



# UPPER RAPIDAN RIVER BASIN BACTERIA TMDL DEVELOPMENT

Virginia Department of Environmental Quality  
Rappahannock-Rapidan Regional Commission  
Engineering Concepts, Inc.

FINAL PUBLIC MEETING  
March 27, 2007

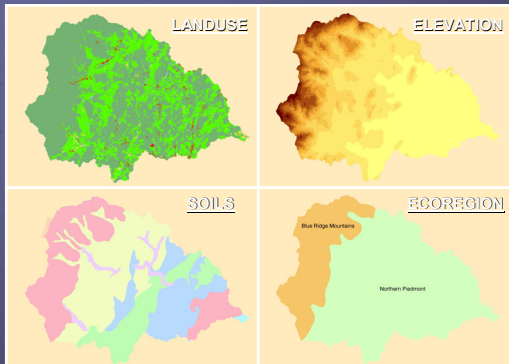


## TMDL DEVELOPMENT PROCESS

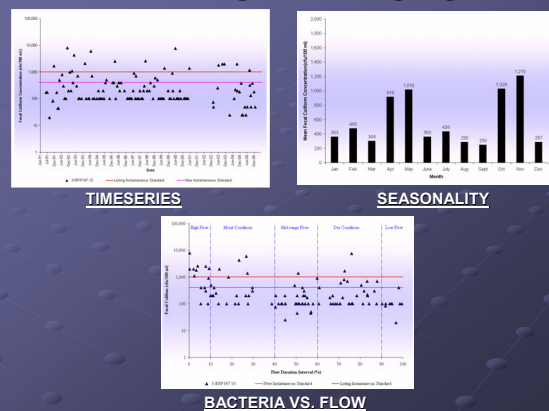
- WATERSHED HISTORY
  - Characterize watershed and identify critical contamination conditions
- SOURCE ASSESSMENT
  - Identify and quantify pollutant sources
- MODELING
  - Link pollutant sources to stream water quality
- ALLOCATION
  - Develop and evaluate reduction scenarios



## WATERSHED HISTORY



## WATERSHED HISTORY





## SOURCE ASSESSMENT

Source Category	Source / Animal Type
Human and Pets	Permitted Discharges
	Straight Pipes
	Failing Septic Systems
	Biosolids Applications
	Dogs / Cats
Agricultural	Dairy & Beef Cattle
	Horses
	Sheep
	Poultry
	Deer
Wildlife	Bears
	Turkeys
	Raccoons
	Muskrats
	Beavers
	Geese
	Ducks

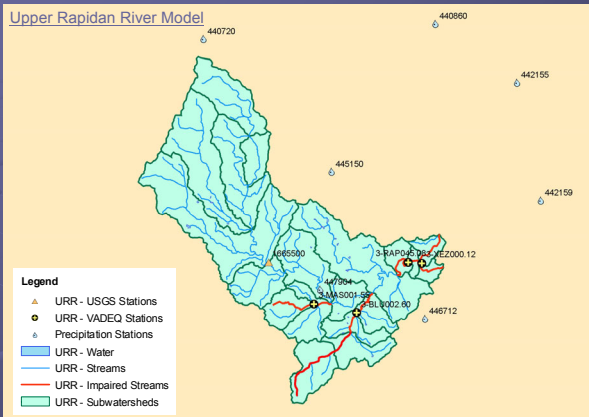


## MODELING

- Link pollutant sources to stream water quality
- Mathematically represent processes that are occurring in the watershed
- Processes
  - Hydrology – water balance
  - Water quality - pollutant fate and transport
- Accuracy Evaluation
  - Based on observed data
    - Flow: USGS gauge = model output
    - Bacteria: VADEQ station = model output

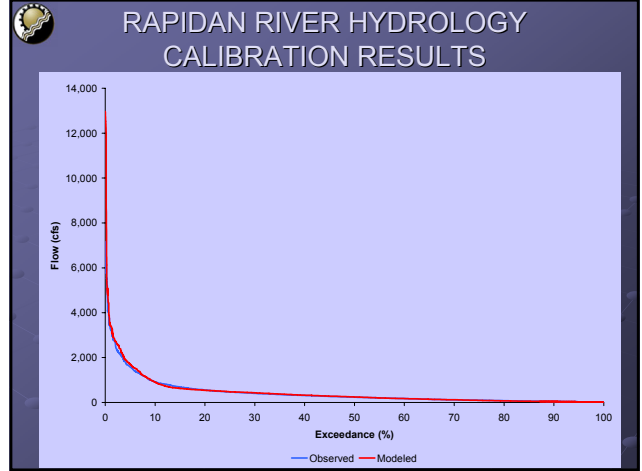
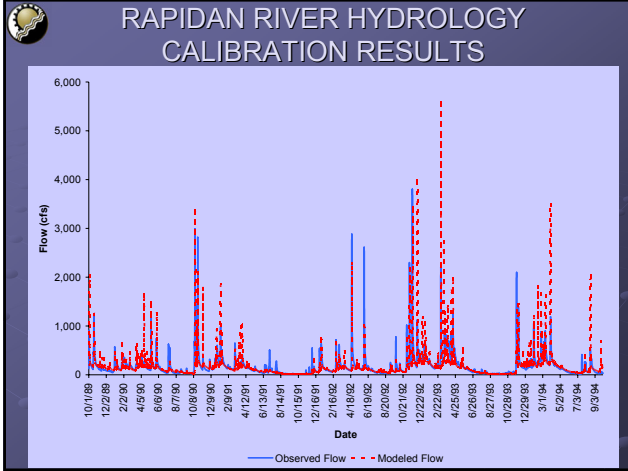


## MODELING



## HYDROLOGIC CALIBRATION

- Hydrograph shape
- Flow duration / cumulative frequency curve
- Flow partition
- Summary statistics



### RAPIDAN RIVER HYDROLOGY CALIBRATION RESULTS

Flow Pathway	Volume (in)	Volume (%)
Surface runoff	11.2	17
Interflow	10.0	15
Baseflow	45.3	68

### RAPIDAN RIVER HYDROLOGY CALIBRATION RESULTS

	Observed	Modeled	Calculated Error	Criterion
Total Flow Volume (in)	106.4	105.6	-0.8%	10%
Total of Highest 10% Flow Volume (in)	41.6	45.7	9.0%	15%
Total of Lowest 50% Flow Volume (in)	17.2	17.5	1.7%	10%
Total Winter Flow Volume (in)	37.9	38.4	1.3%	20%
Total Summer Flow Volume (in)	10.2	10.1	-1.0%	20%
Total Storm Volume (in)	98.1	100.8	2.7%	20%
Coefficient of Determination, $r^2$	0.77			

Period: 10/1/89 – 9/30/94

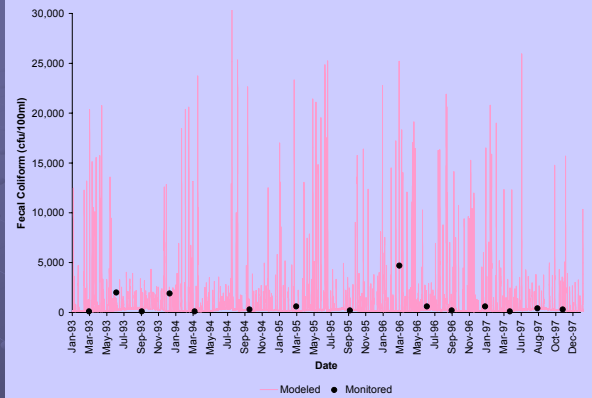


## WATER QUALITY CALIBRATION

- Qualitative - visual inspection
  - Hourly bacteria concentration from model versus grab sample collected by VADEQ
- Quantitative comparison
  - Geometric mean
  - Water quality standard exceedance rate



## BLUE RUN WQ CALIBRATION



## BLUE RUN WQ CALIBRATION

Parameter	Calibration
Geometric mean of VADEQ values (cfu/100mL)	383
Geometric mean of modeled values (cfu/100mL)	405
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of VADEQ values (%)	20
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of modeled values (%)	20
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of VADEQ values (%)	40
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of modeled values (%)	40



## ALLOCATION

1. Calculate design loads for point sources and existing loads for non-point sources
2. Create load reductions scenarios controlling anthropogenic sources first
3. Run model with scenarios
4. Calculate geometric mean and instantaneous water quality standard (WQS) exceedance rate
5. Select scenario with 0% geometric mean and instantaneous water quality WQS exceedance rate



## RAPIDAN RIVER ALLOCATION

Point Source	Permit #	Design Flow (MGD)	Existing Condition Load (cfu/yr)
Rapidan STP	VA0090948	0.600	1.66E+12
Greene County WTP	VA0051144	0.026	0.00E+00
Rapidan Baptist Camp and Conference Center	VA0060879	0.020	5.52E+10
Orange Town Water Treatment Plant	VA0053121	0.266	0.00E+00
Orange Town WWTP	VA0021385	3.000	8.29E+12
Spicers Mill STP	VA0092053	0.090	2.49E+11
Woodberry Forest School	VA0027839	0.039	1.08E+11



## RAPIDAN RIVER ALLOCATION

Non-point Source	Existing Condition Load (cfu/yr)
<b>Direct Deposition</b>	
Straight Pipes	2.19E+14
Livestock	1.49E+14
Wildlife	1.19E+14
<b>Total</b>	<b>4.87E+14</b>
<b>Land-based</b>	
Residential	3.09E+15
Cropland	8.56E+14
Pasture	1.37E+17
Forest	7.70E+14
<b>Total</b>	<b>1.42E+17</b>



## RAPIDAN RIVER ALLOCATION

Scenario Number	Percent Reduction in Fecal Coliform Loading from Existing Conditions							% Violations of E. coli WQS	
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest	GM	Instant.
0	0	0	0	0	0	0	0	80.0	39.8
1	100	100	0	0	0	0	0	26.7	33.6
2	100	100	0	75	75	75	0	3.3	11.2
3	100	100	0	95	95	95	0	0.0	0.6
4	100	100	0	98	98	98	0	0.0	0.0
5	100	98	0	98	98	98	0	0.0	0.0



## RAPIDAN RIVER ALLOCATION

Facility Name	Permit #	Existing Condition Load (cfu/yr)	Loading Reduction (%)	Allocation Condition Load (cfu/yr)
Rapidan STP	VA0090948	1.66E+12	0	1.66E+12
Greene County WTP	VA0051144	0.00E+00	0	0.00E+00
Rapidan Baptist Camp and Conference Center	VA0060879	5.52E+10	0	5.52E+10
Orange Town Water Treatment Plant	VA0053121	0.00E+00	0	0.00E+00
Orange Town WWTP	VA0021385	8.29E+12	0	8.29E+12
Spicers Mill STP	VA0092053	2.49E+11	0	2.49E+11
Woodberry Forest School	VA0027839	1.08E+11	0	1.08E+11

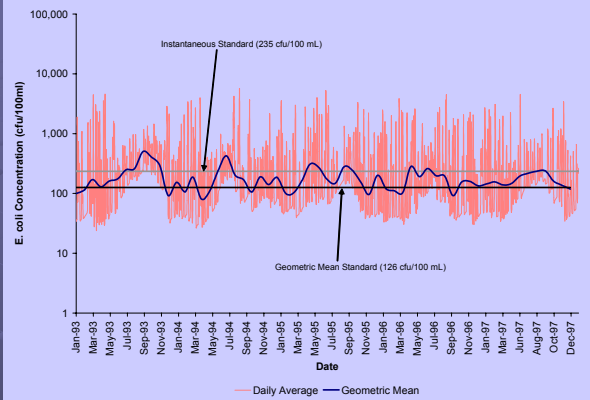


## RAPIDAN RIVER ALLOCATION

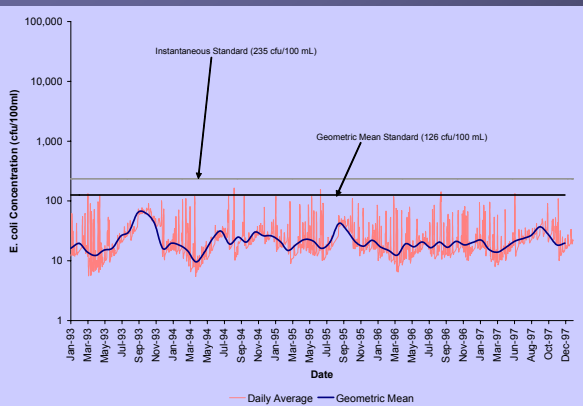
Source	Existing Condition Load (cfu/yr)	Scenario 5 Reduction (%)	Source	Allocation Condition Load (cfu/yr)
<b>Direct Deposition</b>				<b>Direct Deposition</b>
Straight Pipes	2.19E+14	100	Straight Pipes	0.00E+00
Livestock	1.49E+14	98	Livestock	2.97E+12
Wildlife	1.19E+14	0	Wildlife	1.19E+14
<b>Total</b>	<b>4.87E+14</b>		<b>Total</b>	<b>1.22E+14</b>
<b>Land-based</b>			<b>Land-based</b>	
Residential	3.09E+15	98	Residential	6.18E+13
Cropland	8.56E+14	98	Cropland	1.71E+13
Pasture	1.37E+17	98	Pasture	2.74E+15
Forest	7.70E+14	0	Forest	7.70E+14
<b>Total</b>	<b>1.42E+17</b>		<b>Total</b>	<b>3.59E+15</b>



## RAPIDAN RIVER EXISTING CONDITIONS



## RAPIDAN RIVER ALLOCATION CONDITIONS



## ALLOCATION REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Marsh Run (VAN-E13R-03)	100	98	0	98	98	98	0
Blue Run (VAN-E13R-01)	100	99	30	99	99	99	0
UT to Rapidan (VAN-E13R-04)	100	99	38	99	99	99	0
Rapidan River (VAN-E13R-02)	100	98	0	98	98	98	0



## IMPLEMENTATION PLAN DEVELOPMENT

- Next phase of TMDL process after USEPA TMDL approval
- Outlines plan to link load reductions specified in TMDL Development Study to corrective actions (e.g., BMPs)
- Two-stage process



## TMDL IMPLEMENTATION

- Stage I:
  - Attain water quality standard enabling delisting of streams from Section 303(d) List of Impaired Waters
- Stage II:
  - Attainment of TMDL source load allocations required under WQMIRA and USEPA to receive Section 319 grant funds to fund implementation



## STAGE 1 IMPLEMENTATION

1. Calculate design loads for point sources and existing loads for non-point sources
2. Create load reductions scenarios controlling anthropogenic sources only
3. Run model with scenarios
4. Calculate instantaneous WQS exceedance rate
5. Select scenario with less than 10% instantaneous WQS exceedance rate



## STAGE 1 REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Marsh Run (VAN-E13R-03)	100	75	0	75	75	75	0
Blue Run (VAN-E13R-01)	100	90	0	78	78	78	0
UT to Rapidan (VAN-E13R-04)	100	75	0	75	75	75	0
Rapidan River (VAN-E13R-02)	100	95	0	78	78	78	0



## DRAFT TMDL REPORT, LOCATED:

- **VADEQ website:**

[http://gisweb.deq.virginia.gov/tmdlapp/tmdl\\_draft\\_reports.cfm](http://gisweb.deq.virginia.gov/tmdlapp/tmdl_draft_reports.cfm)

- **Rappahannock-Rapidan Regional Commission website:**

<http://www.rrregion.org/rappbasin.html>



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