

HYDRAULIC MODEL OF THE BELLE FOURCHE IRRIGATION DISTRICT USING EPA SWMM 5.0



BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP



OVERVIEW

- Background
- Problem and project goal
- Model goal and development
- Model calibration
 - Data collection
 - Process
 - Results
- Sources of error/uncertainty
- Sensitivity analysis
- Validation plans

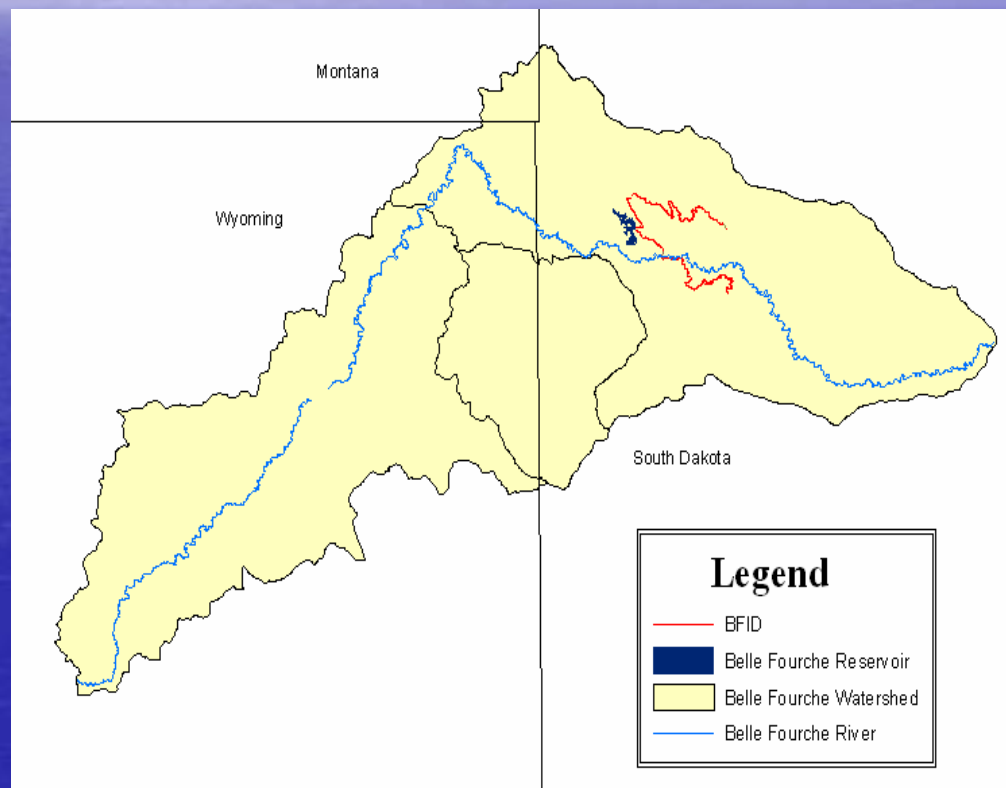


BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP



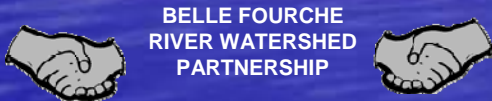
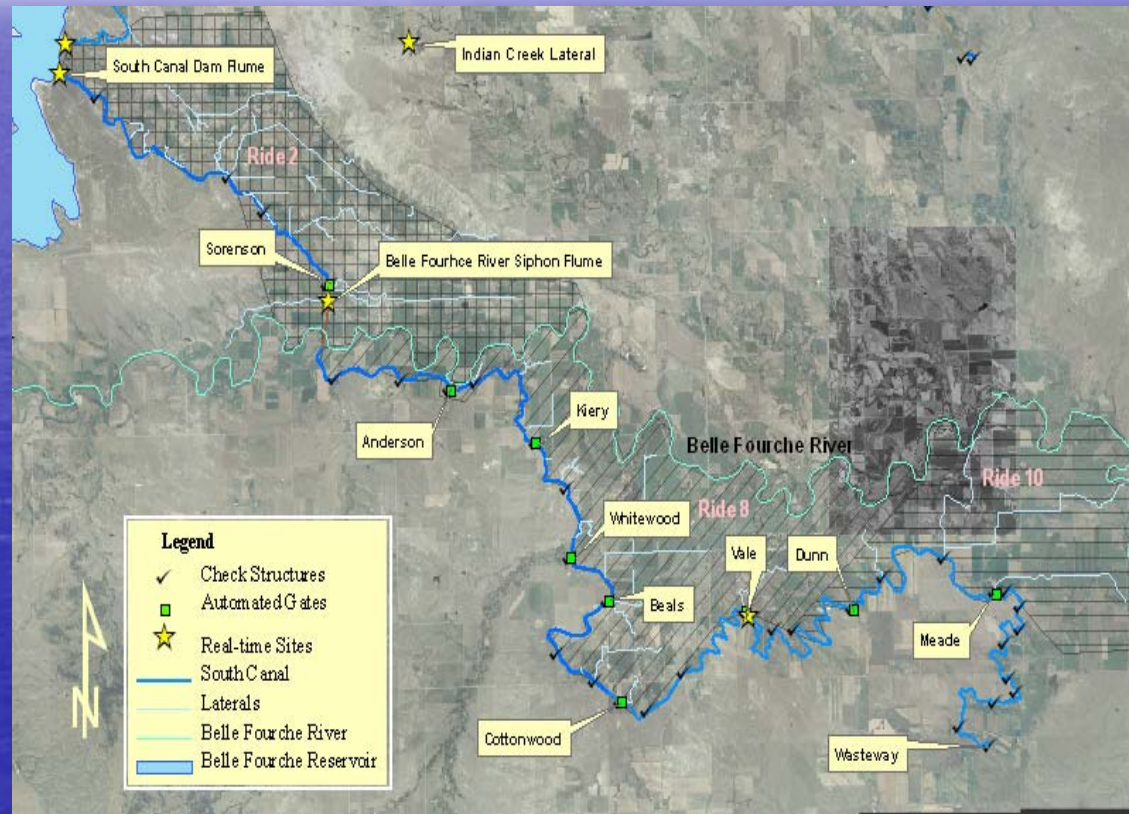
BACKGROUND

- 5 million acre Belle Fourche River watershed
- Belle Fourche Irrigation District (BFID)
 - Operates for USBR
 - Allotment from Belle Fourche Reservoir
 - Services 57,000 acres
 - North Canal – 43 miles
 - South Canal – 44 miles
 - 450 miles of laterals
 - Primarily flood-type



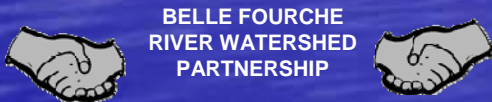
BACKGROUND

- BFID South Canal
 - 32 Checks
 - ~130 turnout and lateral head gates
 - ~30 bridges and road crossings
 - 3 Parshall flumes
 - 5 Siphons



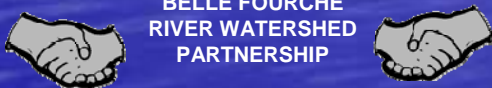
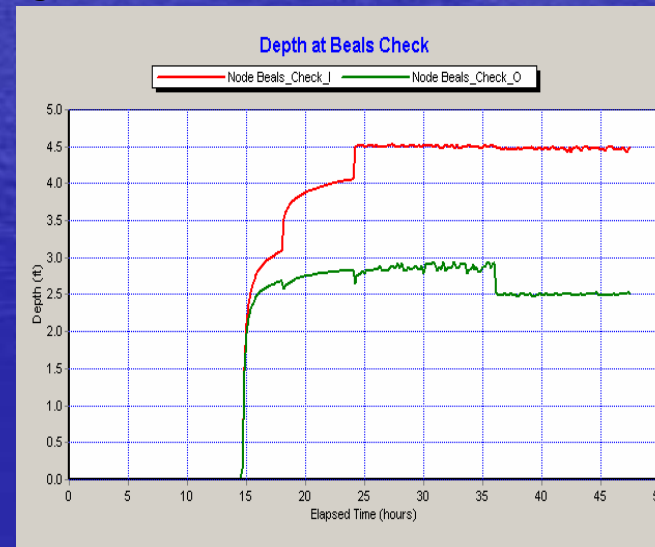
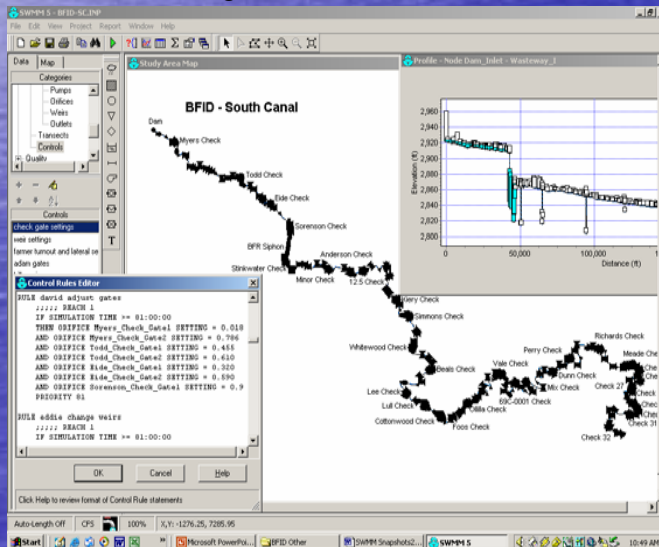
PROBLEM and PROJECT GOAL

- **PROBLEM:** Elevated total suspended solids (TSS) concentrations in Belle Fourche River
- **GOAL:** Implement best management practices (BMPs) to bring Belle Fourche River into compliance:
 - Riparian habitat management
 - Flow automation units
 - Operational model



HYDRAULIC MODEL

- GOAL: Provide useful information to make decisions and adjustments
- BFID South Canal model:
 - EPA Storm Water Management Model (SWMM) 5.0
 - USBR survey data and contract drawings, field measurements

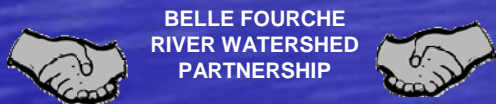


CALIBRATION DATA

- Reach 1 – Dam Flume to Belle Fourche River Siphon (BFRS) Flume
- Reach 2 – BFRS Flume to Beals Check
- Reach 3 – Beals Check to Vale Flume

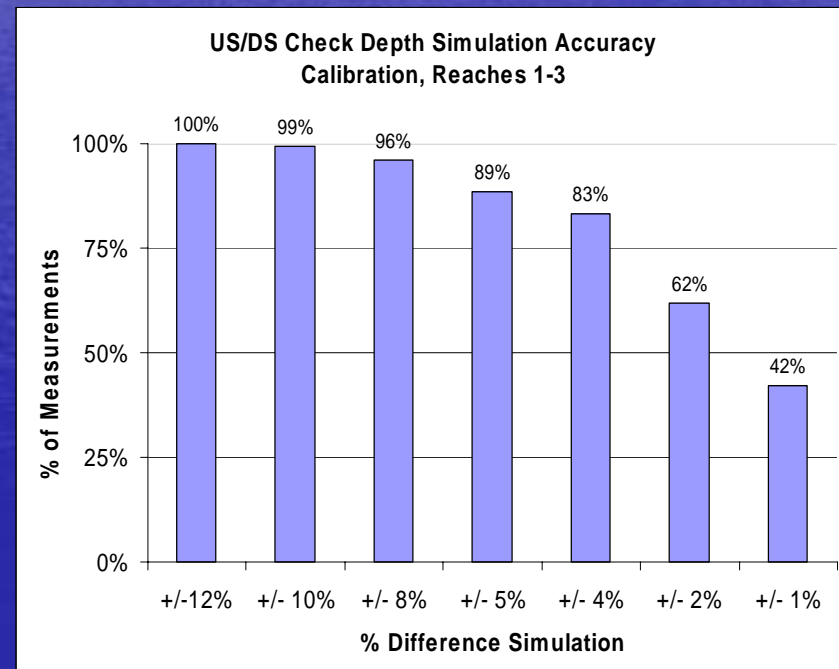
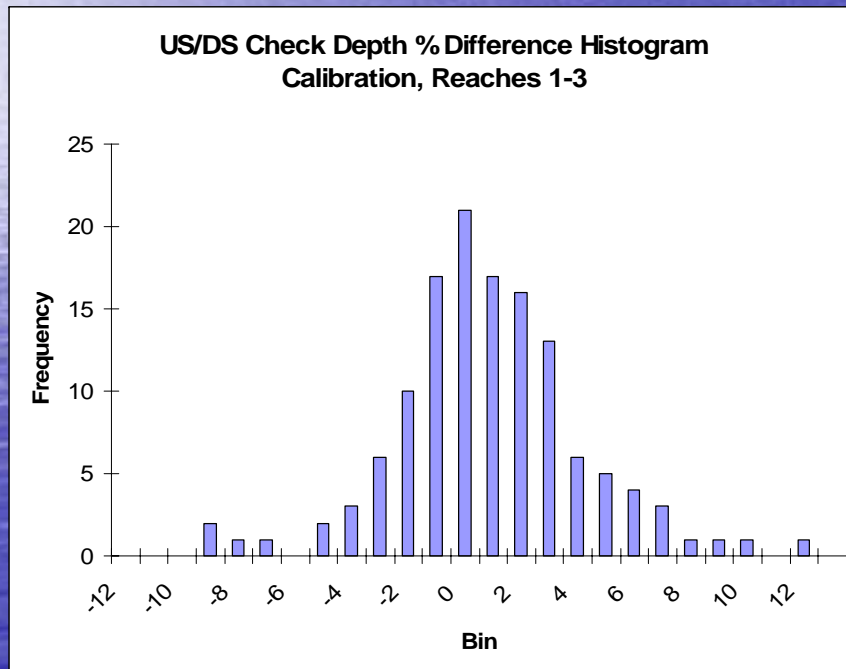


- Flows
- Stages
- Structure Settings



CALIBRATION RESULTS

- Calibration: 99% of predictions +/-10% depth difference
- Calibration check/validation: 89% of predictions +/-10% depth difference



BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP



CALIBRATION RESULTS

Structure	Loss Coefficients	
	Entrance	Exit
Box Culvert	0.5	0.5
Check	0.4	1
Flume	0.4	1
Pipe Bend	0.2	0.2
Siphon	0.4	1

Check Structure	Discharge Coefficients	
	Orifice/Gate	Weir
Meyer	0.67	3.0
Todd	0.67	3.3
Eide	0.60	3.1
Sorenson	0.30	1.5
Stinkwater	0.40	2.6
Minor	0.70	3.0
Anderson	1.00	3.3
12.5	0.65	2.8
Kiery	0.60	2.6
Simmons	0.55	2.6
Whitewood	1.00	3.3
Beals	0.70	2.8
Lee	0.50	2.6
Lull	0.50	2.6
Cottonwood	0.60	2.0
Foos	0.45	2.6
Ollilla	0.65	2.6
Vale	0.50	2.6

Canal Section	Canal Mile	Manning's n
<i>Concrete Structures</i>	-----	0.013
Dam to Todd	0 - 5	0.015
Todd to Eide	5 - 6.2	0.031
Eide to Sorenson	6.2 - 7.7	0.019
Sorenson to BFRS I	7.7 - 8	0.039
BFRS O to Stinkwater	8 - 9.4	0.023
Stinkwater to Minor	9.4 - 11	0.022
Minor to 12.5	11 - 12.5	0.027
12.5 to Kiery	12.5 - 15.1	0.032
Kiery to Simmons	15.1 - 16.2	0.022
Simmons to Whitewood	16.2 - 17.4	0.024
Whitewood to Beals	17.4 - 18.6	0.028
Beals to Lee	18.6 - 20.6	0.010
Lee to Lull	20.6 - 21.5	0.009
Lull to Cottonwood	21.5 - 22.1	0.010
Cottonwood to Foos	22.1 - 22.7	0.022
Foos to Ollilla	22.7 - 23.7	0.017
Ollilla to Vale	23.7 - 26.4	0.017
Vale to Wasteway	26.4 - 43.8	0.025



BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP



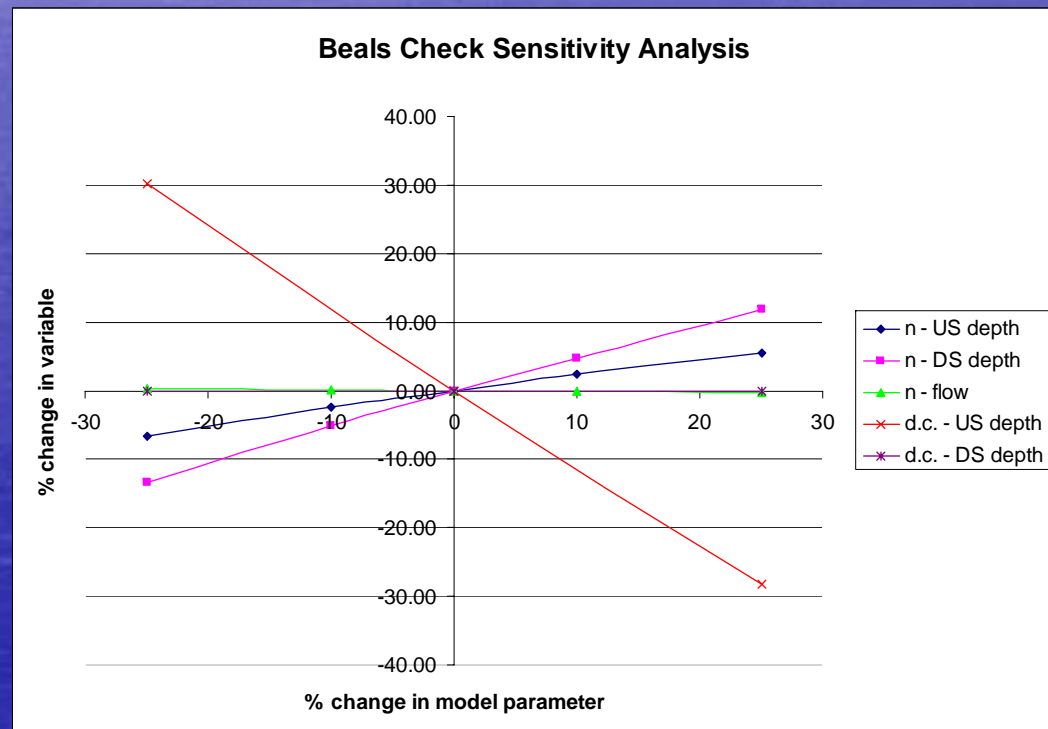
SOURCES OF ERROR

- Field measurements:
 - US water 'piling'
 - DS turbulence
 - Measurement device 'eyeball' accuracy
 - Two measurers
- Flow measurements:
 - Velocity stability
 - Approximations in methods and calcs
- Data logger:
 - Depth corrections
 - Transducer float
 - Submergence



SENSITIVITY ANALYSIS

- Check structure depths sensitivity to:
 - Manning's n
 - Gate and weir discharge coefficients
- Manning's n analyzed in two ways:
 - Changed entire canal
 - Changed to nearest US and DS check structures
- Discharge coefficients: changed all gate and weir
- Key check structures, similar results:
 - Sorenson: mile 8
 - Beals: mile 19
 - Vale: mile 26



MODEL VALIDATION

- 2006 irrigation season
 - Fine-tune model
 - Develop BFID-model relationship
 - Run daily, compare w/ actual system
 - Conduct operational model process
- BFID model uses:
 - Water timing issues
 - Range of structure settings
 - Check structure operation curves
 - Check on human errors



BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP



QUESTIONS?

Producers

BFRWP

SD DENR

Lawrence County

BFID

WY DEQ

Conservation Commission

Whitewood Creek Compensation Fund

SRF Loans

USFWS

SDGF&P

CRP

WHIP

EQIP

COE

BOR

USGS



BELLE FOURCHE
RIVER WATERSHED
PARTNERSHIP

