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Presented by:

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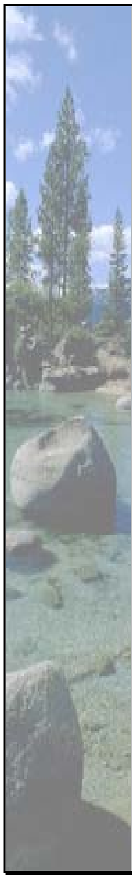
Slide 2

Presentation Overview

- Current Pollutant Budget
- TMDL Overview
- Source Evaluations & Loading Estimates
  - Groundwater
  - Stream Channel and Shoreline Erosion
  - Atmospheric Deposition
  - Upland
- Updated Pollutant Budget
- Load Reductions, Allocations, and Milestones
- Connections with Other Programs

Slide 3



Nutrient Budget (2000)

(Metric Tonnes/year)

Source	Total Nitrogen	Total Phosphorous
Atmospheric Deposition	234 (59%)	12.4 (28%)
Stream Loading	82 (20%)	13.3 (31%)
Direct Runoff	23 (5%)	12.3 (28%)
Groundwater	60 (15%)	4 (9%)
Lake Shore Erosion	1 (1%)	1.6 (4%)
Total	400	43.6

[Jassby et al. (1994), Reuter et al. (2000)]

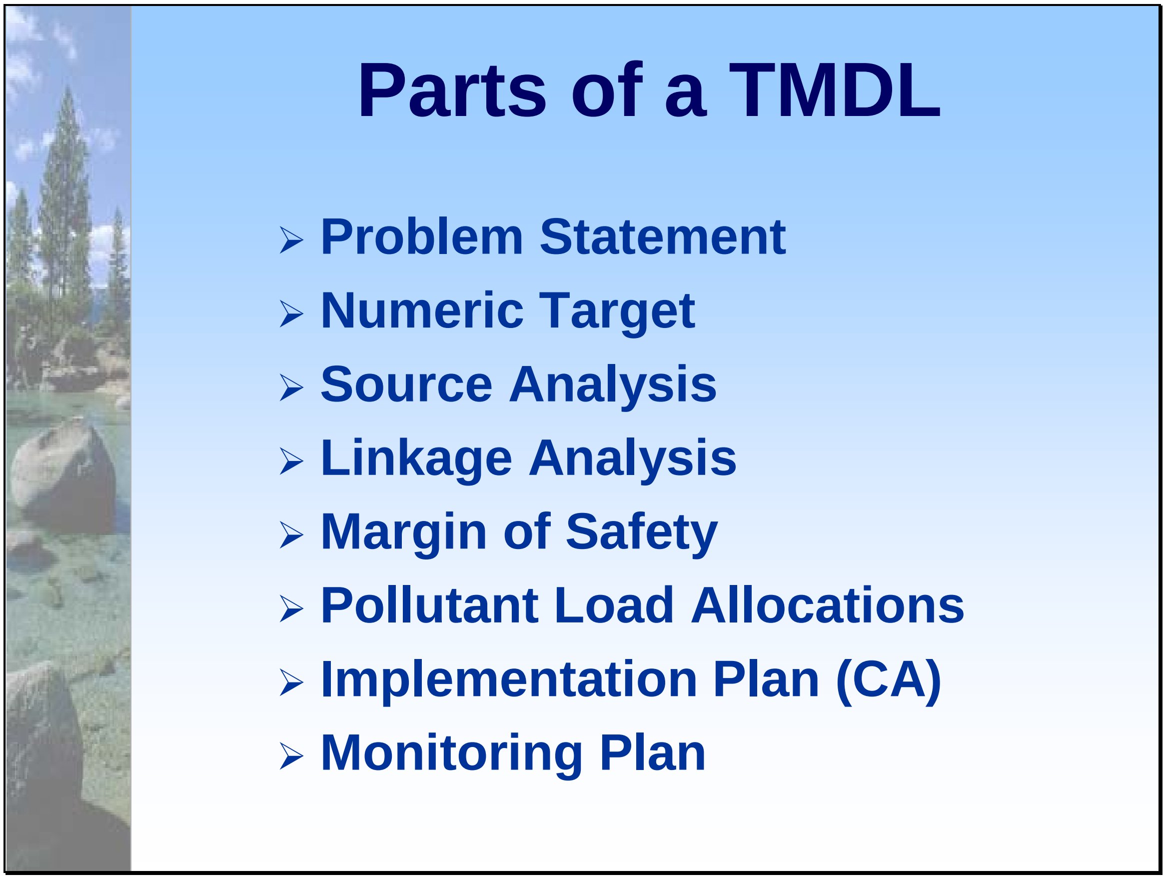
This budget does not provide estimates of fine particulate loading. Fine particulates (less than 63mm) have been demonstrated to have a significant impact on clarity loss.

TMDL related research and information collection was specifically intended to provide more information on specific sources, increased number of nutrient species, and the first basin-wide evaluation of sediment loading by particle size class.

Stream loading in this chart represents both upland and stream channel contributions

Useful conversions for the presentation:
Metric Tonne = 1,000 Kg
Metric Tonne = 1.1 Tons or 2,204.6 lbs
1 Kg = 2.2 Lbs

Slide 4



This presentation will focus on the work completed as part of the Source Analysis.

The Problem Statement articulates the clarity loss of Lake Tahoe

The Numeric Target For Lake Tahoe is 29.7 meters of clarity as measured by a secchi disk

The information presented here will be used to define the current loading information needed for the Lake Tahoe Clarity Model. The Clarity Model will perform the Linkage Analysis which links pollutant sources with lake effect and determines the amount of pollutant load reduction that will need to occur.

The Margin of Safety requires an analysis of future growth potential and uncertainty of evaluation.

Additional work is currently being initiated as part of the Integrated Water Quality Management Strategy which will develop information needed for identification of Pollutant Load Allocations, Implementation Planning (strategies), and the Monitoring Plan.

The Monitoring Plan will need to identify how actual load reductions (as opposed to modeled estimates) will be tracked.

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TMDL Development Phases

Phase I

Product: Technical TMDL – August 2006

- Determines Current Loading – Today
- Determines Basin-wide Load Reduction Needs July 2006

Phase II

Product: Final TMDL – November 2008

- Identify Load Reduction Possibilities
- Allocates Pollutant Load Reductions
- Implementation Plan / Monitoring Plan
- Integrated Water Quality Management Strategy

Phase III

Product: Implementation – Continuous

- Application within a Management System
- Predetermined Review Periods

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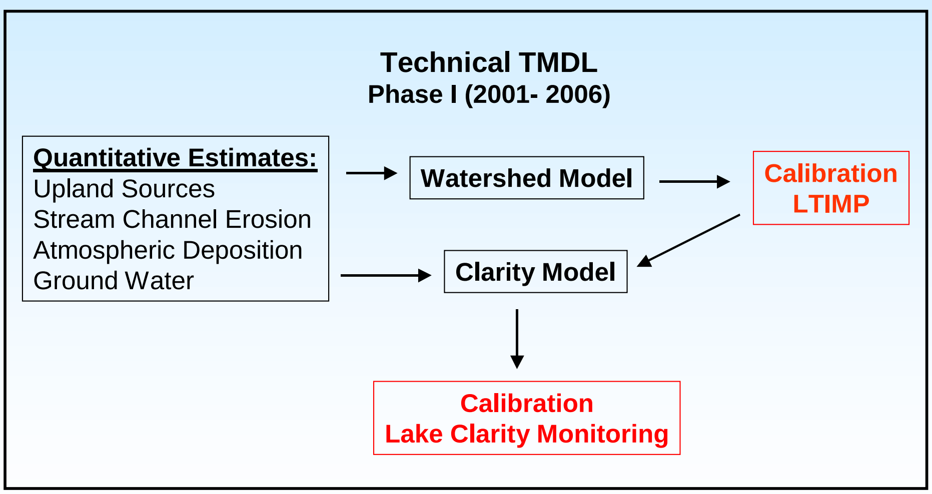
Technical TMDL Flowchart



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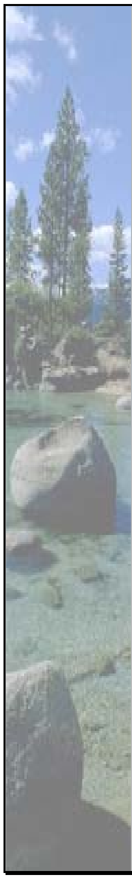

Research and Information Collection

- Involved more than 150 individuals
- Multimillion dollar effort of national significance
- Collaboration of State, Federal, Academic, and Private entities
- Built on impressive amount of local information and expertise
- Addressed many of the current Management Questions
- Specifically developed to provide increased adaptability
- Aimed to develop methods for estimating load reductions over time and incorporating new information to verify estimates

TMDL related research and information collection efforts:

Reconstruction of historic meteorology – UC Davis
Loading of fine sediment – Collective Effort
Stream channel erosion – USDA National Sedimentation Laboratory
Groundwater – US Army Corps of Engineers
Sewer line exfiltration – US Army Corps of Engineers
Stormwater runoff monitoring - Tahoe Research Group (TRG), Desert Research Institute (DRI)
Statistical analysis of loading related to land use characteristics – Hydrokios Consulting, DRI, TRG
Watershed Modeling – Tetra Tech Inc. and others
Biologically available phosphorus – University of Nevada, Reno
Characterization and fate of lake particles – UC Davis
Application of Clarity Model – UC Davis
Stormwater BMP evaluations and implementation feasibility – Geosyntech Consulting
Establish air quality monitoring network – California Air Resources Board (CARB), TRPA and others
Characterization of air quality emission sources – CARB
Modeling of atmospheric deposition to Lake Tahoe – CARB
Nearshore water quality – DRI
Data management – TRPA

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Source Categories

Groundwater
- US Army Corps of Engineers - Groundwater Report

Stream Channel Erosion
- National Sedimentation Laboratory – Basin-wide loading
- Tetra Tech – Watershed Model representation

Atmospheric
- California Air Resources Board
- Tahoe Research Group (UCD)
- Desert Research Institute (DRI)

Upland
- UCD - MM5 historic climate reconstruction
- Tetra Tech - LSPC (Upland Hydrology and Loading)
- UCD, DRI Storm Water Monitoring Network and water quality evaluations

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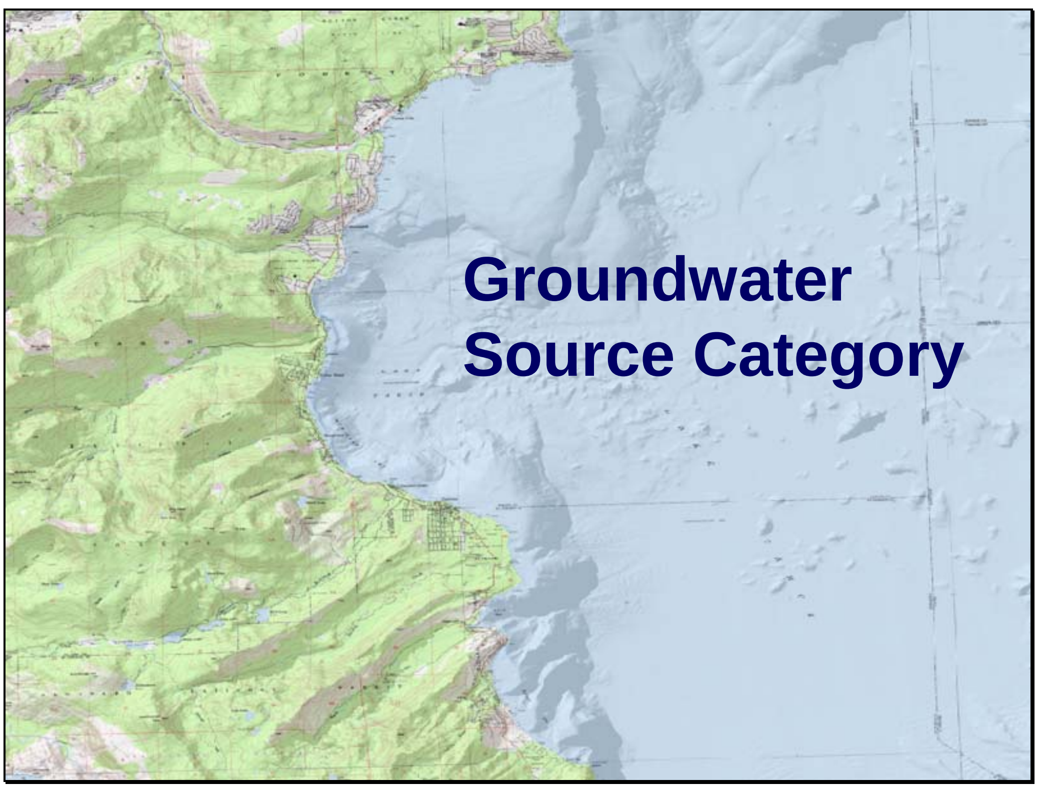

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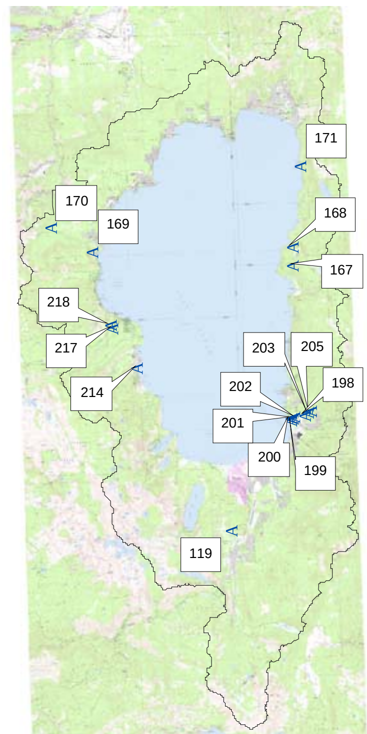

Basin Regions and Ambient Well Locations

Regions mapped here correspond with regional loading estimates presented for groundwater loading

First Basin-wide evaluation of groundwater loading to Lake Tahoe

Ambient wells presented do not represent full amount of monitoring locations evaluated – evaluation included additional wells located throughout the Tahoe Basin in urbanized areas

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Groundwater
Data Analysis and Modeling

- Used available groundwater monitoring information
- First basin-wide evaluation of groundwater loading
- First estimate of ambient loading
- Developed loading estimates by region
- Groundwater modeling
- Updated fertilizer application inventory

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Groundwater Loading Estimates

Region	Total Nitrogen (kg/yr)	Total Phosphours (kg/yr)
South Lake Tahoe/Stateline	2,400	430
East Shore	6,200	140
Incline Village	4,200	770
Tahoe Vista/Kings Beach	9,400	1,100
Tahoe City/West Shore	28,000	4,400
Total	50,000	6,800

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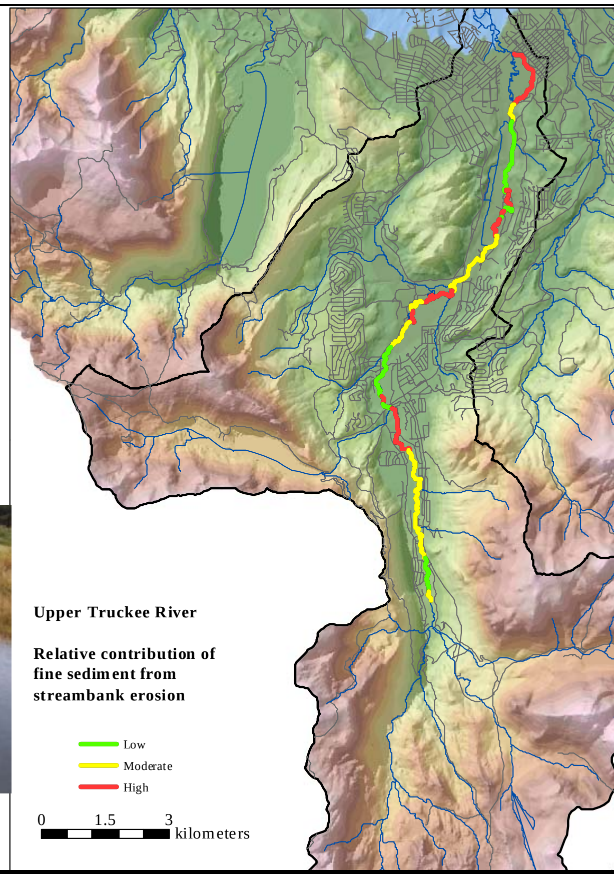
Stream Channel and Shoreline Erosion Source Category



Highlighted river section on this slide is the Upper Truckee River – similar slides showing amount of streambank instability, fine particle contribution from streambank, and others are available for numerous streams in the Basin.

Erosional “hotspots” are also identified

River picture is located along the Upper Truckee River upstream of the highway 50 bridge by Carrows restaurant

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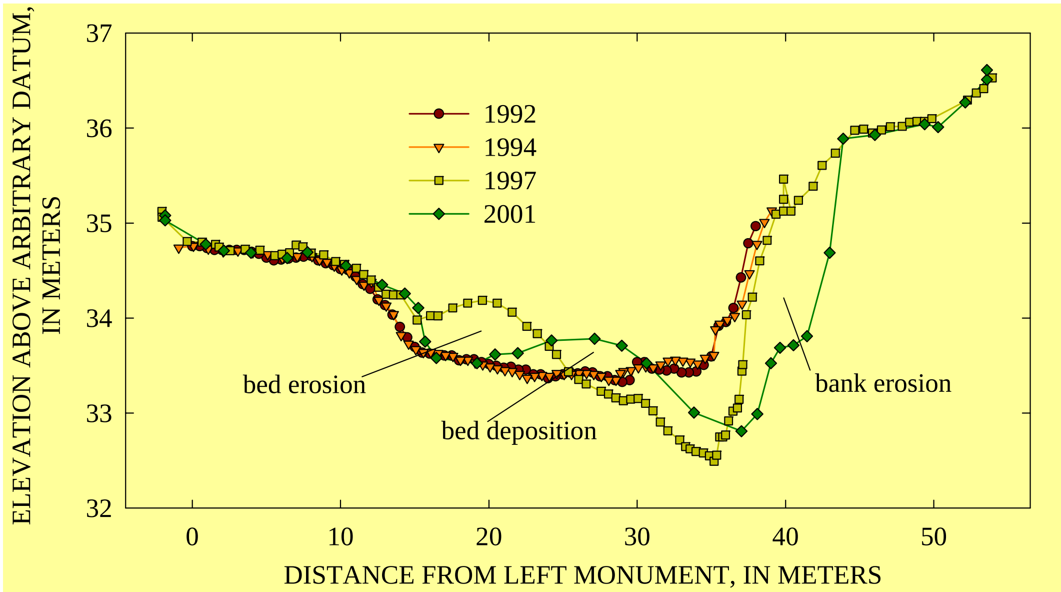
Cross-Section Match: Upper Truckee



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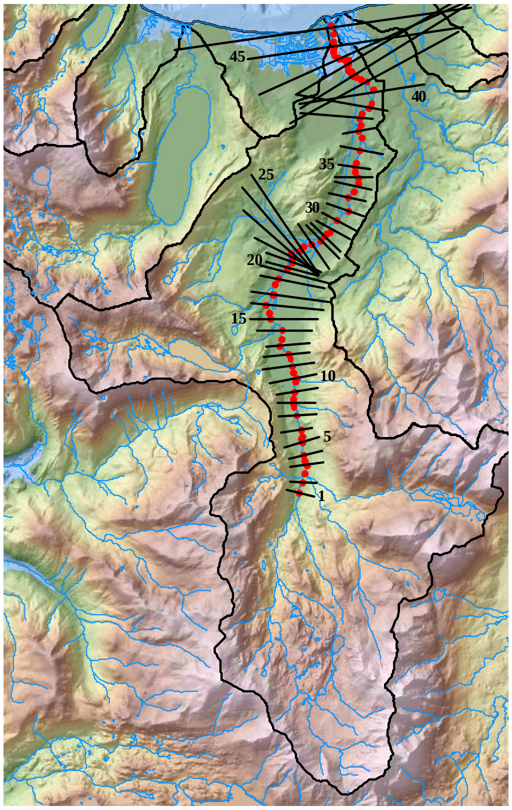
Data Collection Locations for Modeling: Upper Truckee



Cross sections were included with other stream evaluation parameters as input to the CONCEPTS modeling of the Upper Truckee River, General Creek, and Ward Creek

Comprehensive evaluations of LTIMP data was included in the evaluation

In general, streams in urbanized areas showed a relatively higher percentage of stream bank material to upland material than undisturbed streams

Additional applications of CONCEPTS and other stream channel loading models are anticipated in the strategy development process

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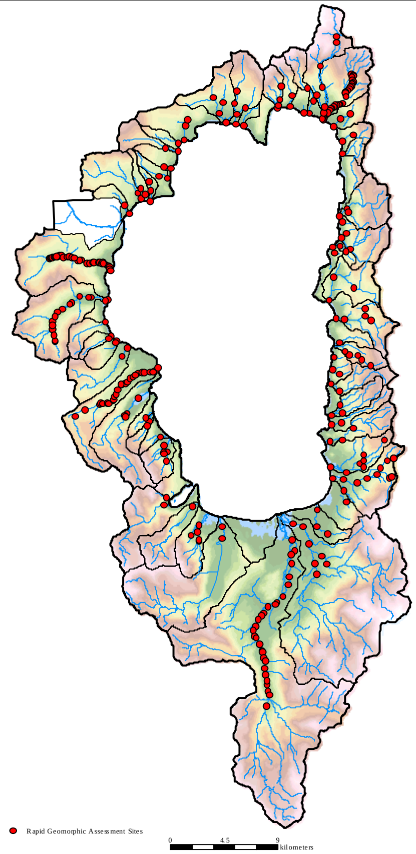
Locations of Rapid Geomorphic Assessments (RGAs)



306 RGAs have been performed around the basin by the National Sedimentation Laboratory

Additional information includes particle size distributions for streambank material, bore-hole sheer testing data, sheer stress information for many streams around the basin.

First Basin-wide evaluation of stream channel erosion conducted

Work conducted to evaluate un-gaged streams is potentially the first conducted in the nation

Few other TMDLS have directly included stream channel erosion in the Source Analysis

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Stream Channel Loading Estimates

Metric Tonnes/year of Fines – less than .063 mm

	Tributary	National Sed Lab Estimates	Watershed Model Estimates
1	Tahoe State Park	0.006	0
2	Burton Creek	0.889	1
3	Barton Creek	0.006	0
4	Lake Forest Creek	0.008	0
5	Dollar Creek	0.109	1
6	Cedar Flats Creek	0.196	1
7	Watson Creek	0.014	0
8	Carnelian Bay Creek	0.008	0
9	Carnelian Canyon Creek	0.012	0
10	Tahoe Vista	0.844	2
11	Griff Creek	4.76	5
12	Kings Beach	0.008	0
14	First Creek	0.620	0
15	Second Creek	0.348	0
16	Burnt Creek	2.38	4
17	Wood Creek	0.016	0
18	Third Creek	30.8	23
19	Incline	4.72	16
20	Mill Creek (a)	0.353	0
21	Tunnel Creek	0.008	0
22	Bonpland	0.008	0
24	Marlette Creek (a)	18.8	2
25	Secret Harbour	0.062	0
26	Bliss Creek	0.520	0
27	Dead Mans Point	0.004	0
28	Slaughterhouse	0.553	1
29	Glenbrook Creek	3.23	21
30	North Logan House Creek	0.010	0
31	Logan House Creek	0.014	0
32	Cave Rock	0.011	0
33	Lincoln Creek	0.025	0
35	North Zephyr Creek	0.535	0
37	Zephyr Creek	1.39	0
38	McFaul Creek	2.77	0
39	Burke Creek	0.115	0
40	Edgewood Creek	2.14	5
41	Bijou Park	0.140	0
42	Bijou Creek	0.014	0
43	Trout Creek	7.00	2
44	Upper Truckee	639	1843
46	Taylor Creek	3.79	3
47	Tallac Creek	0.408	0
48	Cascade Creek	0.020	0
49	Eagle Creek	0.024	0
50	Bliss State Park	0.002	0
51	Rubicon Creek	0.771	3
52	Paradise Flat	0.706	0
53	Lonely Gulch Creek	0.009	0
54	Sierra Creek	0.006	0
55	Meeks Creek	13.1	12
56	General	23.9	48
57	McKinney Creek	0.024	0
58	Quail Lake Creek	0.008	0
59	Homewood Creek	0.038	0
60	Madden Creek	0.013	0
62	Blackwood Creek	431	871
63	Ward	104	484
	TOTAL	1301	3,757

Estimates indicate that 25% of total fine sediment loading to Lake Tahoe is the result of stream channel contributions or approximately 3,757 metric tonnes – representation within the watershed model could require modification to relative contributions

90% of this loading is coming from the Upper Truckee River, Blackwood Creek and Ward Creek

98% of stream channel loading is coming from 10 tributary streams

Identifies significant gauged and un-gauged stream channel contributions

Stream channel restoration projects have great potential to address fine particle loading from stream channel erosion

Nutrient contributions from stream channel erosion are still being developed

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Lake Shoreline Erosion Loading Estimates

Constituent	Metric Tonnes/year
Sediment	
Sands	6,600
Silts	440
Clays	100
Total Phosphours	2
Total Nitrogen	1.8

Estimates for shoreline erosion are based upon work completed by Dr. Ken Adams with the Desert Research Institute

Work completed by Dr Adams represents the only basin-wide evaluation of shoreline erosion completed to date

Clays represent particles smaller that 63 mm – these are the particles of greatest concern

Sands and silts are heavier particles that tend to deposit more rapidly and are not as significant a concern to clarity loss

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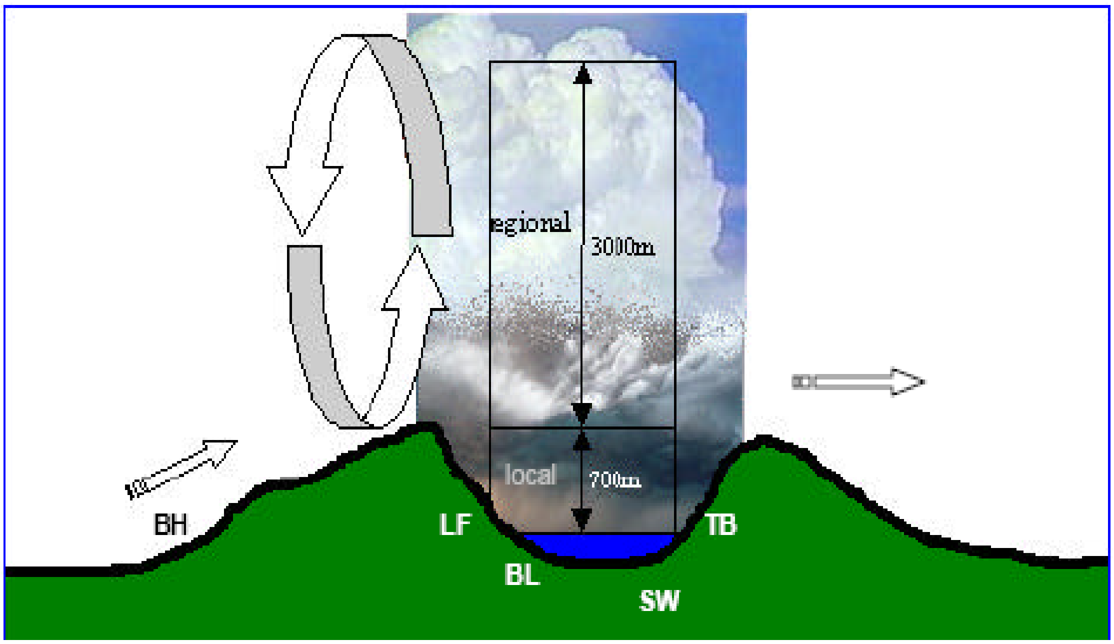
Atmospheric Deposition Source Category



Project evaluated potential contributions of pollutant loading from local regional and distant sources

Local sources appear to contribute greatest amount to pollutant load

Although not fully understood, contributions from regional and distant sources do not appear to play a significant role in clarity loss

Additional work is needed on specific source inventories and atmospheric (airshed) modeling to better understand the origin, magnitude, and transport of local and regional pollutants

Highways, roads, and transportation associated facilities, appear to be a very significant contributors of pollutants, both through the atmosphere and surface flow.

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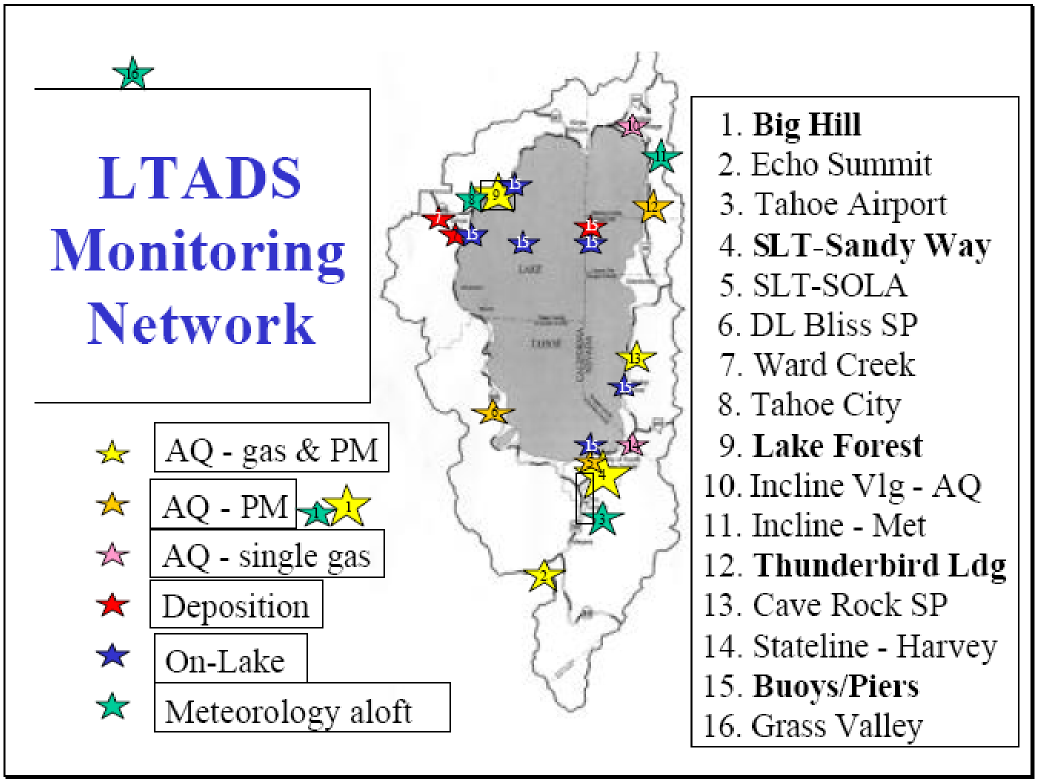

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Atmospheric Transport of Pollutants

- Quantified estimates of out of basin transport are still not known
- Broad scientific agreement that "majority" of pollutants are generated in basin
- Transport could be affected seasonally – more transport in summer than winter
- Limited ability to control transported pollutants or sources
- Increased ability to evaluate and control local sources

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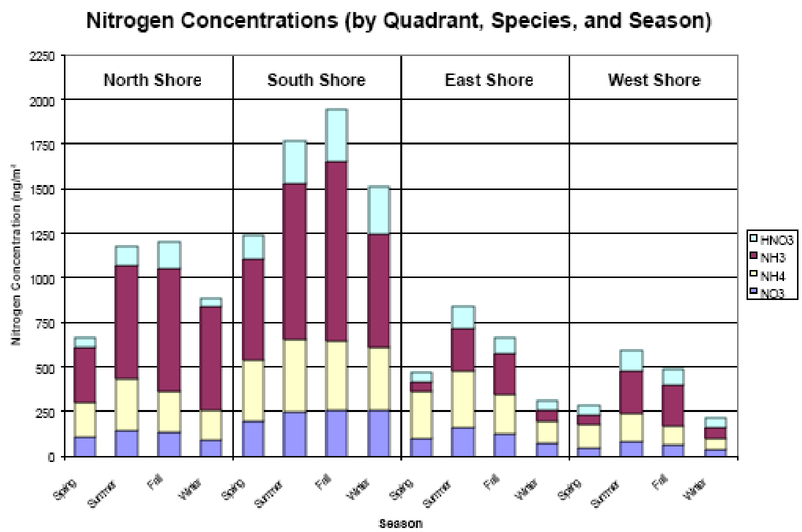
Figure 4-3 Seasonal Average Nitrogen Concentrations, by Chemical Species and Location, as Observed at Lake Forest, Sandy Way - South Lake Tahoe, and Thunderbird, and Inferred for the West Shore as Described in the Text



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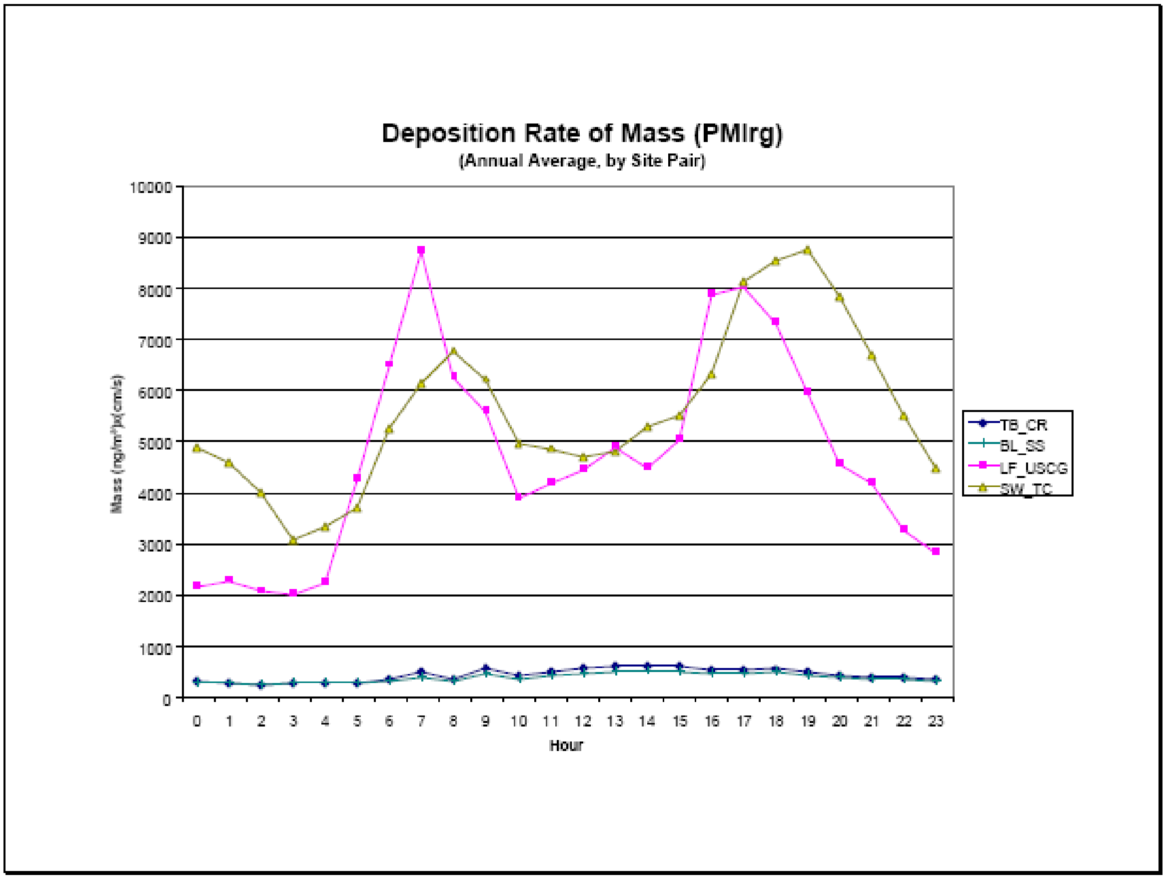

This graph shows typical hourly deposition rates from midnight to 11 pm at different sires around the Lake Tahoe. Developed areas have deposition rates that appear to in crease during typical rush hour traffic. Similar diurnal patterns have been identified for other constituents within the CARB report.

Localized, transportation influenced, transport mechanisms appear to be a significant contributor of atmospheric pollutants.

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Atmospheric Loading Estimates

	Dry Deposition (MT/yr)	Wet Deposition (MT/yr)
Nitrogen		
NO3	28	18
NH4	77	17
DIN	106	35
DON	32	22
TON	38	24
PN	6	2
TN	**144**	**59**
Phosphorus		
SRP	1.3	1.0
TDP	2.4	1.8
TP	**5.4**	**2.8**
Particulate Matter		
PM 2.5	60	399
PM Course (<10)	170	351
PM Large (<10)	350	104
PM Total	**580**	**854**

Atmospheric deposition is a major source of pollutants

More work is needed on specific inventories for both sources and pollutants

Atmospheric transport needs to be better understood and quantified

Detection of atmospheric phosphorous needs to be better developed

Control of local pollutant sources could provide significant load reductions

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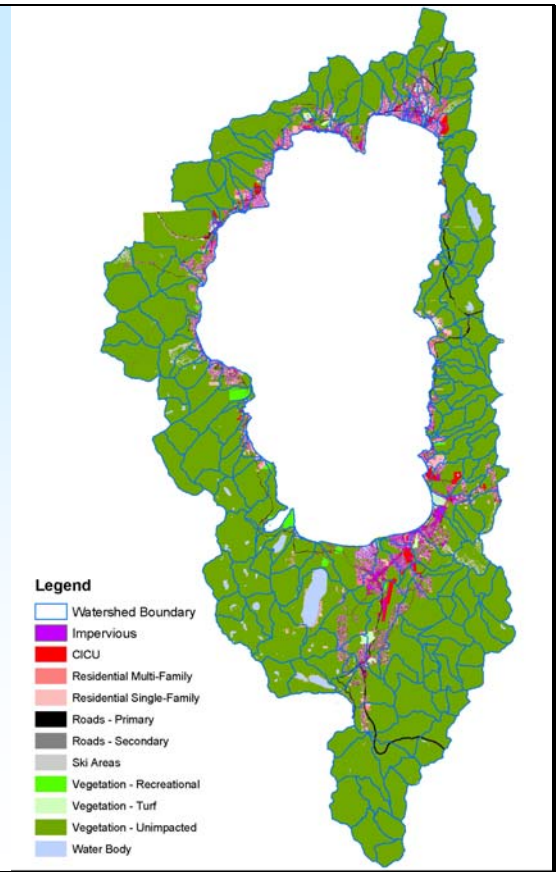
Upland Source Category

Lake Tahoe Basin Watershed Model

Loading Simulation Program C++ (LSPC)



This section of the presentation will follow the normal course of model development and calibration including:

- Sub-watershed delineation
- Land-use identification
- Meteorology
- Hydrology
- Water Quality

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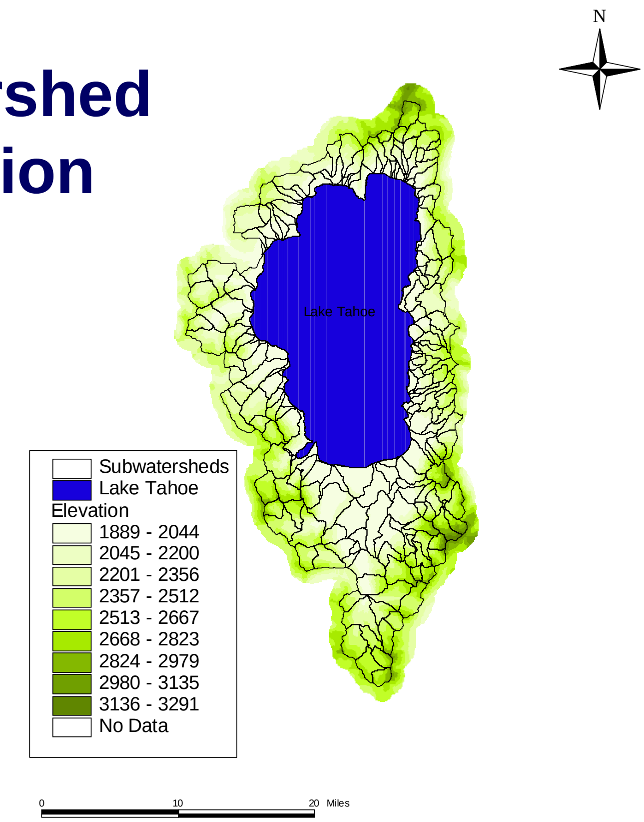
Sub-watershed Delineation



Graphic illustrates all 184 sub-watersheds within the Watershed Model as related to elevation

Additional parameters such as temperature and soil type used to delineate sub-watersheds

Model is currently best applied to basin-wide evaluations – further refinement could take current 184 sub-watersheds to 597 and better represent localized conditions

Further refinement could better facilitate linkage between Watershed Model and project scale BMP modeling

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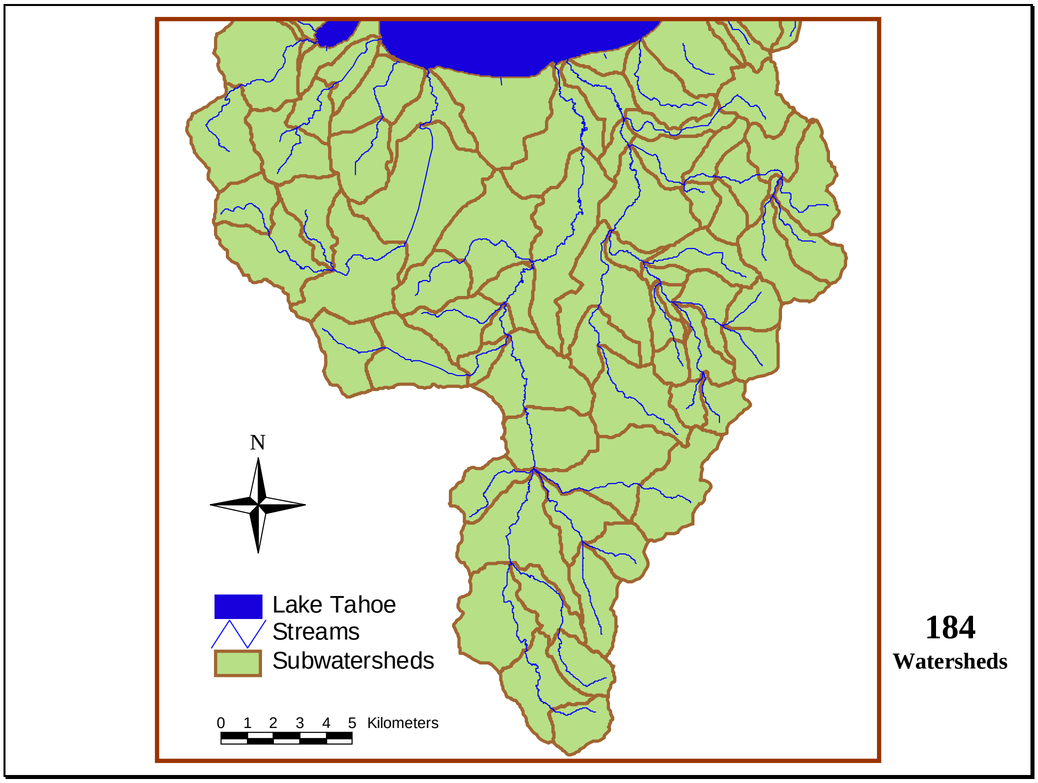

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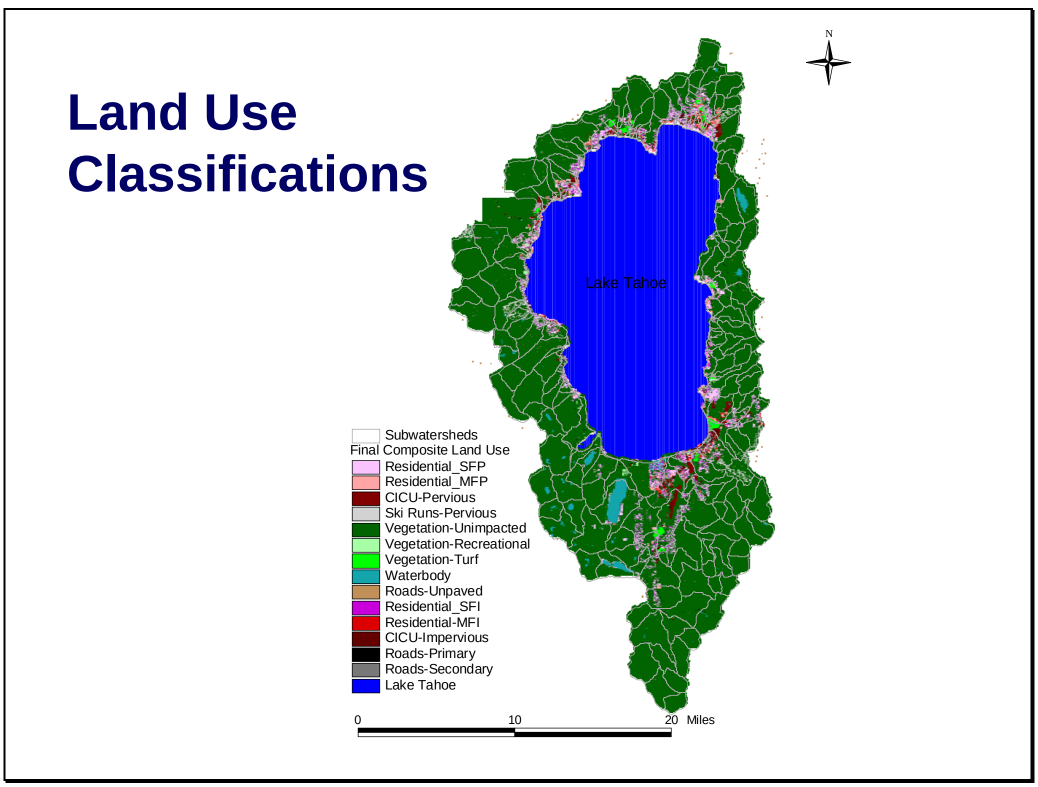

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Upland-erosion Potential

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Watershed Model Landuse Categories

Landuse Category	Pervious/Impervious	Subcategory Name
Single Family Residential	Pervious	SFR - Pervious
	Impervious	SFR - Impervious
Multi Family Residential	Pervious	MFR - Pervious
	Impervious	MFR - Impervious
Commercial/Institutional/ Communications/Utilities	Pervious	CICU - Pervious
	Impervious	CICU - Impervious
Transportation	Impervious	Primary Roads
	Impervious	Secondary Roads
	Pervious	Unpaved Roads
Vegetated	Pervious	Ski Runs
	Pervious	Recreation
	Pervious	Burned
	Pervious	Harvest
	Pervious	Turf Areas
	Pervious	Erosion Potential - 1
	Pervious	Erosion Potential - 2
	Pervious	Erosion Potential - 3
	Pervious	Erosion Potential - 4
	Pervious	Erosion Potential - 5

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Example Target Event Mean Concentrations

Subcategory Name	Target Event Mean Concentrations mg/L				
	TSS	TN	DN	TP	DP
SFR - Previous	56.40	1.752	0.144	0.468	0.144
SFR - Impervious	56.40	1.752	0.144	0.468	0.144
MFR - Pervious	150.00	2.844	0.420	0.588	0.144
MFR - Impervious	150.00	2.844	0.420	0.588	0.144
CICU - Pervious	296.40	2.472	0.293	0.702	0.078
CICU - Impervious	296.40	2.472	0.293	0.702	0.078
Primary Roads	951.60	3.924	0.720	1.980	0.096
Secondary Roads	150.00	2.844	0.420	0.588	0.144
Unpaved Roads	1015.20	2.340	0.014	1.524	0.480
Ski Runs	270.70	0.360	0.132	0.120	0.038
Recreation	459.60	1.035	0.012	0.629	0.209
Burned	1015.20	2.340	0.014	1.524	0.480
Harvest	1015.20	2.340	0.014	1.524	0.480
Turf Areas	12.00	4.876	0.487	1.500	0.263
Erosion Potential - 1	14.00	0.164	0.011	0.034	0.029
Erosion Potential - 2	38.00	0.164	0.011	0.034	0.029
Erosion Potential - 3	101.00	0.164	0.011	0.034	0.029
Erosion Potential - 4	271.00	0.164	0.011	0.034	0.029
Erosion Potential - 5	727.00	0.164	0.011	0.034	0.029

Event mean concentrations (EMC) represent the average concentration of constituents in land-use runoff. TSS – Total Suspended Sediment, TN – Total Nitrogen, DN – Dissolved Nitrogen, TP – Total Phosphorous, and DP – Dissolved Phosphorous.

EMCs for most urban land-uses were developed based upon stormwater monitoring information collected from 16 autosamplers distributed around the Basin.

In some instances, EMC data was not available for specific land uses. In these instances relative evaluations between other land-uses were used to develop EMCs. In other instances available grab sample data, literature information or in-stream concentrations were used to help inform EMC development.

In order to account for variability in loading around the Basin the watershed model will vary EMCs to match measured loading data.

Nutrient EMCs present for erosion potentials 1-5 is represent initial target concentrations concentrations for these areas with sub-watershed specific concentrations developed based on soil characteristics and measured in-stream loading concentrations.

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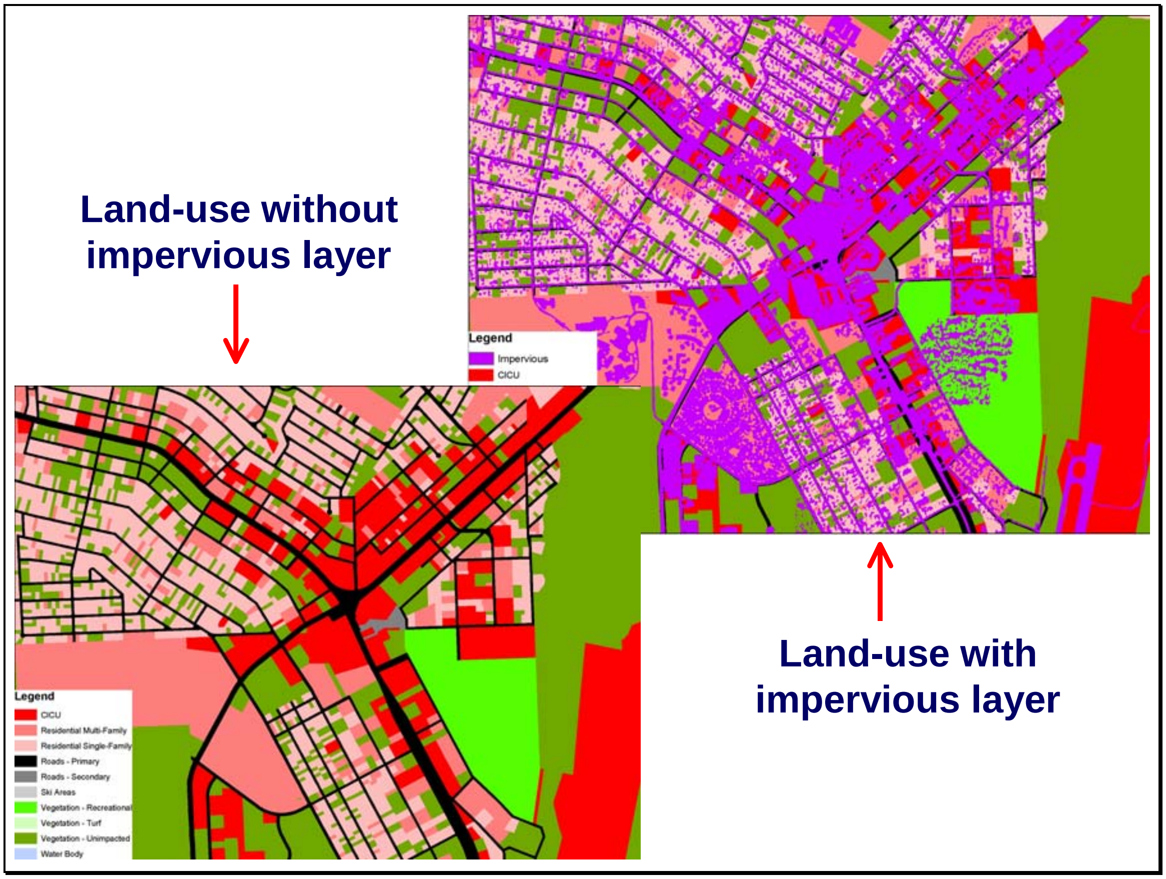

Incorporation of IKONOS impervious coverage evaluation allows for greater resolution of land-uses

Without the addition of the impervious layer, evaluation of coverage impacts would not be possible

Although current monitoring information cannot distinguish between pervious and impervious areas, hydrologic impacts such as increased flow over impervious areas can be modeled.

Additional monitoring and refined modeling could allow for greater distinction between concentrations of pollutants originating from pervious and impervious areas

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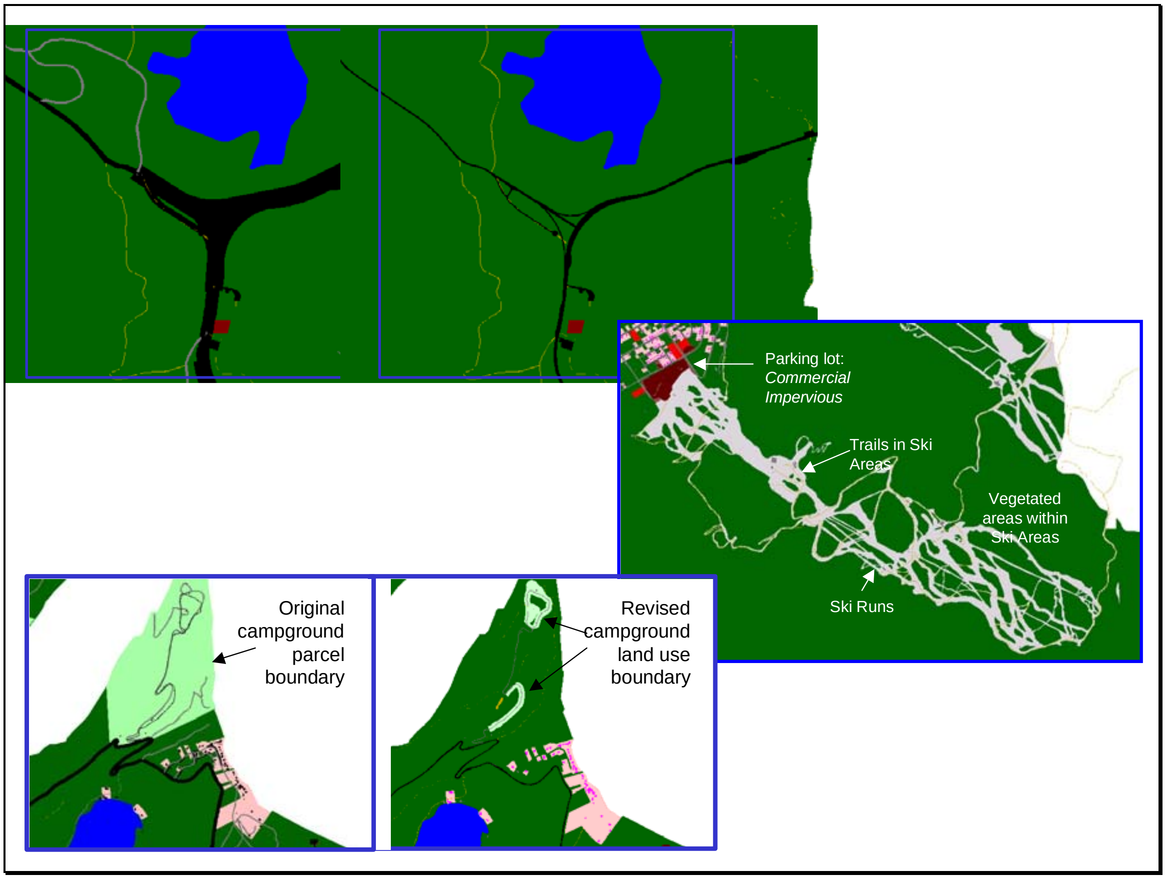

Parking lot:
Commercial Impervious
Trails in Ski Areas
Vegetated areas within Ski Areas
Ski Runs
Original campground parcel boundary
Revised campground land use boundary

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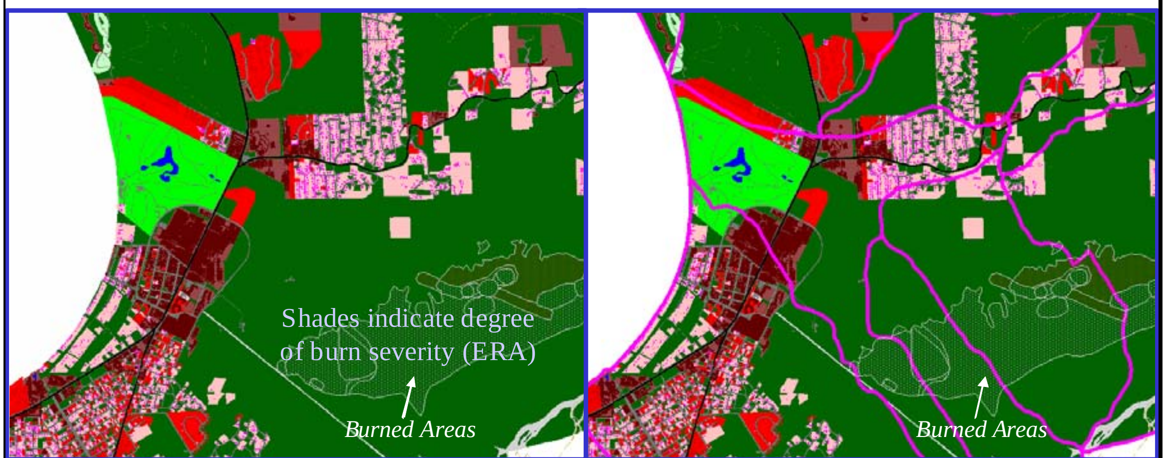

The watershed model does not represent land-uses as discrete footprints on the landscape but totals the amount of each land-use type in each sub-watershed as illustrated on the right.

Model has the ability to represent the impacts of both wildfire and controlled burns.

Forest management activities can also be simulated.

Once land-uses have been totaled, the watershed model references additional information such as soil type, infiltration, slope, etc.

Meteorological information then defines precipitation parameters which drive pollutant transport.

Loading information is then available for each of the 184 sub-waterseds

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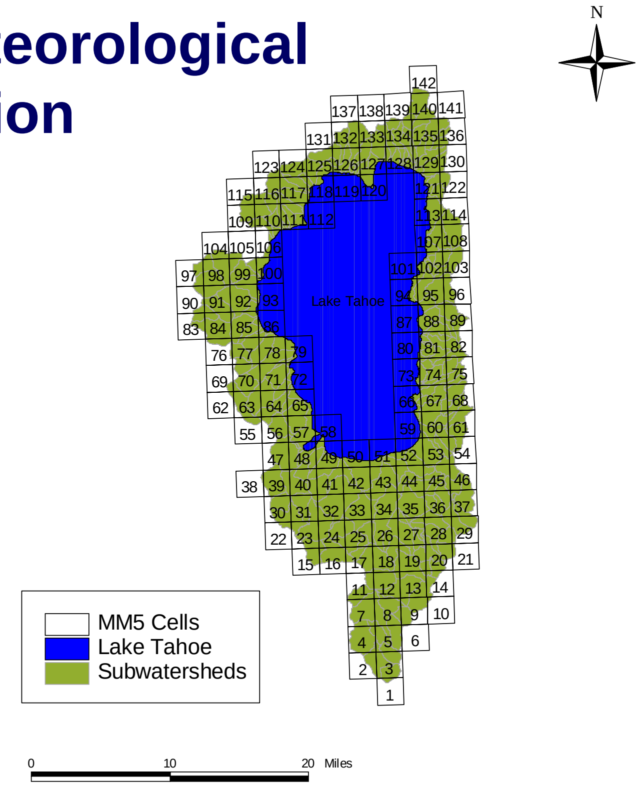
Modeled Meteorological Reconstruction MM5



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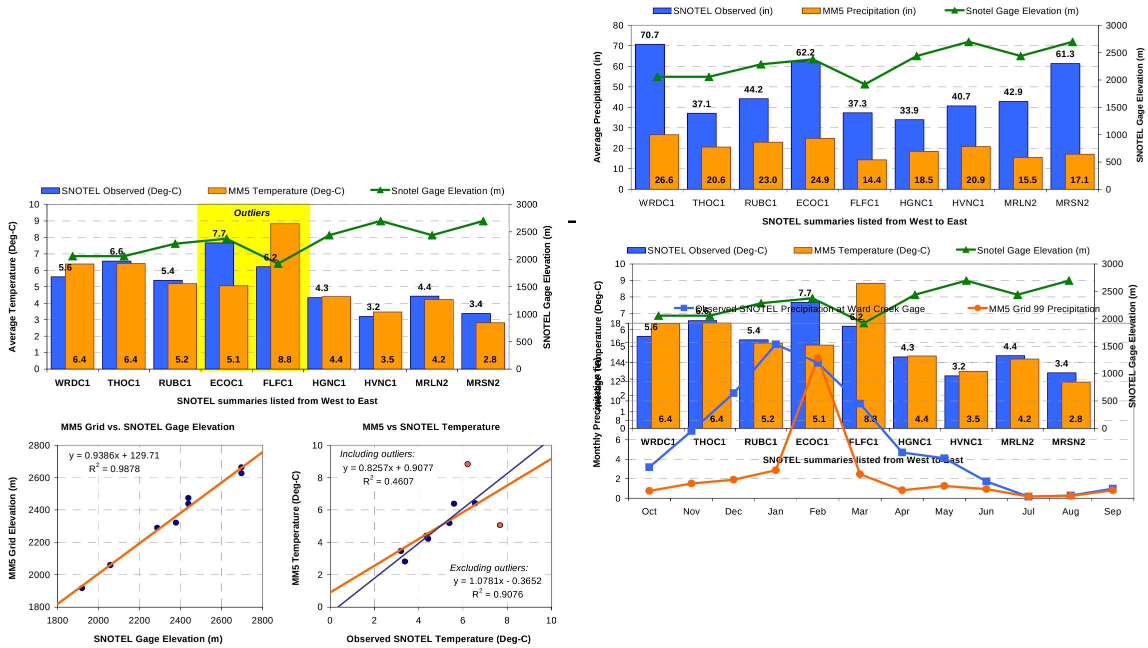
Meteorological Comparison



Once hydrology calibration of the watershed model began, it was noticed that the precipitation values from MM5 were consistently under predicted.

The resulting impact to modeled flow was significant and recalibration of MM5 output is a time intensive effort that could not be accomplished in the time frame needed for TMDL completion. It was decide to use local measured meteorological information in place of the MM5 information.

The MM5 weather information is a powerful modeling tool and will be incorporated into the watershed model once it is recalibrated. Funding has been secured for the recalibration of the MM5 and should be completed in fall of 2006.

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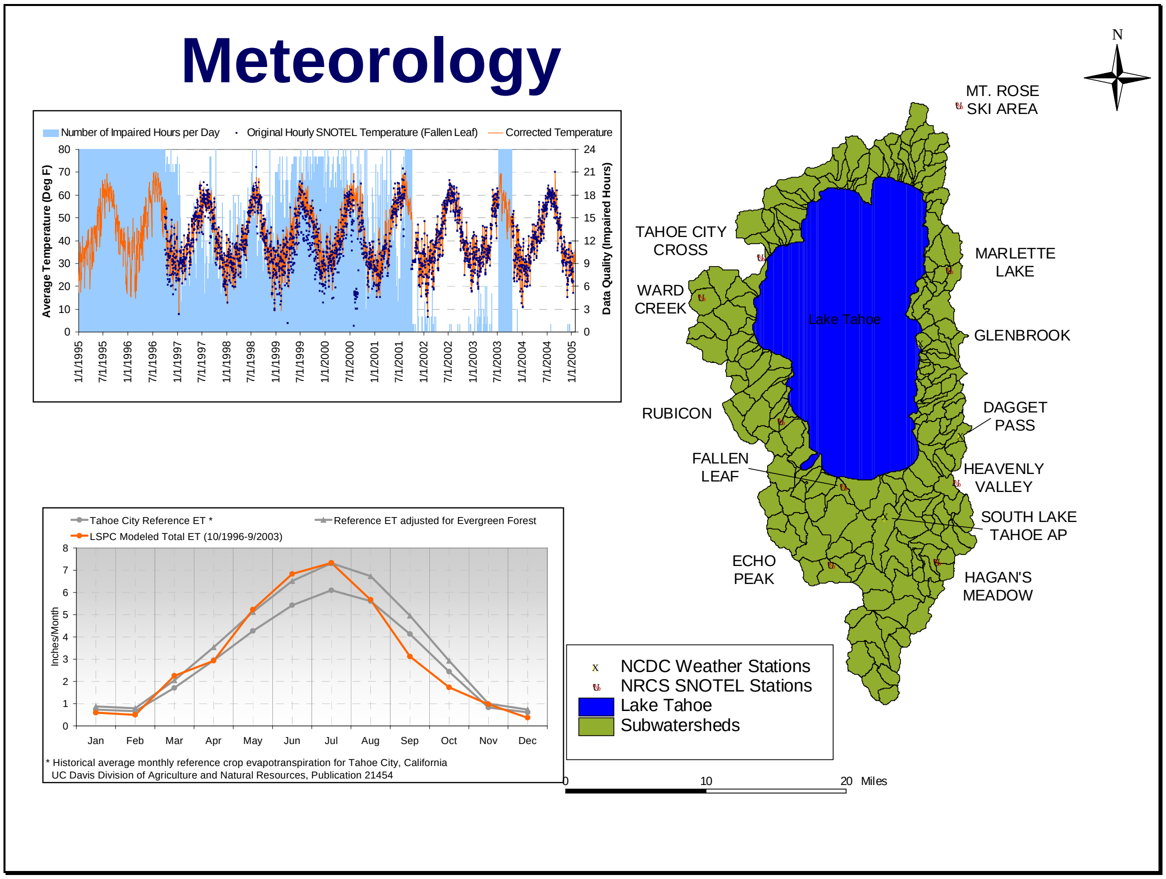

The application of measured weather information required some preprocessing prior to incorporation in the model. Corrected information is illustrated in the upper left hand graph. Development of Tahoe specific evaporation rates and temperature lapse rates for elevation were also completed.

The locations of the SNOTEL sites used to develop the meteorology are distributed throughout the Basin as illustrated on the upper right.

Extrapolation of this information across the entire watershed was completed by standard practices commonly used for watershed modeling

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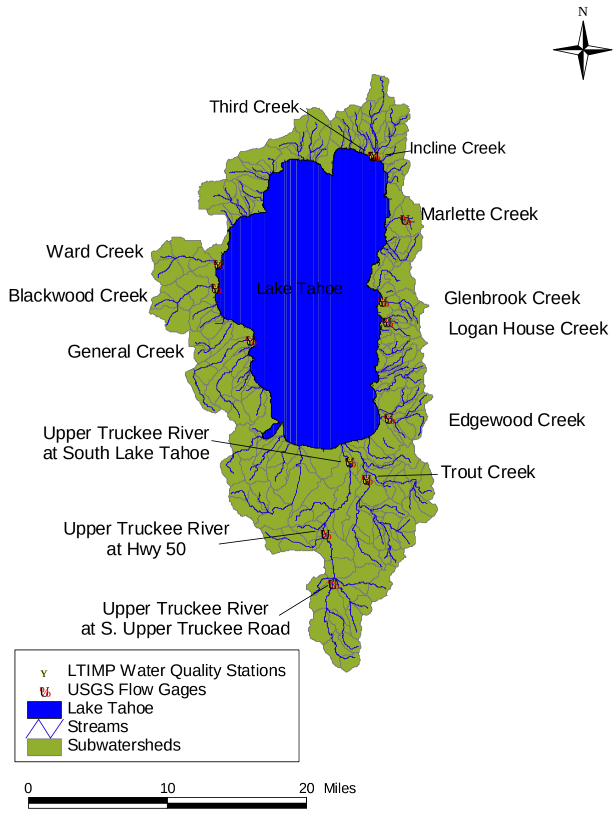
Calibration and Validation



Loading information developed by the watershed model was compared and calibrated to LTIMP monitoring locations.

LTIMP is a significant data set that has a long period of record for in-stream loading information.

Flow from LTIMP stream represents about half of the total flow into Lake Tahoe

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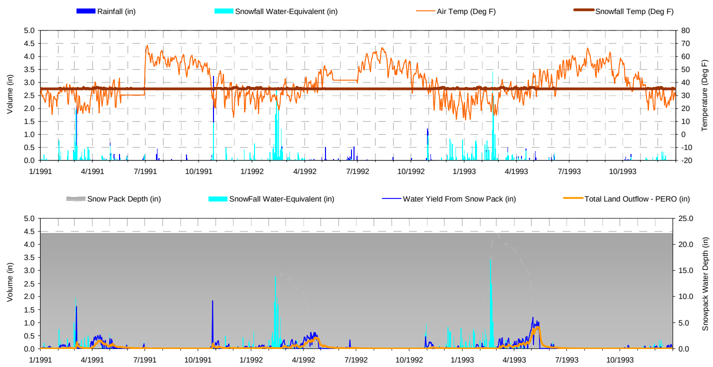
Preliminary Model Results for Snow



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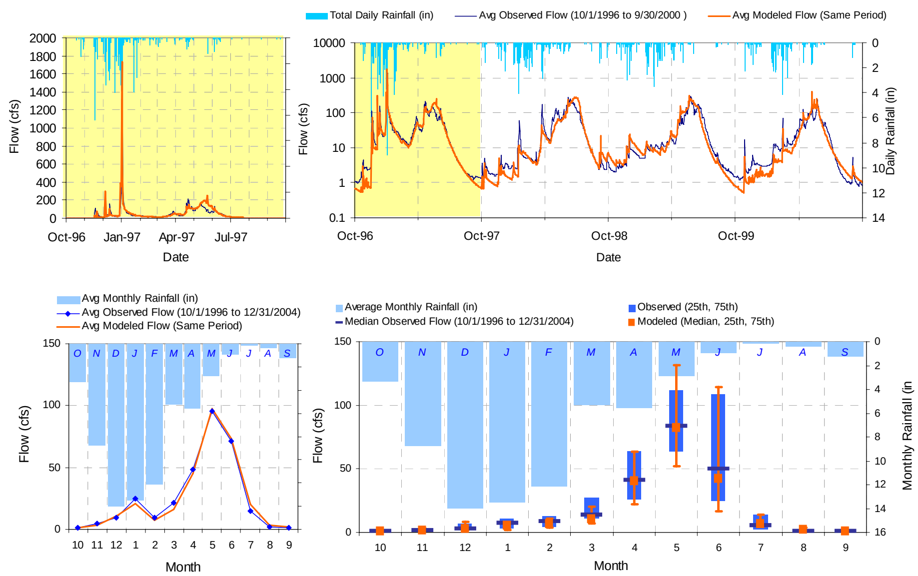
Example Hydrology Output

Calibration and Validation Runs



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Upland Loading Estimates by Tributary

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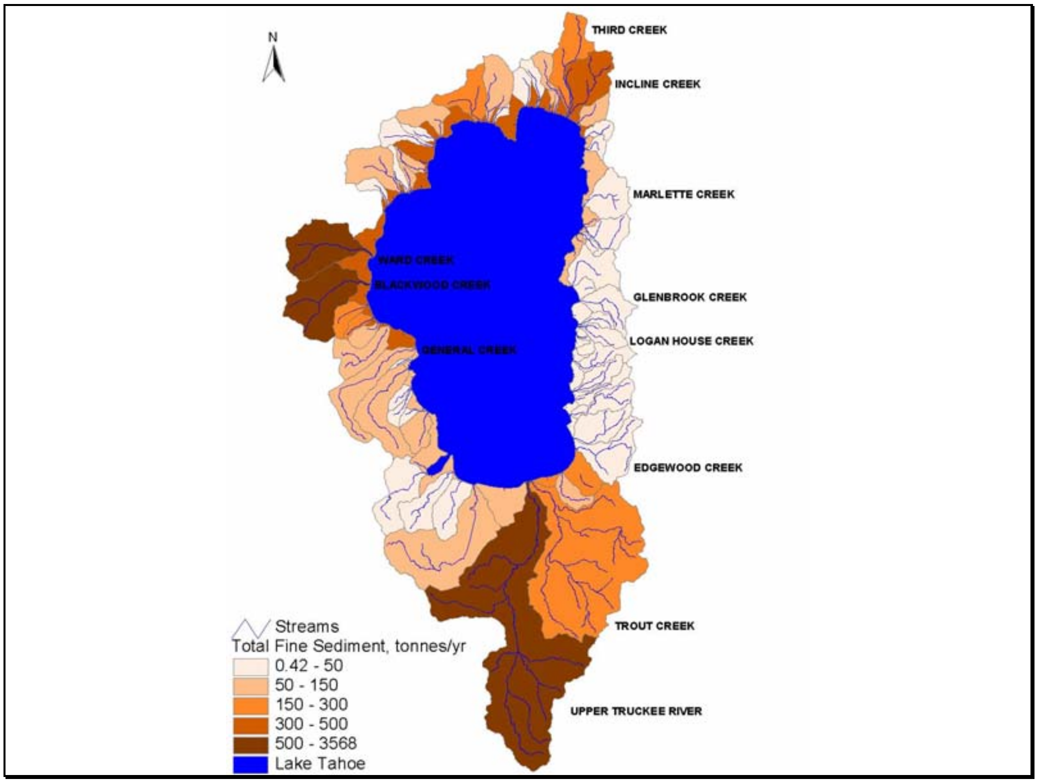

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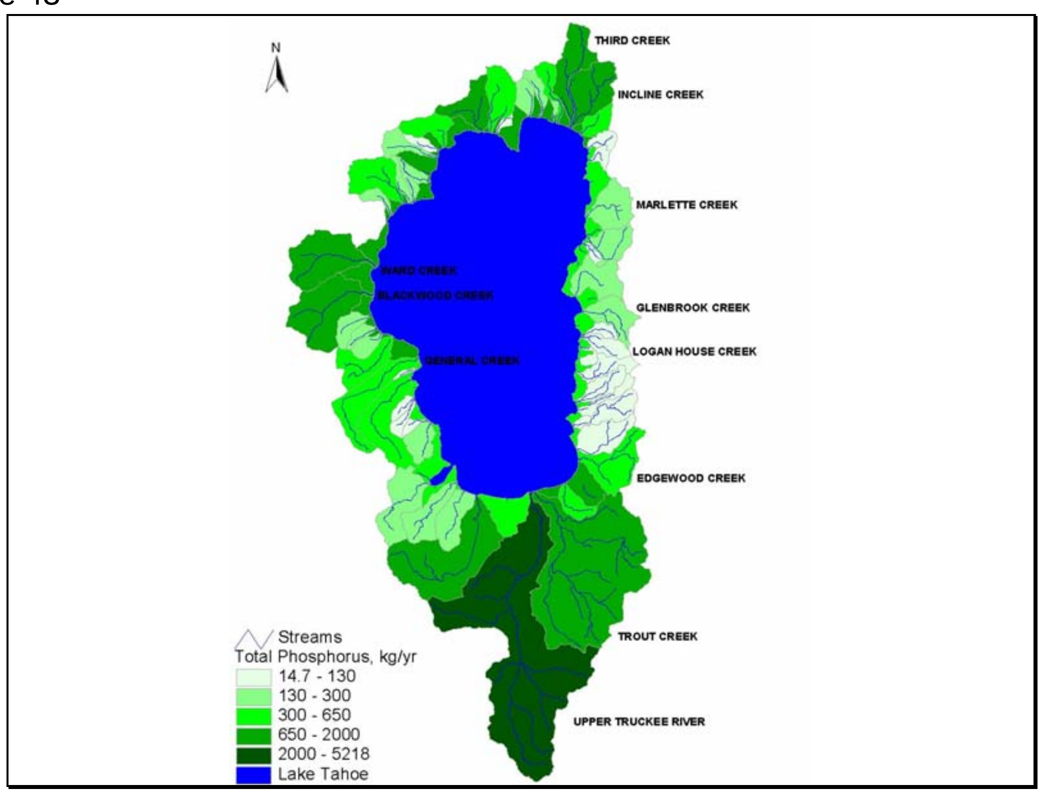

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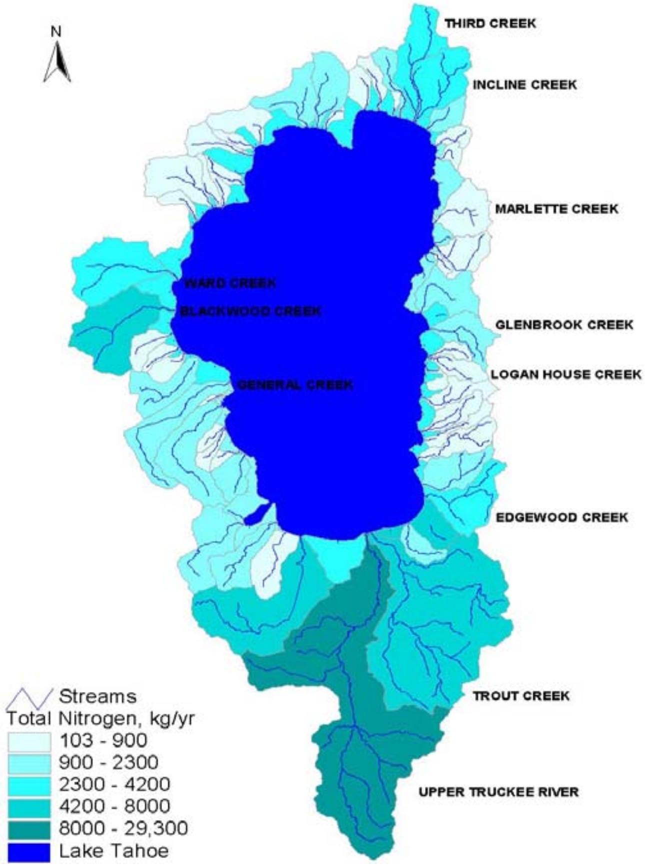

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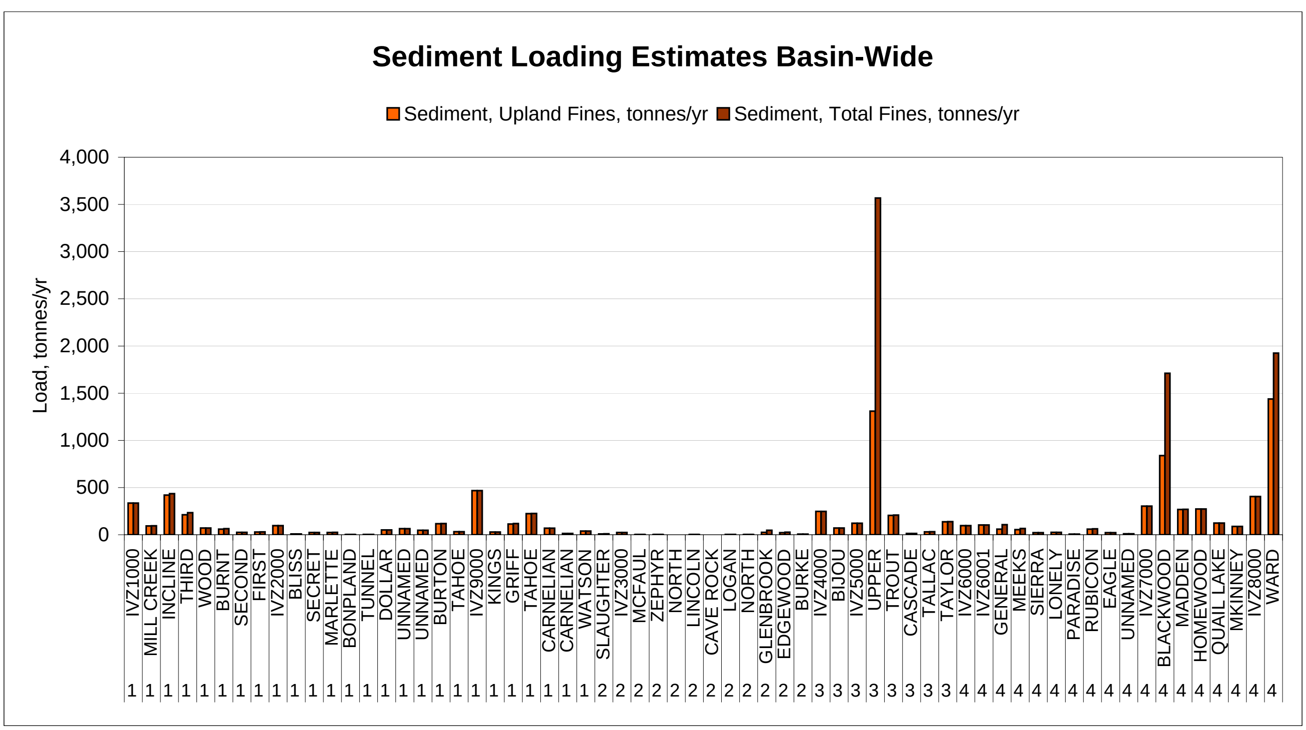

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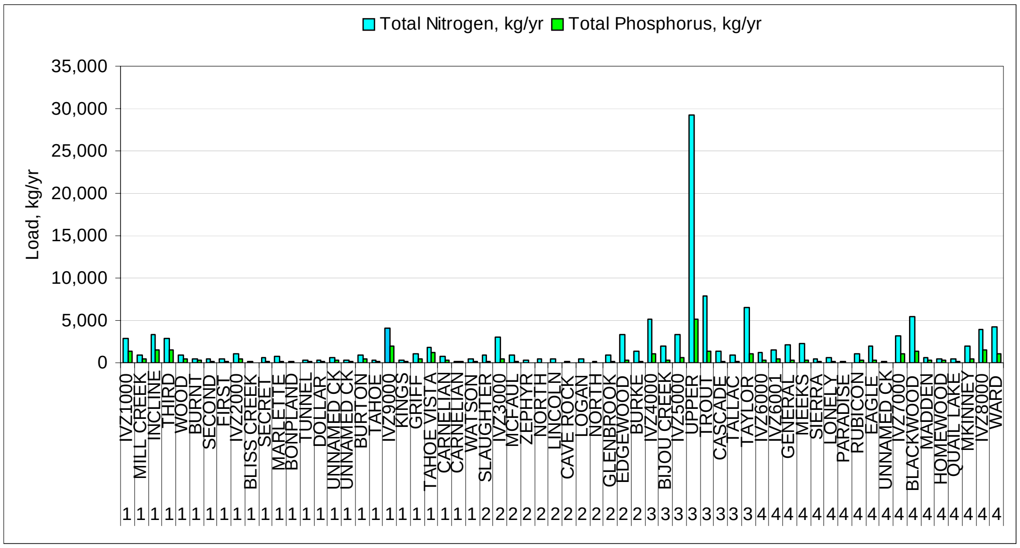
Nutrient Loading Estimates Basin-wide



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Upland Loading Estimates by Land-use

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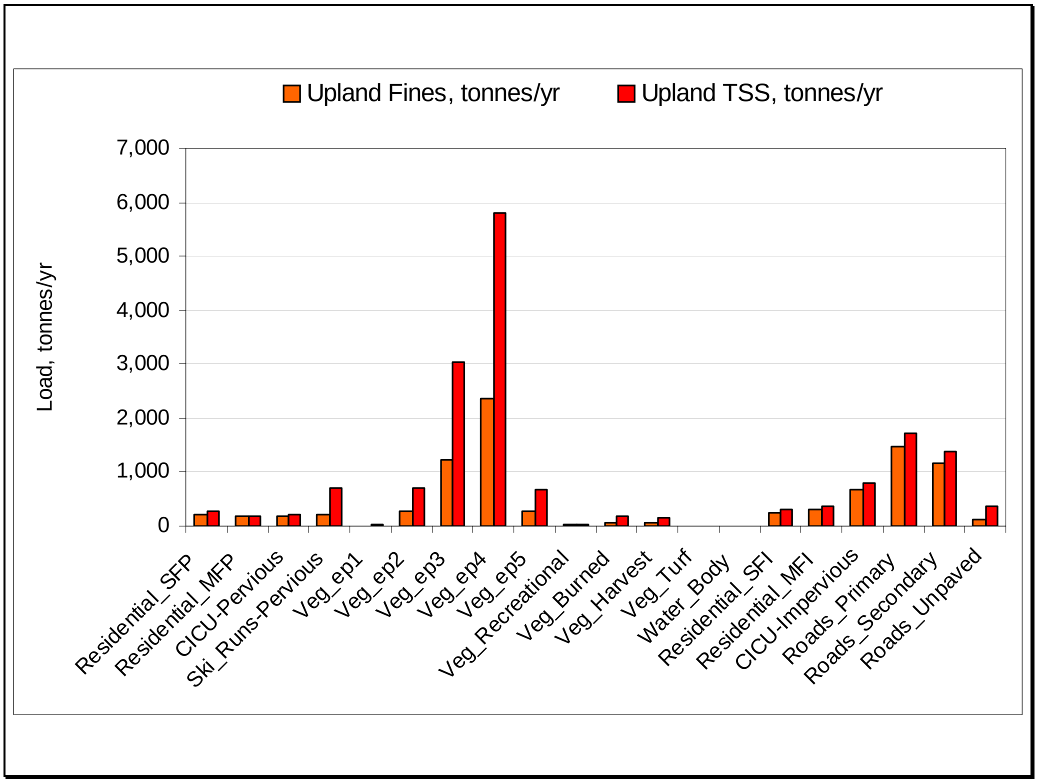

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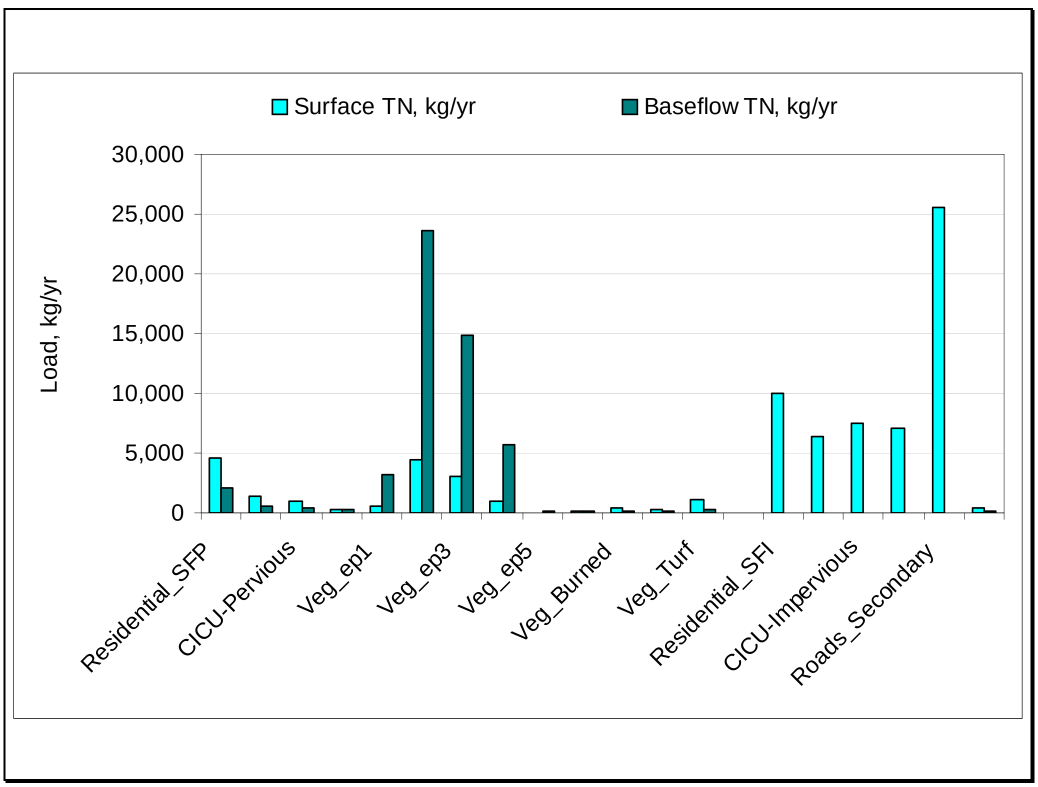
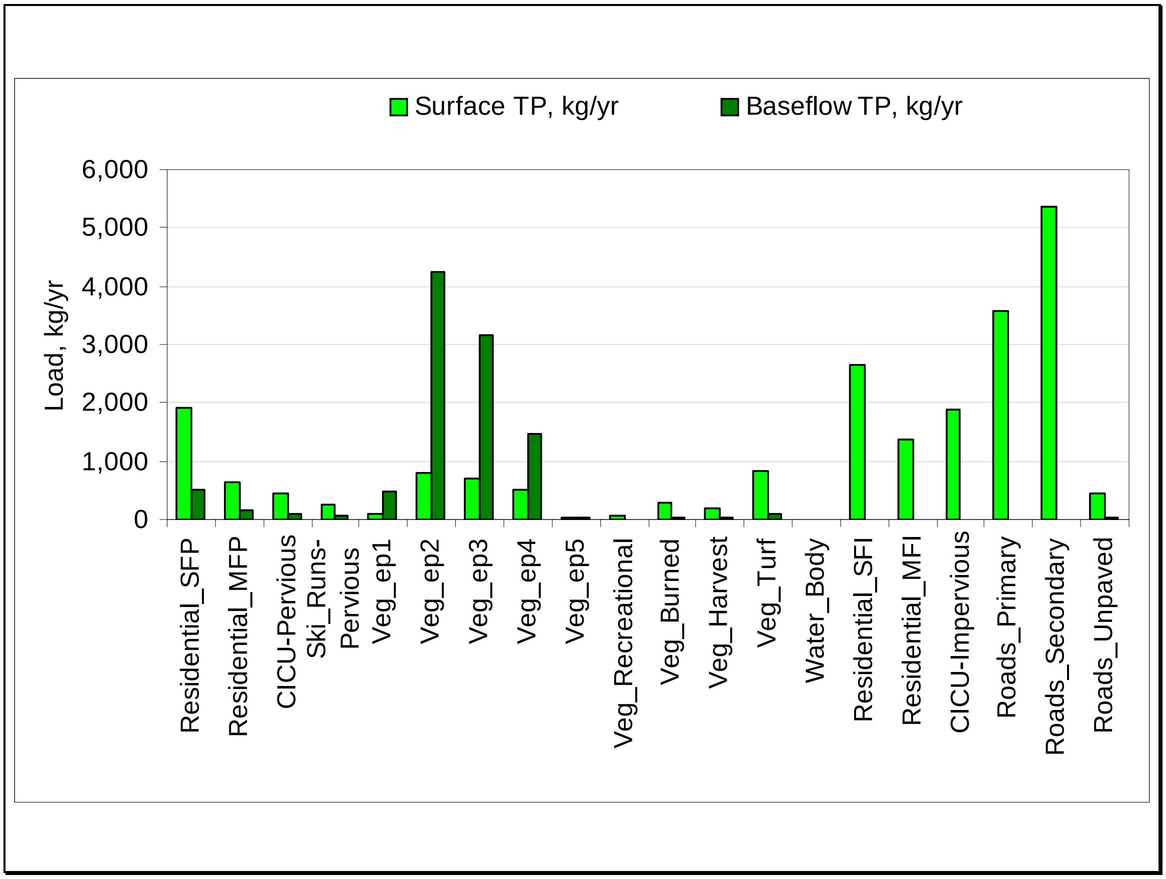


Slide 50


Surface TP, kg/yr
Baseflow TP, kg/yr
Load, kg/yr
6,000
5,000
4,000
3,000
2,000
1,000
0
Residential_SFP
Residential_MFP
CICU-Pervious
Ski_Runs-Pervious
Veg_ep1
Veg_ep2
Veg_ep3
Veg_ep4
Veg_ep5
Veg_Recreational
Veg_Burned
Veg_Harvest
Veg_Turf
Water_Body
Residential_SFI
Residential_MFI
CICU-Impervious
Roads_Primary
Roads_Secondary
Roads_Unpaved

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Watershed Model Scenarios

Climate Change

- Evaluating potential changes in temperature and precipitation
- Applying different climate change scenarios to watershed model

Future Growth Potential

- Developing GIS land-use layer of full build out
- Use GIS layer to estimate potential loading

Coverage Modification

- Working with TRPA to develop coverage change scenarios
- Using watershed model to evaluate hydrology change

The TMDL team is currently working with climate change specialists at the USGS to develop various climate change scenarios. Twelve different combinations of temperature change and precipitation are intended to be applied to the watershed model. Differences in loading could then be evaluated and used to inform decision makers on the potential and significance of climate change impacts to water quality.

Evaluation of future growth potential is a requirement of the TMDL program. A GIS layer representing a full build out condition was developed by the USGS. This GIS layer will be used to evaluate the potential for additional loading from future development.

The model has the ability to measure differences in hydrology resulting from changes to coverage. Different coverage change scenarios have been developed with the Soils/SEZ Core Group and will be evaluated with the watershed model.

Although specific impacts to lake clarity will not be known until completion of the clarity model, relative differences in loading will be apparent.

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Watershed Scale & Project Scale Modeling Linkage

- **Developing Project Scale to Watershed Scale Linkages**
- **Developing BMP Models applicable to Project and Sub-watershed Scales**
- **Utilizing Local and National BMP Effectiveness Information**
- **Development will include local implementers**

Provides opportunity to evaluate load reductions at project scale

EIP Accomplishment Units

Applications to potential pollutant trading programs

Application to load reduction tracking

Opportunities for cross-validation between different modeled approaches

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Updated Pollutant Budget

Source Category	Total Nitrogen	Total Phosphorous	Total Fines
Groundwater	50 (13%)	7 (14%)	NA
Stream Channel Erosion	10 (2.5%)	2 (4%)	3757 (25%)
Shoreline Erosion	2 (1%)	2 (4%)	550 (4%)
Atmospheric Deposition	203 (51%)	8 (16%)	1400* (9%)
Upland	127 (32%)	31 (62%)	9100 (61%)
TOTAL	393	50	14,807

2000 Nutrient Budget

Source	Total Nitrogen	Total Phosphorous
Atmospheric Deposition	234 (59%)	12.4 (28%)
Stream Loading	82 (20%)	13.3 (31%)
Direct Runoff	23 (5%)	12.3 (28%)
Groundwater	60 (15%)	4 (9%)
Lake Shore Erosion	1 (1%)	1.6 (4%)
Total	400	43.6

Numbers are presented as metric tonnes and percent of total loading for each constituent

Upland Loading in the updated pollutant budget could be broken into:
Stream Loading: Total Nitrogen-97 MT (25%), Total Phosphorous-23 MT (46%), Fines-6900 MT (47%)
Intervening Zones: TN-30 MT (8%), TP-8 MT (16%), Fines-2200 MT (15%)

Asterisk next to atmospheric fine loading estimate indicates a different is sampling technique between air and water sampling. Air sampling measures total particulates in the air. However, particles collected are typically very small particles less than .030 mm.

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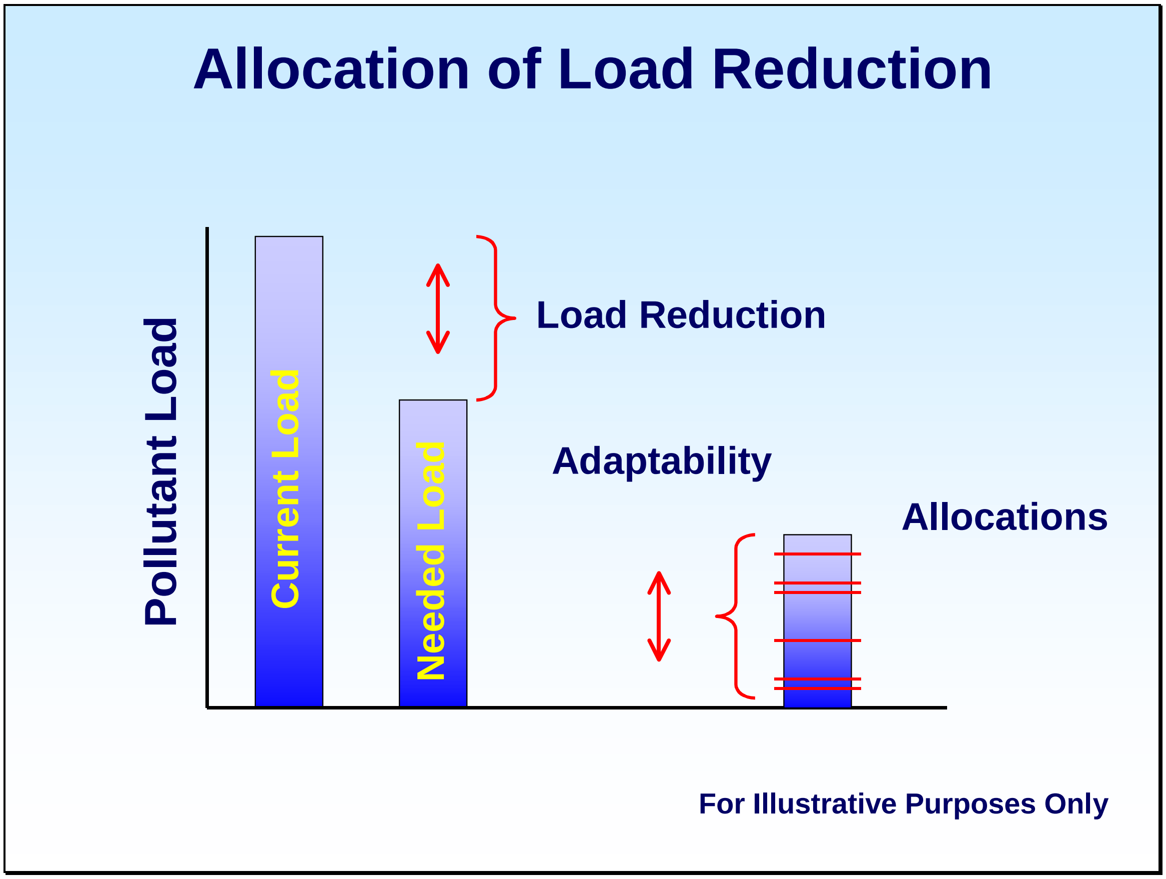

Allocations need to be developed for each source category – it has not been decided how allocations will be represented

Allocations could be developed by source category, watershed, land-use type, jurisdiction, etc.

For example, allocations could be developed by implementation strategy i.e. land-use strategies, regulatory strategies, physical improvement strategies, and educational strategies.

The Integrated Water Quality Management Strategy will be developing various control strategies with input from the Forum and the public. The Pathway agencies will use this information to determine appropriate load reduction allocations.

It is intended that load reduction estimation techniques will be developed for each source category to assist in load reduction tracking and possible connection to pollutant trading programs

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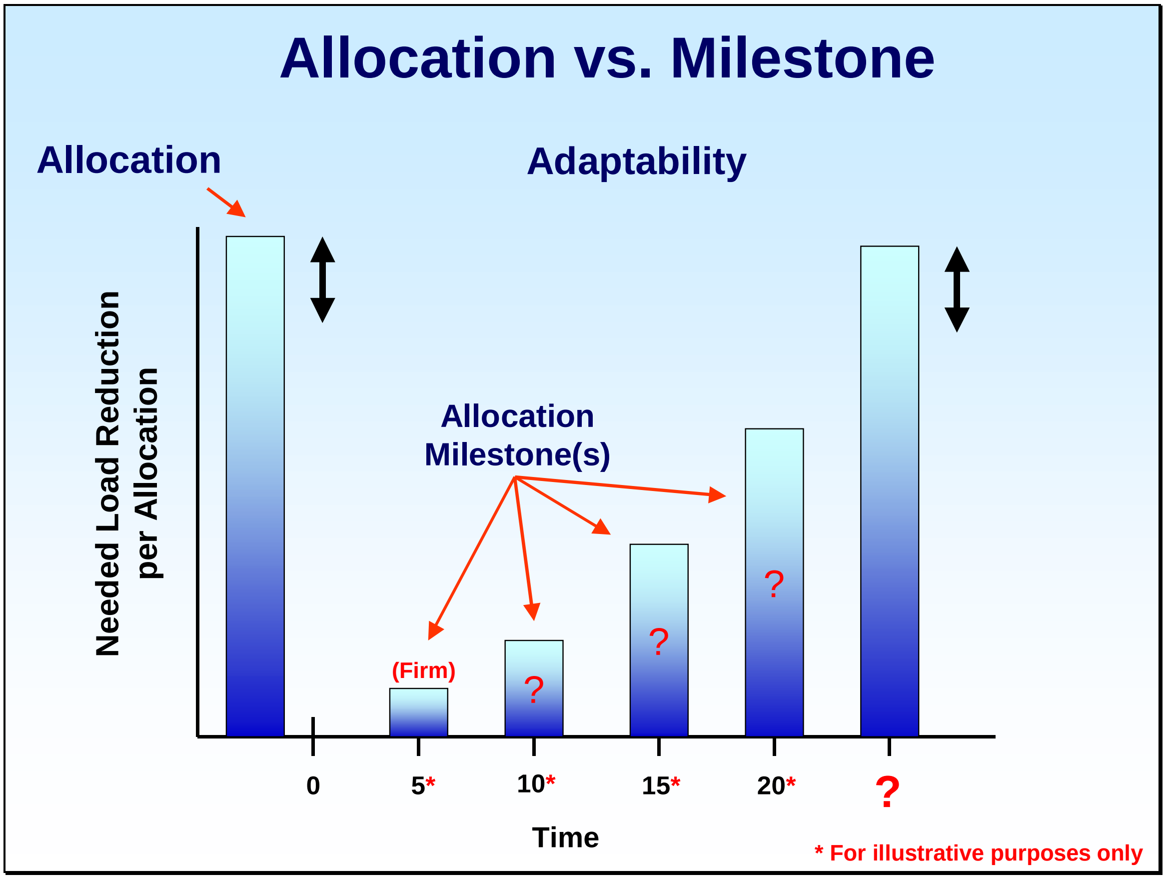

Allocation of load reductions is intended to meet long-term load reduction objectives

Short-term (5 year) milestones will be developed during the IWQMS process and will be firm targets.

Process for determining load reduction milestones is still to be determined through the IWQMS process

Monitoring information should be used to report actual progress made

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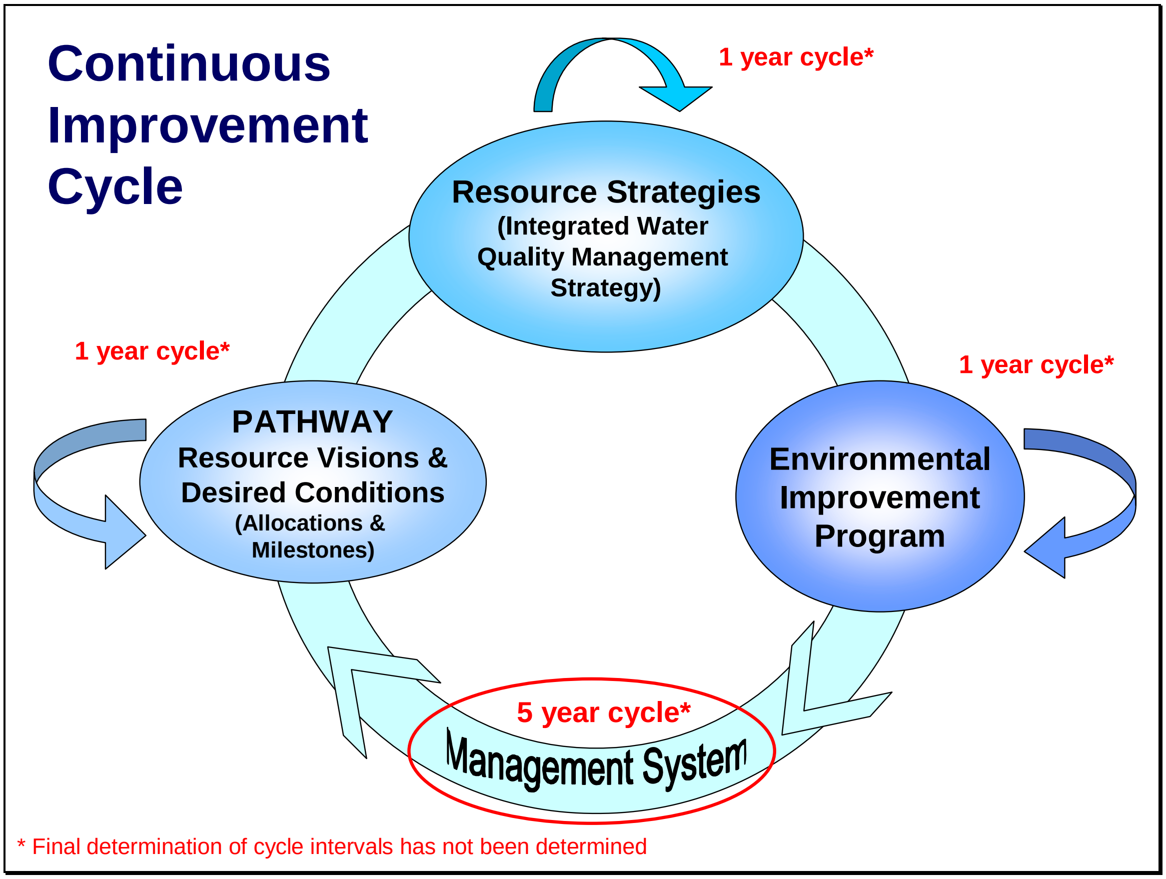

Planning cycles should address the planning needs of regulatory and implementing agencies when possible

Development of a functional Management System is an important need of the TMDL program – provides framework for model improvements and refinements, incorporation of new data and information

Management System is intended to provide a framework to apply the cooperative and focused ability of various agencies on specific resource management issues

One year planning cycles should provide information to help direct larger five-year planning revisions