Regional Spreadsheet Model:

Contaminants

Presentation to SPLWG

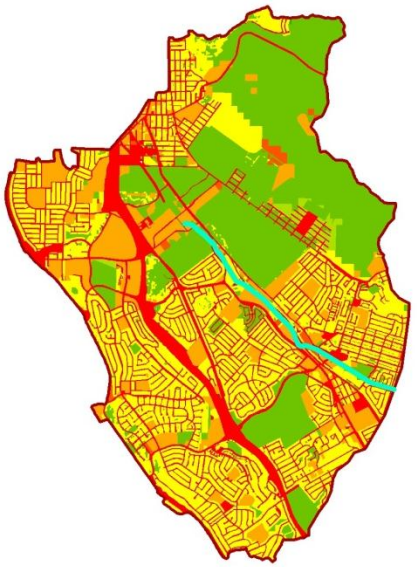
Oct. 25, 2011

Outline of presentation

- Overview of contaminant model and data requirements
- Preliminary model runs
- Further development of input data
- Proposed Year 3 next steps

Approach for modeling sediment and contaminant loading…

Runoff volume*	x	Concentration	=	Load



*or sediment load

Input data

EMCs: Concentrations that are spatially-based, e.g., linked to a map of land use, soil type, etc.

and/or

Loads: Measured or empirically-derived loads linked to map of catchments

- Simplest case: SS and POC EMCs
- Next simplest case: SS EMCs and POC particle strength
- More complicated: SS loads and POC particle strength

Sediment EMCs

SSC (mg/L):

Land Use	Alameda (WCC 1991)	Santa Clara (WCC 1991)	BASMAA (1995)	SCCWRP (2000)	**Mean SSC**	**Median SSC**
Indust	114	152	135	174	144	144
Trans	192				192	
Comm	192	76	98	118	121	108
Resid	192	76	90	102	115	96
Open	11	85		371	156	85
Agri				2068	2068	

Calculating Mercury EMCs

Land Use	**literature: Hg EMCs (ng/L)**	**n**	Median of **Hg in soil (ppm)** world literature data	Local **SSC** EMCs **(mg/L)**	[Hg] in soil x local SSC EMCs = **Hg (ng/L)**
Indust	5-280	4	2.3	144	330
Trans	7.5-35	8	2.3	192	440
Comm	41	1*	0.16	108	17
Resid	46	1*	0.16	96	15
Open	2300	1*	0.053	85	4.5
Agri	120	1*	0.053	2068	110

*of questionable quality due to analytical technique

Calibration data

Loads: long-term average annual load at bottom of watershed

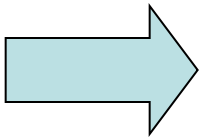
Watershed	SS	Cu	Hg	PCBs	N	P	Se	PBDEs	PAHs	Pyre.	OC pest.
Zone 4 Line A	x	x	x	x	x	x	x	x	x	x	x
Guadalupe R*	x	x	x**	x				x			x
Coyote Ck*	x		x	x							
Ettie St. P.S.	x	x	x	x	x	x					
Richmond P.S.	x	x	x	x	x	x					
Cerrito Ck	x	x	x		x	x					

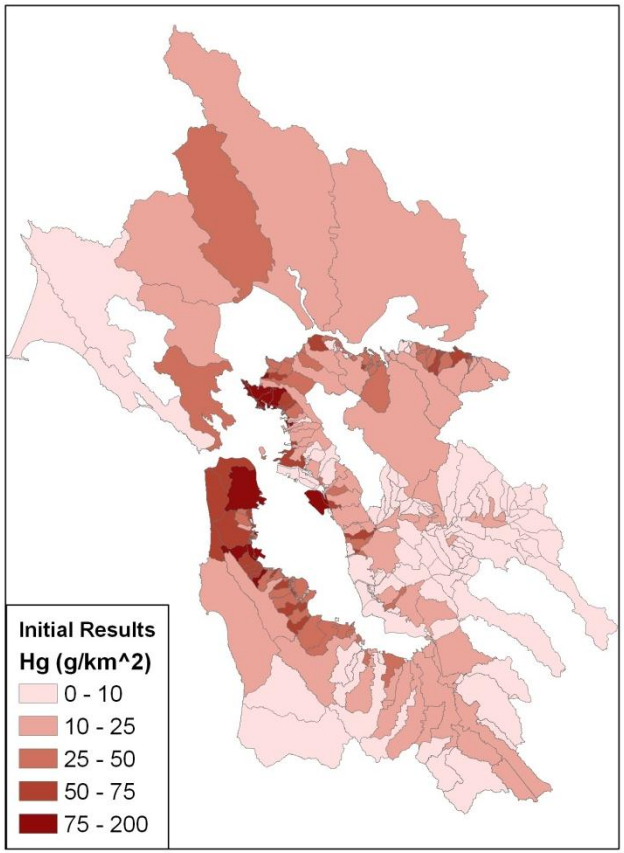
*have to account for reservoir-influence
**extreme outlier for Hg

Any others?

Initial contaminant results

Land Use	**Hg in soil (ppm)** X	**SSC (mg/L)** =	**Hg (ng/L)**
Indust	2.3	144	330.05
Trans	2.3	192	441.60
Comm	0.16	108	17.28
Resid	0.16	96	15.36
Open	0.053	85	4.51
Agri	0.053	2068	109.60





POC	Best Estimate*	Regional Output	Bay Drainage Output
S.S. (Mt)	1.28	0.73	0.68
Hg (kg)	185 (+115 Guad)	153	140

* SS load from Lewicki and McKee 2009; POC loads from SPLWG 5-yr workplan 2008

Refining input data:

Back-calculate EMCs from downstream data

Approach

Set up system of linear equations:

Watershed specific area & runoff weights

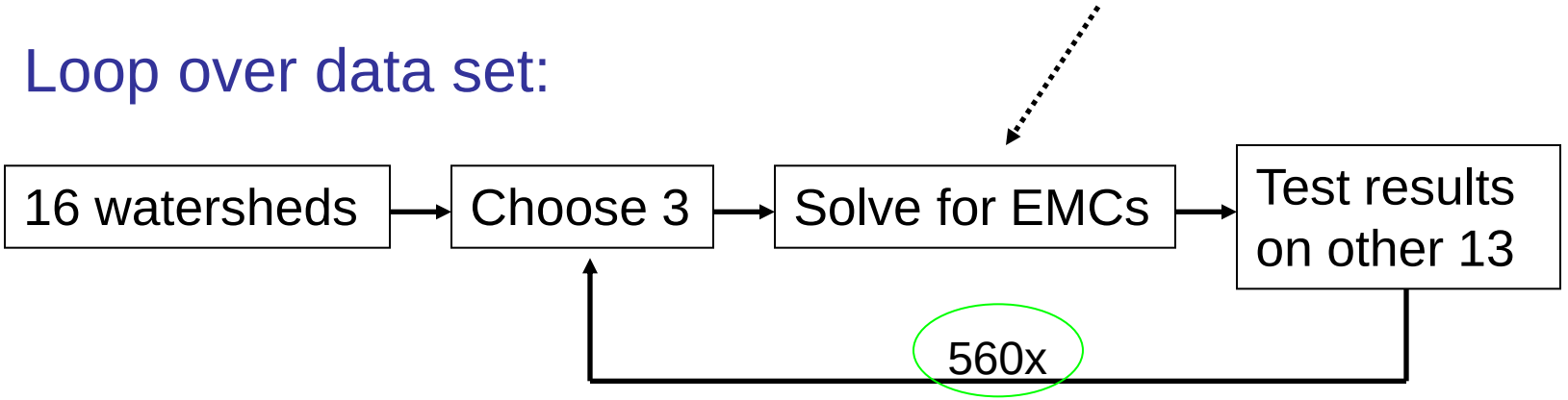
Land use EMCs

Downstream concentrations

$$\begin{pmatrix} W_{1,A} & W_{1,B} & W_{1,C} \\ W_{2,A} & W_{2,B} & W_{2,C} \\ W_{3,A} & W_{3,B} & W_{3,C} \end{pmatrix} \begin{pmatrix} C_A \\ C_B \\ C_C \end{pmatrix} = \begin{pmatrix} C_1 \\ C_2 \\ C_3 \end{pmatrix}$$

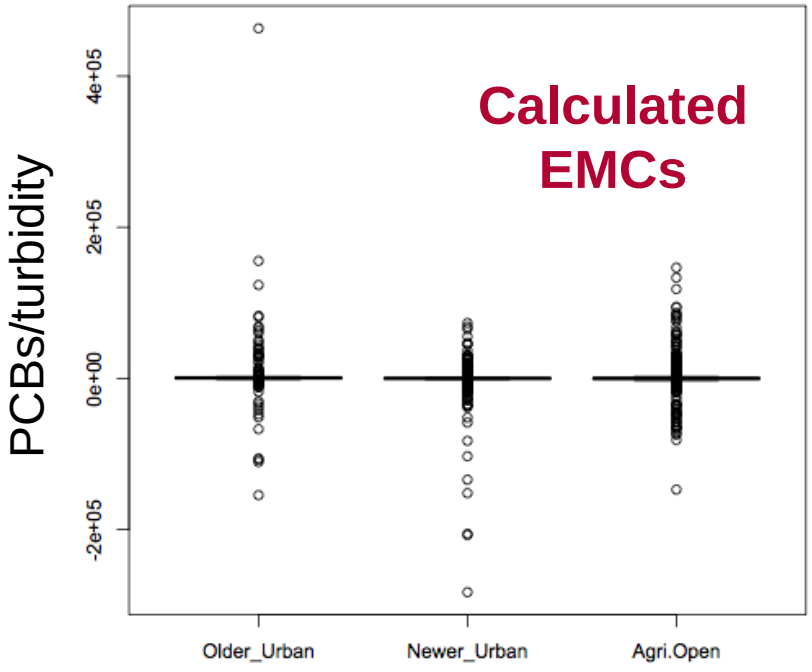
known/estimated | unknown | known

Loop over data set:

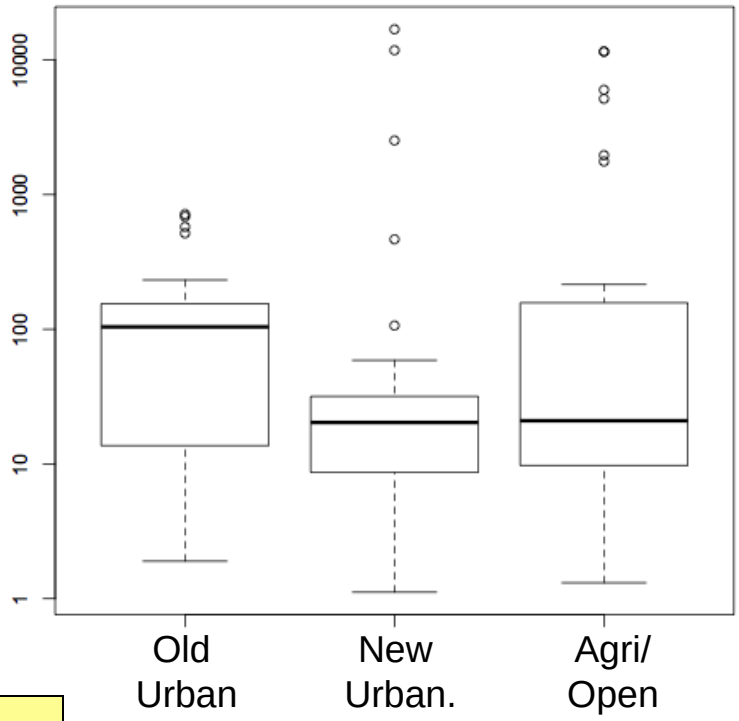


But the majority of the solutions have a negative concentration!

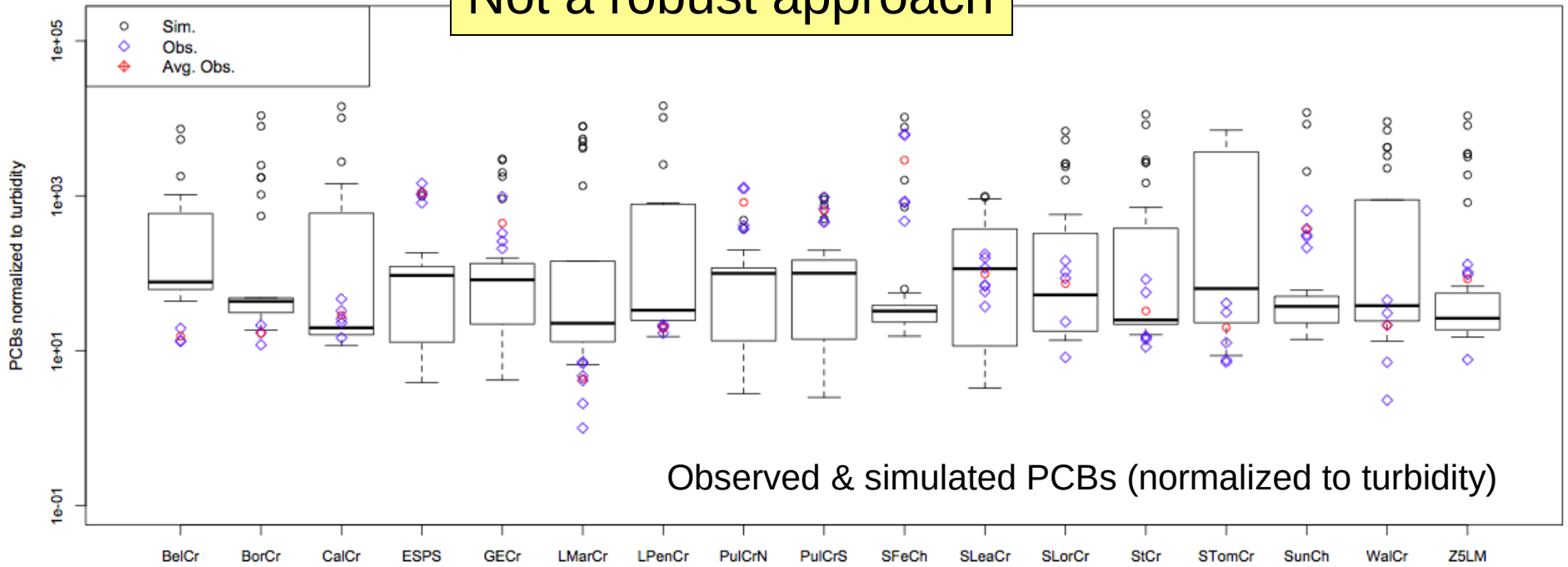
Ref: Silverman, Stenstrom, and Fam, 1988.



Remove results with neg. conc.



Not a robust approach



Alternative EMC derivation approach

Constrained optimization

Minimize $\Delta(Conc_{i,Obs} - Conc_{i,Sim})$ across set of watersheds *i*

Where $Conc_{i,Sim} = f_{i,LU\ 1} * Conc_{LU\ 1} + f_{i,LU\ 2} * Conc_{LU\ 2} + \ldots$

and $f_{i,LU\ X}$ = the proportion of runoff contributed by L.U. X

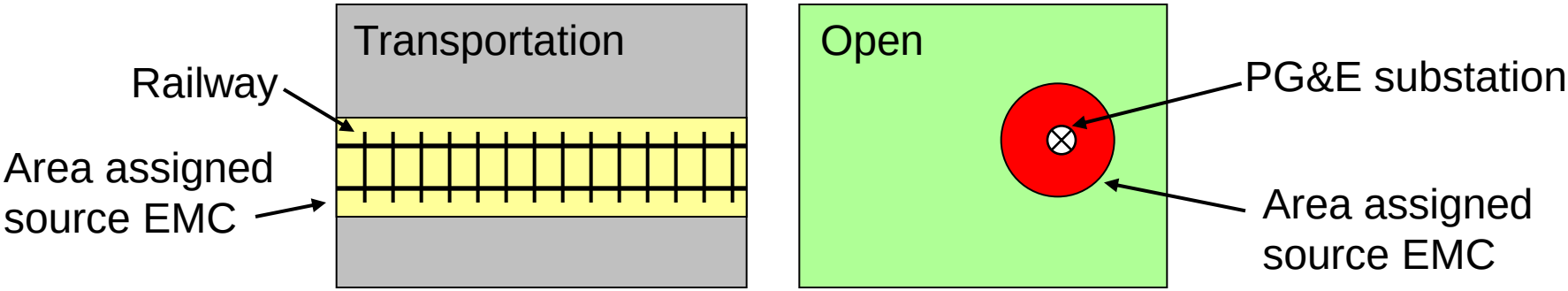
Subject to:
$0 \leq Conc_{LU\ 1}$ (< Max. $Conc_{LU\ 1}$)
$0 \leq Conc_{LU\ 2}$ (< Max. $Conc_{LU\ 2}$)
…

Recommendations for Year 3

- **Develop constrained optimization framework for contaminant of choice**
- **Propose test case of PCBs and WY 2011 wet weather data set incorporating land uses recommended by fact sheets (as supported by existing data)**

Recommendations for Year 3

- **Develop GIS layers to incorporate POC source areas into model, as recommended by fact sheets AND supported by existing data**



Recommendations for Year 3

- **Refine sediment model**
  - **Compare Lewicki and McKee approach against other approaches found in literature**
  - **For any approach applied at watershed level, develop apportionment method to support land use / source specific POC model**