LCRA's RiverWare Model

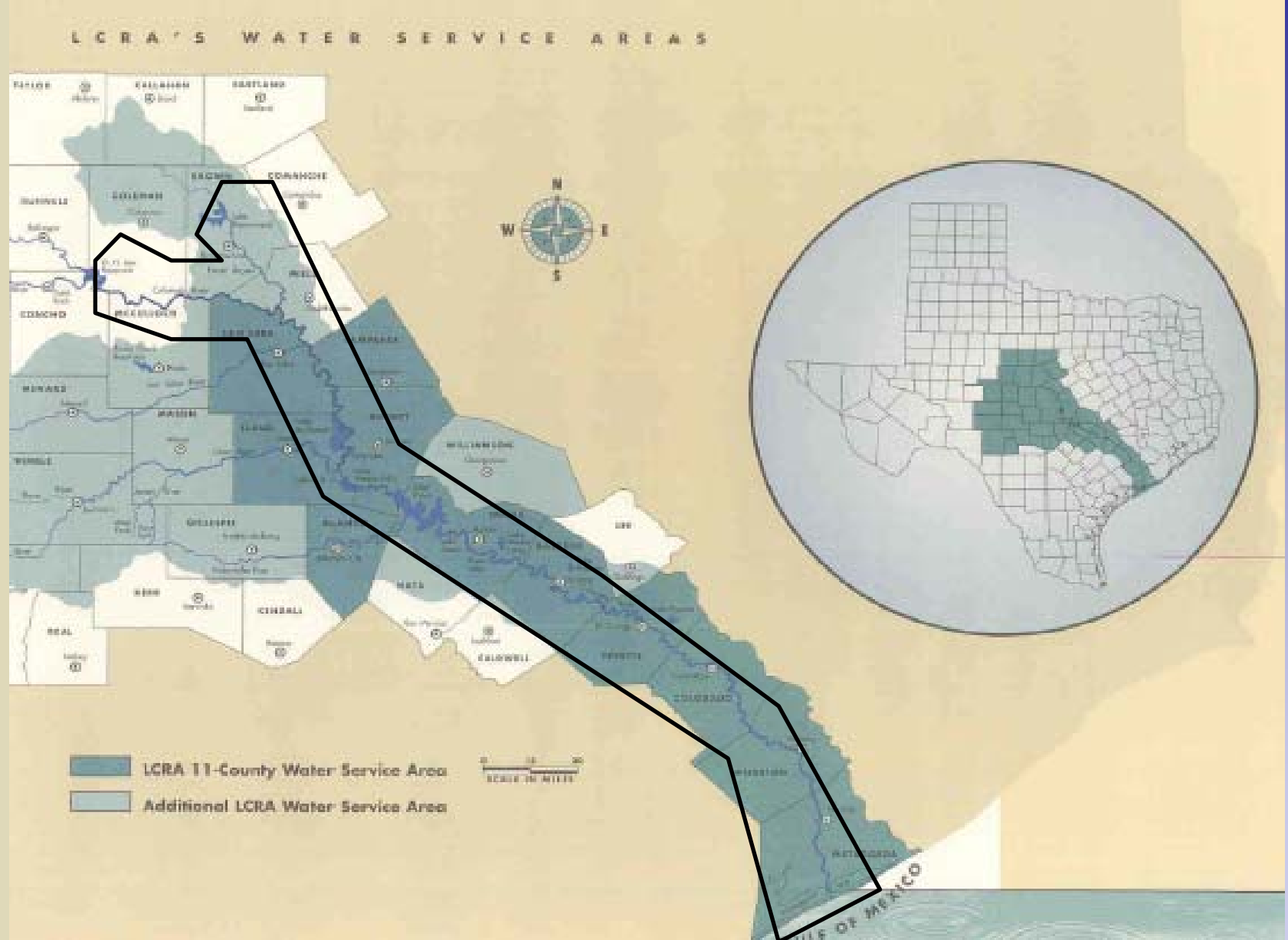*March 8, 2005*
Users Group Meeting
Boulder, CO

What we started with:

- RESPONSE Model:
  - ➤ Hybrid Monthly/Daily time step
  - ➤ LCRA's planning model since 1970s
  - ➤ Used for Water Management Plan analyses
  - ➤ Difficult to modify (FORTRAN)

- WAM / WRAP:
  - ➤ Monthly time step
  - ➤ Used by State of Texas to evaluate water rights

What we were looking for:

- **Replacement for RESPONSE in a modern modeling platform**

- **User ability to clearly define:**
  - ➤ **physical system,**
  - ➤ **operating policies,**
  - ➤ **legal constraints**

Model Geographic Domain

LCRA'S WATER SERVICE AREAS

LCRA 11-County Water Service Area
Additional LCRA Water Service Area

Model Characteristics

- **Monthly or daily operation**
- **Partial basin, lower portion**
- **Largely series system**
- **619 Rules**
- **385 Objects**
- **~100 water users**
- **Accounting not physical system driven**

Input Data - Alternatives

- **Inflows from WAM**
  - ➢ **Data sets for different priority dates**
  - ➢ **Time period: 1940-1998**

- **Demands**
  - ➢ **Data sets for different operating schemes**
    - ▪ **Full Authorization vs. 2030 Demands**
    - ▪ **Variable Irrigation vs. Fixed Irrigation**

Accounting

Water user accounts

> **Tracks delivery of water from various supplies to each water user's account**

> **Demands met by sources in the order, as appropriate:**

- ROR from Below Travis (local inflows)
- ROR from Above Travis (pass-through)
- Release from Highland Lakes Storage
  - o Interruptible
  - o Firm

Priority Based Accounting Solution

- **Year**
  - ➤ **Day**
    - ▪ Initial Solution
      - o Allocate demands downstream of storage
      - o Priority date is set to determine the non-modeled upstream diversions,
      - o above storage water is allocated in four groups (pre 1926 water rights, environmental, Highland Lakes storage and direct users, post 1926 water rights),
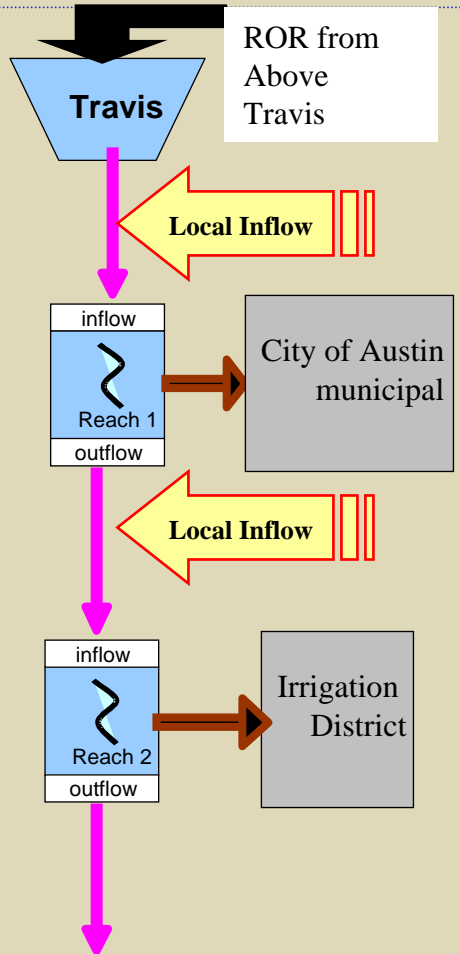   - o then releases from storage are set
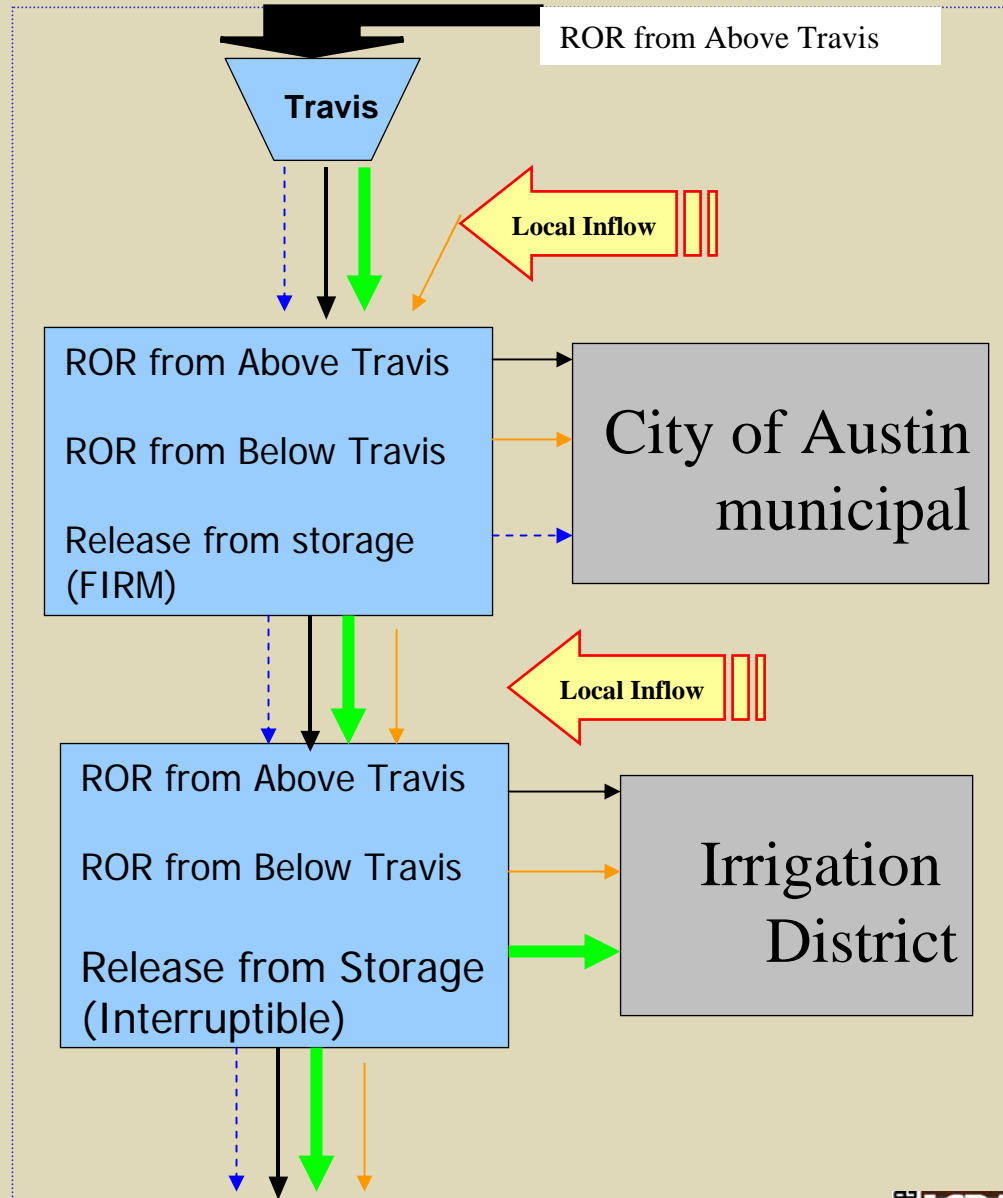   - ▪ Repeat for Final Values

Water Right Module Under Development

- **Priority Call Solution**
  - ➢ **Replace multiple rules**

- **Instream Flow Solution**
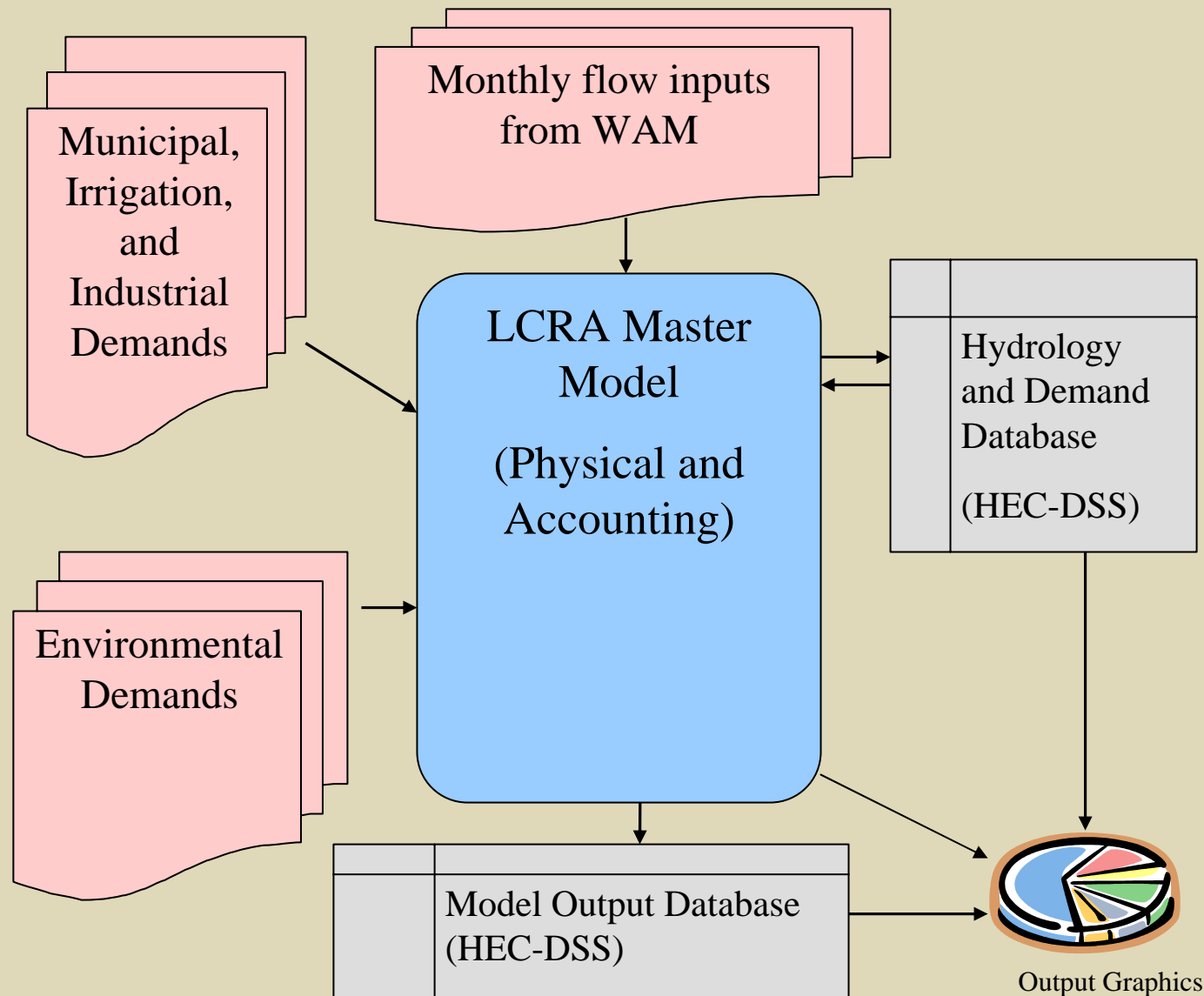 - ➢ **Replace rules and tables**

Physical View

Travis

ROR from Above Travis

Local Inflow

inflow

Reach 1

outflow

City of Austin municipal

Local Inflow

inflow

Reach 2

outflow

Irrigation District

Etc., Etc

Accounting View

Travis

ROR from Above Travis

Local Inflow

ROR from Above Travis

ROR from Below Travis

Release from storage (FIRM)

City of Austin municipal

Local Inflow

ROR from Above Travis

ROR from Below Travis

Release from Storage (Interruptible)

Irrigation District

Data Flow in Model

Municipal, Irrigation, and Industrial Demands

Monthly flow inputs from WAM

LCRA Master Model

(Physical and Accounting)

Hydrology and Demand Database

(HEC-DSS)

Environmental Demands

Model Output Database (HEC-DSS)

Output Graphics

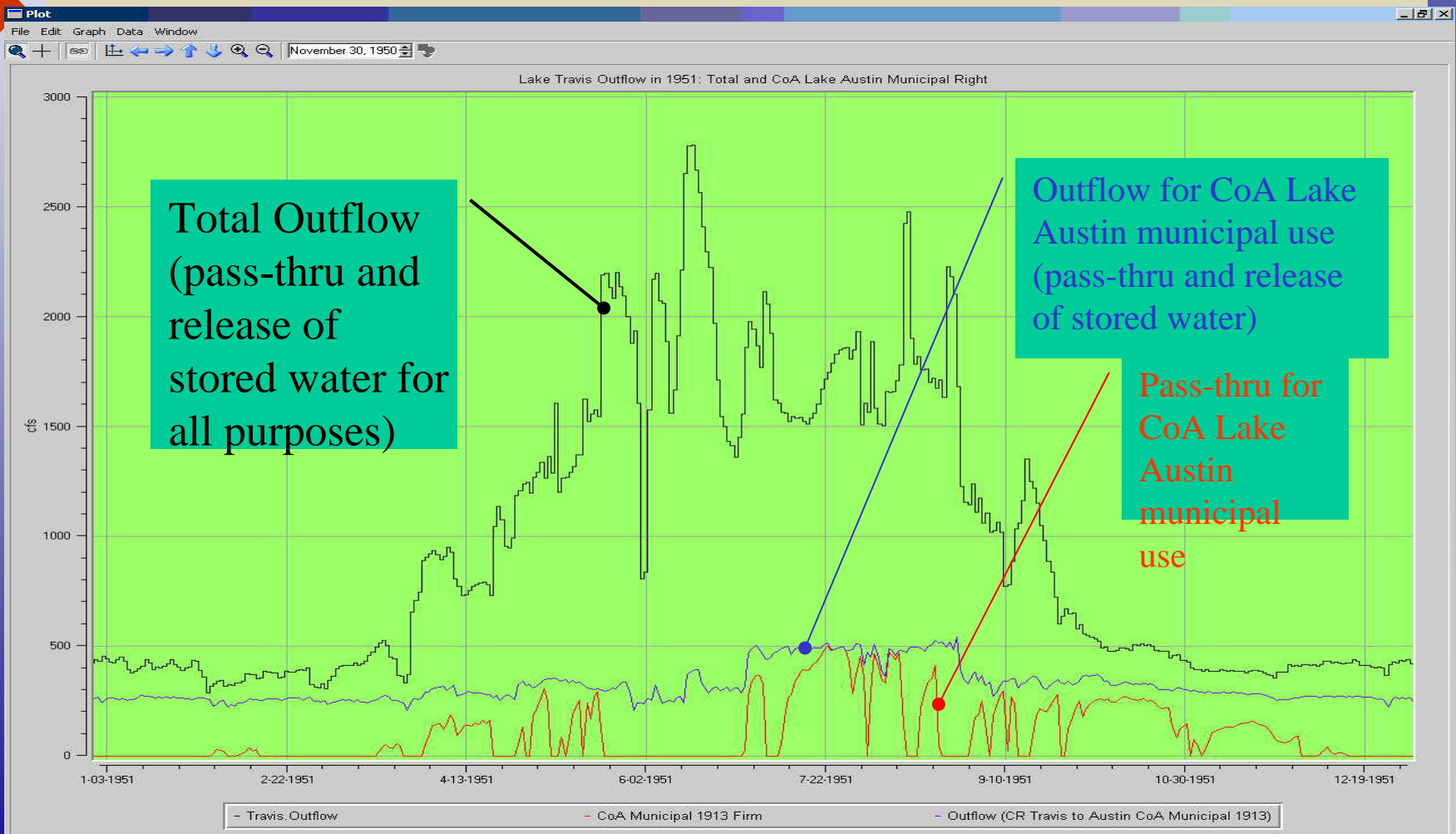# Model Status

- **Monthly**
  - ➢ **Being Validated against WAM**
  - ➢ **Run time 60 min for 60 years**
  - ➢ **Single simulation for POR with normal RAM**
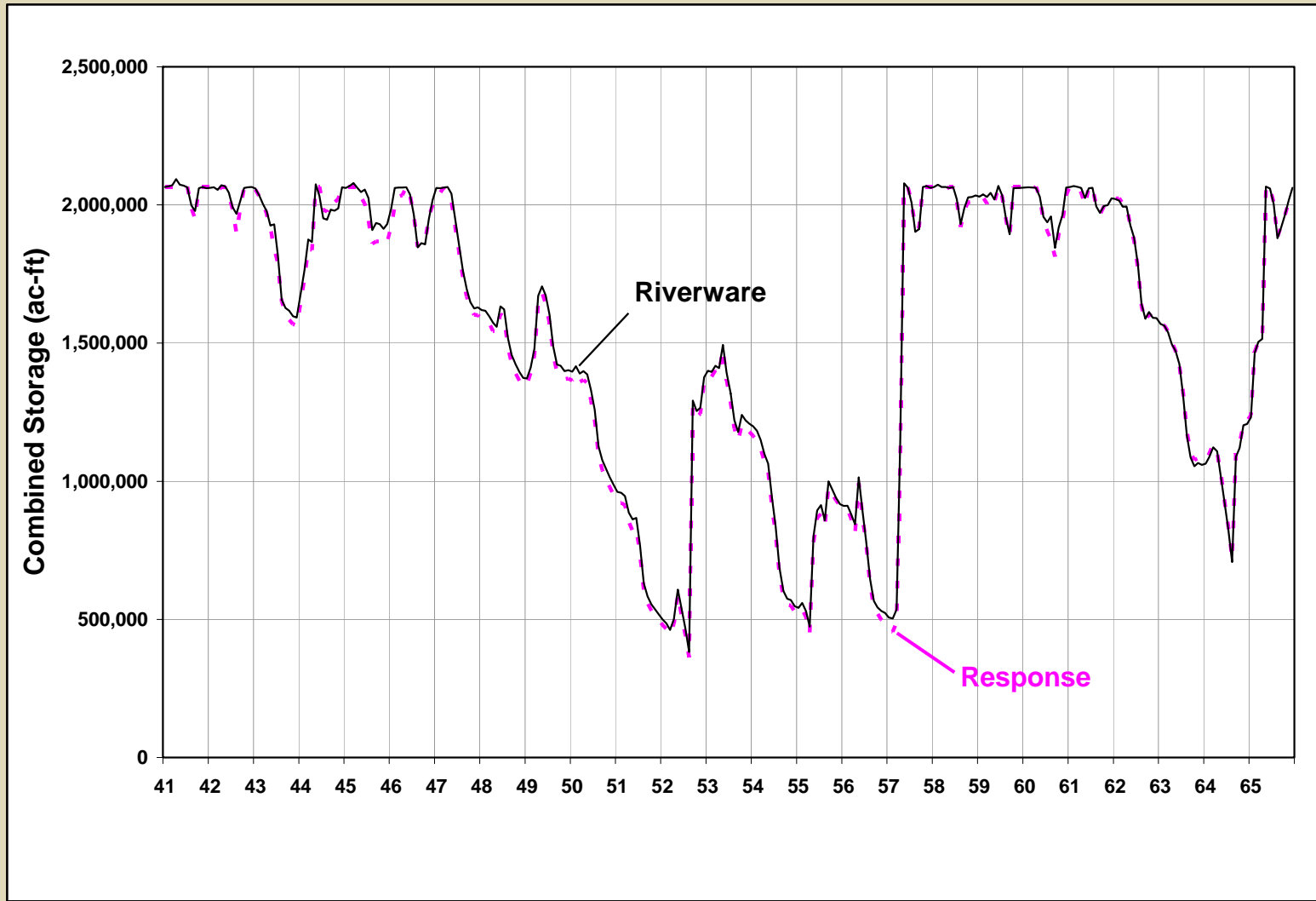
- **Daily**
  - ➢ **Being validated against Monthly**
  - ➢ **Run time approx 22 hours for 60 years**
  - ➢ **Approximately six 10 year simulations**

RiverWare Graphical Output - Outflows

## Lake Travis Outflow for 1951 - some "account" information shown

Plot

File Edit Graph Data Window

November 30, 1950

Lake Travis Outflow in 1951: Total and CoA Lake Austin Municipal Right

Total Outflow (pass-thru and release of stored water for all purposes)

Outflow for CoA Lake Austin municipal use (pass-thru and release of stored water)

Pass-thru for CoA Lake Austin municipal use

cfs

3000
2500
2000
1500
1000
500
0

1-03-1951   2-22-1951   4-13-1951   6-02-1951   7-22-1951   9-10-1951   10-30-1951   12-19-1951

– Travis.Outflow   – CoA Municipal 1913 Firm   – Outflow (CR Travis to Austin CoA Municipal 1913)

X, Y = (11-20-1951 11:52:31, 2977.27)

Comparison: RiverWare vs RESPONSE

Maximum deviation is 90,000 AF
Average deviation is 16,000 AF

Highland Lakes Storage:
WAM vs RiverWare

Deviation from WAM:
1941-1998   - 0.6%
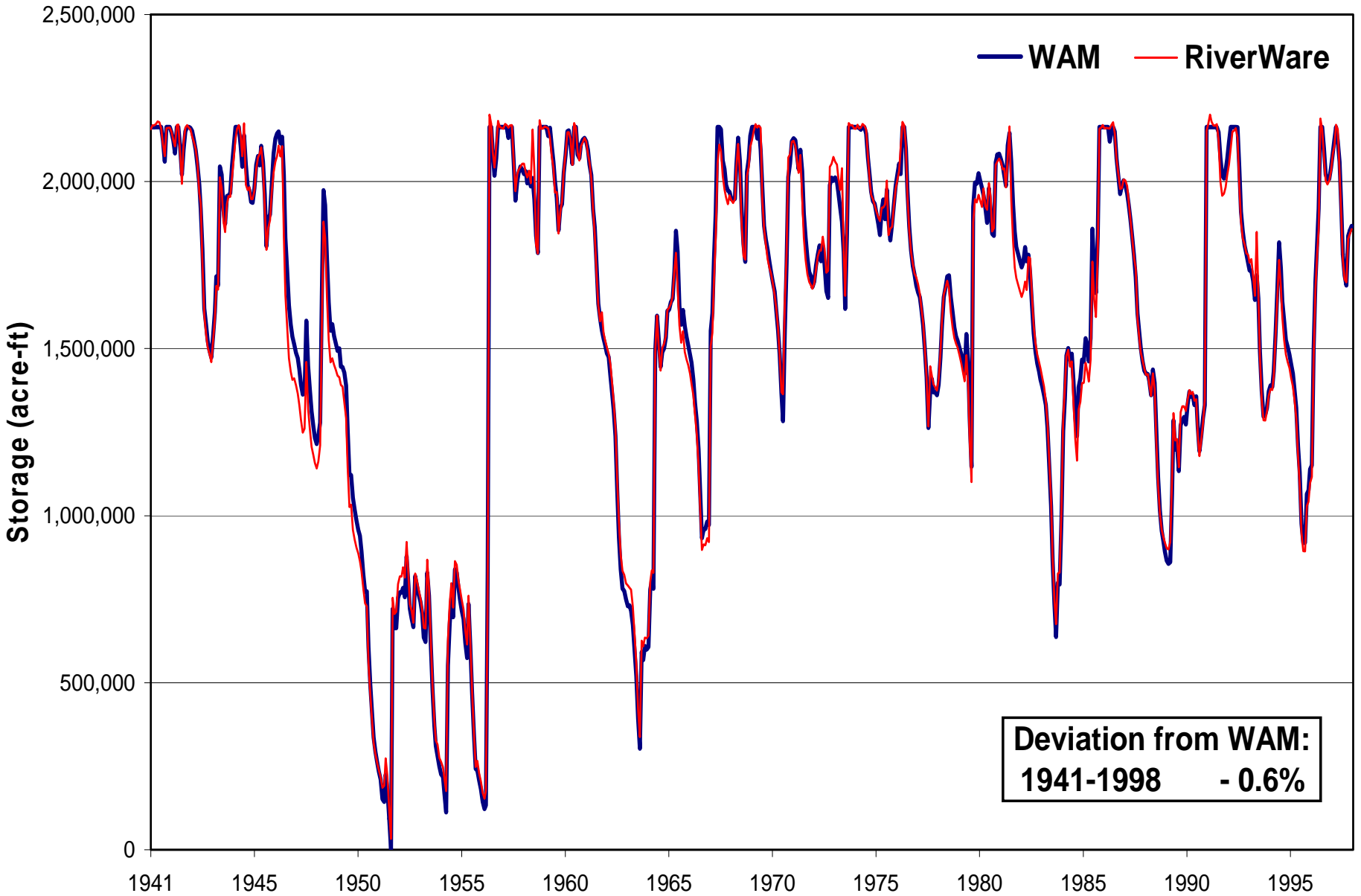
Flow to Matagorda Bay:
WAM vs RiverWare
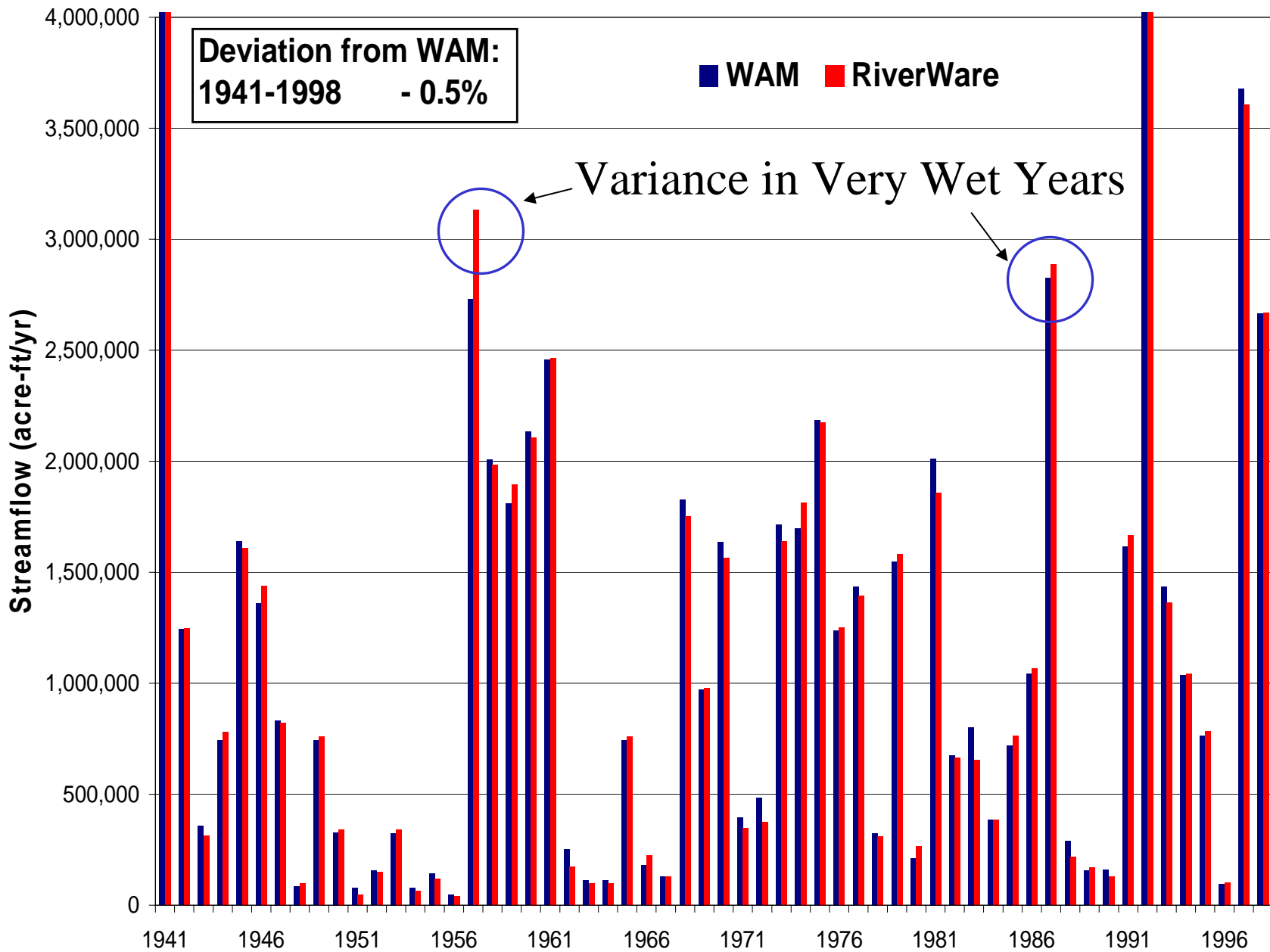
Future Potential Uses

- **Groundwater modeling integration**

- **Utilization for daily operations**

- **Water Supply Planning based on with stochastic hydrology**

- **Optimize hydropower generation**

Initial Lessons Learned

- **Starting with a monthly model or a demonstration project would have been prudent**
- **Began on the 'bleeding edge' of the accounting model technology**
- **Partial basin extents required work-around**
- **Water rights administration in accounting module requires a lot of coding and architecture despite object orientation**
- **Heavy use of accounting results in slow simulations**
- **Use of batch mode defeats many of RiverWare's graphical analysis tools.**
- **Lags are limited to integer days when using accounting**