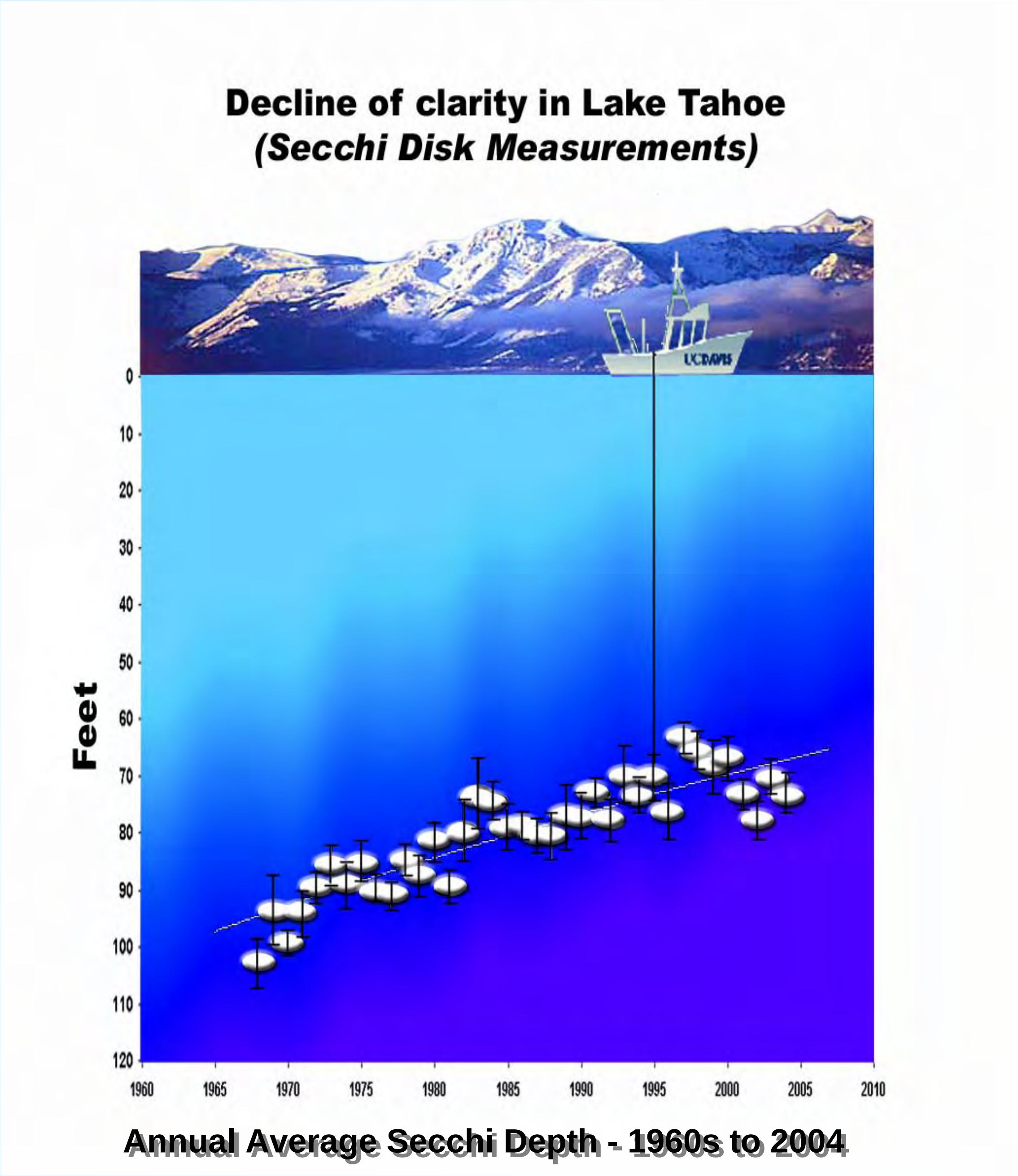
Lake Tahoe Sediment and Nutrients TMDL

Clarity Model Analysis

Presented to:
PATHWAY Forum
July 27,2006

Presented by:
Dave Roberts
Lahontan RWQCB

Dr. Geoff Schladow
UC Davis



Presentation Overview

- **Brief overview of loading estimates and application**
    - **Appreciation to UC Davis, Dr. Reuter and Dr. Schladow**

- **Results of Clarity Model analysis, Dr. Schladow**

- **Integrated Water Quality Management System development process**

WATER QUALITY

Draft July 27, 2006

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 deep water of Lake Tahoe. (Type I). Nearshore aesthetics (Type III).

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 III)

Proposed Standards

Pollutant Load Reductions
The TMDL Tool Box (including modeling efforts) will be used in concert with the management strategies to determine pollutant reductions for achieving the clarity standards.

Clarity
Secchi depth transparency shall not be less than annual average of 29.7 meters. Existing turbidity standard in place until new standards adopted. *Appropriate nearshore aesthetic standard(s) will be developed (after 2008).*

WQ Health
Compliance with established federal, state and local standards.

IBI Index –
See standards for Index of Biological Integrity, reference Wildlife and Fisheries Addendum.

Pollutant Load Reductions

The TMDL Tool Box (including modeling efforts) will be used in concert with the management strategies to determine pollutant reductions for achieving the clarity standards.

TMDL Development Phases

Phase I

Product: Technical TMDL – August 2006

- Determine Current Loading – June 2006
- Determine Basin-wide Load Reduction Needs – July 2006

Phase II

Product: Final TMDL – November 2008

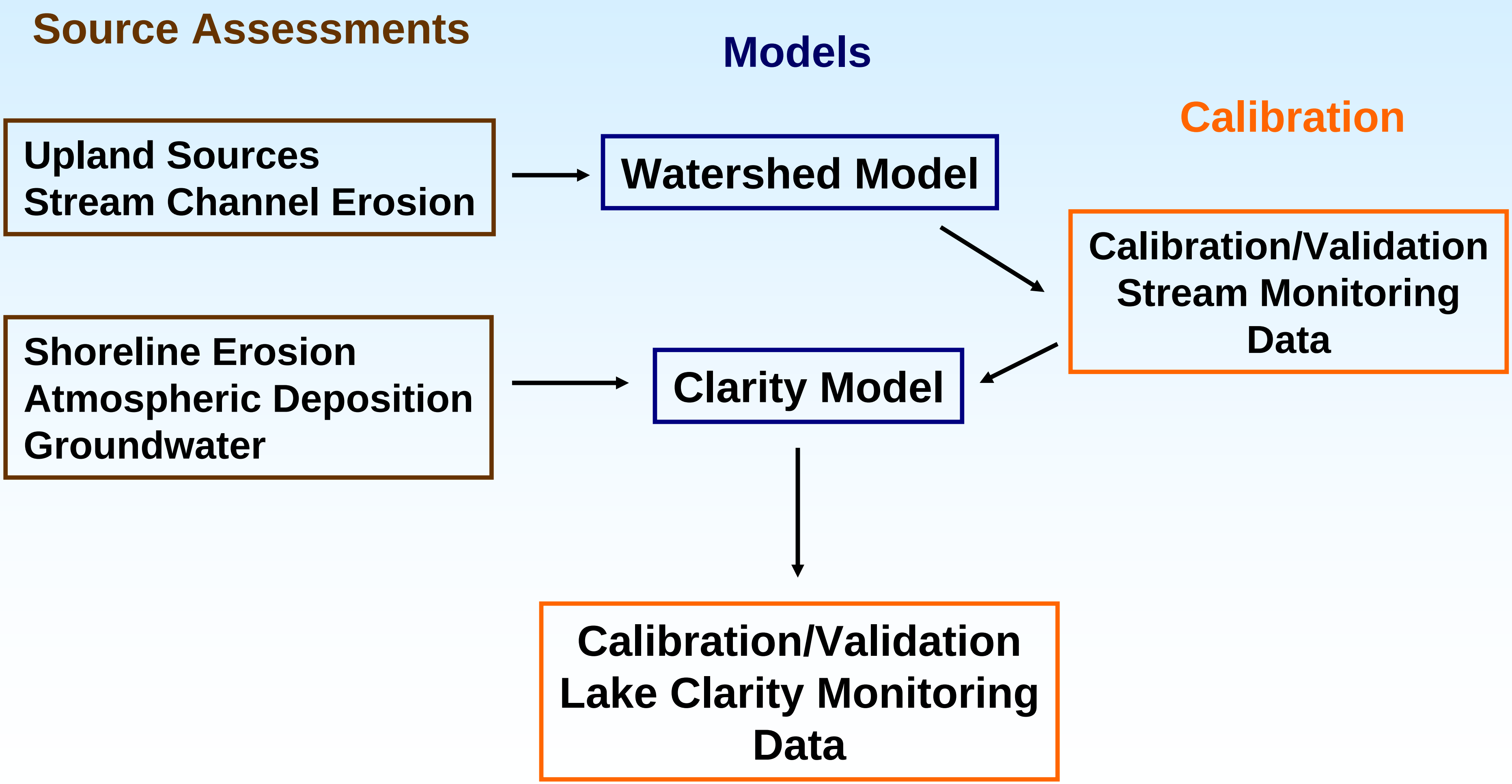
- Identify Load Reduction Possibilities
- Allocates Pollutant Load Reductions
- Implementation Plan / Monitoring Plan
- Integrated Water Quality Management Strategy

Phase III

Product: Implementation – Continuous Improvement Cycle

- Application within a Management System
- Predetermined Review Periods

Technical TMDL
Phase I (2001-2006)



Updated Pollutant Budget (MT/yr)

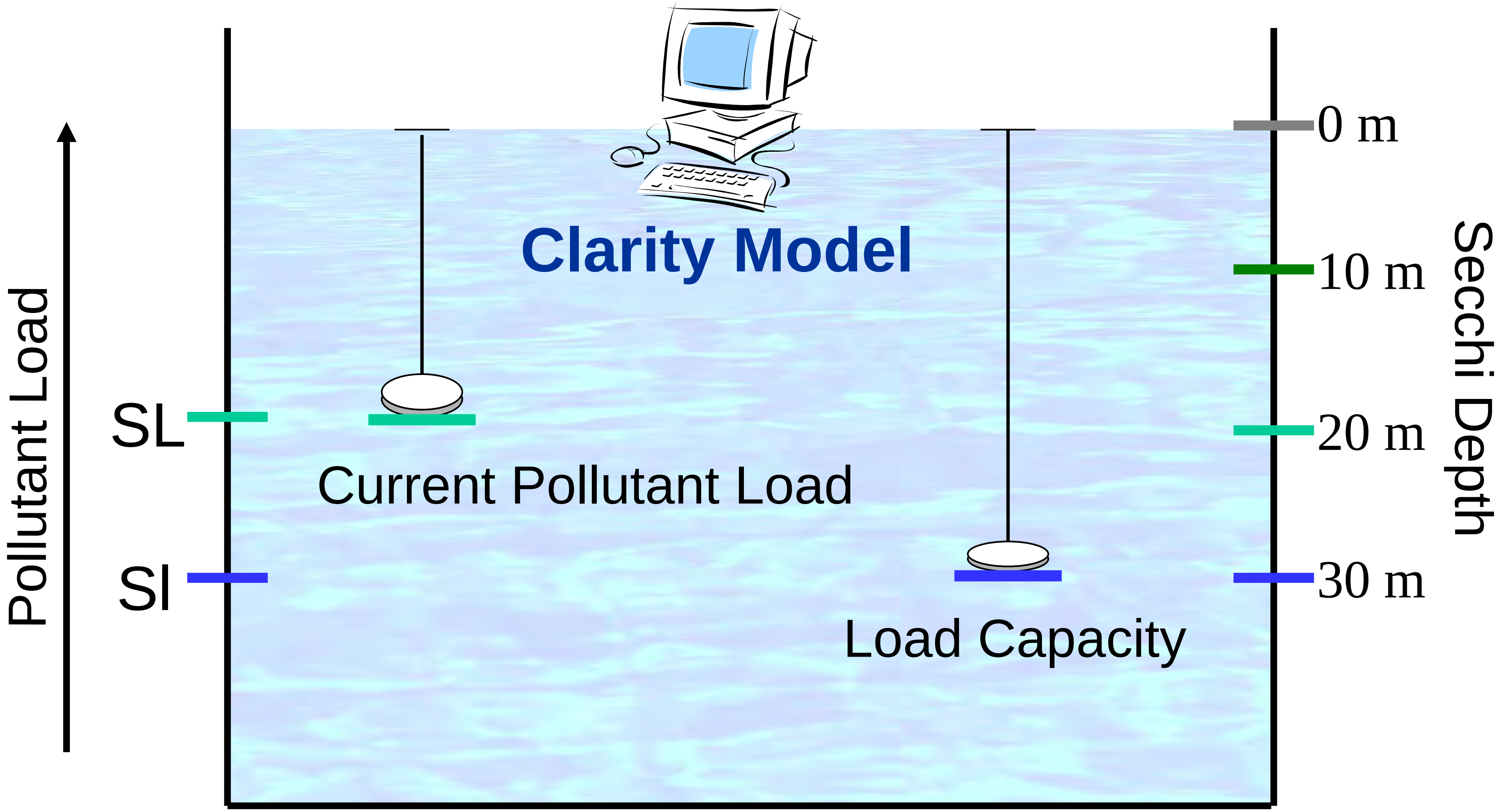
Source Category		Total Nitrogen	Total Phosphorus	Total Fines
Upland Runoff	Stream Loading	97 (25%)	23 (46%)	6,900 (47%)
	Intervening Zones	30 (8%)	8 (16%)	2,200 (15%)
Stream Channel Erosion		10 (2%)	2 (4%)	3,800 (25%)
Atmospheric Deposition		203 (51%)	8 (16%)	1,400* (9%)
Groundwater		50 (13%)	7 (14%)	NA
Shoreline Erosion		2 (1%)	2 (4%)	500 (4%)
TOTAL		393	50	14,800

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

Previous Nutrient Budget (MT/yr)

Source	Total Nitrogen	Total Phosphorus
Stream Loading	82 (20%)	13.3 (31%)
Intervening Zones	23 (5%)	12.3 (28%)
Atmospheric Deposition	234 (59%)	12.4 (28%)
Groundwater	60 (15%)	4 (9%)
Shoreline Erosion	1 (1%)	1.6 (4%)
Total	400	43.6

Linkage Analysis



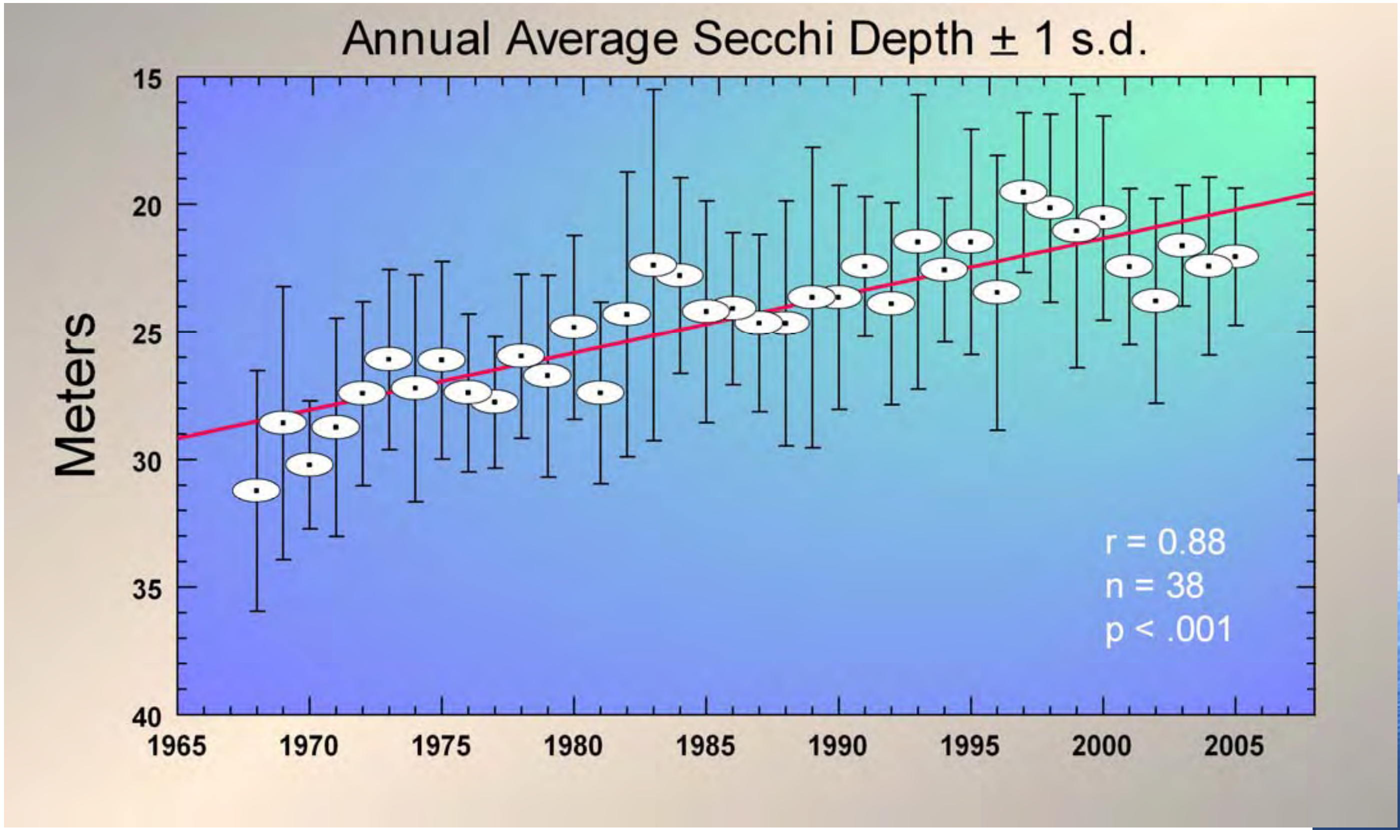
SL – Sl = Total Required Load Reduction

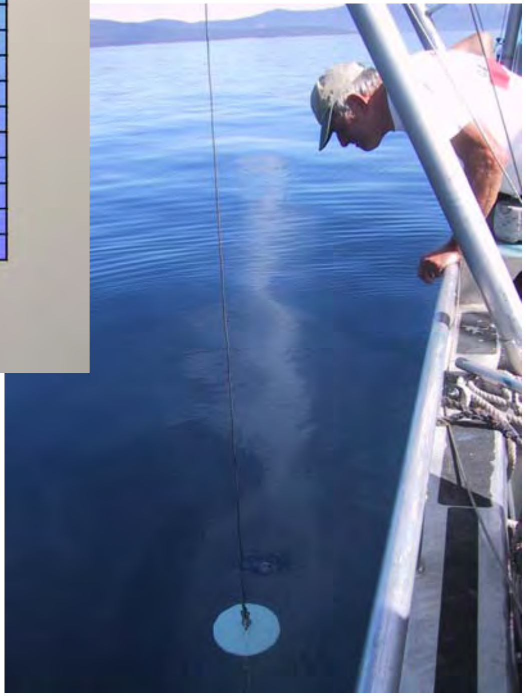
THE WHO, WHAT, WHY AND WHERE OF THE TAHOE CLARITY MODEL

S. Geoffrey Schladow
Tahoe Environmental Research Center

Pathways 2007 Forum, July 27, 2006

THE “IMPAIRMENT”





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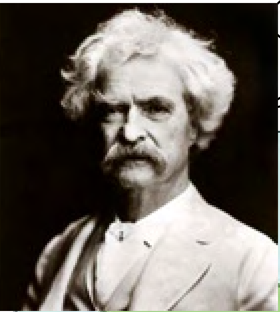
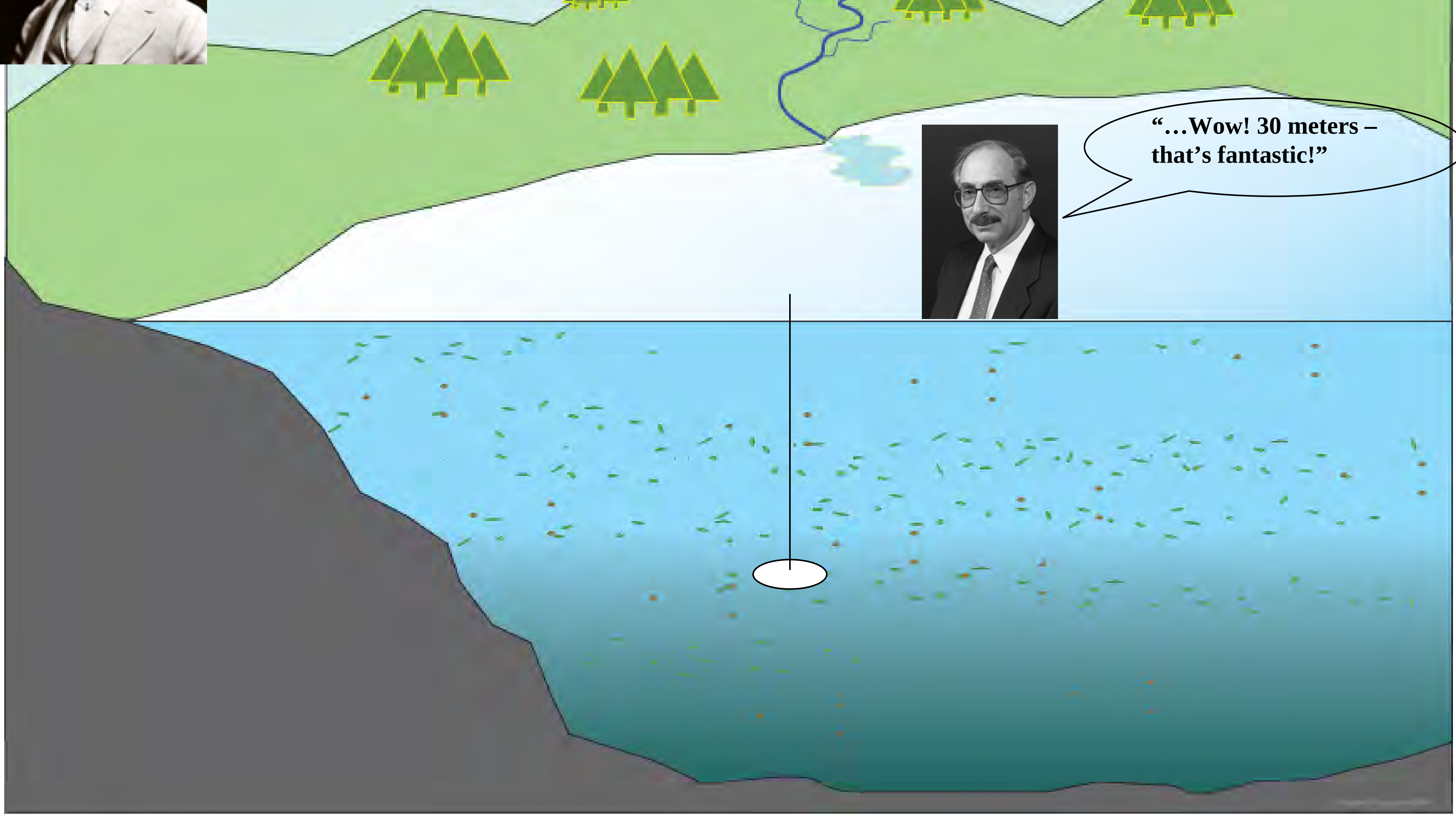
IN THE BEGINNING…





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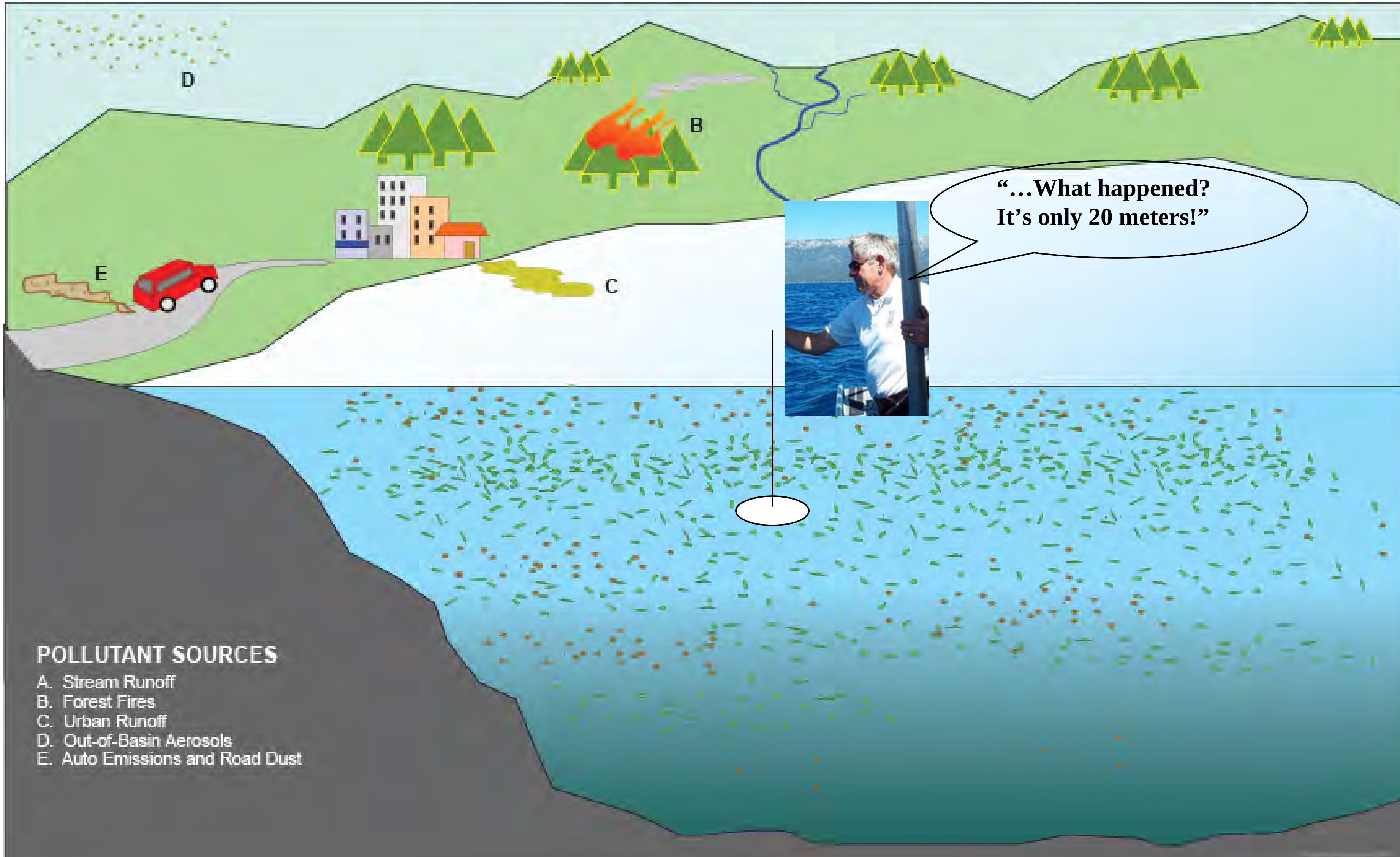
SOME TIME LATER …



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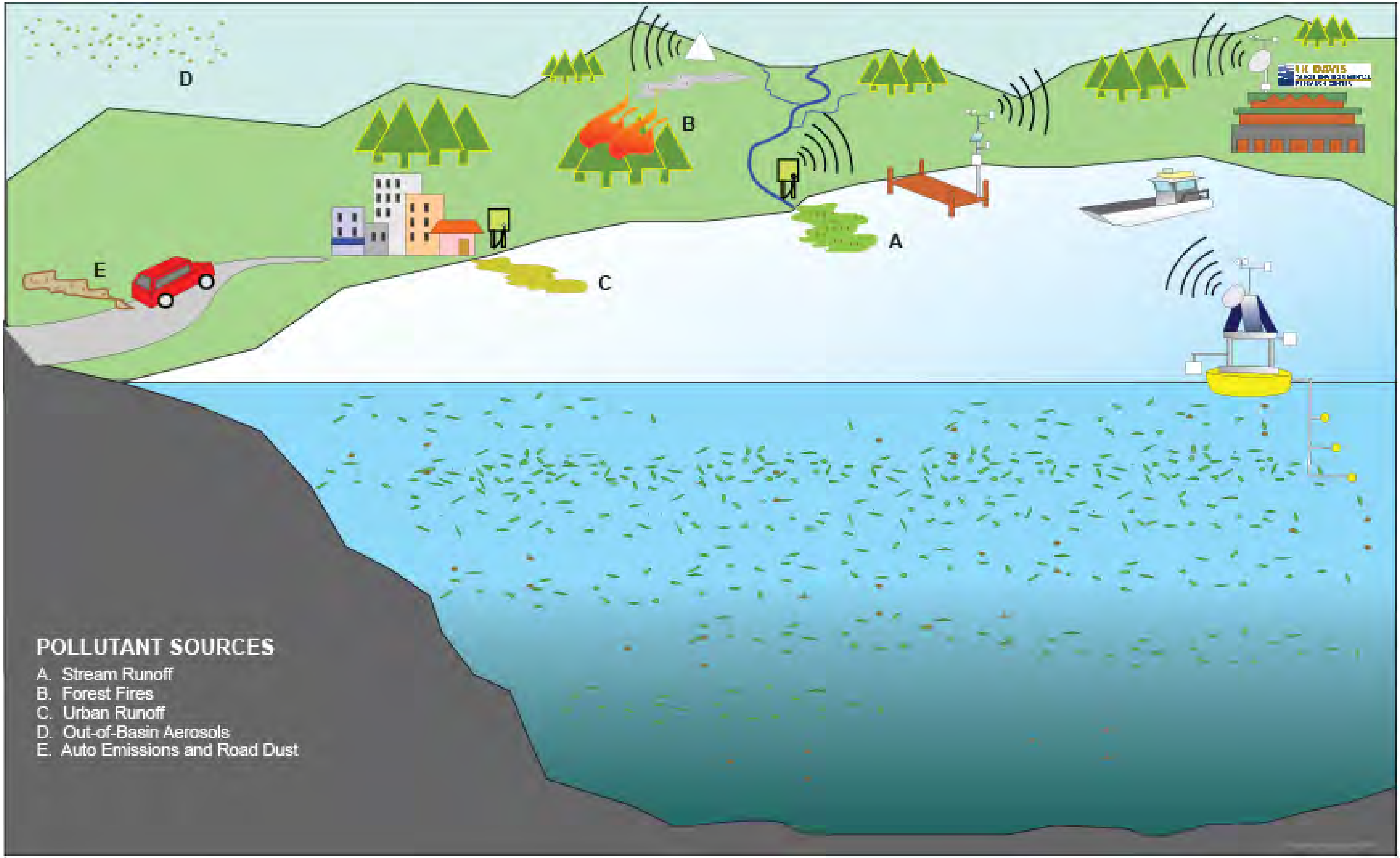
INITIALLY THE MEASUREMENTS SUGGESTED NUTRIENT LOADING WAS THE PROBLEM



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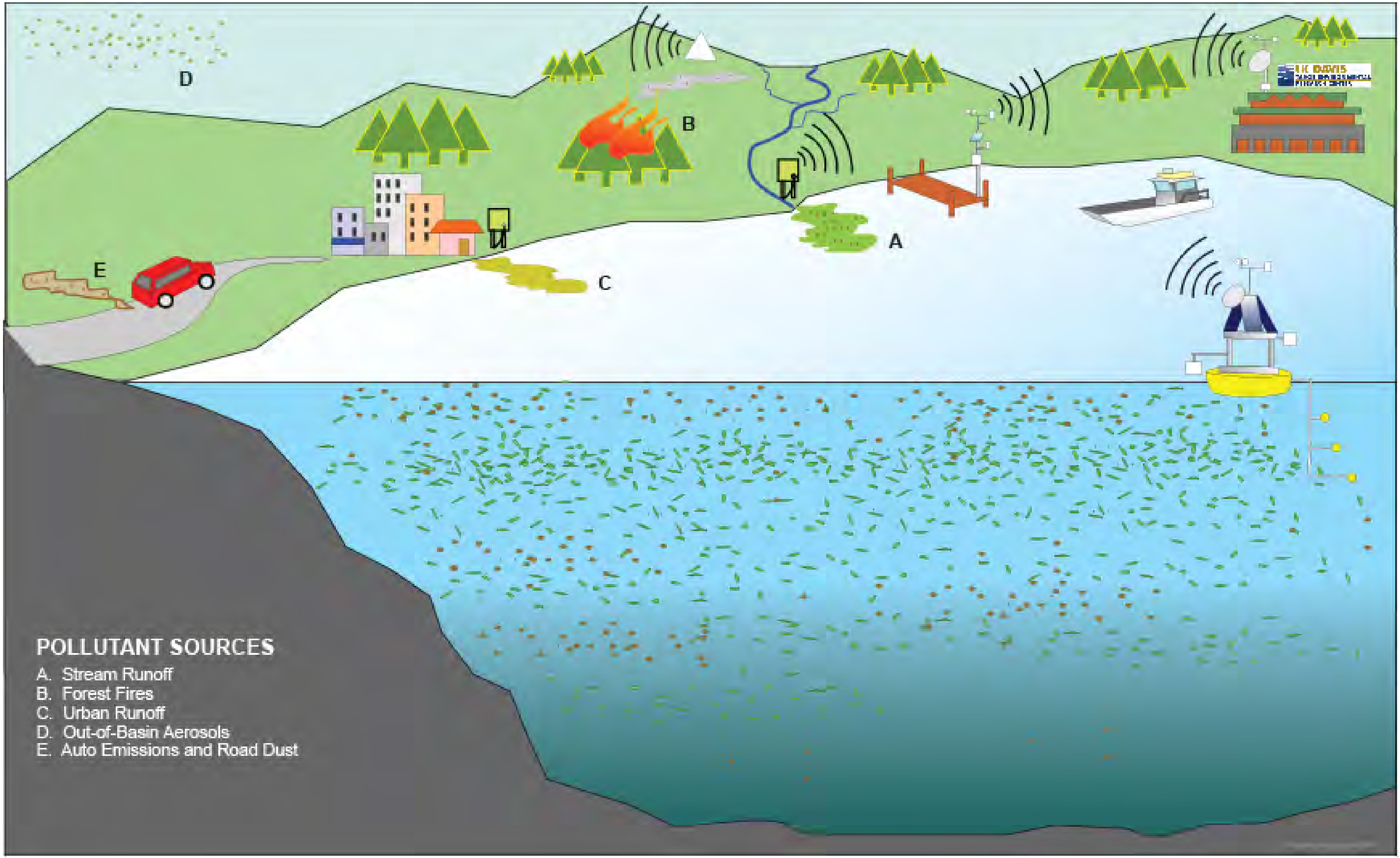
LATER MEASUREMENTS SHOWED FINE PARTICLE LOADING AND NUTRIENT LOADING WERE IMPORTANT.



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HOW DOES THIS KNOWLEDGE ALONE HELP IN THE MANAGEMENT OF LAKE TAHOE?

i.e. HOW DO WE COME UP WITH A TMDL FOR POLLUTANTS THAT ARE CAUSING CLARITY DECLINE? HOW MUCH DO WE NEED TO REMOVE? DO ALL SOURCES ACT EQUALLY?

THIS IS WHERE A PREDICTIVE MODELING CAPABILITY IS INDISPENSIBLE

OR FOR THE CYNICS, “TO ERR IS HUMAN, TO REALLY SCREW UP YOU NEED A MODEL”

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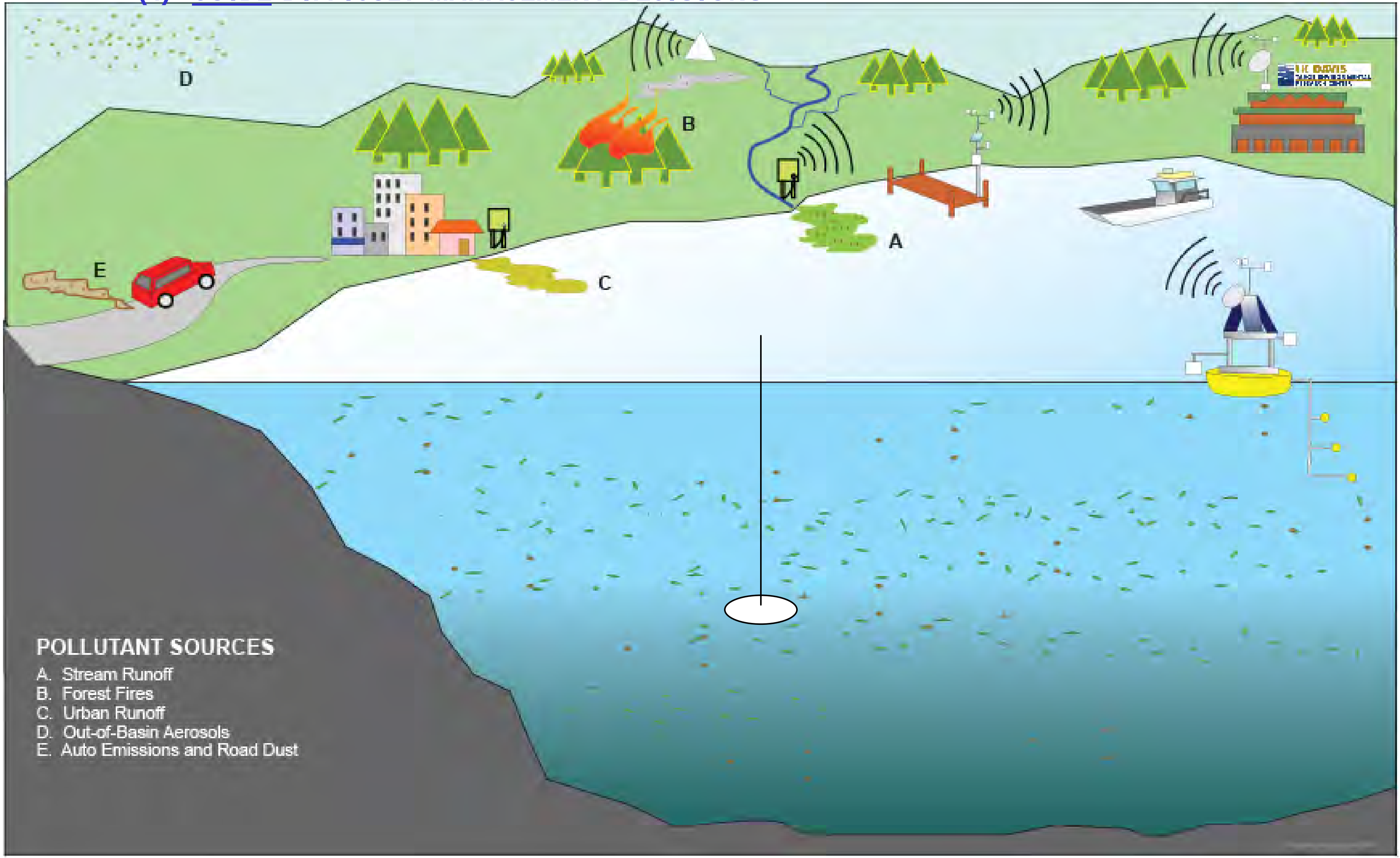
A PROCESS-BASED NUMERICAL MODEL PROVIDES THE MEANS TO:
(1) UNDERSTAND HOW EACH POLLUTANT SOURCE INTERACTS WITH THE LAKE
(2) QUANTIFY THE EFFECTS OF FUTURE REDUCTIONS OF LOADS
(3) QUANTIFY THE FUTURE TEMPORAL RESPONSE OF THE LAKE
(4) GUIDE DIFFICULT MANAGEMENT DECISIONS



THE TAHOE CLARITY MODEL IS A PROCESS-BASED NUMERICAL MODEL.

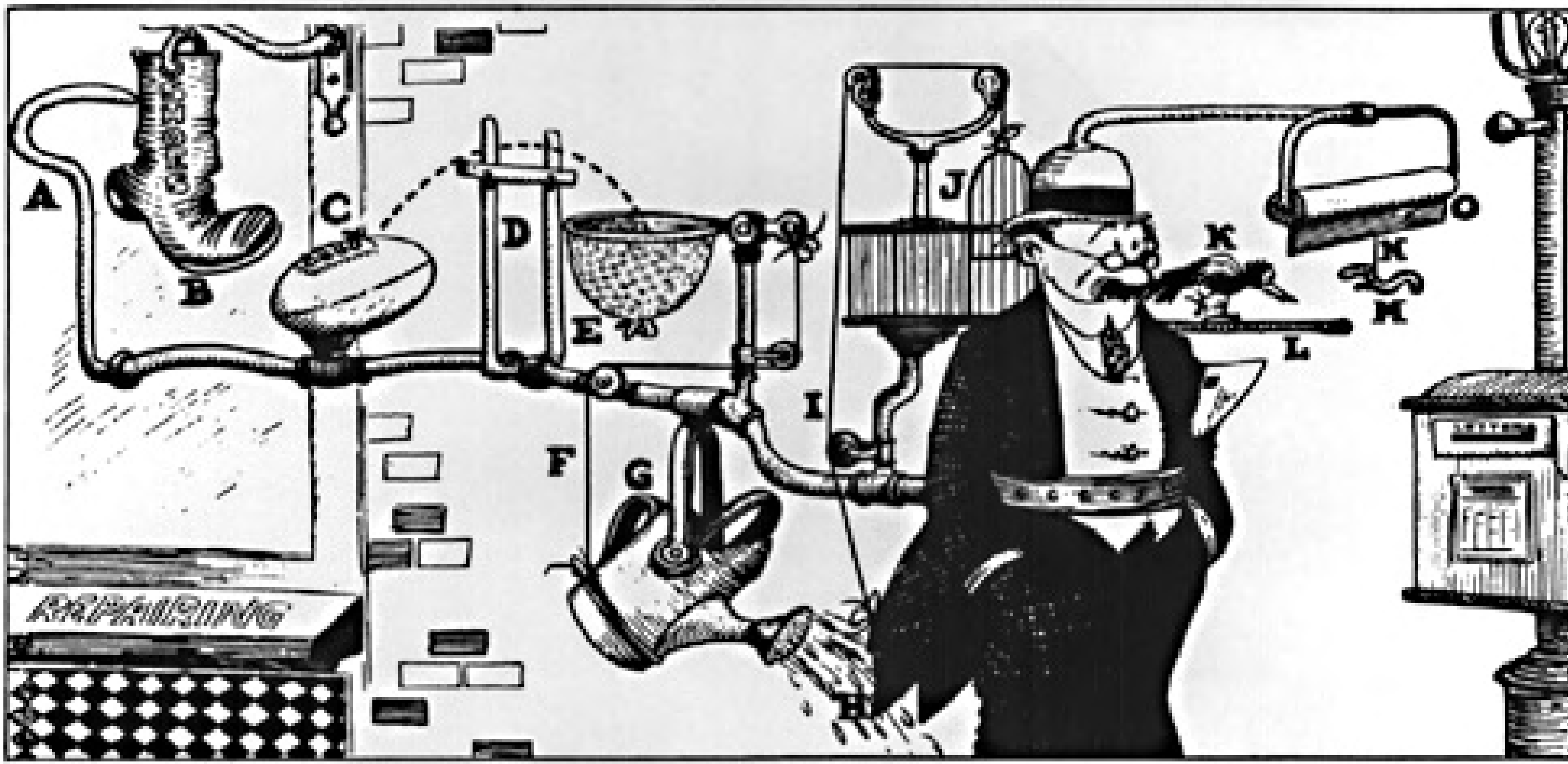
IT IS ACTUALLY SEVERAL MODELS COMBINED INTO ONE:

- HYDRODYNAMIC/THERMODYNAMIC MODEL
- WATER QUALITY (ECOLOGICAL) MODEL
- PARTICLE FATE MODEL
- OPTICAL MODEL

IN ADDITION, IT HAS "INPUTS" FROM OTHER MODELS

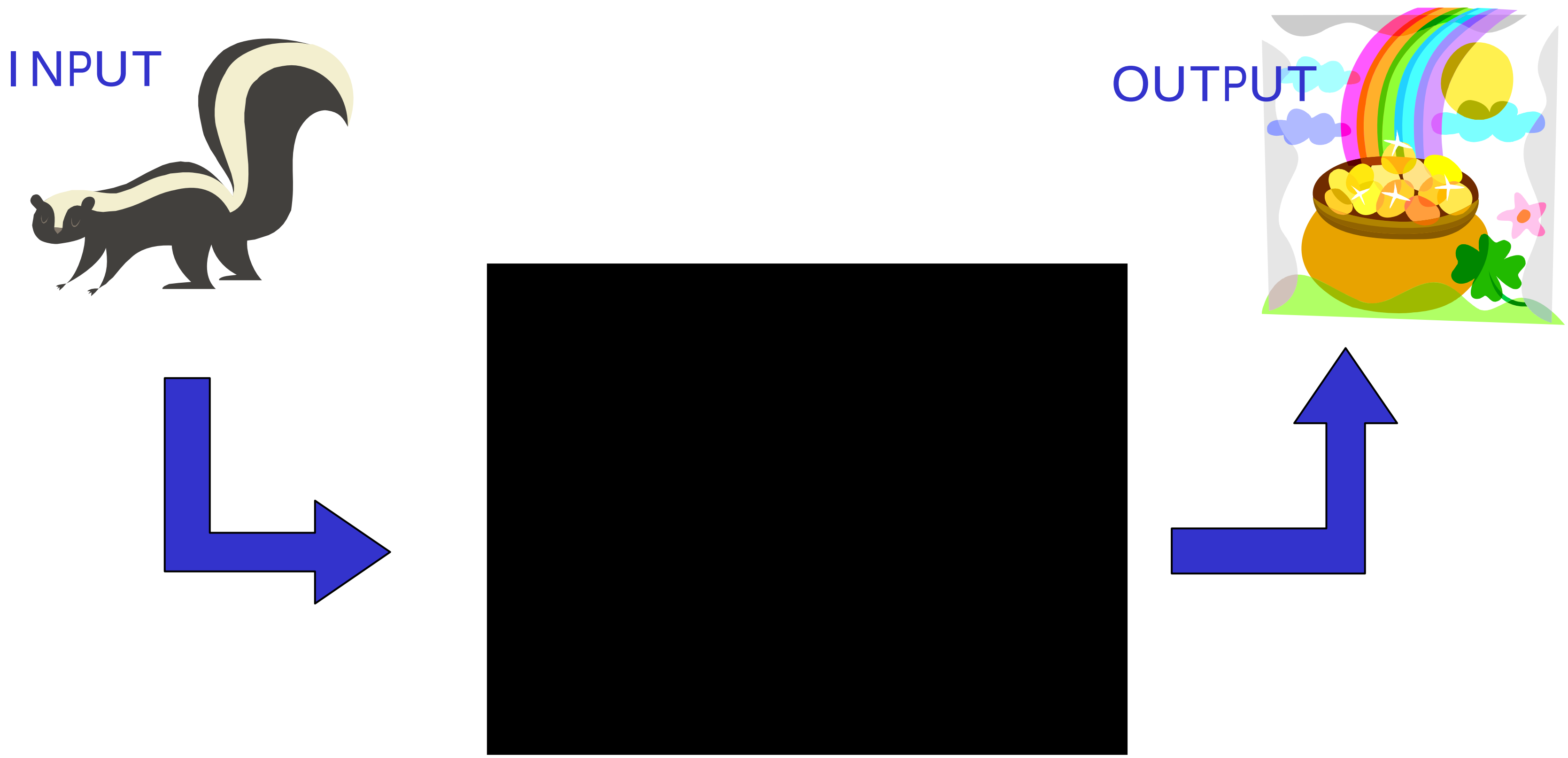
- WATERSHED MODEL
- METEOROLOGY MODEL
- ATMOSPHERIC MODEL

A PROCESS-BASED MODEL IS LIKE A RUBE GOLDBERG CARTOON – IT IS A SERIES OF MECHANISMS DESIGNED TO SIMULATE NATURE. IF THE SIMULATION RESULT IS POOR, ONE CAN REPLACE OR IMPROVE ONE OR MORE OF THE MECHANISMS

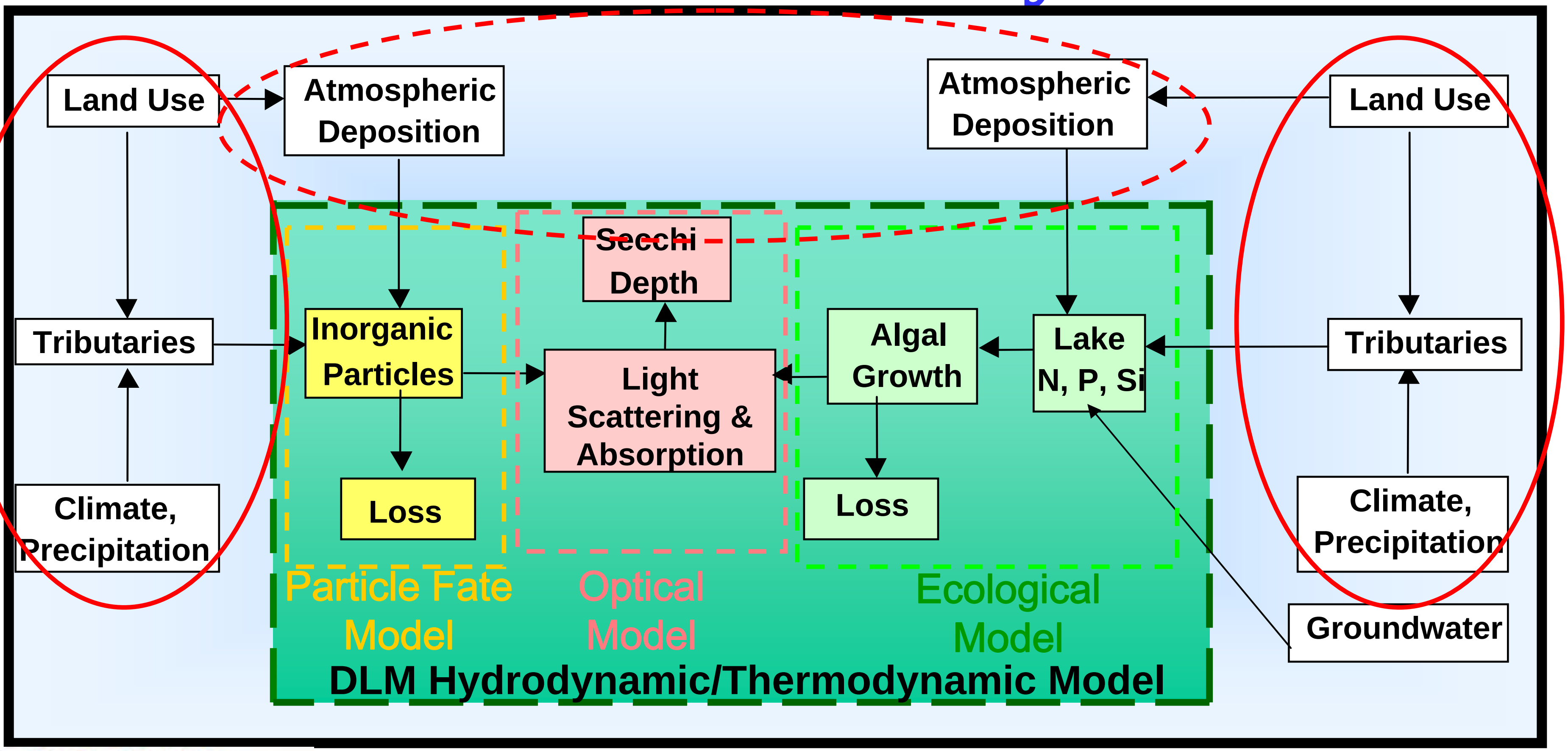


Keep You From Forgetting To Mail Your Wife's Letter RUBE GOLDBERG (tm) RGI 049

BY CONTRAST A "BLACK-BOX MODEL" HAS AN INPUT AND AN OUTPUT. THE INTERNAL WORKINGS OF THE MODEL ARE NOT EVIDENT. TYPICALLY THEY ARE BASED ON A REGRESSION – IF FUTURE CONDITIONS ARE LIKE THE PAST (i.e. no species change, no climate change, no change in limiting nutrient, no change in load makeup) THEN A BLACK BOX MODEL WILL BE A GOOD PREDICTOR. IF FUTURE CONDITIONS ARE DIFFERENT, THEN A BLACK BOX MODEL HAS NO PREDICTIVE OR ANALYTICAL VALUE.



Lake Tahoe Clarity Model



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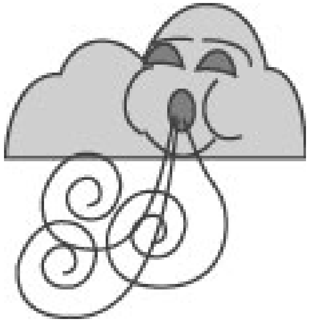
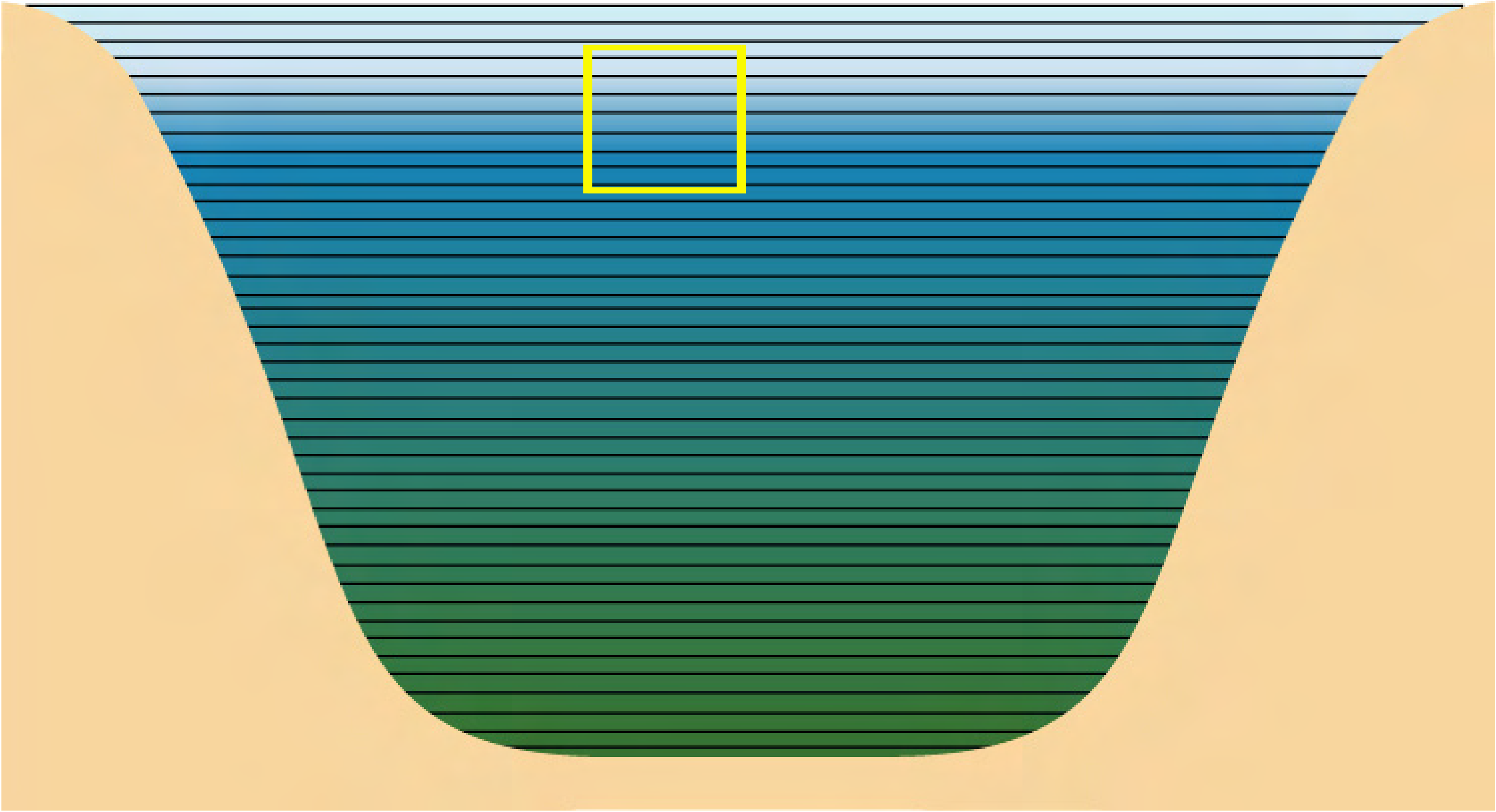
PHYSICAL MIXING





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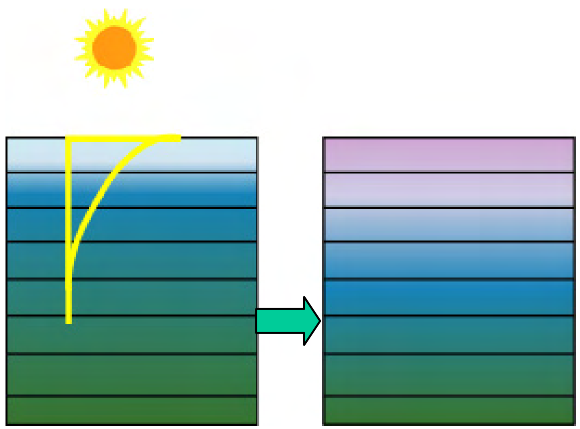
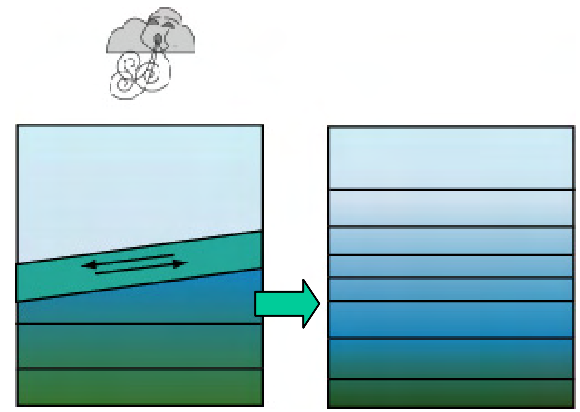
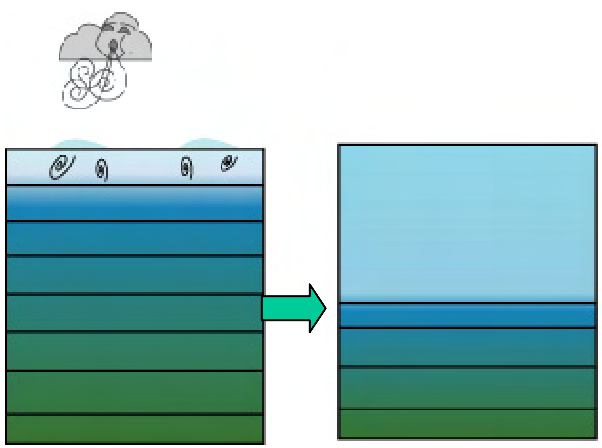
1-D STRATIFICATION AND MIXING PROCESSES



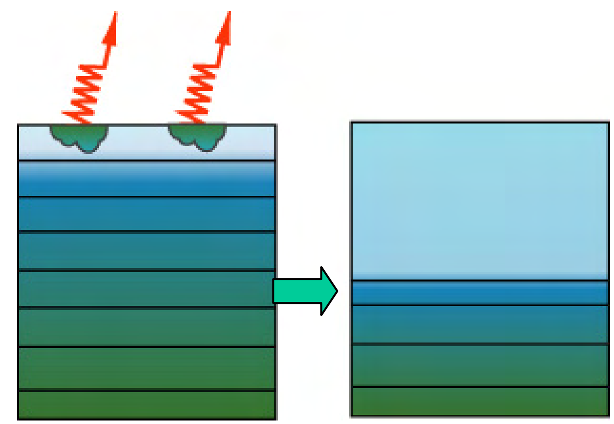
THERMAL STRATIFICATION



INTERFACIAL SHEAR

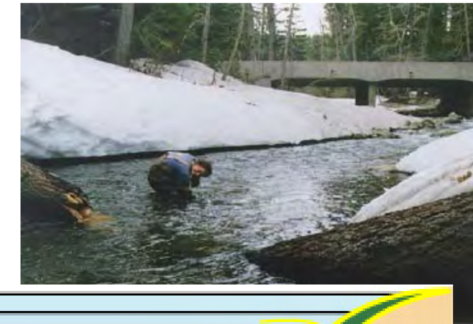


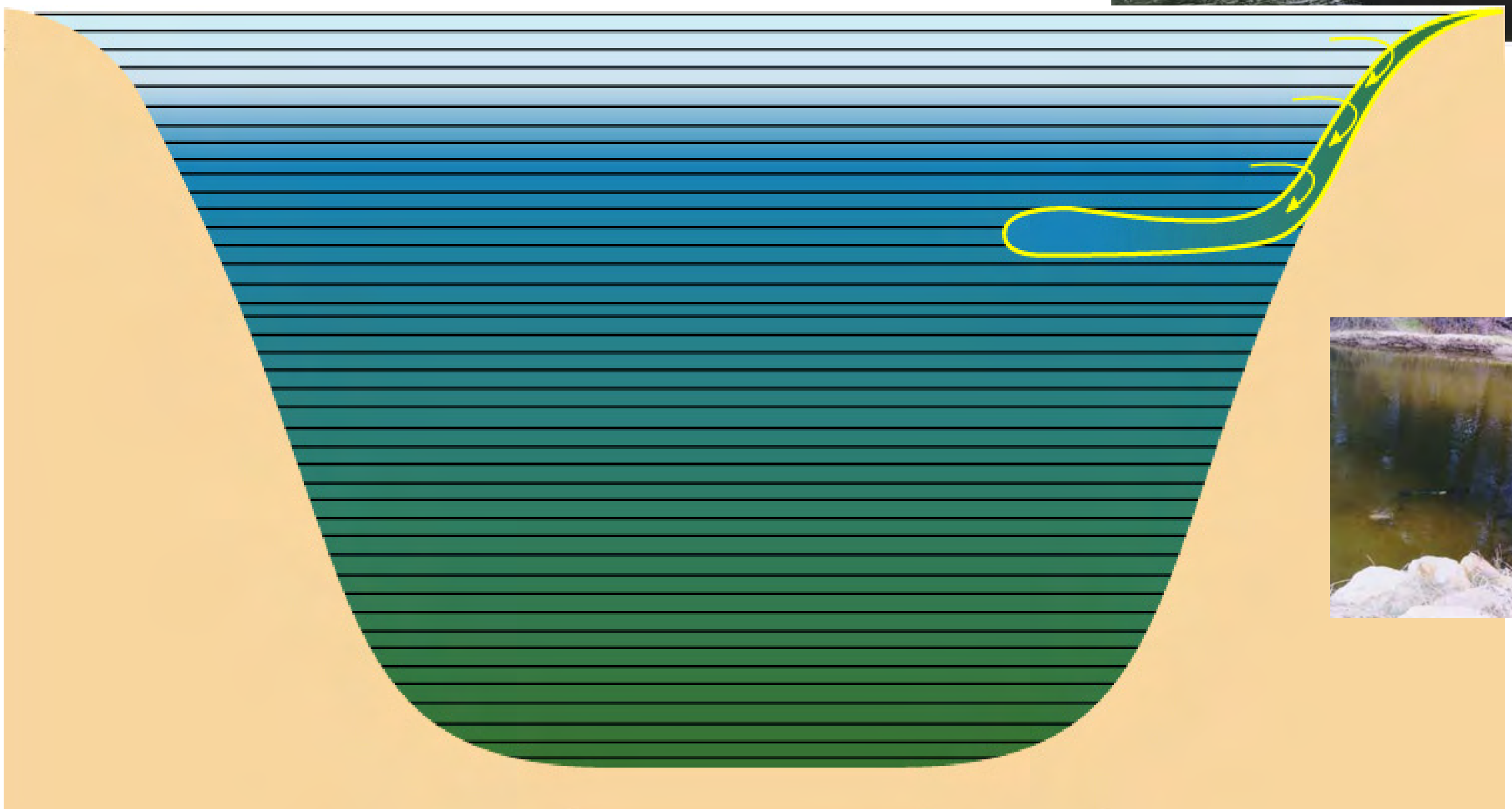
WIND MIXING



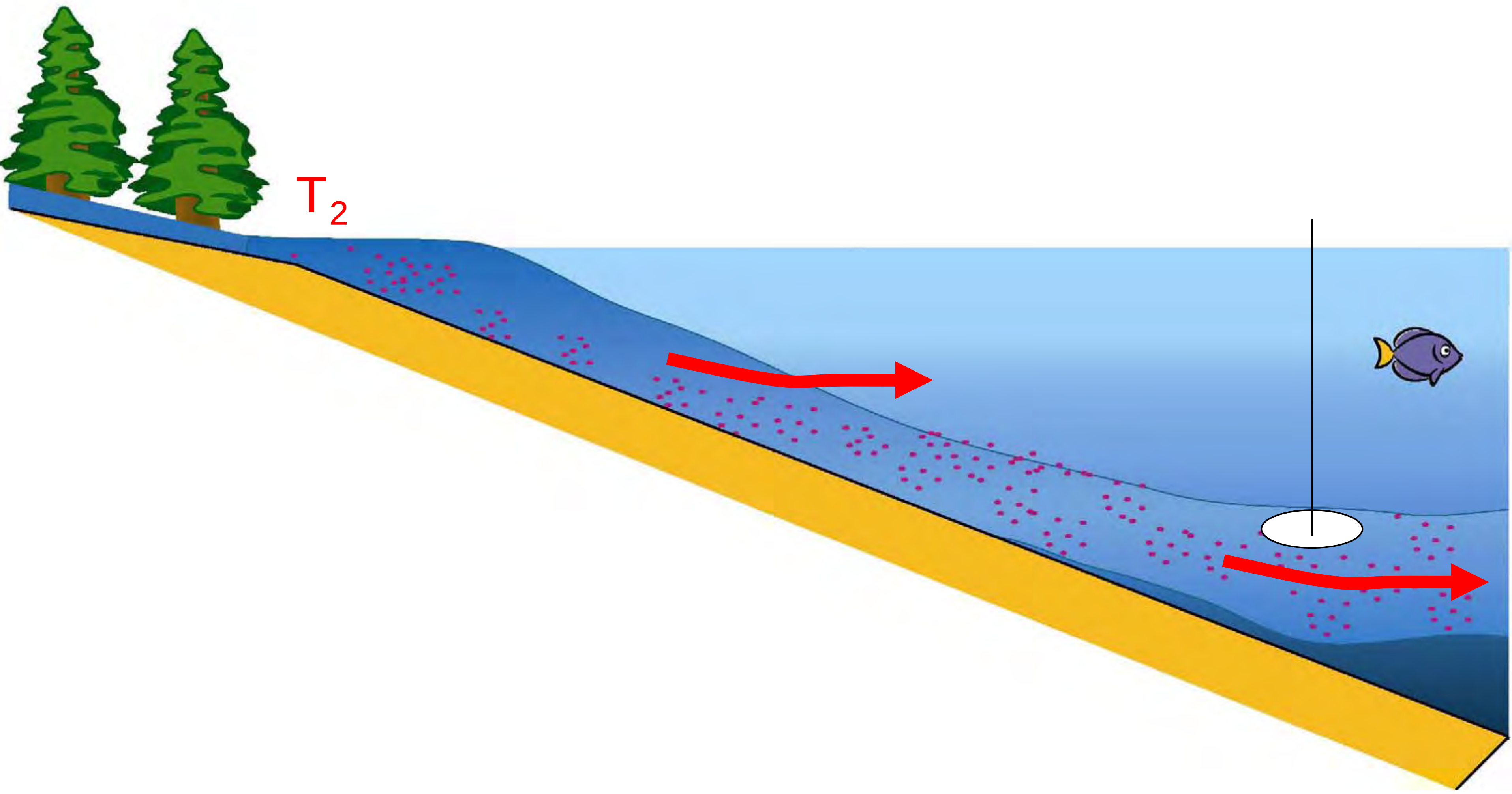
PENETRATIVE CONVECTION

STREAM INFLOWS





ACCURATE MODELING OF INFLOWS IS CRUCIAL!



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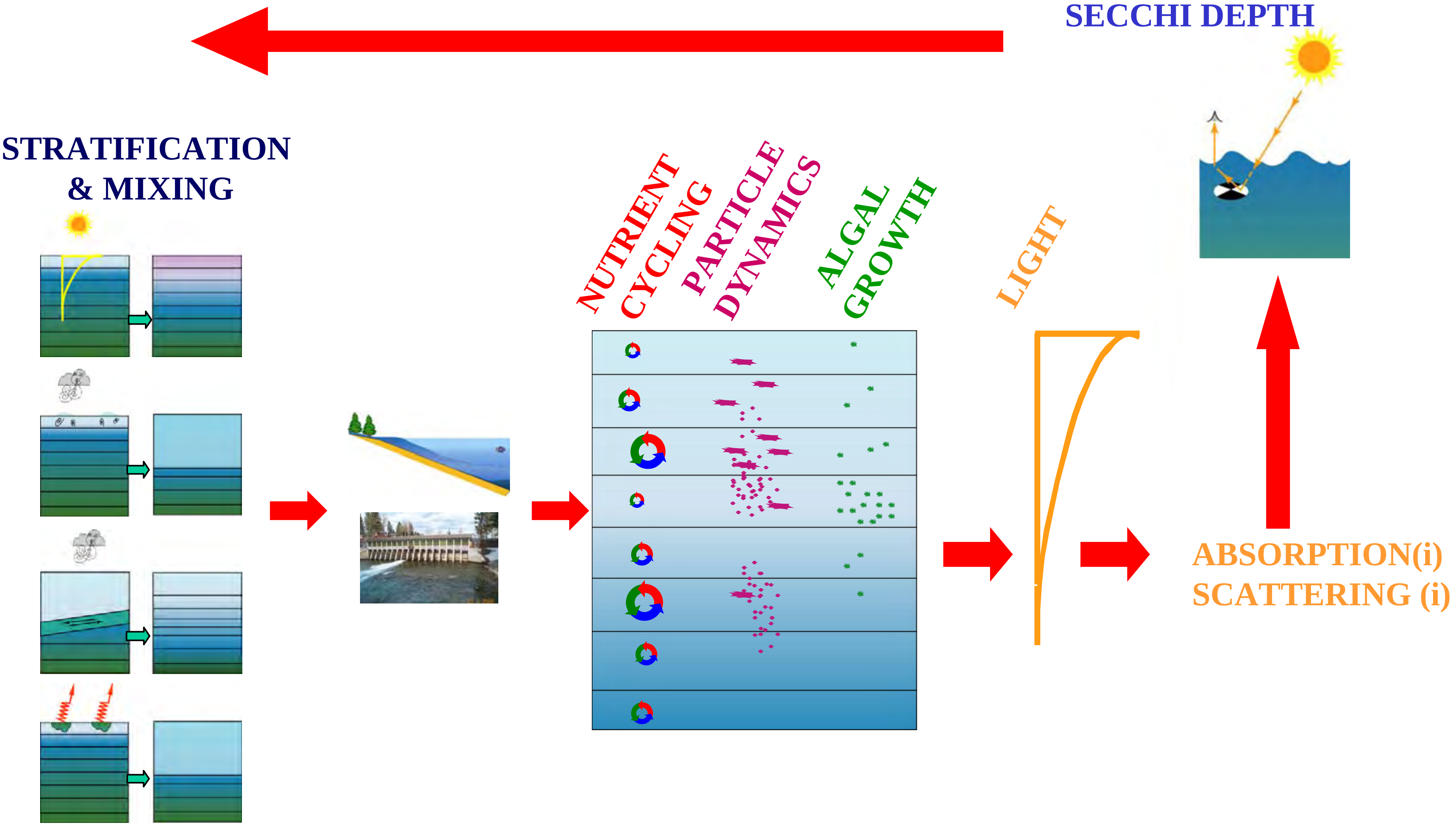
WITHIN EACH 2-HOUR MODEL TIMESTEP



A 20-YEAR MODEL RUN TAKES 8 HOURS!

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UNCERTAINTIES IN ANY MODEL'S RESULTS CAN COME FROM VARIOUS SOURCES

1. THE MODEL ITSELF IS INADEQUATE OR UNTESTED
2. SOME OF THE MODEL PARAMETERS ARE NOT KNOWN WITH SUFFICIENT CONFIDENCE
3. THE INPUTS ARE UNCERTAIN OR IN ERROR

MODEL ADEQUACY AND TESTING?

IT HAS BEEN DEVELOPED OVER MANY YEARS, HAS HAD EXTENSIVE PEER REVIEW, AND DIFFERENT VERSIONS OF IT HAVE BEEN USED ON DIFFERENT LAKES WORLD-WIDE.

Coker, J., 2000. Optical water quality of Lake Tahoe. MS Thesis. UC Davis

Hamilton, D.P. & S.G. Schladow, 1997. Prediction of water quality in lakes and reservoirs. Part I - Model Description. Ecological Modelling 96: 91-110

Heald, P. C., Schladow, S. G. , Reuter, J. E. and Allen, B 2005. Modeling MTBE and BTEX in Lakes and Reservoirs Used for Recreational Boating. Environmental Science and Technology, 39 (4), 1111-1118.

Hocking, G.C., B.S. Sherman & J.C. Patterson, 1988. An algorithm for selective withdrawal from a stratified reservoir. Journal of the Hydraulics Division-ASCE 114: 707-719

Imberger, J. & J. C. Patterson, 1981. A dynamic reservoir simulation model - DYRESM: 5, in Transport Models for Inland and Coastal Waters, edited by H. B. Fischer, Academic Press, New York, 310-361

Imberger, J., J.C. Patterson, R.H.B. Hebbert & I.C. Loh, 1978. Dynamics of a reservoir of medium size. Journal of the Hydraulics Division-ASCE 104: 725-743.

McCord, S.A. & S.G. Schladow, 1998. Numerical simulations of degassing scenarios for CO2-rich Lake Nyos, Cameroon. Journal of Geophysical Research B: Solid Earth, 103(B6): 12355-12364

Perez-Losada, J., 2001. A Deterministic Model for Lake Clarity. Application to Lake Tahoe (California, Nevada), USA . PhD University of Girona, Spain.

Schladow, S. G. & D.P. Hamilton, 1997. Prediction of water quality in lakes and reservoirs. Part II - Application to Prospect Reservoir. Ecological Modelling 96: 111-123

Rabidoux, A. 2005. Spatial and temporal distribution of fine particle and elemental concentrations in suspended sediments in Lake Tahoe streams, California-Nevada. MS Thesis, UC Davis.

Sunman, B. 2004. Spatial and temporal distribution of particle concentration and composition in Lake Tahoe, California-Nevada MS Thesis, UC Davis.

Swift, T. J., Perez-Losada, J., Schladow, S. G., Reuter, J. E., Jassby, A. D. and Goldman, C. G. 2006. A mechanistic clarity model of lake waters: Linking suspended matter characteristics to clarity. Aquatic Sciences 68, 1-15.

Terpstra, R. 2005. Presence and characterization of biotic particles and limnetic aggregates in Lake Tahoe, California-Nevada, MS Thesis, UC Davis.

MODEL PARAMETERS KNOWN WITH SUFFICIENT CONFIDENCE?

#	Parameter	Symbol	Range Min/Max	Model Value	Units	Ref.
	Algae					
1	Maximum growth rate	G_{max}	1.0-2.5	1.0	d^{-1}	1
2	Maximum respiratory rate	k_r	0.05-0.20	0.007	d^{-1}	2
3	Maximum mortality rate	k_m	0.003-0.17	0.003	d^{-1}	3
4	Temperature multiplier for growth/respiration/death	θ	1.0-1.14	1.12	n. d.	4
5	Light saturation	I_s	50-500	55.0	$\mu E\ m^{-2}\ s^{-1}$	5,12
	Light extinction					
6	Light attenuation of pure water		Light Model		m^{-1}	19
7	Specific extinction coefficient of Chla (mg/L)		Light Model		m^{-1}	19
8	Specific extinction coefficient Particles (#/m3)		Light Model		m^{-1}	19
	Nutrient utilization					
9	Phosphorus to chlorophyll mass ratio	a_p	0.3-1.0	0.75	n. d.	6
10	Nitrogen to chlorophyll mass ratio	a_n	5.0-15.0	11.0	n. d.	6
	Settling					

There are 31 model parameters – these have been selected and refined based on an earlier calibration and validation phase.

Some parameters are more "sensitive" than others (see later).

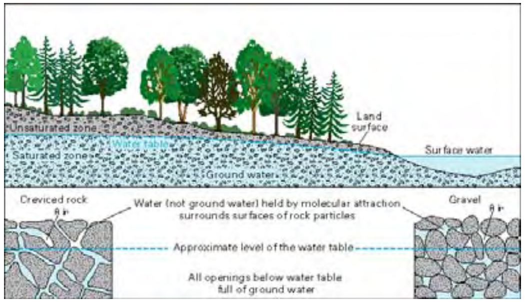
Further sensitivity analysis will be undertaken in Phase 2.

INPUTS UNCERTAIN OR IN ERROR?

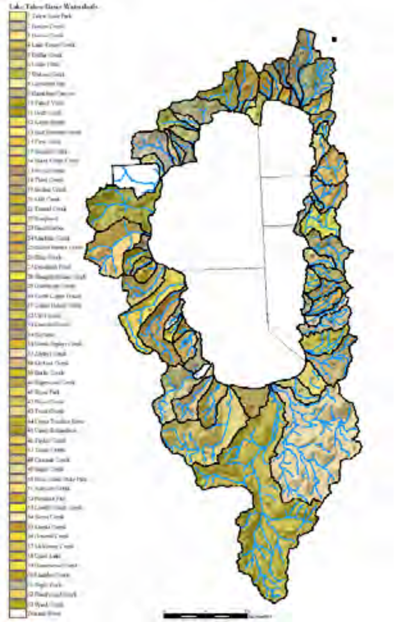
METEOROLOGY
(Tetratech)

OUTFLOW

GROUNDWATER –
Q, N, P



INFLOW – Q, N, P, PSD
(Tetratech watershed model)



BATHYMETERY

ATMOSPHERIC – N, P, PSD

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LAKE TAHOE ANNUAL WATERSHED LOADS

SOURCE	Total N (MT)	Total P (MT)	Inorganic Fine Particles (MT)
Atmospheric Dep.	203	8	1400[1]
Stream Load	97	23	6900[2]
Intervening Zone Load	30	8	2200[2]
Stream bank erosion	10	1.3	3800[2]
Shoreline Erosion	2	2	550[2]
Groundwater	50	7	0

[1] < 20 microns

[2] < 63 microns

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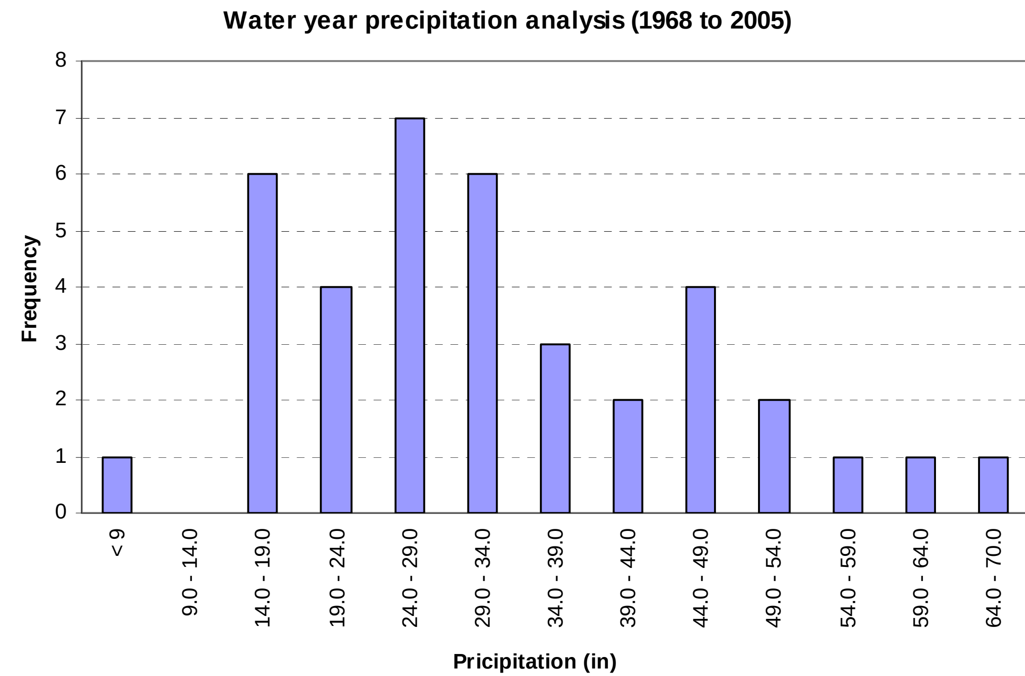
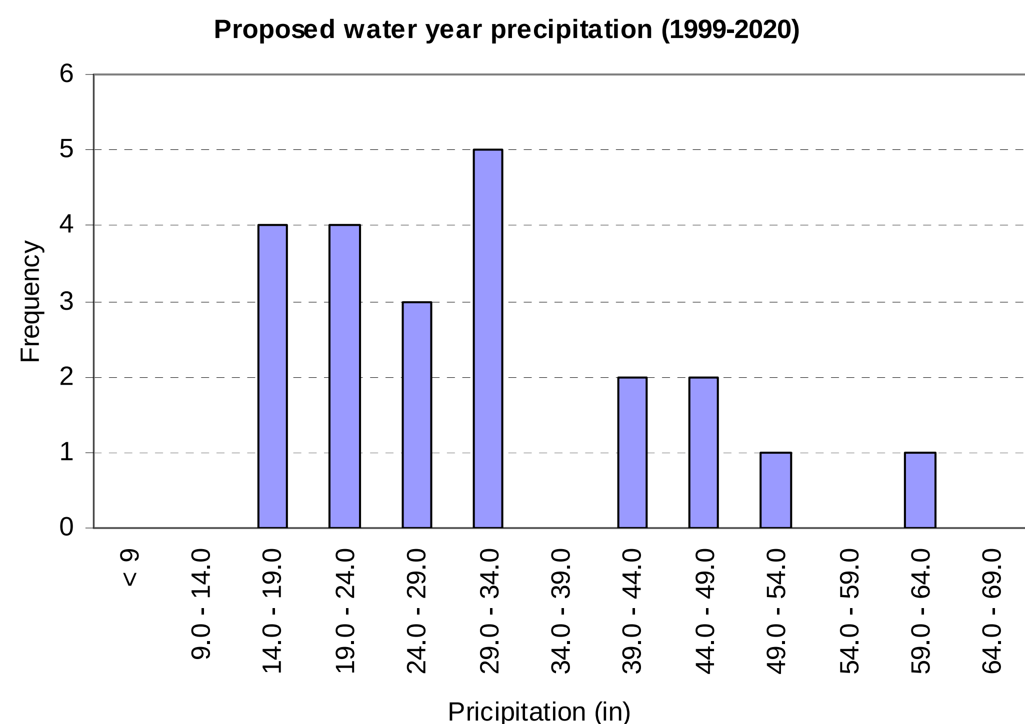
NEED TO MAKE SOME ASSUMPTIONS ABOUT FUTURE METEOROLOGICAL (AND THEREFORE HYDROLOGIC SCENARIOS)





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AND NOW FOR SOME

PRELIMINARY

MODEL RESULTS

BASE LINE SIMULATION

SENSITIVITY TESTS (on model parameters and on loads)

DIFFERENT WAYS TO SKIN A CAT

TIME TRAJECTORIES OF PHASED IMPLEMENATION

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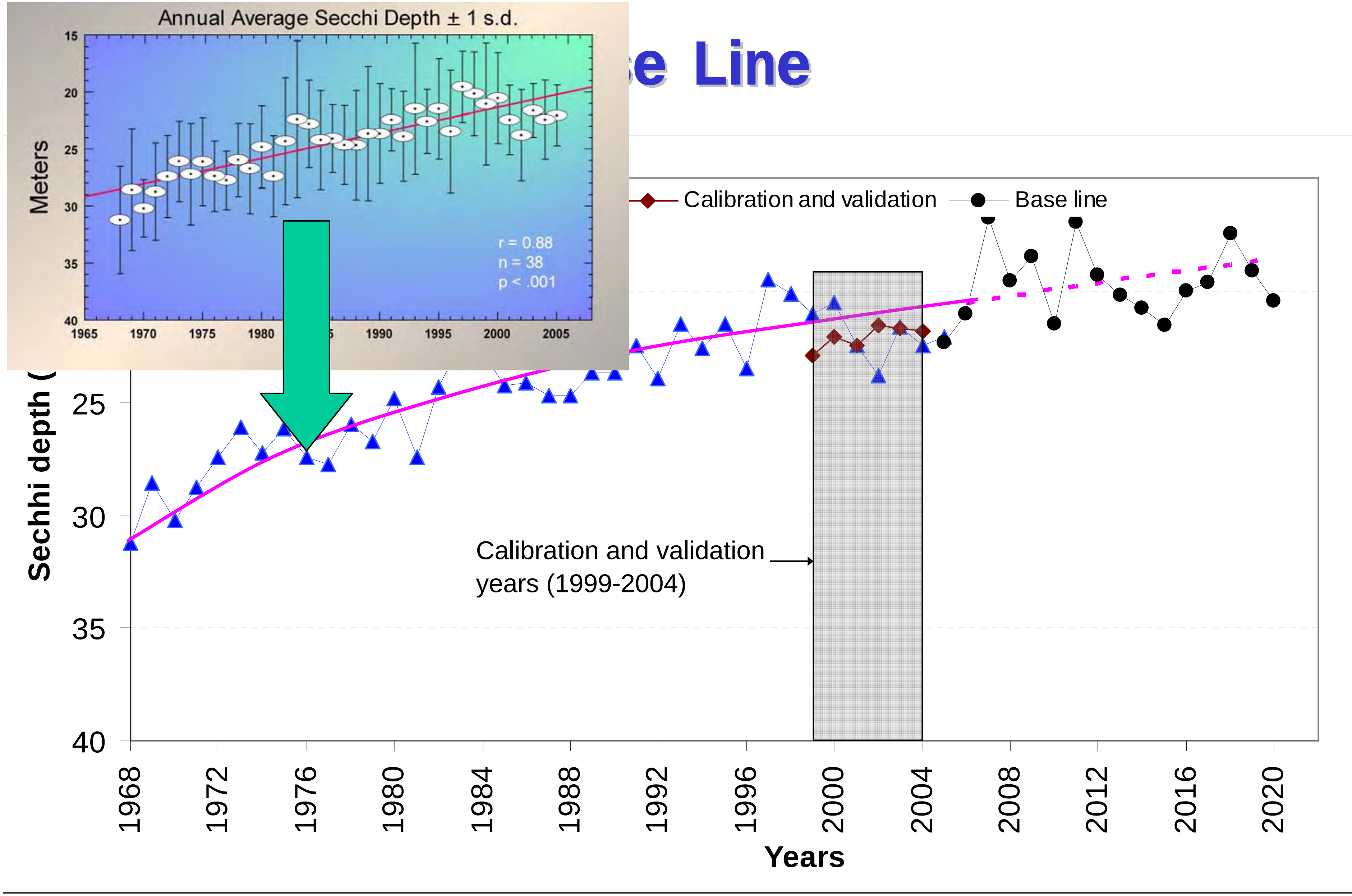
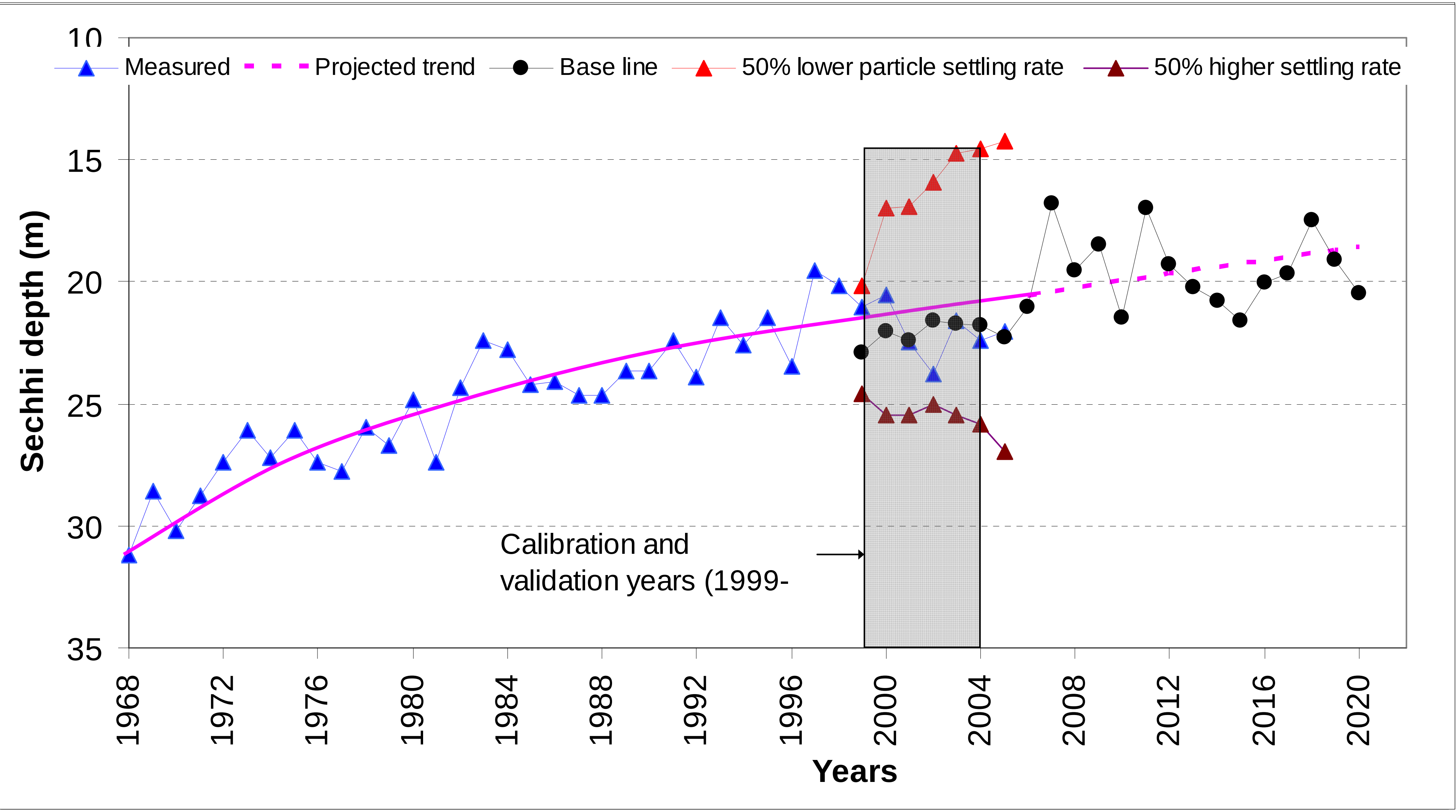
e Line



SECCHI DEPTH 2020 18.5 m

Sensitivity Analysis (Particle settling rate)



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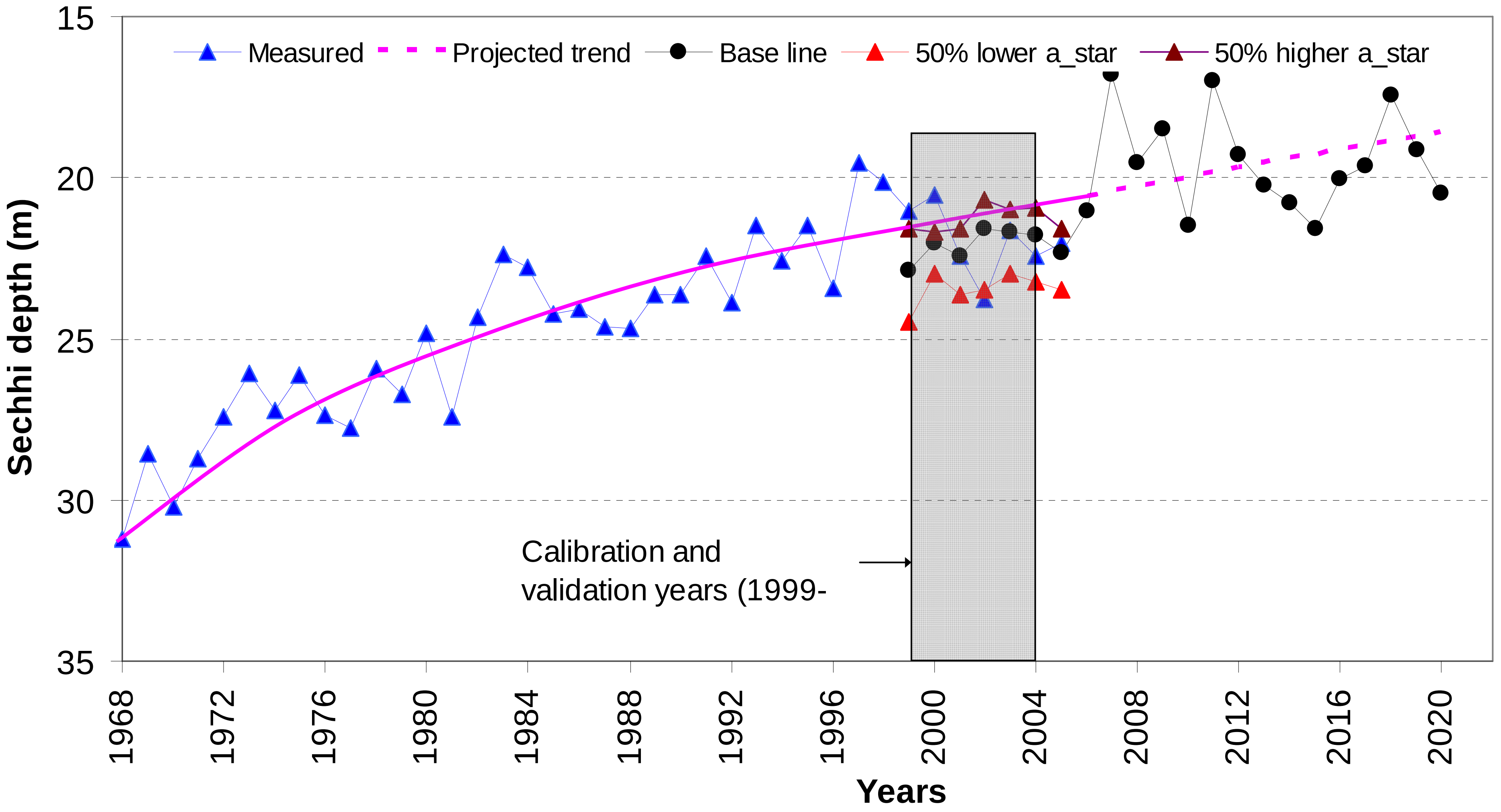
Sensitivity Analysis (Light absorption)



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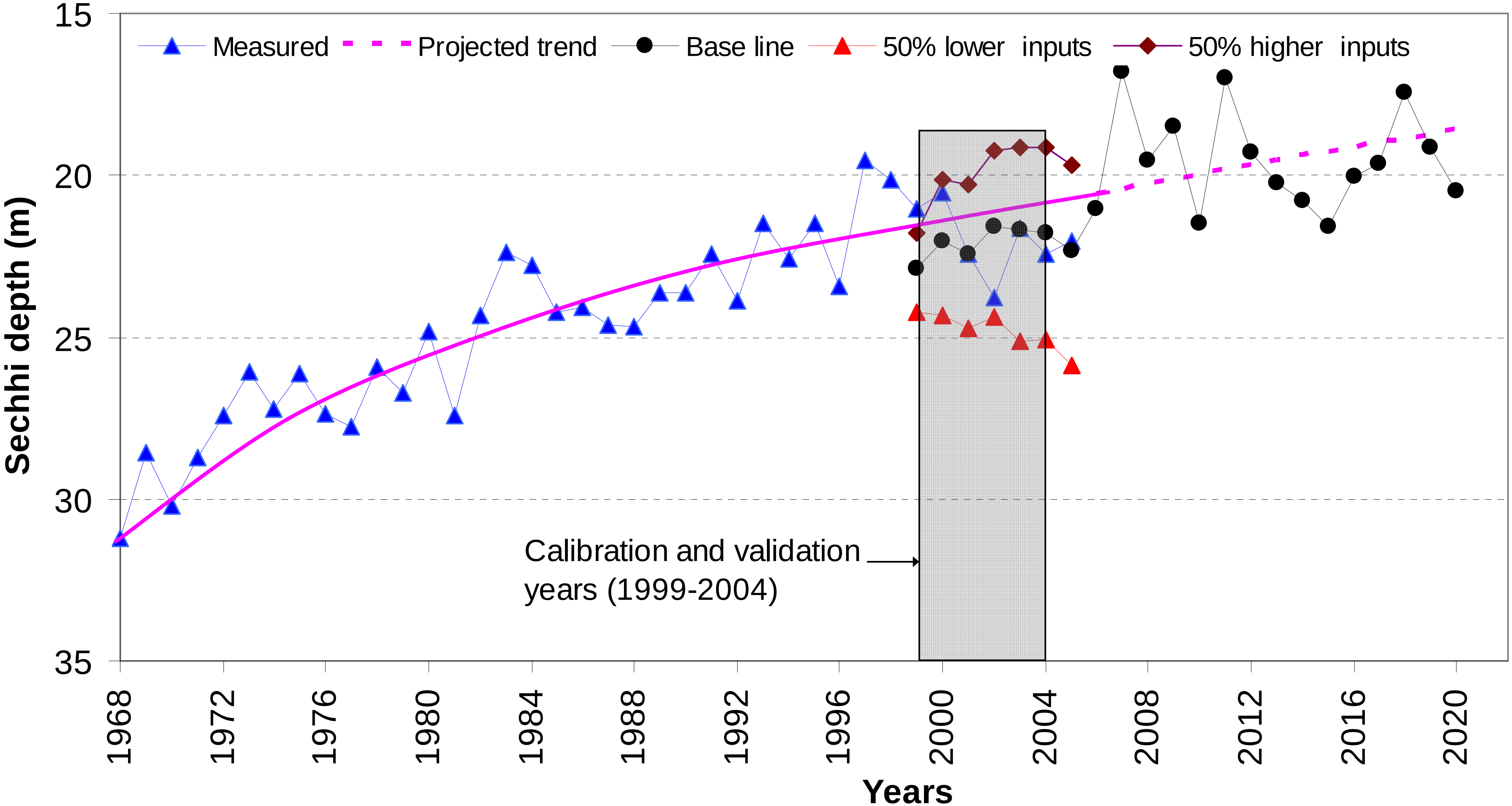
Sensitivity Analysis (Atmospheric Loads)



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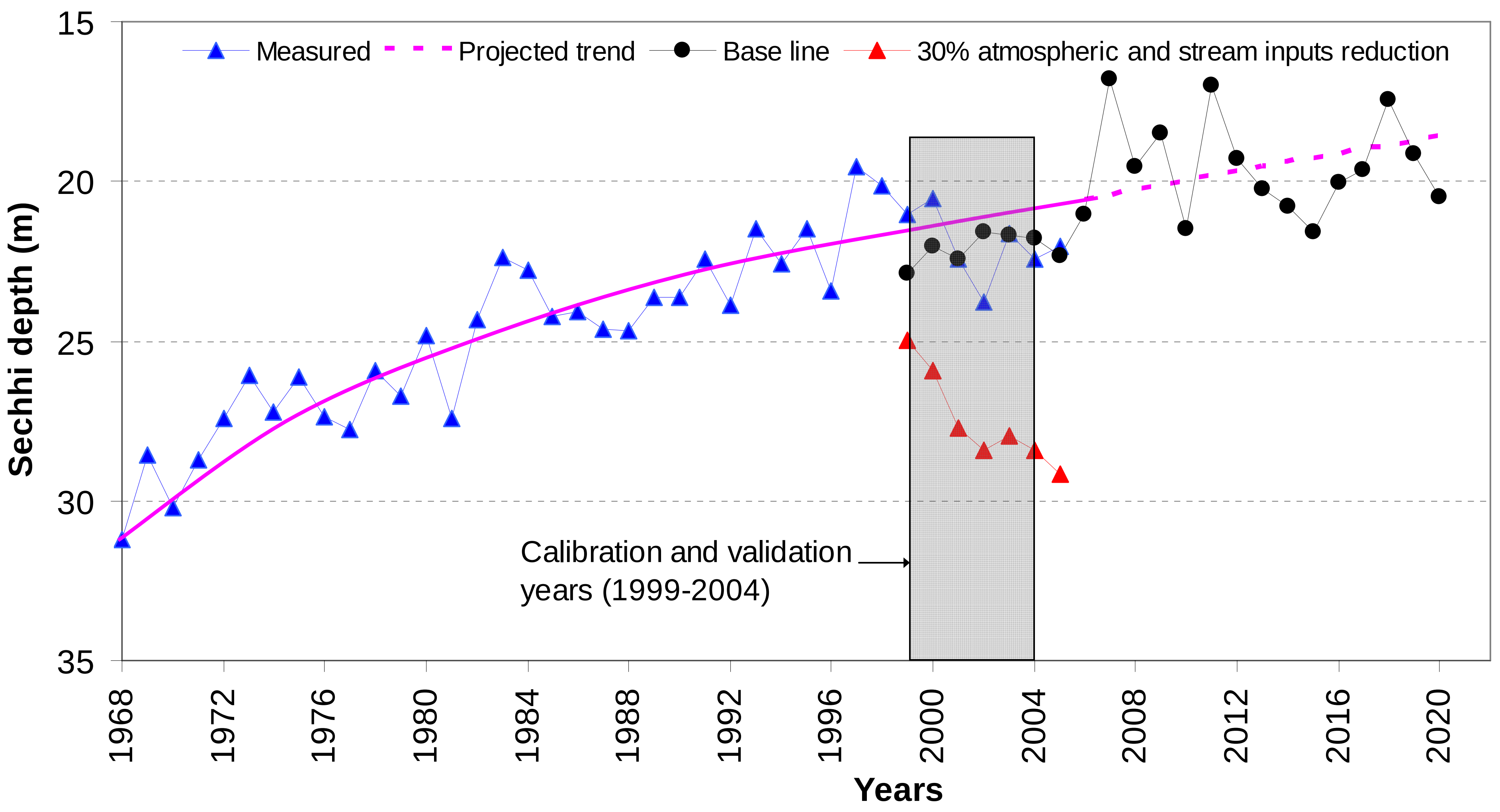
30% Atmospheric and 30% Stream Load "instantaneous" reduction



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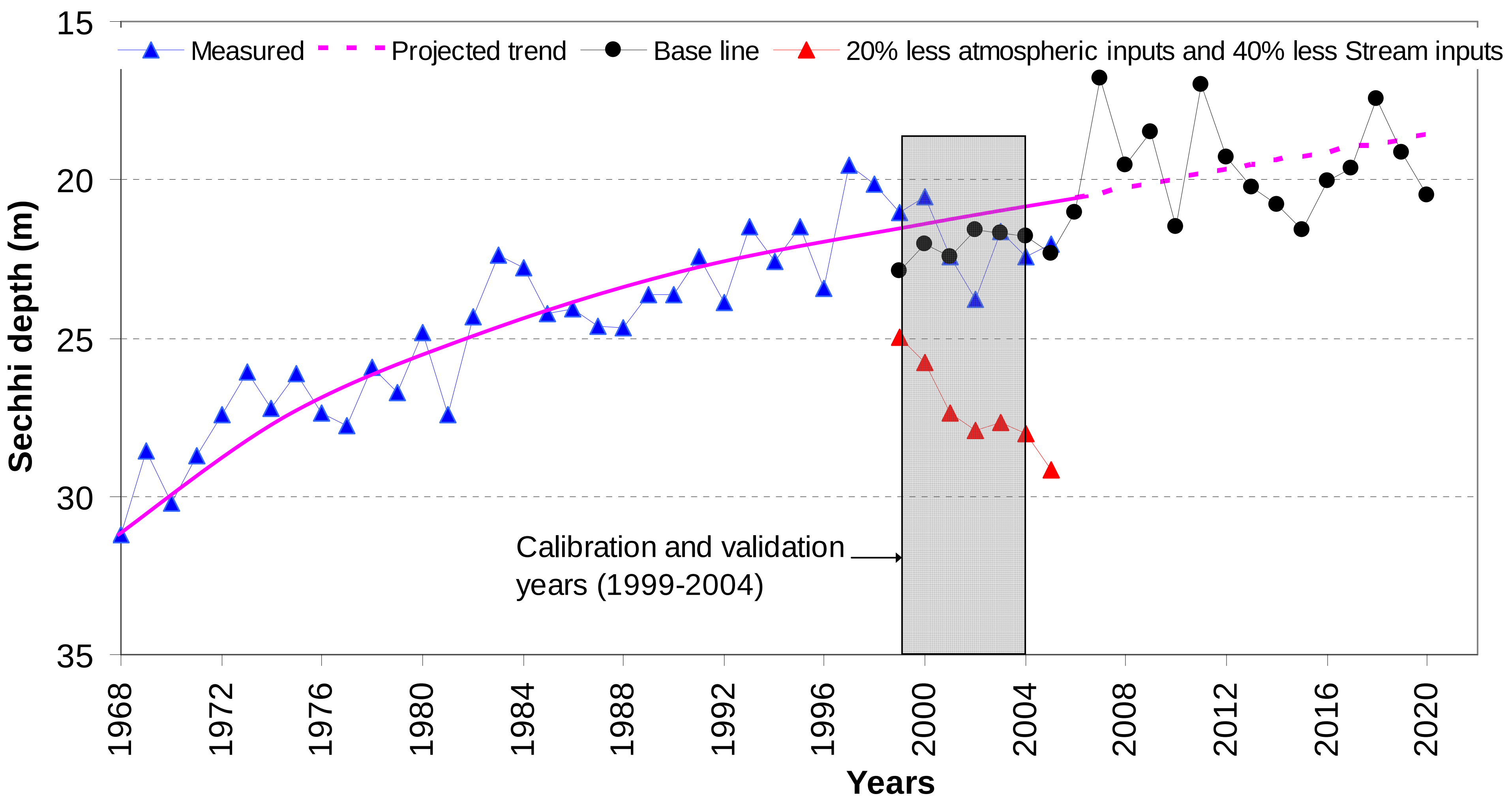
20% Atmospheric and 40% Stream input "instantaneous" reduction



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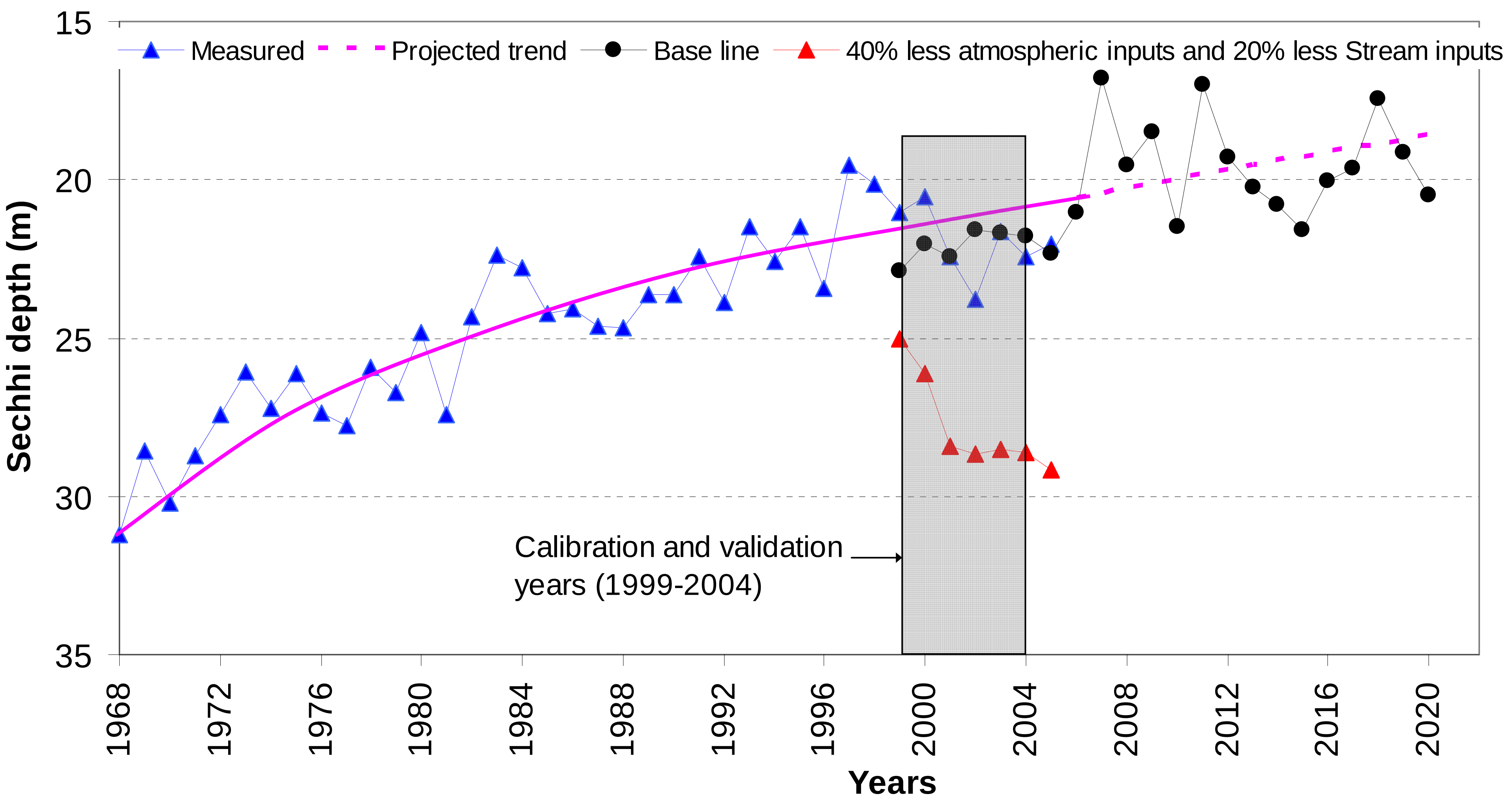
40% Atmospheric and 20% Stream input "instantaneous" reduction



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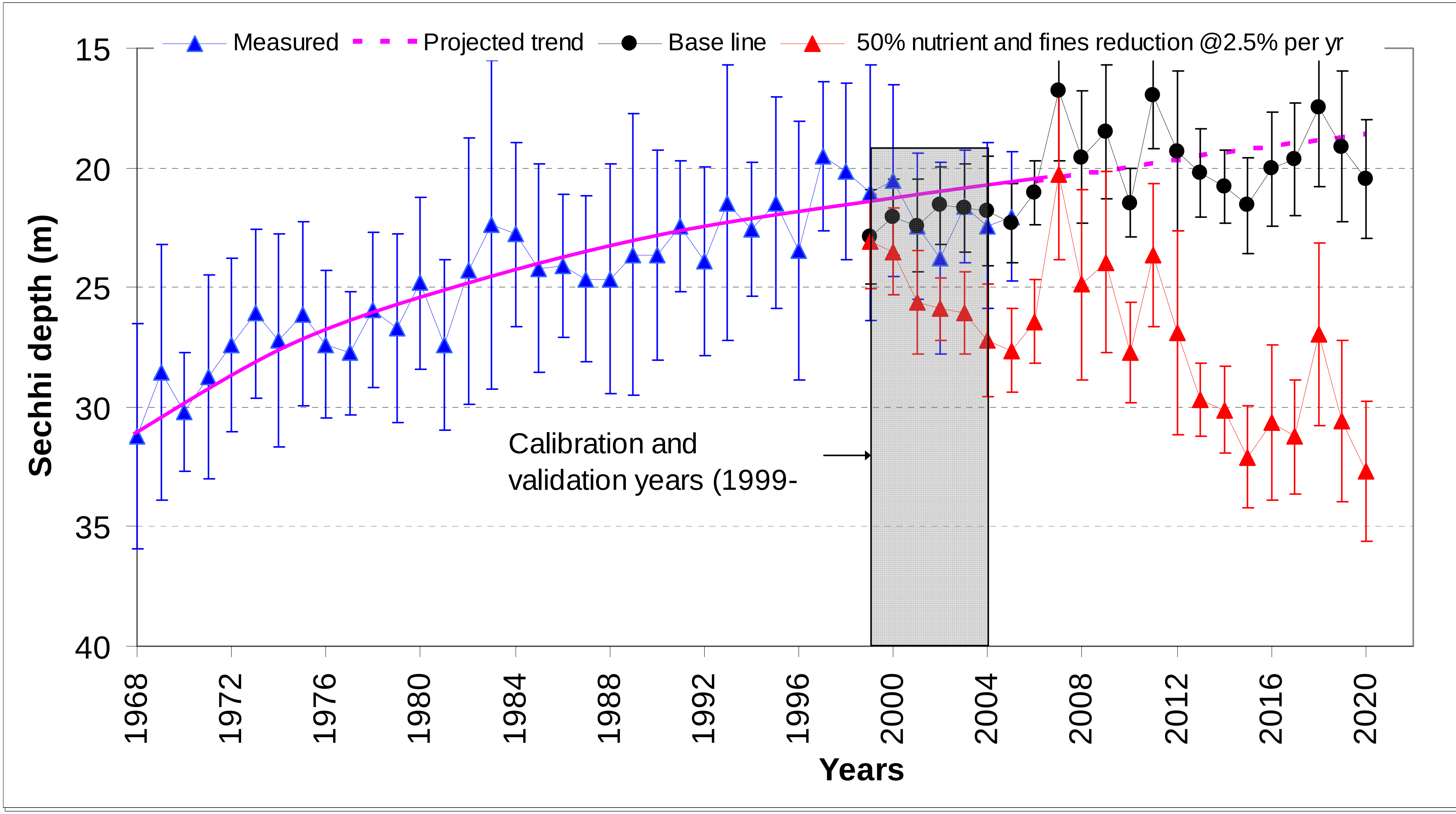
50% fines and nutrients reduction 2.5% per year for 20 years



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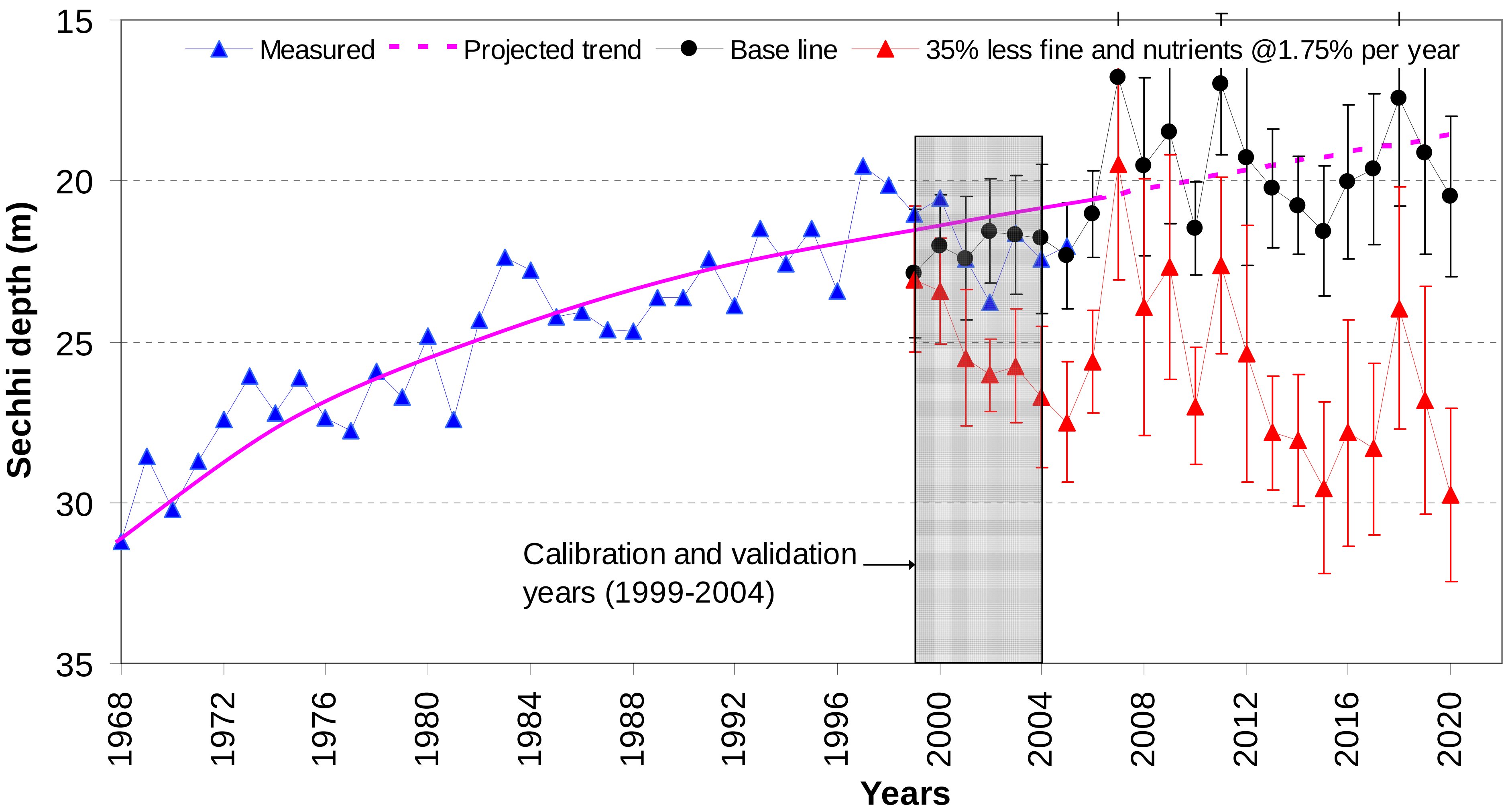
35% fines and nutrients reduction
1.75% per year for 20 years



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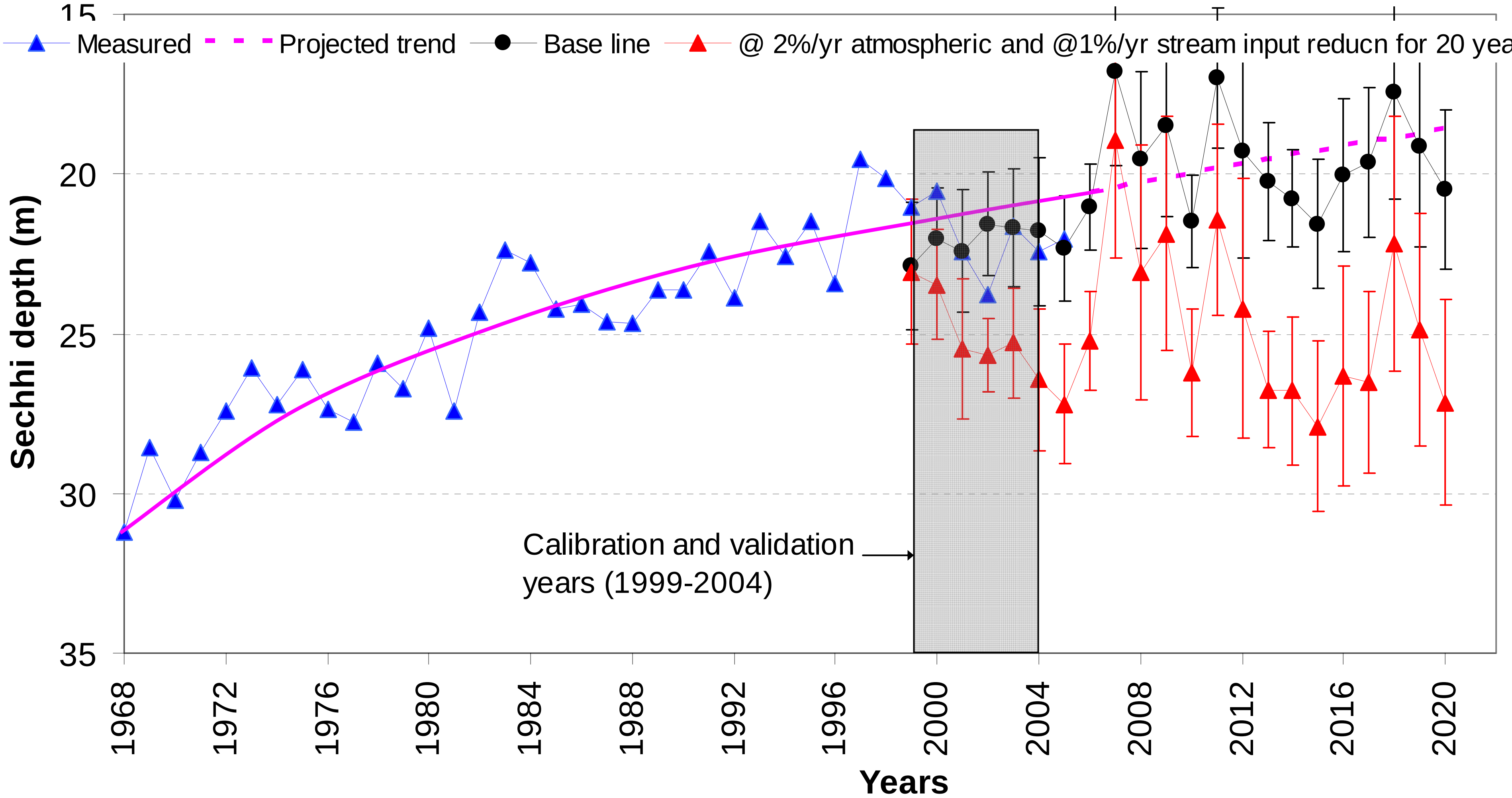
40% Atmospheric Load (2%/y), 20% Stream Load (1%/y) reduction for 20 years



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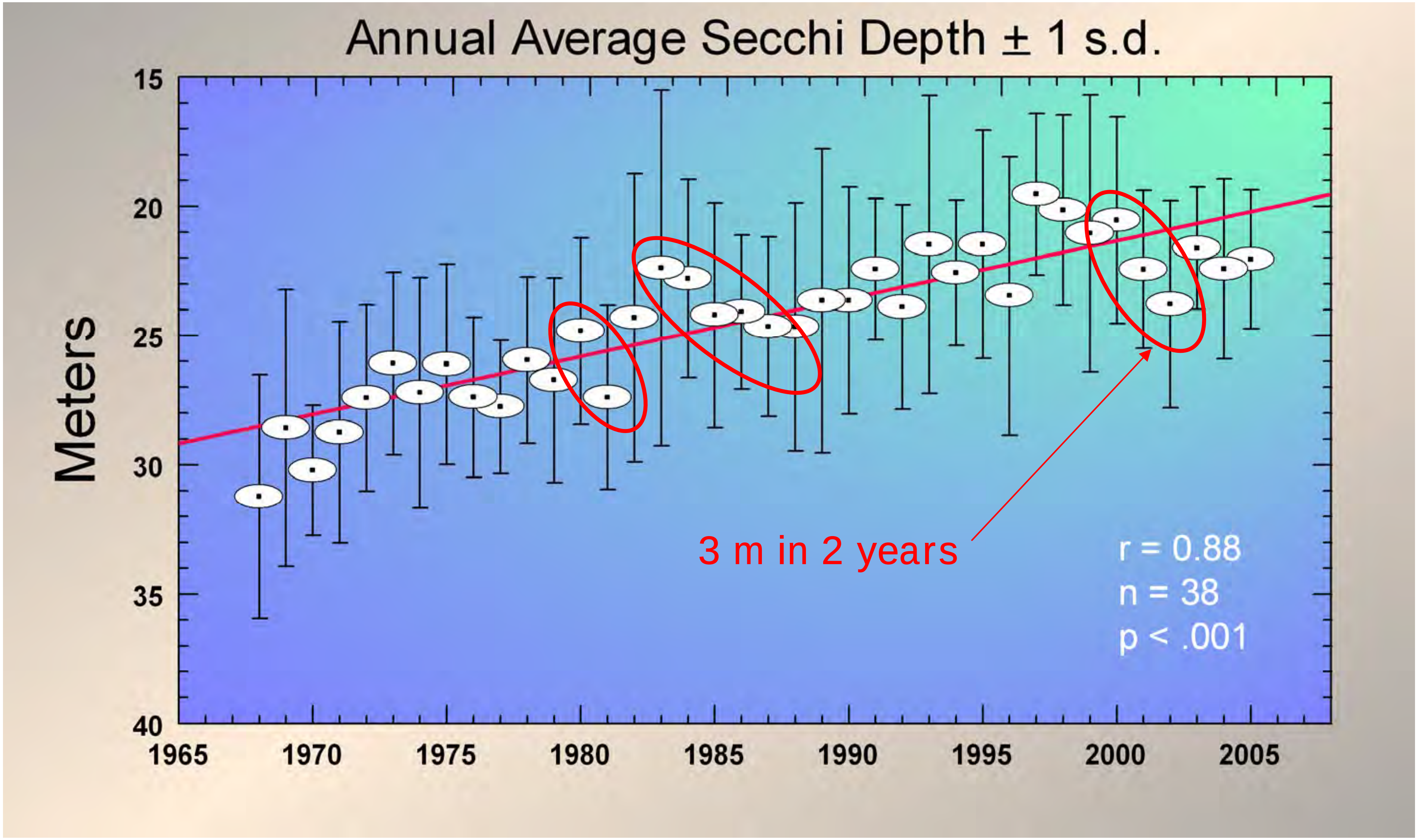
STILL NOT CONVINCED?



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TAKE HOME MESSAGES

1. THESE MODEL RESULTS ARE PRELIMINARY
2. THE LARGEST MODEL UNCERTAINTIES ARE IN THE ESTIMATES OF THE LOADS
3. LOAD REDUCTIONS ON THE ORDER OF 30-40% OVERALL APPEAR SUFFICIENT TO RESTORE CLARITY
4. THE RESULTS VARY WITH WHICH LOADS ARE REDUCED (PARTICLES OR NUTRIENTS) AND WHICH SOURCES ARE ADDRESSED (ATMOSPHERIC, STREAM… etc.)
5. THERE IS NOT A SINGLE SOLUTION – THE FINAL MIX OF WHICH LOADS AND WHICH SOURCES TO REDUCE AND BY HOW MUCH IS AN ISSUE FOR MANAGEMENT AGENCIES AND THE PUBLIC TO ADDRESS
6. MODELS DO NOT REMOVE THE NEED FOR CONTINUED MONITORING. ON THE CONTRARY, THEY RELY ON IT. ONLY MONITORING CAN TELL US WHEN CONDITIONS HAVE CHANGED (e.g. CLIMATE CHANGE)

ACKNOWLEDGEMENTS

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The research upon which this model has been based is derived from the contributions of many colleagues at UC Davis and other organizations. Their contributions are gratefully acknowledged.

The staff of the Lahontan Regional Water Quality Control Board were integral participants in the development of the Clarity Model over the last 5 years. Their contributions are greatly appreciated.

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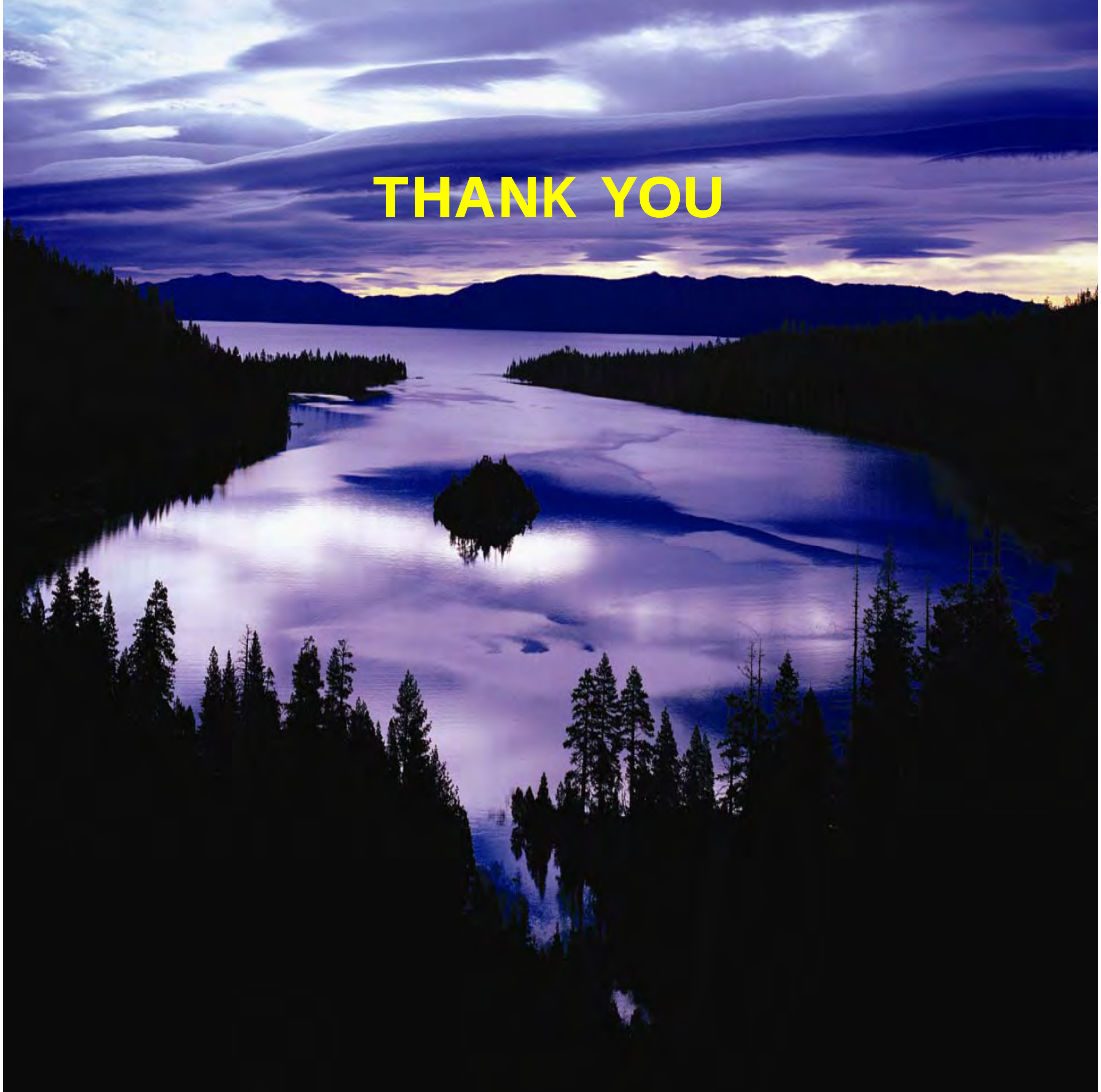

THANK YOU

Model Application & Next Steps

Phase II

Product: Final TMDL – November 2008

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

Phase III

Product: Implementation – Continuous Improvement Cycle

- Application within a Management System
- Predetermined Review Periods

Program Goals

- Evaluate load reduction opportunities by source category
- Develop load reduction strategies
- Develop strategy specific load allocations
- Establish evaluation framework and continuous improvement process for the Management System
- Develop required elements for completion of a Final TMDL

IWQMS Development Process

1) Organize source category groups – Summer 2006
2) List load reduction opportunities by source category – Fall 2006
3) List evaluation parameters – Fall 2006
4) Develop assessment methodology – Winter 2006/07
5) Evaluate load reduction potential by source category – Spring 2007
6) Develop load reduction strategies – Summer 2007
7) Select load reduction strategy – Summer 2007
8) Develop strategy specific load allocations – Winter 07/08
9) Implement strategy and evaluate progress – Ongoing

IWQMS Development Process

1) Organize source category groups – Summer 2006
   - Urban Stormwater, Forest Runoff, Stream Channel Erosion, Groundwater, Atmospheric Deposition/Transportation
   - Groups consisting of expert lead, researcher, and local expertise

2) List load reduction opportunities by source category – Fall 2006
   - Develop list of BMPs, programs, etc. to control pollutants from each source category

3) List evaluation parameters – Fall 2006
   - Develop list of evaluation parameters e.g. effectiveness, cost, acceptability, feasibility, etc.

Conceptual Load Reduction Matrix

Sources	Effectiveness	Cost	Contstraints	Etc.	Estimated Load Reduction
STORMWATER- URBAN					
Infiltration	4	$	2		xx kg/yr
Wetland Treatment	7	$$	7		xx kg/yr
Source Control	6	$	1		xx kg/yr
Chemical Enhancement	9	$$$	8		xx kg/yr
ATMOSPHERIC					
Vehicle Emission Control	4	$$	4		xx kg/yr
Wood Stove Management	5	$$	3		xx kg/yr
Out-of-Basin Source Control	2	$$$	9		xx kg/yr
Dust Management	7	$	2		xx kg/yr
STREAM CHANNELS					
Stream Restoration	7	$$$	5		xx kg/yr
Bank Stabilization	7	$$	3		xx kg/yr
Hydrological Controls	5	$	2		xx kg/yr
GROUND WATER					
Fertilizer Management	3	$$	7		xx kg/yr
Source Control	8	$	2		xx kg/yr
STORMWATER - FORESTED AREAS					
Road Management	6	$$$	6		xx kg/yr
Trail Management	5	$$	5		xx kg/yr
Fire Restoration	7	$$	4		xx kg/yr
Total Possible Load Reduction					**xx kg/yr**

Parameters are for illustrative purposes only

IWQMS Development Process

4) Develop assessment methodology – Winter 2006/07

- Each source category group will develop a methodology to evaluate load reduction potential and evaluation parameters
- Methodology will, by necessity, be a combination of qualitative and quantitative approaches

5) Evaluate load reduction potential by source category – Spring 2007

- Use list of load reduction opportunities and evaluation parameters to begin work on populating the load reduction matrix

6) Develop load reduction strategies – Summer 2007

- Evaluation of pollutant load reduction opportunities will allow for the development of alternative strategies to achieve lake clarity
- Strategies could emphasis pollutant control in certain source categories

Example Load Reduction Alternatives

A

Urban (34%)
Atmospheric (12 %)
Stream Channels (20%)
Ground Water (12%)
Forested Areas (22%)

TOTAL REDUCTION = 15,000 kg tbd/yr

B

Urban (20%)
Atmospheric (25%)
Stream Channels (25%)
Ground Water (15%)
Forested Areas (15%)

TOTAL REDUCTION = 15,000 kg tbd/yr

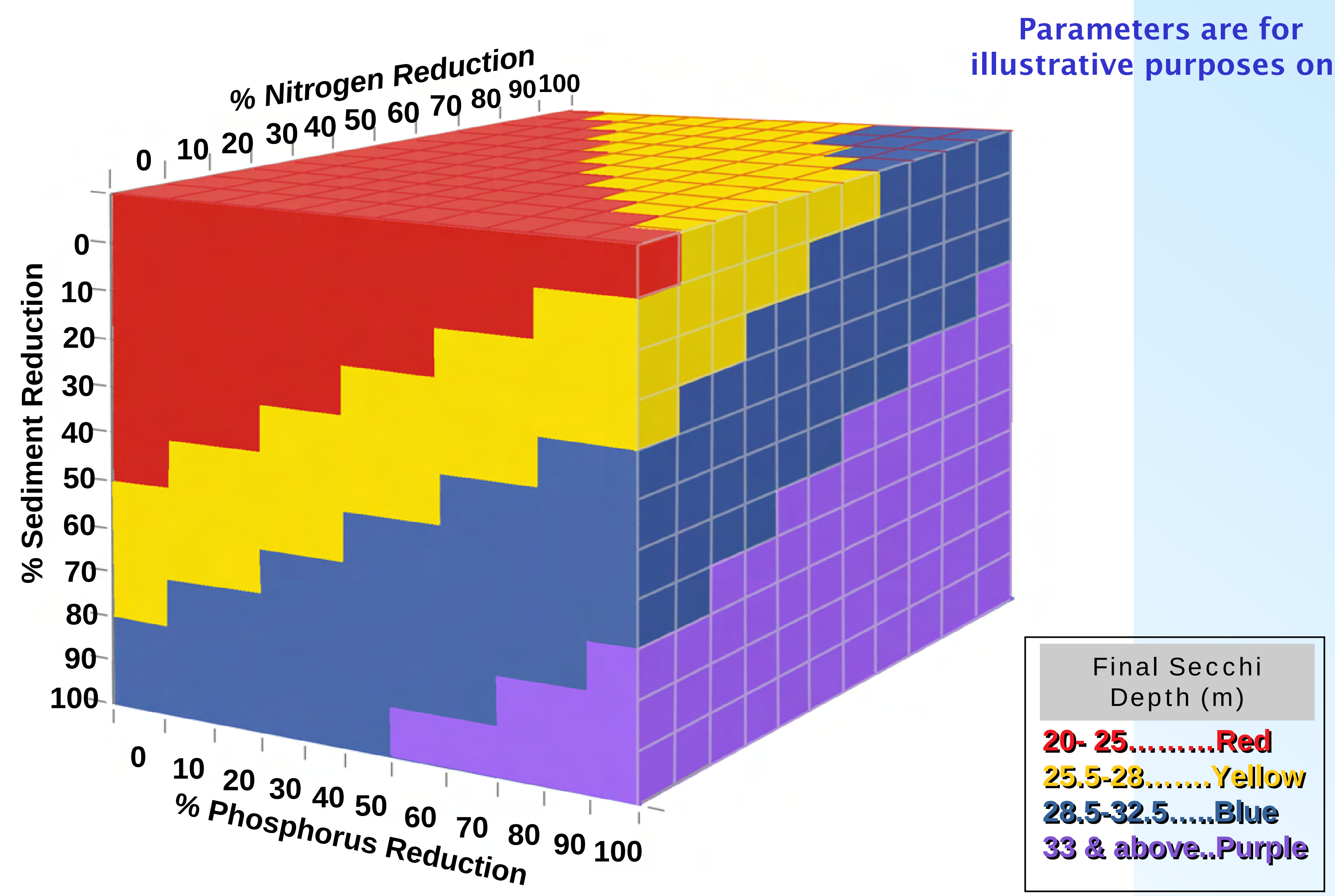
C

Urban (20%)
Atmospheric (15%)
Stream Channels (30%)
Ground Water (25%)
Forested Area (15%)

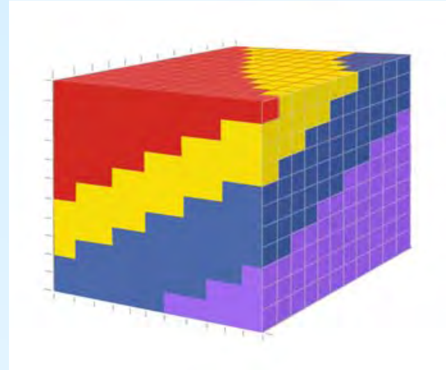
TOTAL REDUCTION = 15,000 kg tbd/yr

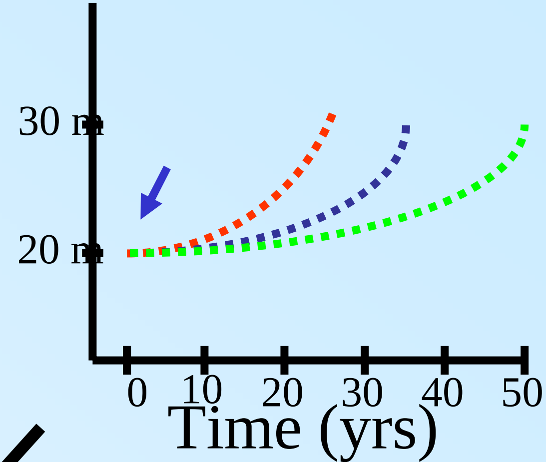
Parameters are for illustrative purposes only

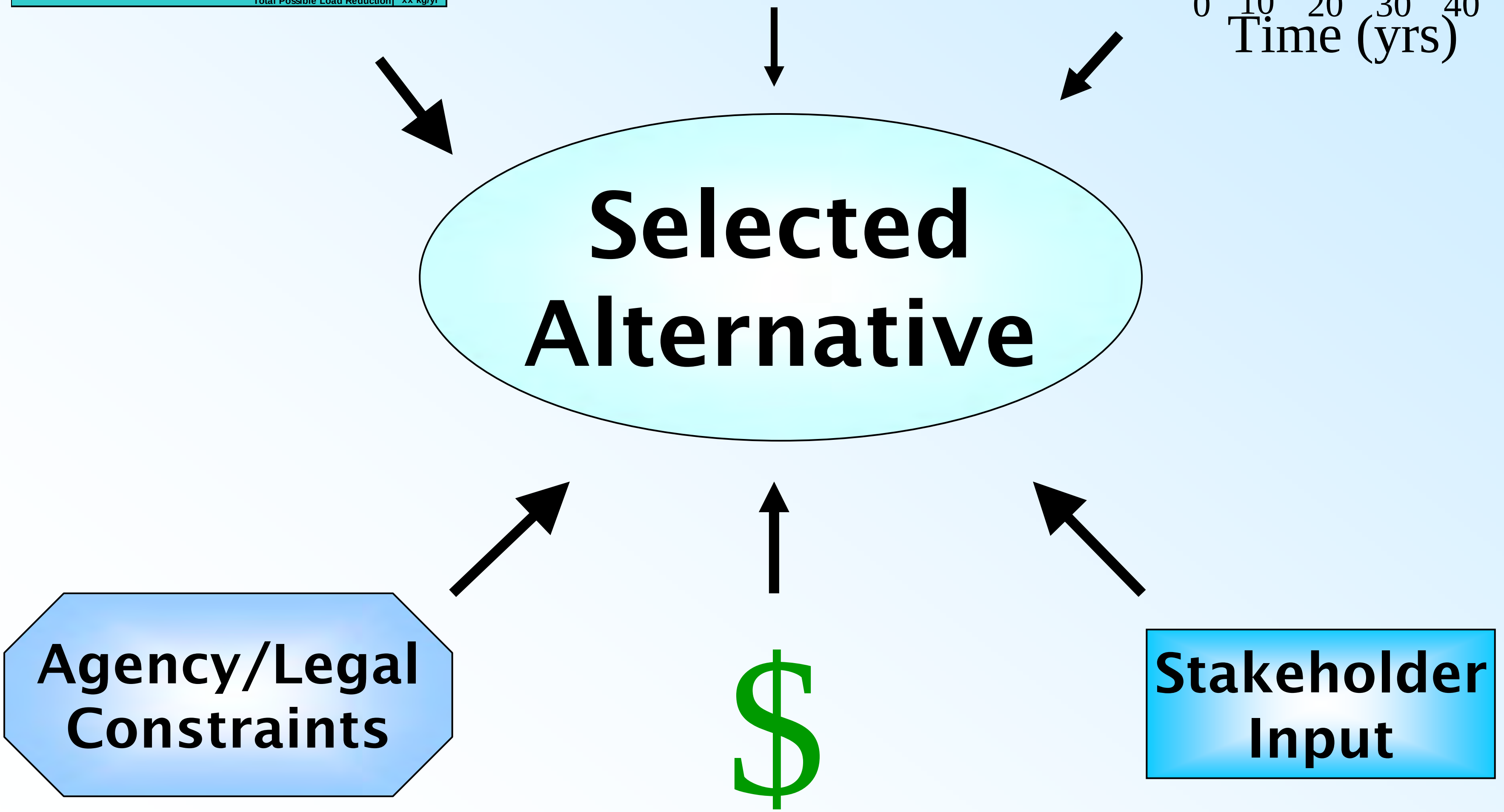
Conceptual Load Reduction Model



Load Reduction Opportunities		Effectiveness	Cost	Contstraints	Etc.	Estimated Load Reduction
URBAN						
U-1	Infiltration	4	$	2	tbd	xx kg/yr
U-2	Wetland Treatment	7	$$	7	tbd	xx kg/yr
U-3	Source Control	6	$	1	tbd	xx kg/yr
U-4	Chemical Enhancement	9	$$$	8	tbd	xx kg/yr
ATMOSPHERIC						
A-1	Vehicle Emission Control	4	$$	4	tbd	xx kg/yr
A-2	Wood Stove Management	5	$$	3	tbd	xx kg/yr
A-3	Out-of-Basin Source Control	2	$$$	9	tbd	xx kg/yr
A-4	Dust Management	7	$	2	tbd	xx kg/yr
STREAM CHANNELS						
ST-1	Stream Restoration	7	$$$	5	tbd	xx kg/yr
ST-2	Bank Stabilization	7	$$	3	tbd	xx kg/yr
ST-3	Hydrological Controls	5	$	2	tbd	xx kg/yr
GROUND WATER						
GW-1	Fertilizer Management	3	$$	7	tbd	xx kg/yr
GW-2	Source Control	8	$	2	tbd	xx kg/yr
FORESTED AREAS						
FA-1	Road Management	6	$$$	6	tbd	xx kg/yr
FA-2	Trail Management	5	$$	5	tbd	xx kg/yr
FA-3	Fire Restoration	7	$$	4	tbd	xx kg/yr
					Total Possible Load Reduction	**xx kg/yr**







IWQMS Development Process

7) Select load reduction strategy – Summer 2007

- Selected alternative will be the IWQMS
- Selection process is still to be determined

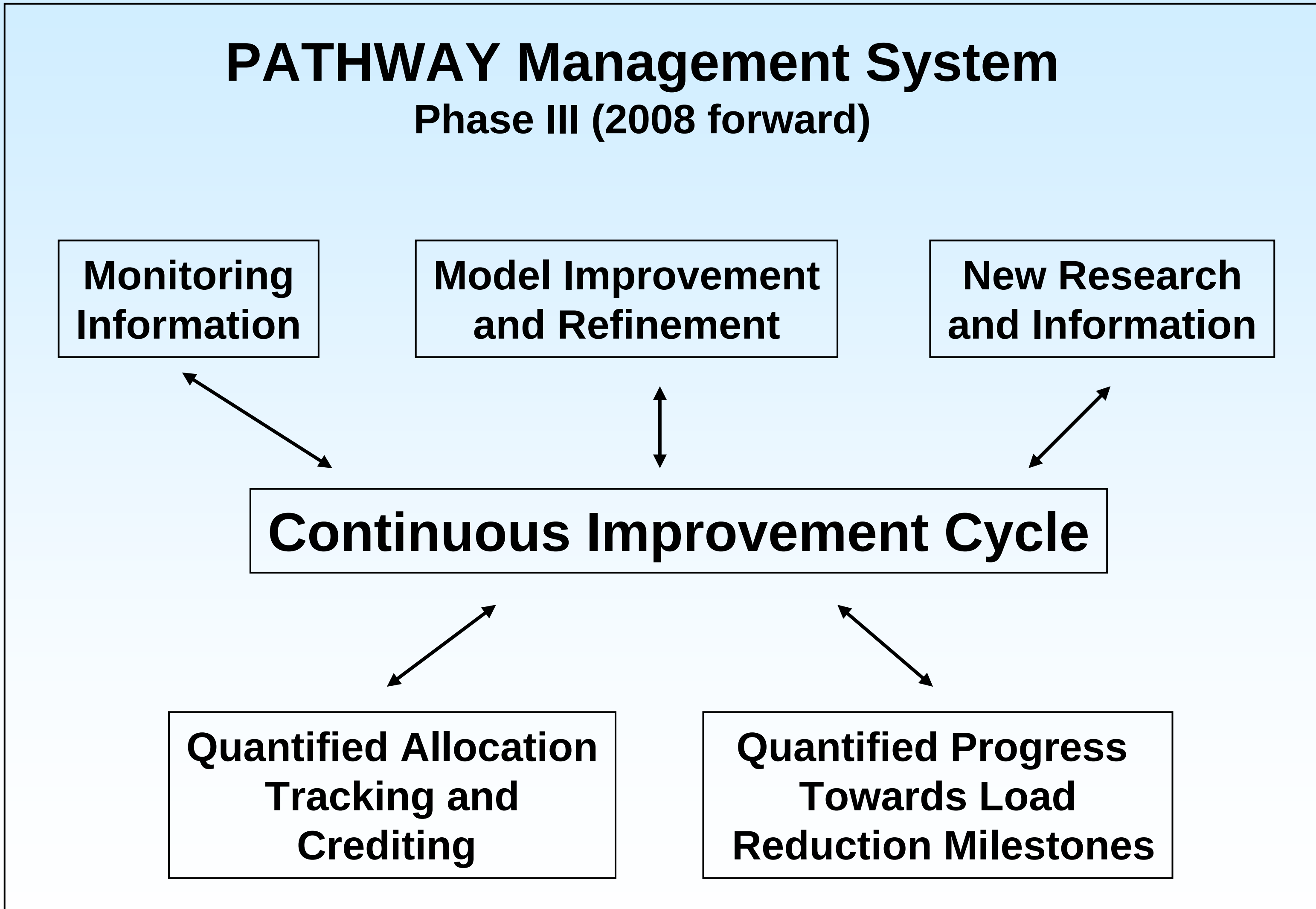
8) Develop strategy specific load allocations – Winter 07/08

- Allocations will be specifically tailored to selected strategy
- Allocations are intended to reflect magnitude of pollutant reductions anticipated through implementation
- Allocations could be made to source category, watershed, programs, jurisdictions, or a combination

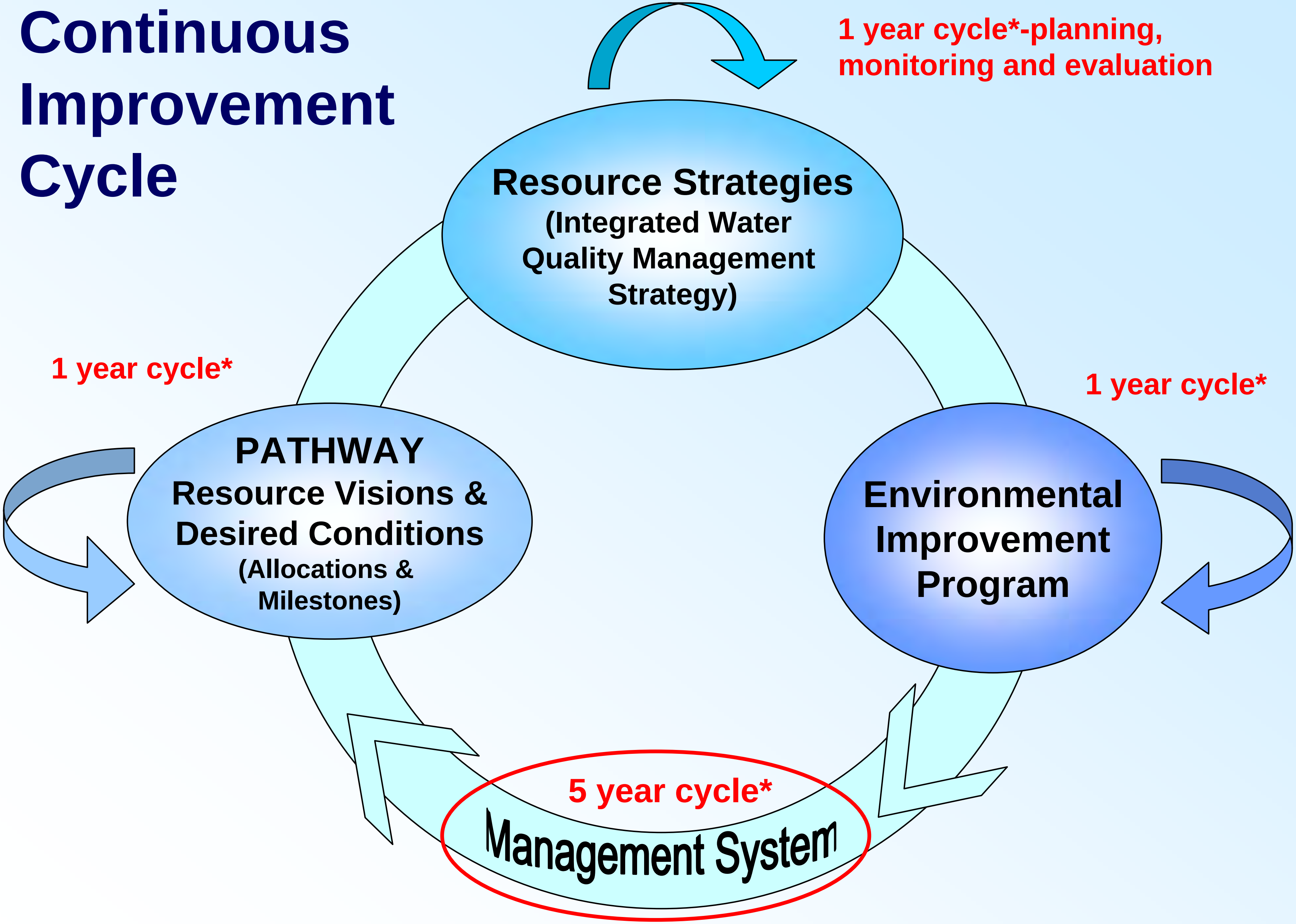
9) Implement strategy and evaluate progress – Ongoing

- Phase III of TMDL development reflects the need to continuously incorporate new information and assess accuracy of estimates and progress towards achieving load reductions

TMDL Phase III



Continuous Improvement Cycle



* Final determination of cycle intervals has not been determined

Forum Interaction

- ✓ Listing of load reduction opportunities by source category – Fall 2006
- ✓ Listing of evaluation parameters – Fall 2006
- ✓ Review assessment methodology – Winter 2006/07
- ✓ Development of load reduction strategies – Summer 2007
- ✓ Selection of load reduction strategy – Summer 2007
- ✓ Development of strategy specific load allocations – Winter 07/08

Previous Pollutant Load Reduction Efforts

1949 Nevada prohibits direct sewage disposal to lake

1958 Lahontan prohibits sewage disposal to surface waters

1968 Sewer system completed

1978 All sewage exported from basin

1980 TRPA and LRWQCB implement SEZ protection measures and land use regulations

1982 Environmental Thresholds adopted

1988 Current Regional Plan adopted

2008 ?

Questions