary layer (which depicts road right-of-way) versus (right) based on actual impervious coverage determined by IKONOS satellite (HIC Layer). Note that the amount of roaded area represented in the original roads layer is significantly greater than in the refined layer.

TMDL Development Team Guides Modeling of Forested Watershed

Because the Lake Tahoe Basin straddles the California-Nevada state line, is seven-eighths publicly owned and operated, and is regulated by a unique bi-state authority (the Tahoe Regional Planning Agency), the Total Maximum Daily Load must by necessity be coordinated among a wide range of agencies and natural resource managers. Lahontan Regional Water Quality Control Board (RWQCB) and Nevada Division of Environmental Protection (NDEP), the two water quality authorities responsible for the TMDL, have assembled a team of technical experts from the most prominent land and water management agencies in the basin to guide, advise and assist us throughout development of the plan. The so-called TMDL Development (or D-) Team's most recent and focused effort has been compiling information to assist in modeling as accurately as possible the forested portion of the Lake Tahoe Basin, which covers nearly three quarters of the watershed.

D-Team meetings benefit from the regular attendance of resource managers with a cumulative experience of over 50 years' work on Lake Tahoe Basin management issues. Participating agencies and their representatives include the U.S. Forest Service (Sue Norman, Adaptive Management Group Leader), the Tahoe Regional Planning Agency (Larry Benoit, Water Quality Program Manager), the California Tahoe Conservancy (Kim Carr, Watershed Restoration Specialist), NDEP and Lahontan RWQCB, with the occasional participation of water quality experts from other specialized entities such as the Natural Resources Conservation District, the United States Geological Survey, the Nevada Division of State Lands, and researchers from the University of California's Tahoe Research Group and the Desert Research Institute. Due to the lack of a single source of information about the volume, flowrate and quality of runoff from the forested and other vegetated areas in the basin, the D-Team was given the challenging task of identifying both spatial and water quality information to guide development of the Watershed Model, as described in the accompanying article.

The information obtained is assisting Tetra Tech, the consulting firm developing the Watershed Model, to more accurately represent the processes affecting runoff of sediment and nutrients into Lake Tahoe from vegetated areas. The watershed model, once fully calibrated, validated and coupled with the Lake Clarity Model, will then be used to determine the pollutant load reductions necessary to restore the lake to its historic clarity.

Lake Tahoe TMDL Symposium

On December 9 and 10, 2004, Lahontan RWQCB and NDEP staff organized and hosted a symposium on the Lake Tahoe TMDL at the Embassy Suites Hotel in South Lake Tahoe. The symposium included presentations of TMDL research and discussions of the coordinated public participation process associated with the TMDL, the TRPA's Regional Plan, and the USFS forest management plan update (Pathway 2007). About 150 members of the public, scientists, consultants and interested agency staff attended. The first day concerned research results to date and their integration into the watershed and lake clarity models during Phase 1 of TMDL development, culminating in the Technical TMDL later this year. The second day was devoted to Phase 2: TMDL implementation planning and Pathway 2007. In keeping with the initiation of the Pathway 2007 public process and the more stakeholder-driven nature of Phase 2, there was more opportunity for questions and general discussion than the previous day. The TMDL Team presented new research projects that will enable us to evaluate existing and new pollution control approaches, model their impact and track their progress, and to determine whether such projects and load reductions could be traded during TMDL implementation. In the afternoon, senior managers from TRPA, Lahontan, NDEP and USFS presented the Pathway 2007 collaborative planning process and described opportunities for public participation in the coming year. Presentations and handouts from the symposium may be viewed at: http://www.waterboards.ca.gov/lahontan/TMDL/Tahoe/tahoe_symposium_12_04.html, and written comments from attendees, with responses, will soon be posted at the same website.

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