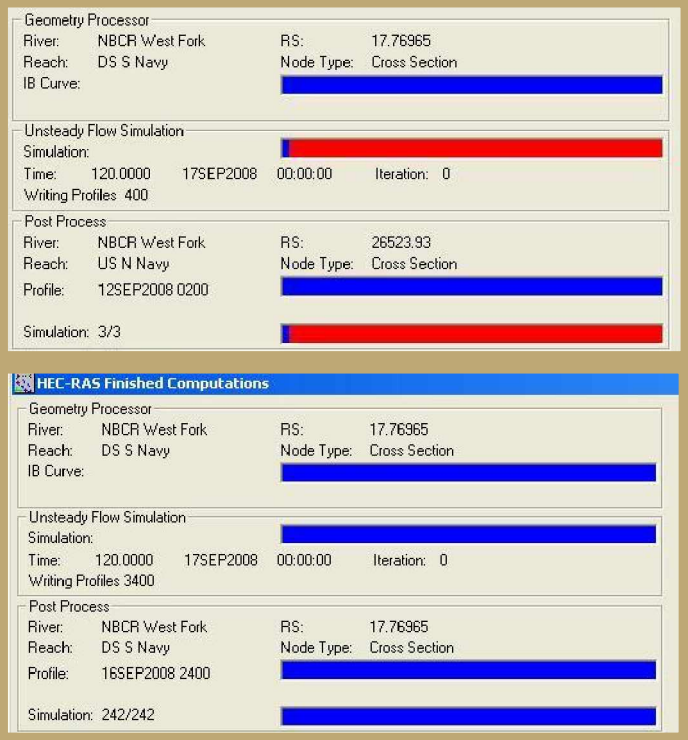
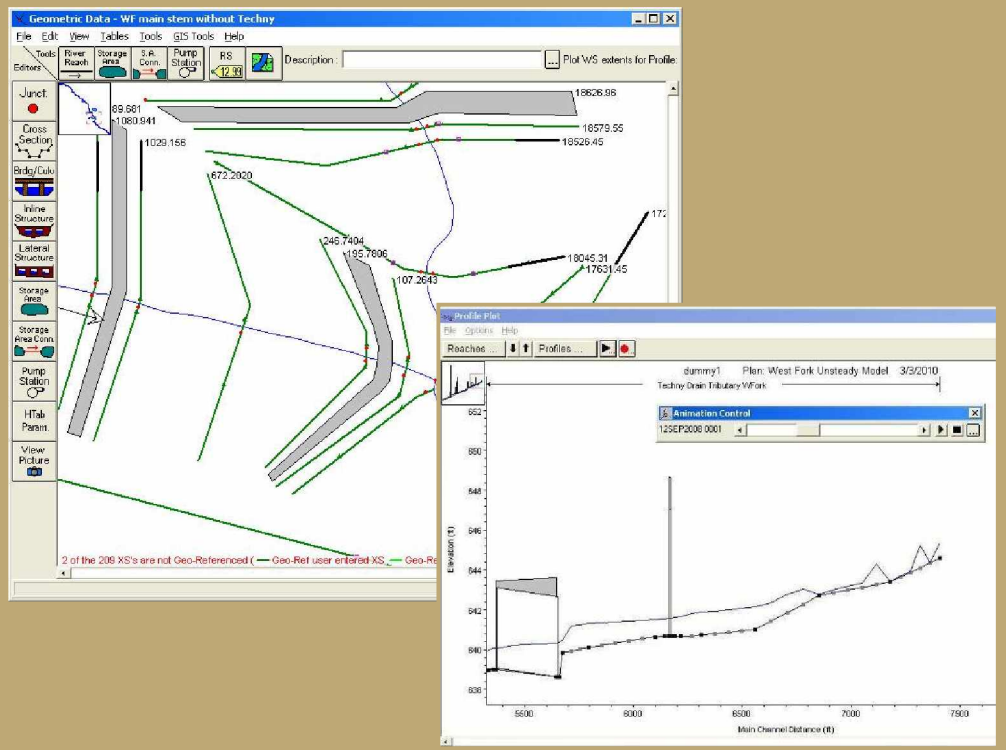
# De-Bugging a HEC-RAS Unsteady Flow Model



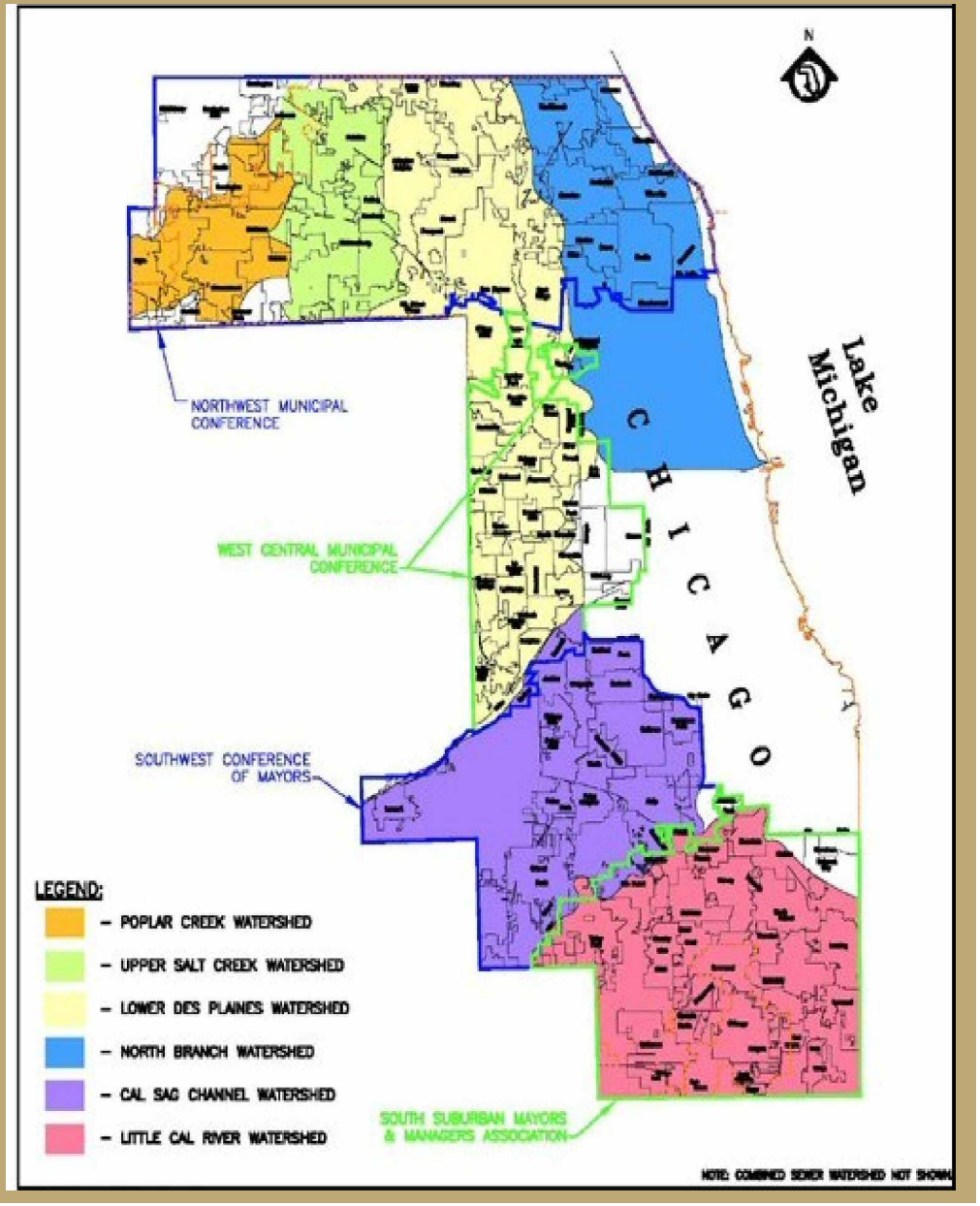

Presented by:

**Jennifer Maercklein, P.E., CFM**

**V3 Companies**

# Presentation Agenda

- Goals
- Model Errors Before Simulation Begins
- De-bugging Initial Conditions
- De-bugging Runtime Errors
- Resources for Help
- Questions

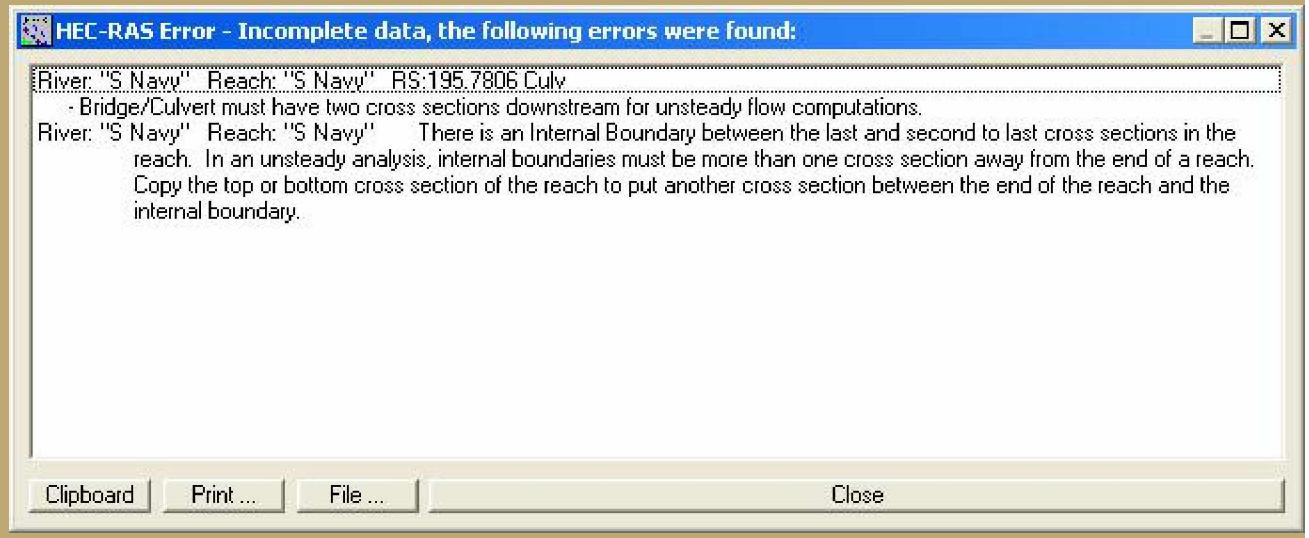


# Presentation Goals

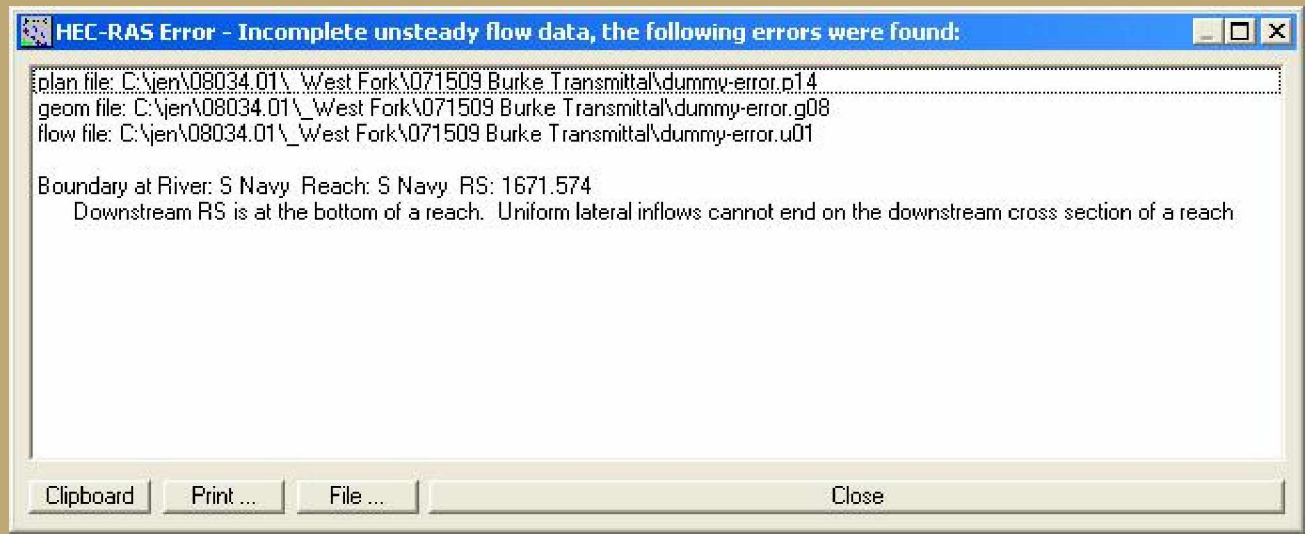
- Tips to get started with de-bugging
  - Useful HEC-RAS tools for debugging
  - Tips to find sources of error
- De-bugging ideas presented here do not represent an exhaustive list of de-bugging techniques
- Presentation Assumptions
  - Familiarity with HEC-RAS
  - Familiarity with Unsteady Flow Modeling

# Model Errors Before Simulation Begins

- Model Errors – Before Simulation Begins
  - Cross Section Location Errors

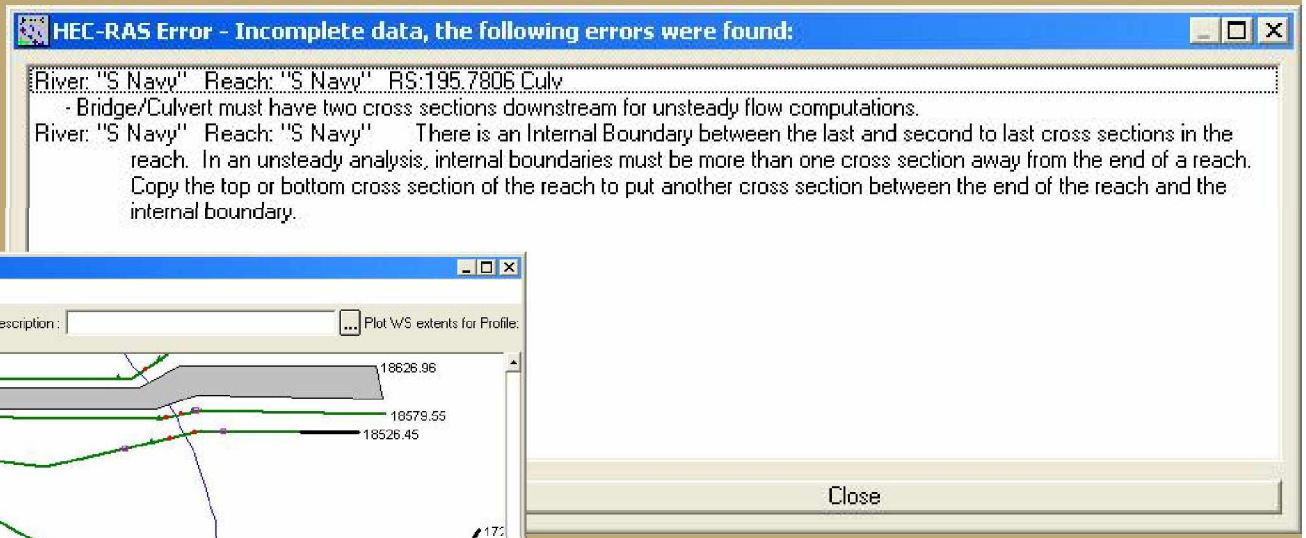


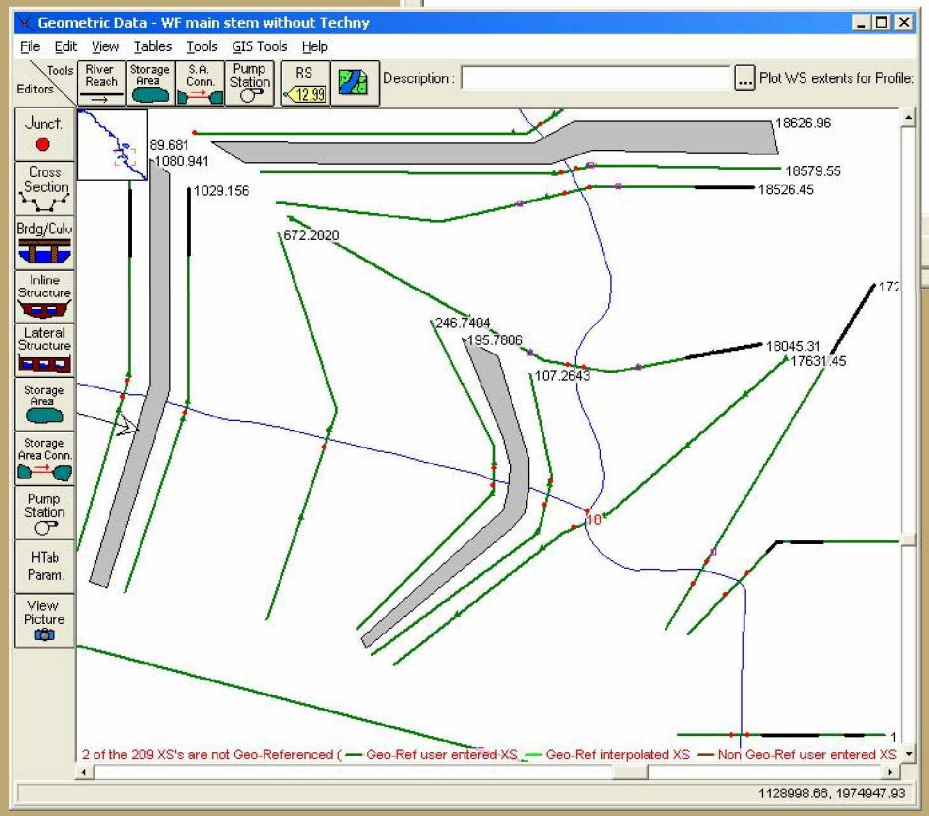

  - Unsteady Flow Inflow Errors



# Model Errors Before Simulation Begins

- Cross Section Locations

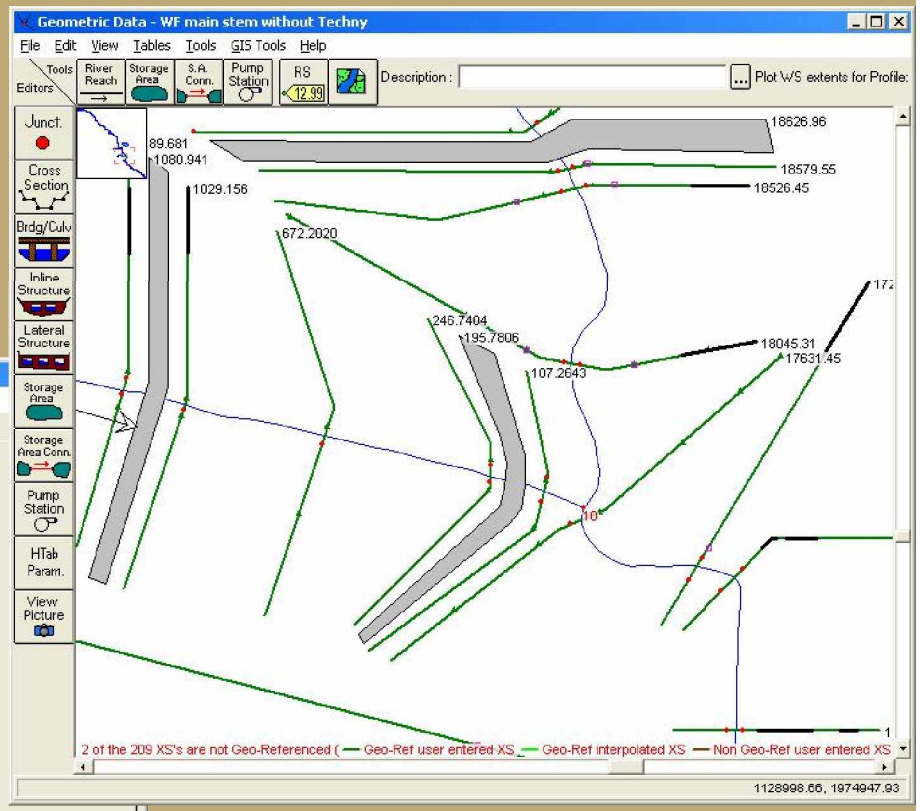


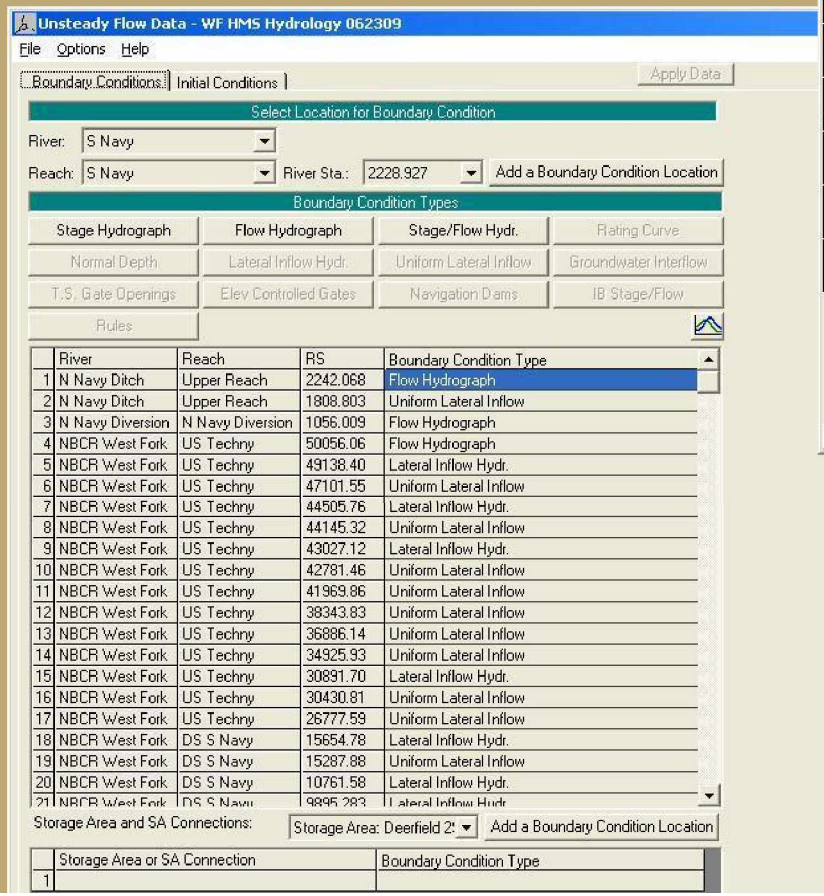




- Two XS d/s of each structure
- Two XS between internal boundary and confluence

# Model Errors Before Simulation Begins

- Unsteady Flow Inflow Errors



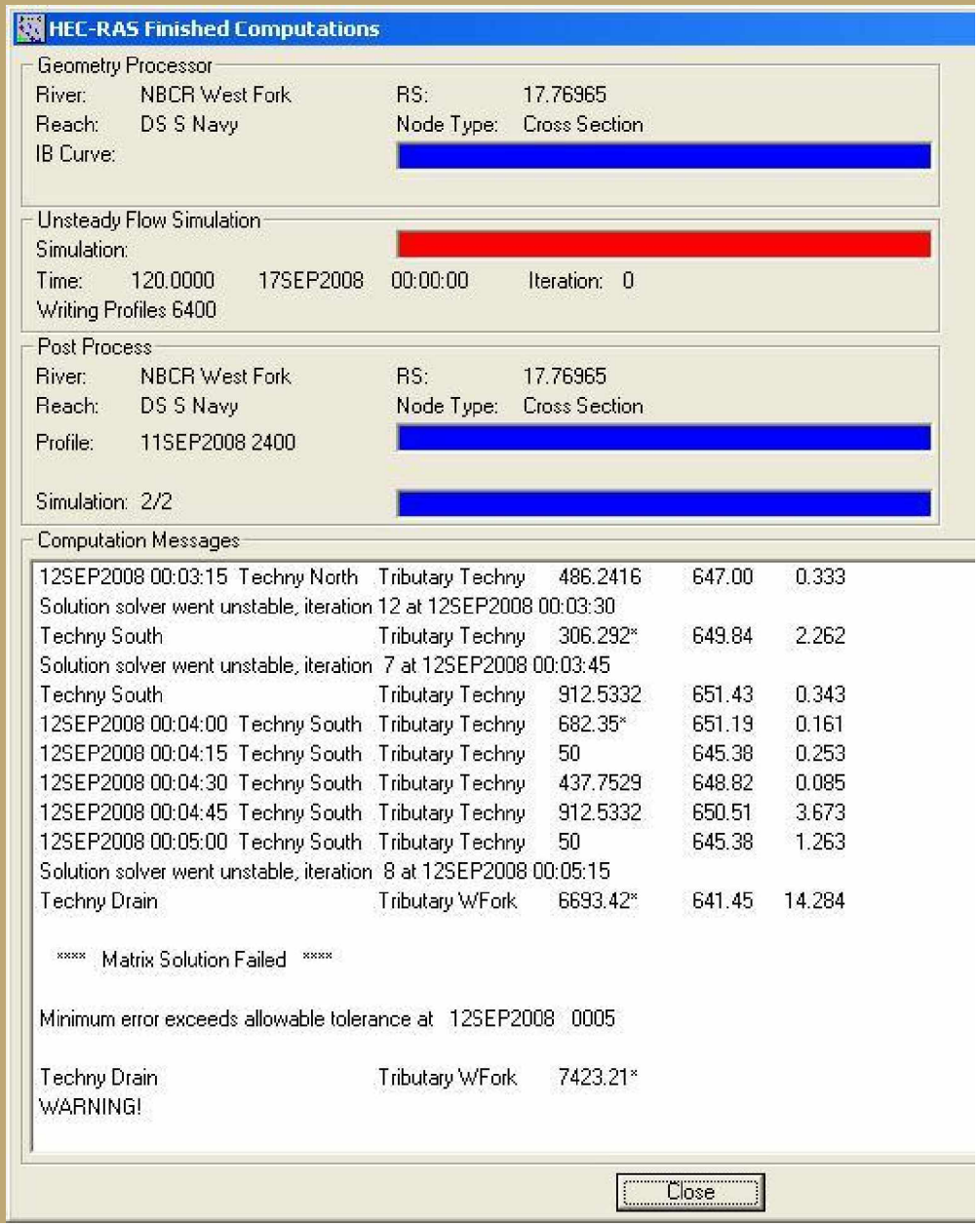

| | River | Reach | RS | Boundary Condition Type |
|---|---|---|---|---|
| 1 | N Navy Ditch | Upper Reach | 2242.068 | Flow Hydrograph |
| 2 | N Navy Ditch | Upper Reach | 1808.803 | Uniform Lateral Inflow |
| 3 | N Navy Diversion | N Navy Diversion | 1056.009 | Flow Hydrograph |
| 4 | NBCR West Fork | US Techny | 50056.06 | Flow Hydrograph |
| 5 | NBCR West Fork | US Techny | 49138.40 | Lateral Inflow Hydr. |
| 6 | NBCR West Fork | US Techny | 47101.55 | Uniform Lateral Inflow |
| 7 | NBCR West Fork | US Techny | 44505.76 | Lateral Inflow Hydr. |
| 8 | NBCR West Fork | US Techny | 44145.32 | Uniform Lateral Inflow |
| 9 | NBCR West Fork | US Techny | 43027.12 | Lateral Inflow Hydr. |
| 10 | NBCR West Fork | US Techny | 42781.46 | Uniform Lateral Inflow |
| 11 | NBCR West Fork | US Techny | 41969.86 | Uniform Lateral Inflow |
| 12 | NBCR West Fork | US Techny | 38343.83 | Uniform Lateral Inflow |
| 13 | NBCR West Fork | US Techny | 36886.14 | Uniform Lateral Inflow |
| 14 | NBCR West Fork | US Techny | 34925.93 | Uniform Lateral Inflow |
| 15 | NBCR West Fork | US Techny | 30891.70 | Lateral Inflow Hydr. |
| 16 | NBCR West Fork | US Techny | 30430.81 | Uniform Lateral Inflow |
| 17 | NBCR West Fork | US Techny | 26777.59 | Uniform Lateral Inflow |
| 18 | NBCR West Fork | DS S Navy | 15654.78 | Lateral Inflow Hydr. |
| 19 | NBCR West Fork | DS S Navy | 15287.88 | Uniform Lateral Inflow |
| 20 | NBCR West Fork | DS S Navy | 10761.58 | Lateral Inflow Hydr. |
| 21 | NBCR West Fork | DS S Navy | 9895.283 | Lateral Inflow Hydr. |

| | Storage Area or SA Connection | Boundary Condition Type |
|---|---|---|
| 1 | | |

- Uniform Lateral Inflow Can't Span Structures
- Uniform Lateral Inflow Can't End at D/S End of Reach

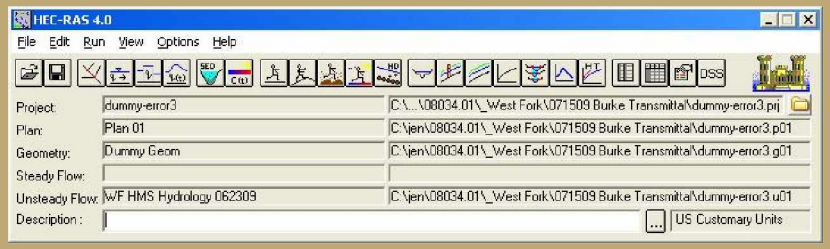
# De-bugging Initial Conditions

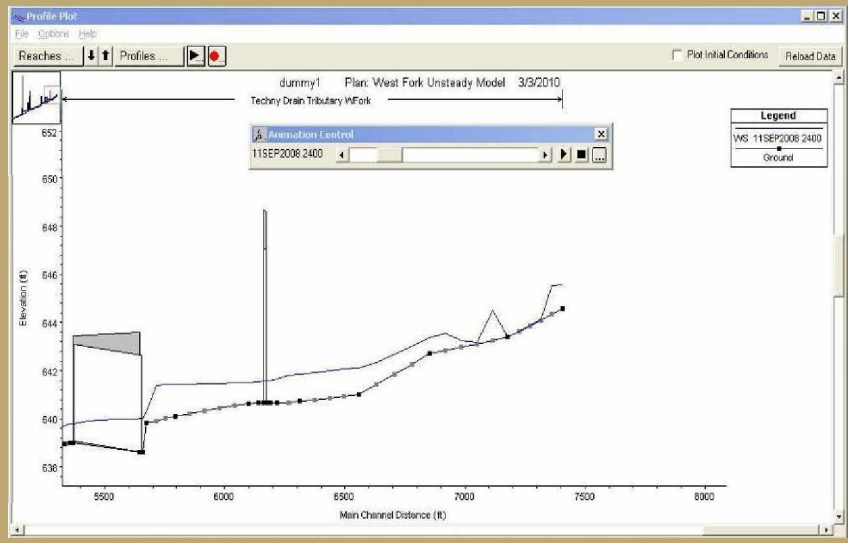
- Model crashes at beginning of simulation
- Problem with Initial Conditions
  - Flow too low, reaches go “dry”
  - Flow u/s of confluence ≠ flow d/s
  - Supercritical
- Computational Time Step

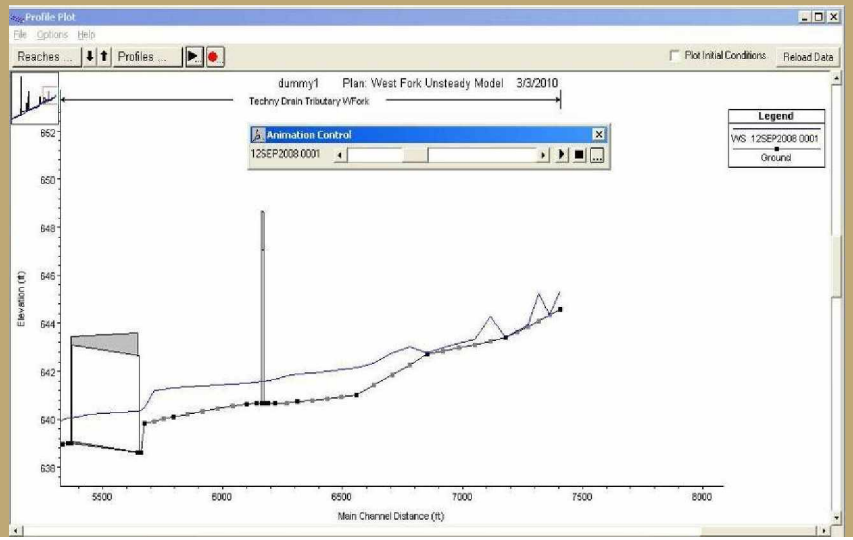


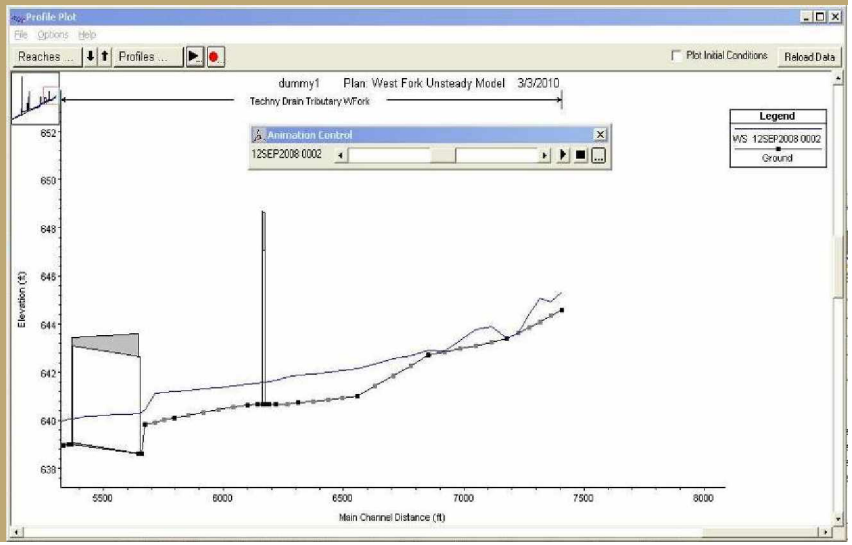
# De-bugging Initial Conditions

- Initial flow too low, reaches go “dry”
- Animate Profile



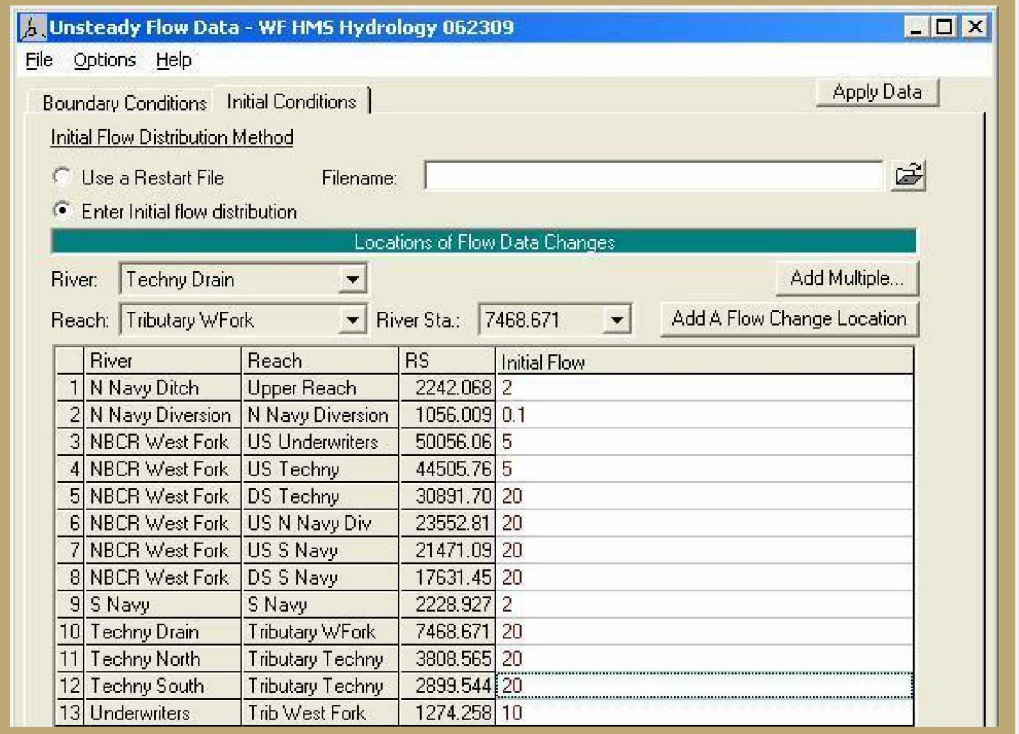



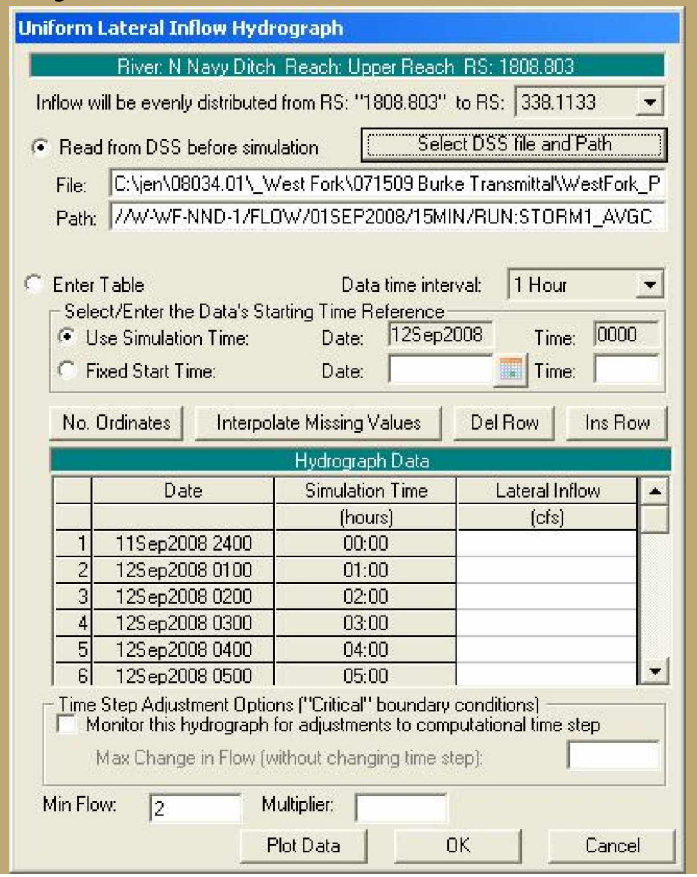



# De-bugging Initial Conditions

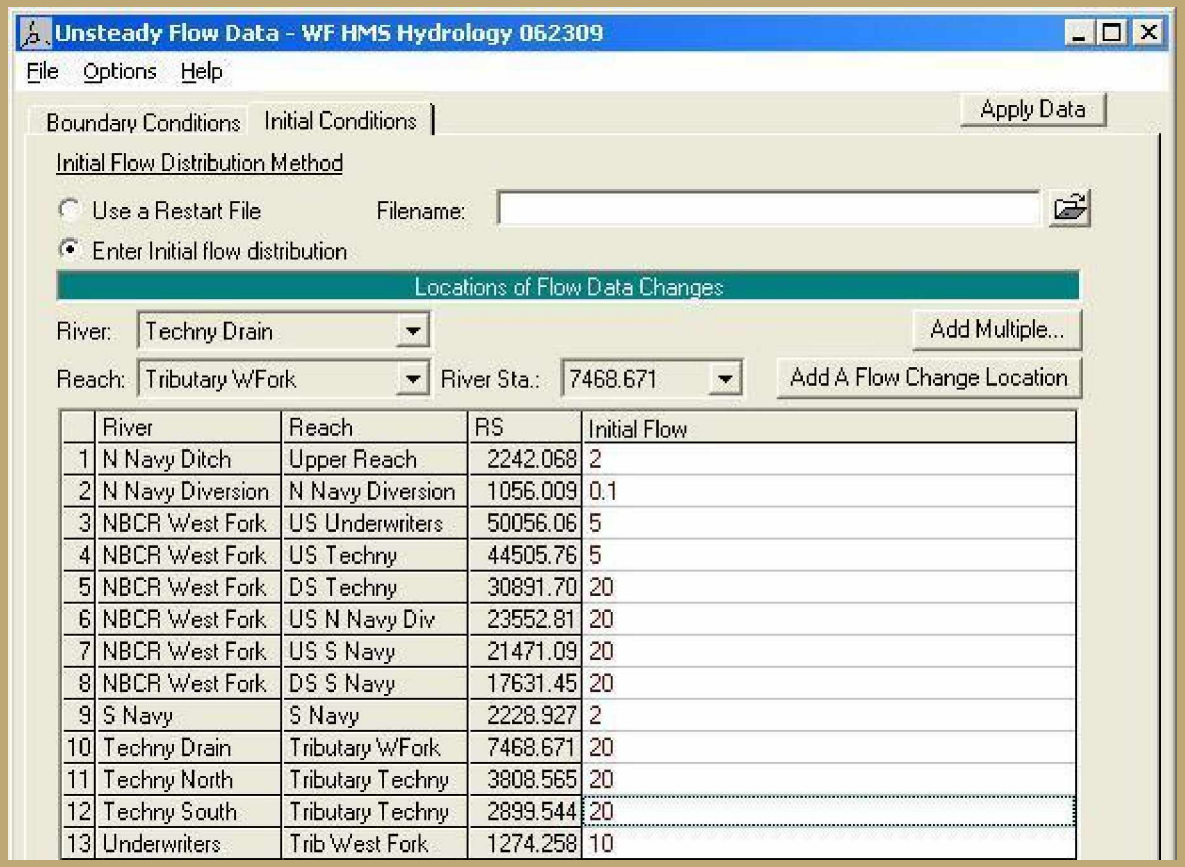
- Keep Reaches “Wet”
  - Check Initial Flows
  - Check Minimum Flows
  - Add Dummy Flow to Emergency/Diversion Channels



# De-bugging Initial Conditions

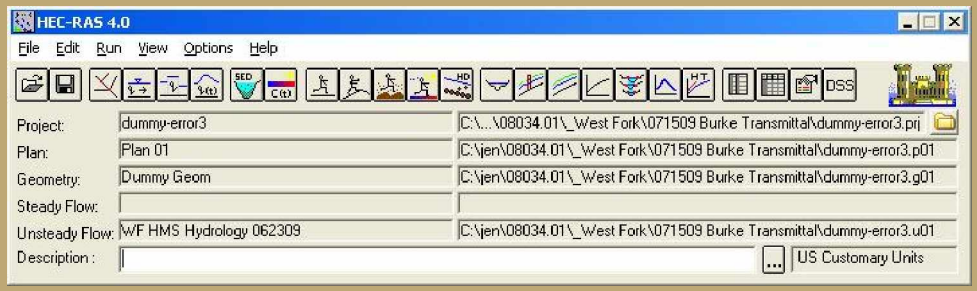
- Flow upstream of confluence not equal to flow downstream of confluence




| | River | Reach | RS | Initial Flow |
|---|---|---|---|---|
| 1 | N Navy Ditch | Upper Reach | 2242.068 | 2 |
| 2 | N Navy Diversion | N Navy Diversion | 1056.009 | 0.1 |
| 3 | NBCR West Fork | US Underwriters | 50056.06 | 5 |
| 4 | NBCR West Fork | US Techny | 44505.76 | 5 |
| 5 | NBCR West Fork | DS Techny | 30891.70 | 20 |
| 6 | NBCR West Fork | US N Navy Div | 23552.81 | 20 |
| 7 | NBCR West Fork | US S Navy | 21471.09 | 20 |
| 8 | NBCR West Fork | DS S Navy | 17631.45 | 20 |
| 9 | S Navy | S Navy | 2228.927 | 2 |
| 10 | Techny Drain | Tributary WFork | 7468.671 | 20 |
| 11 | Techny North | Tributary Techny | 3808.565 | 20 |
| 12 | Techny South | Tributary Techny | 2899.544 | 20 |
| 13 | Underwriters | Trib West Fork | 1274.258 | 10 |

# De-bugging Initial Conditions

- Supercritical Flow, Model Unable To Converge To Solution
- Review Summary Output Tables




Profile Output Table - Standard Table 1

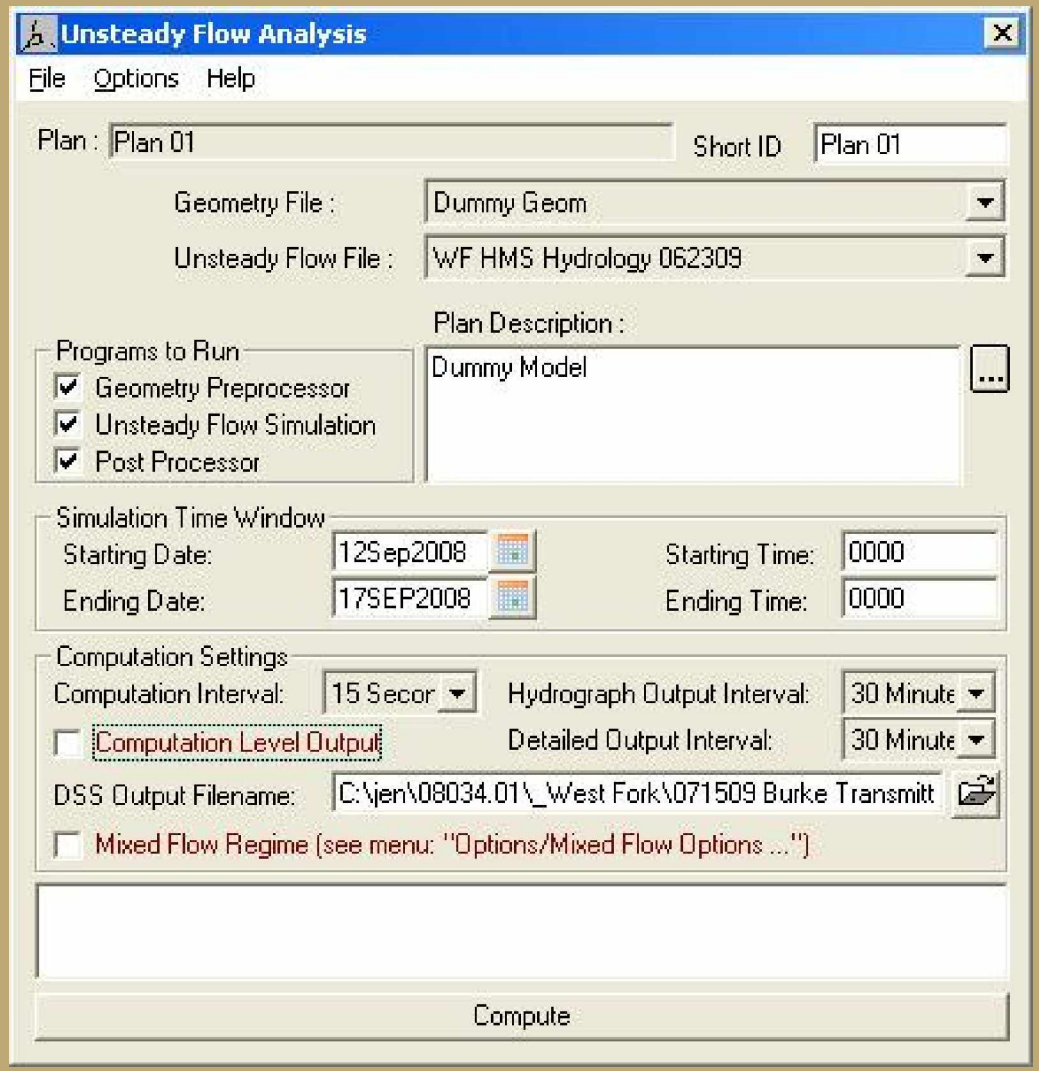
File Options Std. Tables User Tables Locations Help

HEC-RAS Plan: WestForkUnsteady River: Techny Drain Reach: Tributary WFork Profile: 12SEP2008 0005 (Reload Data)

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Tributary WFork | 7468.671 | 12SEP2008 0005 | -8.45 | 644.590 | 644.76 | 645 | 645 | 0 | -4 | 2 | 18 | 2.37 |
| Tributary WFork | 7423.21* | 12SEP2008 0005 | 28.06 | 644.350 | 645.60 | | 646 | 0 | 1 | 29 | 35 | 0.19 |
| Tributary WFork | 7377.75* | 12SEP2008 0005 | 26.67 | 644.110 | 645.11 | | 645 | 0 | 2 | 16 | 27 | 0.37 |
| Tributary WFork | 7332.28* | 12SEP2008 0005 | -2.91 | 643.870 | 643.91 | 644 | 966 | 4430 | -144 | 0 | 1 | 180.65 |
| Tributary WFork | 7286.82* | 12SEP2008 0005 | -2.08 | 643.630 | 643.65 | 644 | 3866 | 97357 | -456 | 0 | 0 | 765.95 |
| Tributary WFork | 7241.367 | 12SEP2008 0005 | -0.81 | 643.390 | 643.41 | 644 | 1846 | 36848 | -278 | 0 | 0 | 467.87 |
| Tributary WFork | 7176.16* | 12SEP2008 0005 | -1.68 | 643.250 | 643.48 | 644 | 644 | 1 | -5 | 0 | 3 | 2.74 |
| Tributary WFork | 7110.95* | 12SEP2008 0005 | -2.64 | 643.120 | 643.14 | 644 | 10859 | 364456 | -811 | 0 | 0 | 1361.85 |
| Tributary WFork | 7045.75* | 12SEP2008 0005 | 0.57 | 642.980 | 643.00 | 643 | 1059 | 15973 | 164 | 0 | 0 | 274.82 |
| Tributary WFork | 6980.54* | 12SEP2008 0005 | 3.95 | 642.850 | 643.47 | | 644 | 0 | 2 | 2 | 8 | 0.53 |
| Tributary WFork | 6915.343 | 12SEP2008 0005 | 4.46 | 642.710 | 643.57 | | 644 | 0 | 1 | 5 | 10 | 0.26 |
| Tributary WFork | 6841.37* | 12SEP2008 0005 | 5.63 | 642.280 | 643.51 | | 644 | 0 | 1 | 6 | 10 | 0.22 |
| Tributary WFork | 6767.39* | 12SEP2008 0005 | 4.50 | 641.850 | 642.68 | | 643 | 0 | 2 | 2 | 5 | 0.56 |
| Tributary WFork | 6693.42* | 12SEP2008 0005 | -5.23 | 641.430 | 642.48 | | 643 | 0 | -2 | 3 | 6 | 0.40 |
| Tributary WFork | 6619.455 | 12SEP2008 0005 | -8.29 | 641.000 | 641.68 | 642 | 642 | 0 | -6 | 1 | 4 | 1.94 |
| Tributary WFork | 6557.86* | 12SEP2008 0005 | -0.35 | 640.930 | 640.95 | 641 | 1421 | 32297 | -224 | 0 | 0 | 376.36 |
| Tributary WFork | 6496.26* | 12SEP2008 0005 | 3.22 | 640.860 | 642.04 | | 642 | 0 | 1 | 4 | 7 | 0.20 |
| Tributary WFork | 6434.67* | 12SEP2008 0005 | 2.39 | 640.800 | 641.94 | | 642 | 0 | 1 | 4 | 8 | 0.16 |
| Tributary WFork | 6373.082 | 12SEP2008 0005 | 2.36 | 640.730 | 641.89 | | 642 | 0 | 1 | 4 | 10 | 0.15 |
| Tributary WFork | 6326.95* | 12SEP2008 0005 | 2.43 | 640.690 | 641.84 | | 642 | 0 | 1 | 4 | 9 | 0.18 |
| Tributary WFork | 6280.837 | 12SEP2008 0005 | 2.52 | 640.660 | 641.66 | | 642 | 0 | 1 | 3 | 10 | 0.32 |

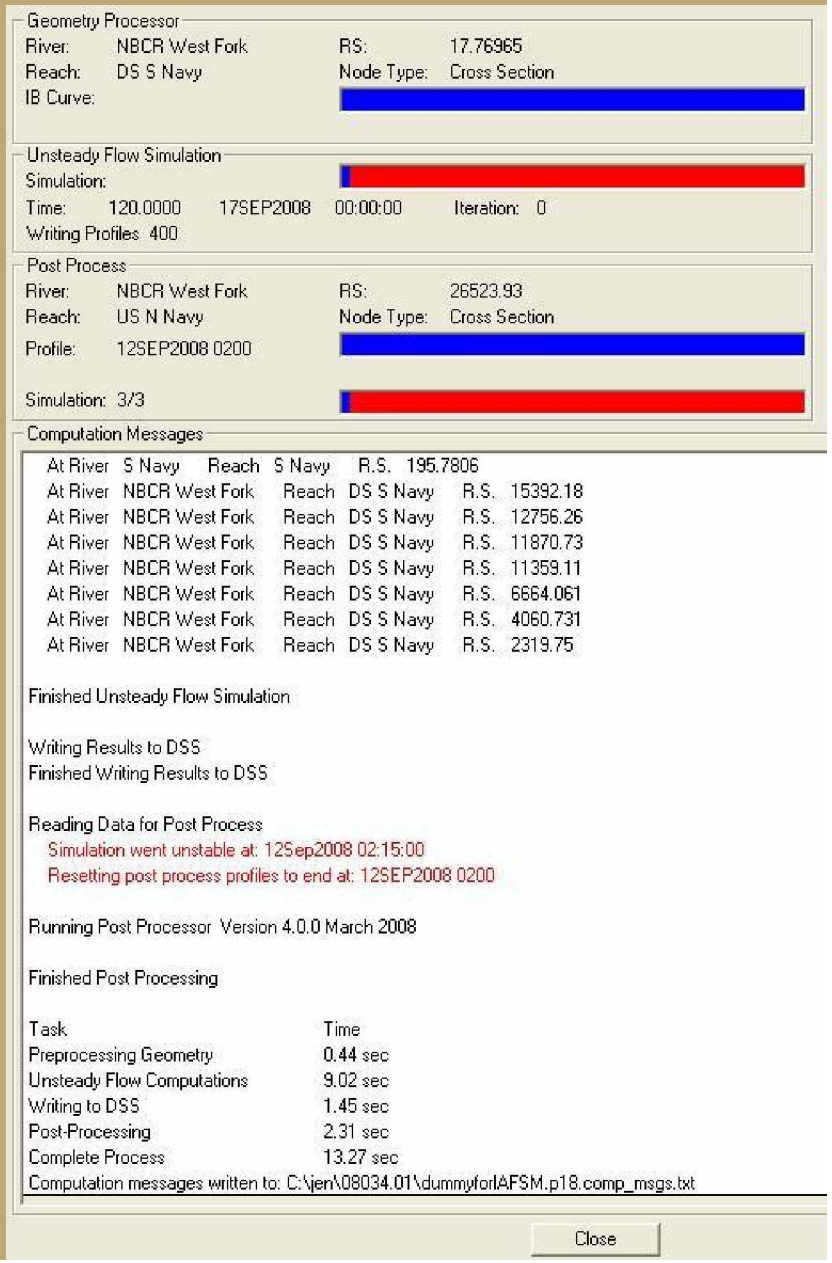
# De-bugging Initial Conditions

- Computational Parameters
  - May need shorter computational time step to allow HEC-RAS to converge
  - May need shorter output time step to enable user to see results at time of failure



# De-bugging Runtime Errors

- De-bugging Runtime Errors
- Identify Source of Model Crashes
  - Note time and location of model crash
  - Find problematic XS and consider HEC-RAS suggestions
- Heed Model Extrapolation Warnings

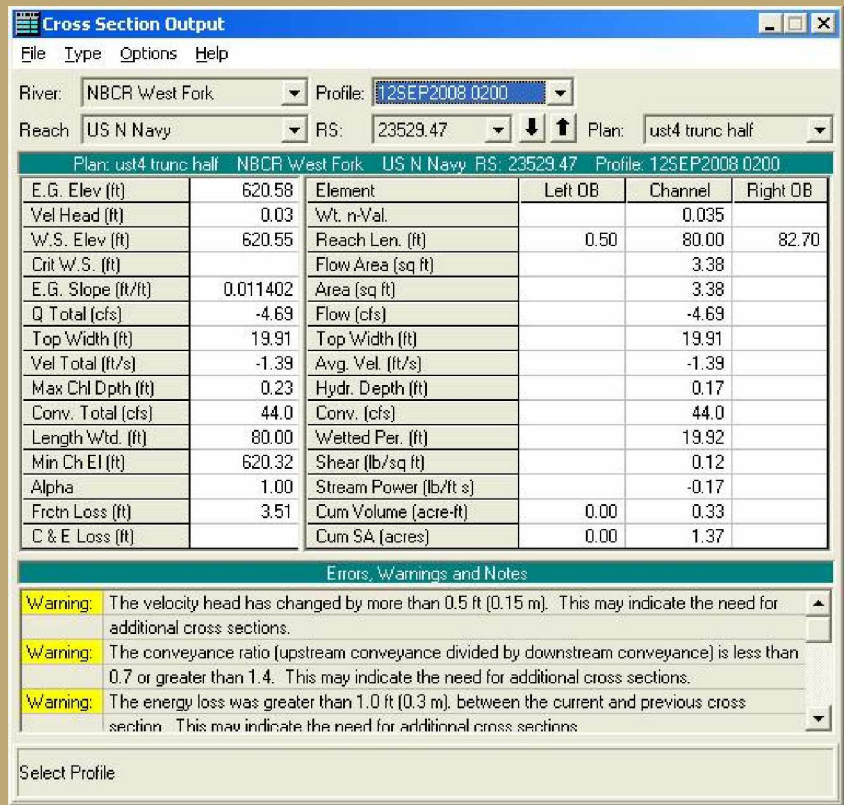


# De-bugging Runtime Errors

- Identify Source of Model Crashes
  - Note time and location of model crash

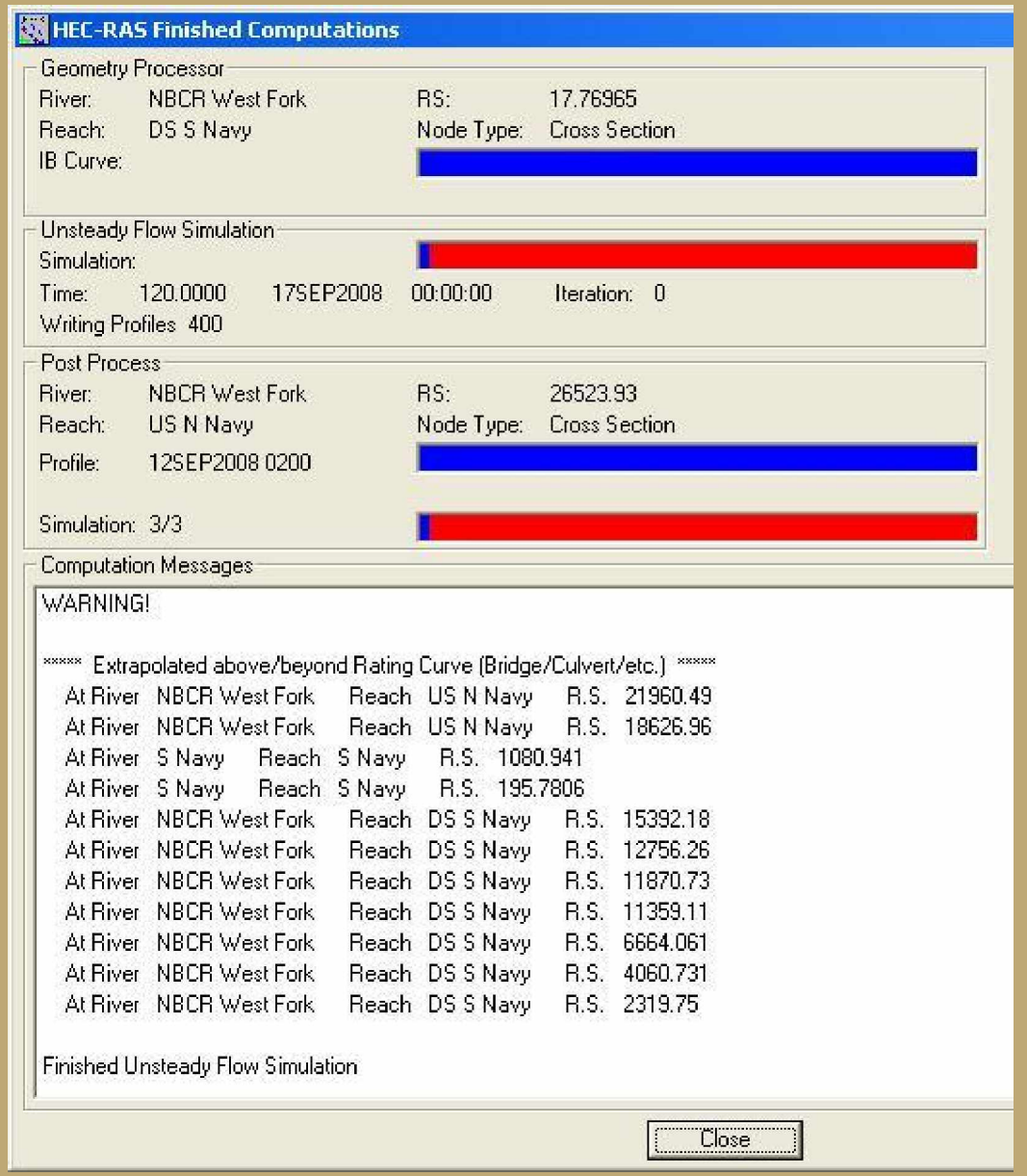
```
   *****   Matrix Solution Failed   *****
Minimum error exceeds allowable tolerance at   12SEP2008   0214
NBCR West Fork          US N Navy                23529.47
```

  - Review detailed output tables
  - Find problematic cross section and consider HEC-RAS suggestions
  - Often, just need more cross sections



# De-bugging Runtime Errors

- Heed Model Extrapolation Warnings
  - Adjust Hydraulic Table (HTab) Parameters
  - Adjust Storage Ratings

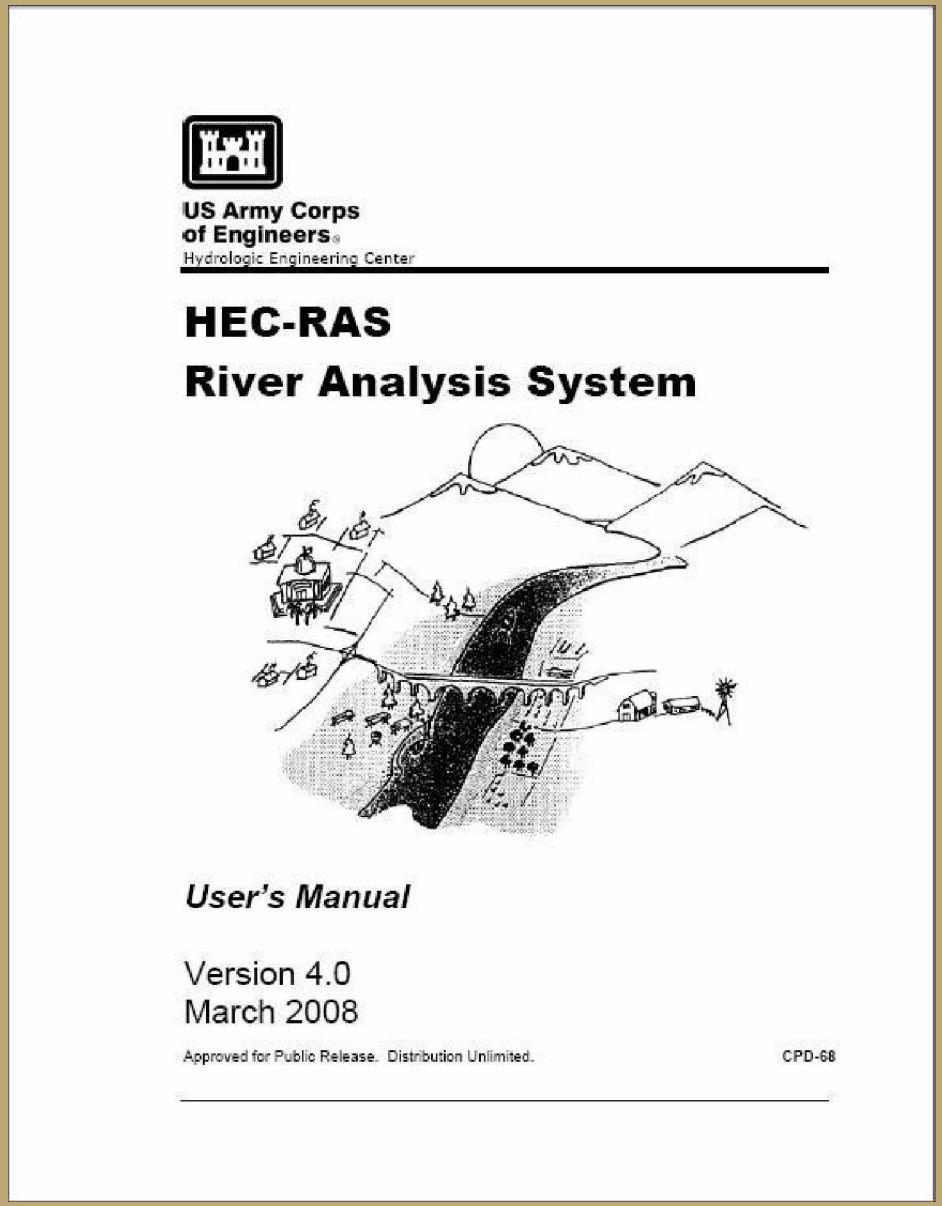


# Summary

- Start with Good XS Locations, Good Unsteady Flow Input Locations
- Use HEC-RAS Graphical & Tabular Tools
  - Review .txt file to find time & location of error
  - Animate Profile
  - Review Summary Output Tables
  - Review Detailed Output Tables
- Pay Attention to:
  - Initial Flows
  - Supercritical Flow
  - Cross Section Spacing
- Consider HEC-RAS Warnings

# Resources for Help

- Resources for Help
  - HEC-RAS Help
  - ASCE HEC-RAS Unsteady Flow Class and/or Class Manual



US Army Corps of Engineers
Hydrologic Engineering Center

**HEC-RAS**

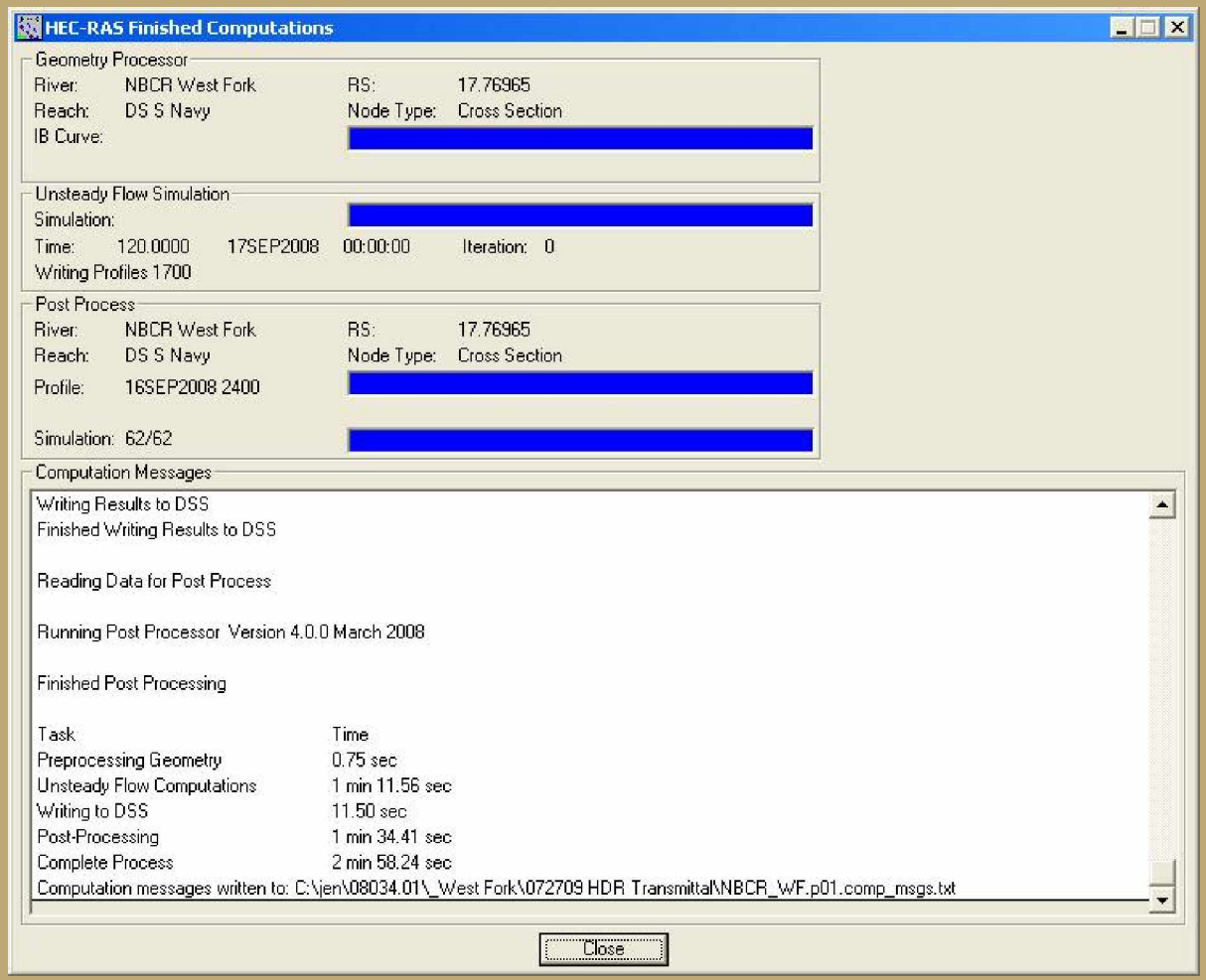
**River Analysis System**

***User's Manual***

Version 4.0
March 2008

Approved for Public Release. Distribution Unlimited. CPD-68

# Model Runs! Success!




**Questions?**