



VLAWMO BATHTUB MODEL



HDR

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PRESENTATION OVERVIEW

- # **Project Overview**
- # **Model Development**
- # **Results**
- # **Next Steps**
- # **Q&A**

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Project Overview

- ✦ **To improve the understanding of water quality dynamics and processes in the VLAWMO chain of lakes**
- ✦ **To support sustainable lakes management planning efforts and decision-making with respect to water quality management**



Model Development



Precipitation
Watershed Runoff
Atmospheric Deposition

Lake/Cell

Evaporation
Groundwater
Outflow
Sedimentation



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Assumptions

1. Phosphorus concentration for a given land use was based on literature values
2. Canfield Bachman – Natural Lakes for Sedimentation
3. Charley, Deep, Pleasant, Sucker and East Vadnais lakes – discharge constant (St. Paul Water Utility)



Model Development



Model Development

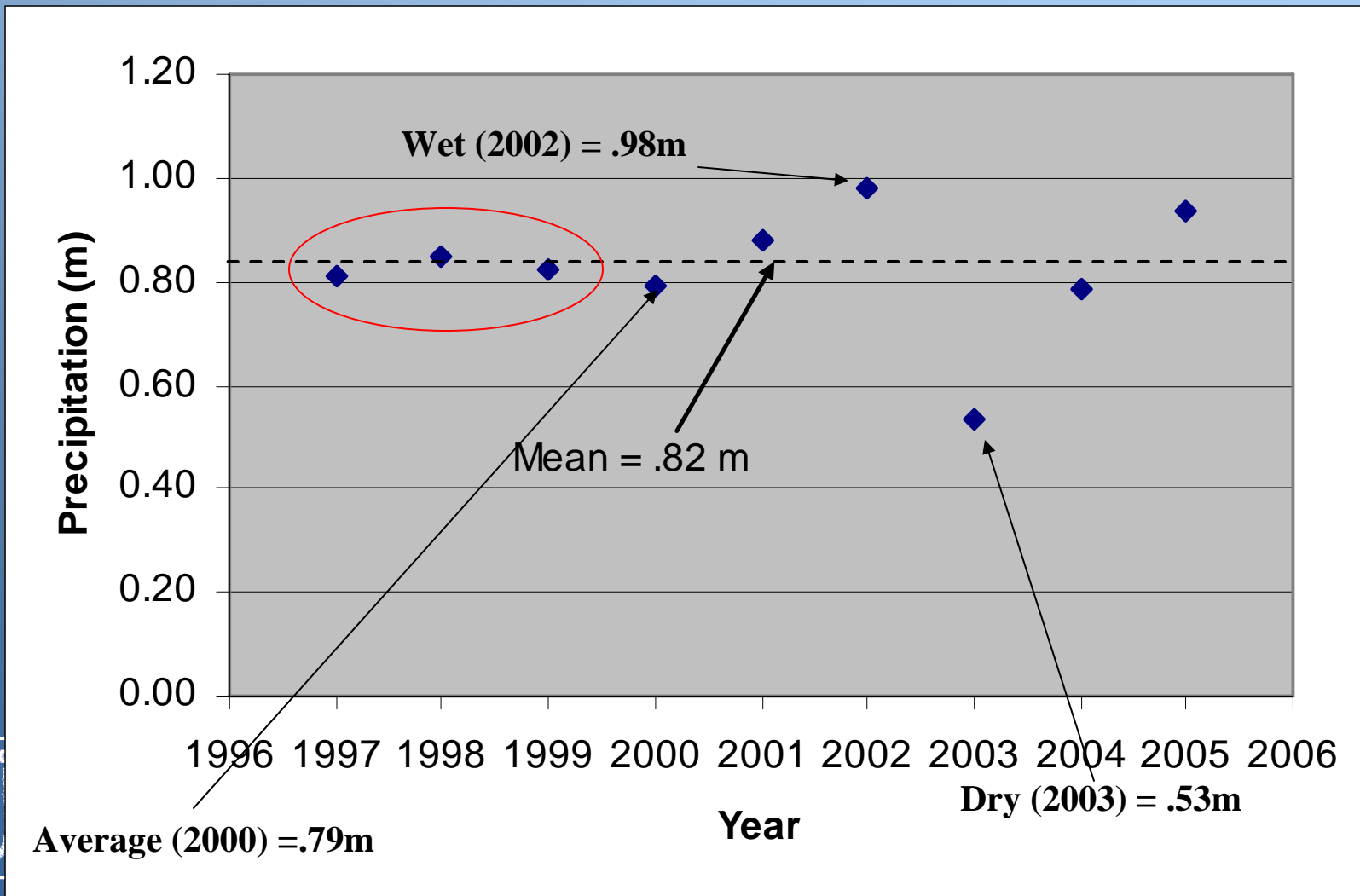


Precipitation Inputs

- Gage: Ramsey White Bear (T30N,R22W,S29)
- Data Collected from 1997 – 2005



Model Development



Model Development



Evaporation Inputs

Lakes Evaporation

$$E = ER * SA * k$$

E = lake evaporation (million gal/mo)

ER = Evaporation rate (in/mo)

SA = Surface area (ac)

k = .0271 (million gal / ac - in)

Evaporation Rate (Eagleson Report, 1970)

- Air temperature
- Dew point
- Wind speed
- Solar radiation (Thompson, 1976)



Model Development



Annual Evaporation

Year	Evaporation (m)
2000	.73
2002	.68
2003	.76



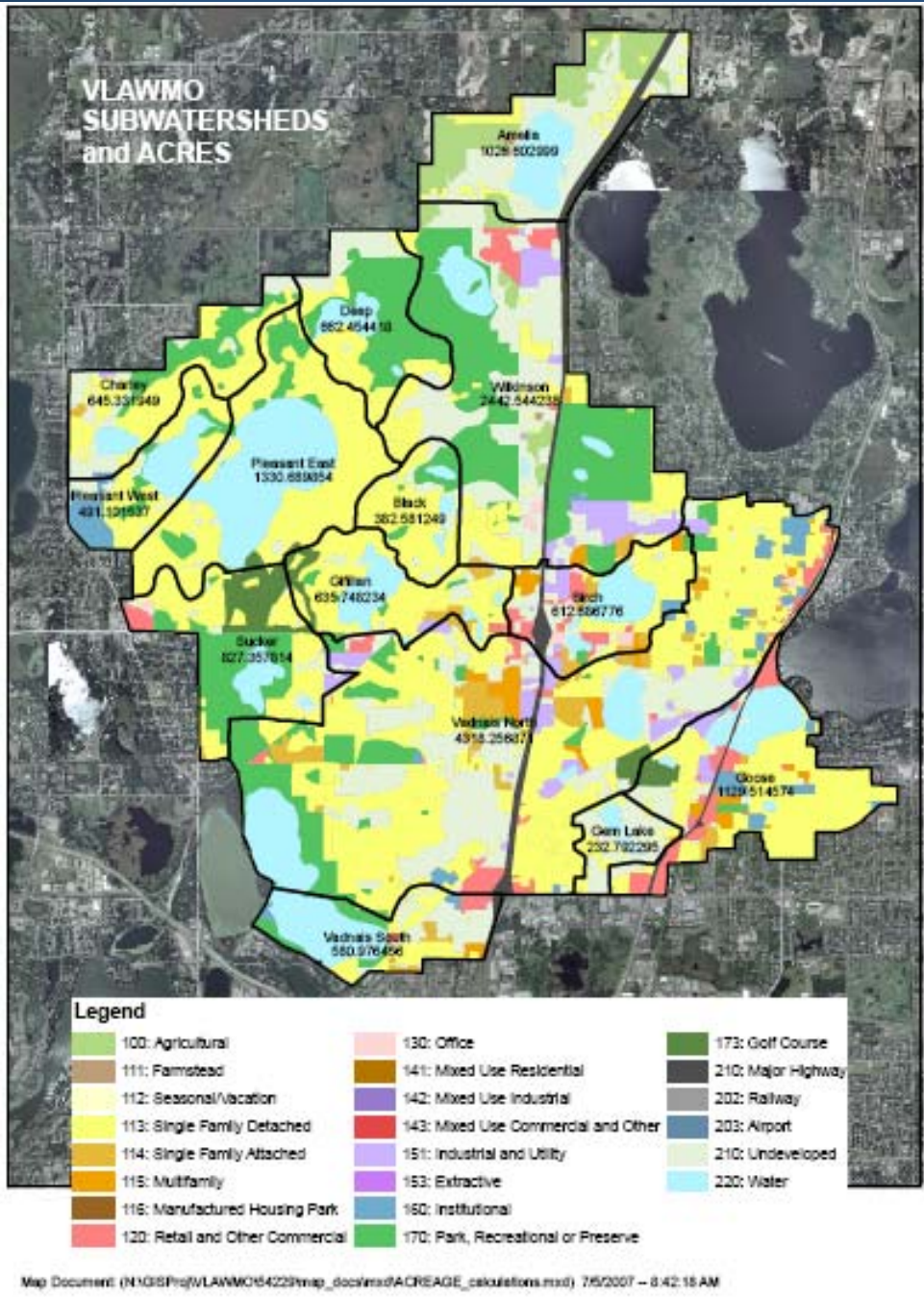
Model Development



Watershed Inputs

- Landuse (GIS)
 - ◆ Urban
 - ◆ Rural Residential (farmstead)
 - ◆ Cropland
 - ◆ Open space*
 - ◆ Forest (none detected)
 - ◆ Wetlands*
 - ◆ Water







Model Development

Subwatershed	Urban km ²	Rural Residential Area	Cropland Area	Open Area	Wetland Area	Water Area
Amelia	19%	1%	30%	24%	10%	15%
Birch	65%	-	-	12%	2%	20%
Black	68%	-	-	21%	3%	8%
Charley	51%	-	-	35%	8%	6%
Deep	29%	-	-	59%	1%	12%
Gem	30%	-	-	48%	9%	14%
Gilfillan	67%	-	-	12%	2%	19%
Goose	76%	-	-	10%	1%	13%
Pleasant East	54%	-	-	10%	-	37%
Pleasant West	58%	-	-	18%	1%	24%
Sucker	42%	-	-	48%	2%	8%
Vadhais North	63%	-	-	21%	10%	6%
Vadhais South	40%	-	-	27%	1%	32%
Wilkinson	31%	0%	3%	54%	8%	5%

Land Use Distribution



Regional Phosphorus Concentrations and Land Use Runoff Coefficients

Land Use	Total Phosphorus ug/L (ppb)	Runoff Coefficients		
		2000(m/yr)	2002(m/yr)	2003 (m/yr)
Urban	375	0.32	0.39	0.21
Rural Residential	200	0.22	0.28	0.15
Cropland	450	0.17	0.21	0.11
Open Space	125	0.15	0.19	0.10
Wetland	100	0.15	0.19	0.10



Model Development



Lake Morphology Inputs

1. Surface area
2. Mean depth
3. Flow length
4. Water level change
5. Volume above normal water level





Model Development

Observed/monitored water quality data

1. Total Phosphorus
2. Secchi Disk Transparency
3. Chlorophyll_a
4. Dissolve phosphorus
5. Temperature
6. Dissolve oxygen

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East Vadnais Lake (Cell 1) Example Results

Phosphorus (ppb)

	2000	2002	2003
Observed	34	33	27
Predicted	33	34	29

DOES THIS MAKE SENSE?





Goose Lake Example Results

Phosphorus (ppb)

	2000	2002	2003
Observed	43	731	470
Predicted (1)	45	44	42

DOES THIS MAKE SENSE?

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Goose Lake Example Results

Phosphorus (ppb)

	2000	2002	2003
Observed	43	731	470
Predicted (1)	45	44	42
Predicted (2)	734	726	688

What is going on in the lake?

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Next Step



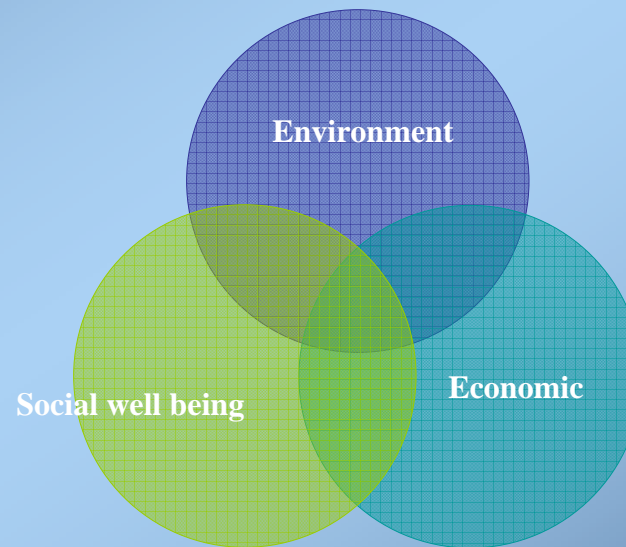
Fill Data Gaps

- Lake level
- TP, Secchi, Chl-a
- DO, Temp
- Flow
- Sediment release

Other Sources

- Curly leaf pondweed?
- Condition for anoxic release?
- Septic?

Sustainable Lakes Management Plan



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Questions?

Thank you.

