IGSM2 RESERVOIR OPERATIONS MODULE

WRIME, Inc.

JUNE 27, 2003

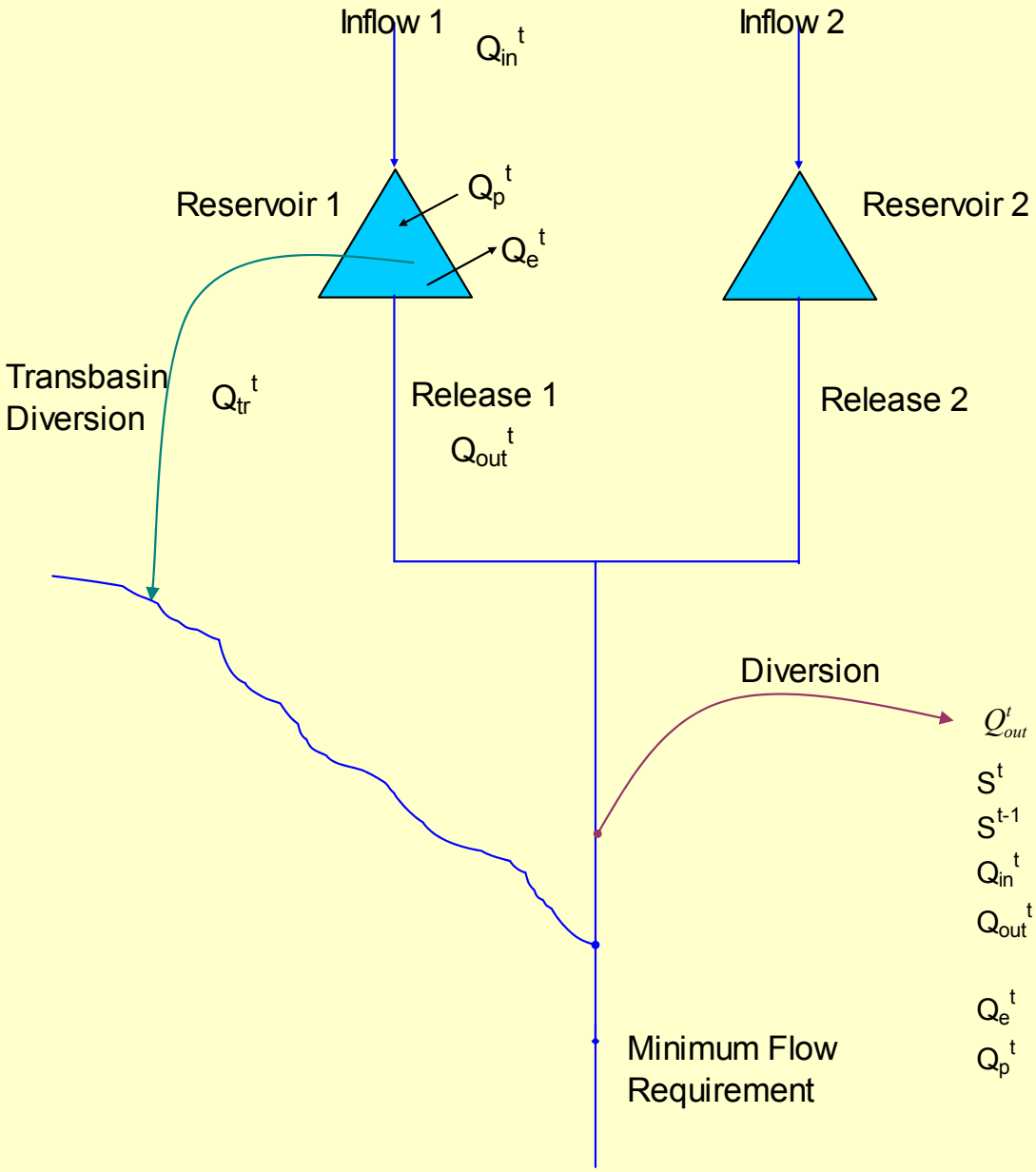
SCOPE OF WORK

- Transfer reservoir operations and water release priorities module from IGSM 5.0 to IGSM2:
  - Incorporate model source code from IGSM 5.0 into IGSM2
  - Test IGSM2 reservoir operations module on sample problems
  - Prepare documentation for revised IGSM2 input and output files, and source code

GENERAL OPERATIONS RULES

- Allocating natural flows and reservoirs storage to multiple water release priority holders
- Regulating reservoirs to meet flood control criteria
- Meeting downstream minimum flow requirements

SCHEMATIC OF IGSM RESERVOIR OPERATIONS SIMULATION



$$Q_{out}^{t} = S^{t-1} - S^{t} + Q_{in}^{t} - Q_{e}^{t} + Q_{p}^{t} - Q_{tr}^{t}$$

S^{t} = Reservoir storage at time t

S^{t-1} = Reservoir storage at previous time t-1

Q_{in}^{t} = Inflow to reservoir at time t

Q_{out}^{t} = Release from storage for D/S demands or to meet flood control rules at time t

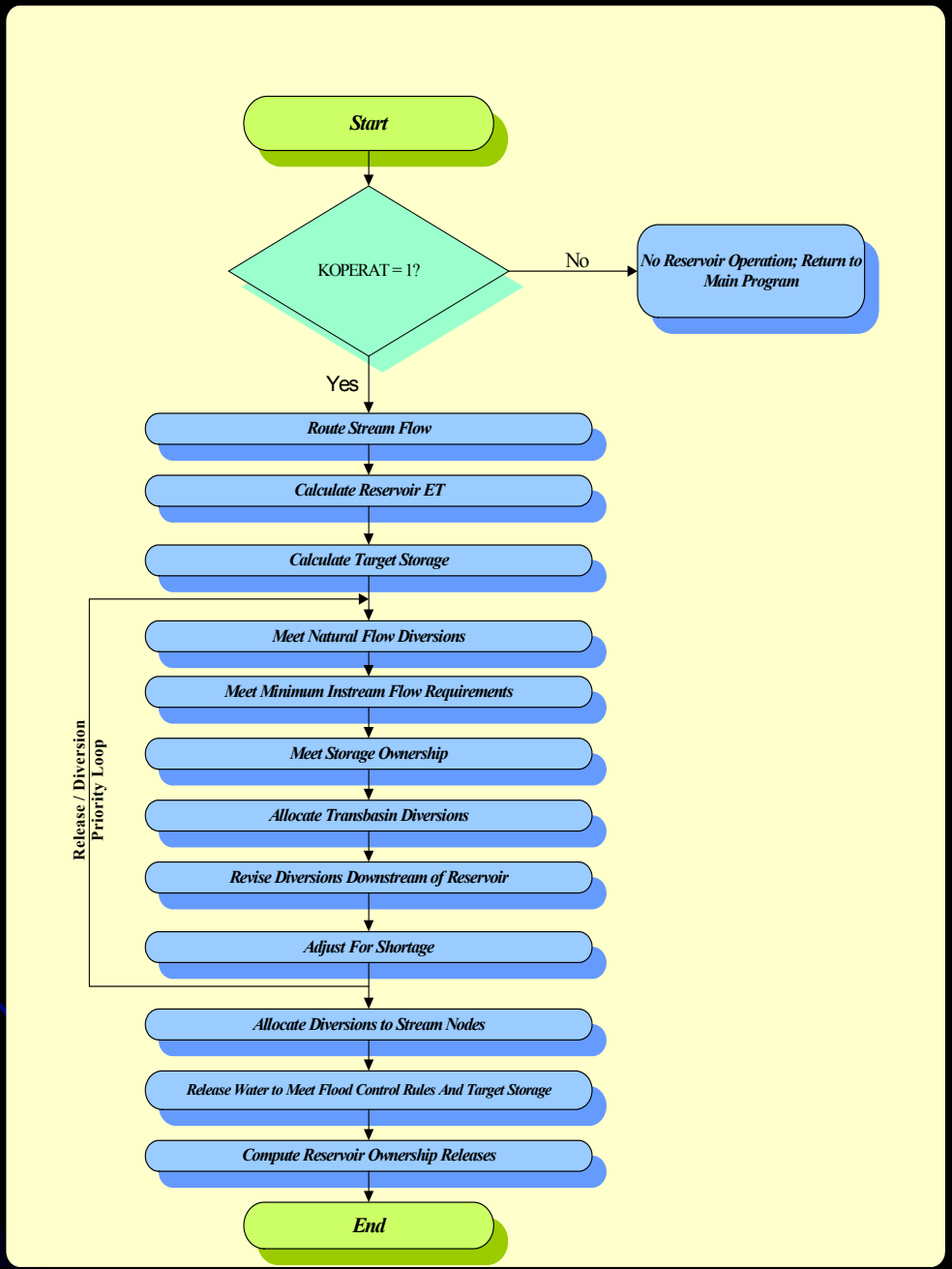
Q_{e}^{t} = Evaporation at time t

Q_{p}^{t} = Precipitation at reservoir site at time t

MULTIPLE RESERVOIR OPERATIONS SIMULATION

- Simulated using Target Storage Rules (TSR) specified by users
- Releases are made to meet the downstream flow and diversion requirements
- TSR honors the priorities set for each demand on the reservoir, and releases are calculated accordingly

FLOW CHART OF RESERVOIR OPERATION



INPUT DATA REQUIREMENTS

- Reservoir storage-area-elevation curve
- Flood control rules
- Target storage rules
- Reservoir operations priorities
- Downstream minimum flow requirements
- Reservoir evaporation
- Precipitation at reservoir site
- Inflow to Reservoir

INPUT DATA FILES FOR RESERVOIR OPERATIONS

New Input Data Files:

- OPERAT.DAT
- MINFLOW.DAT
- RESEVAP.DAT

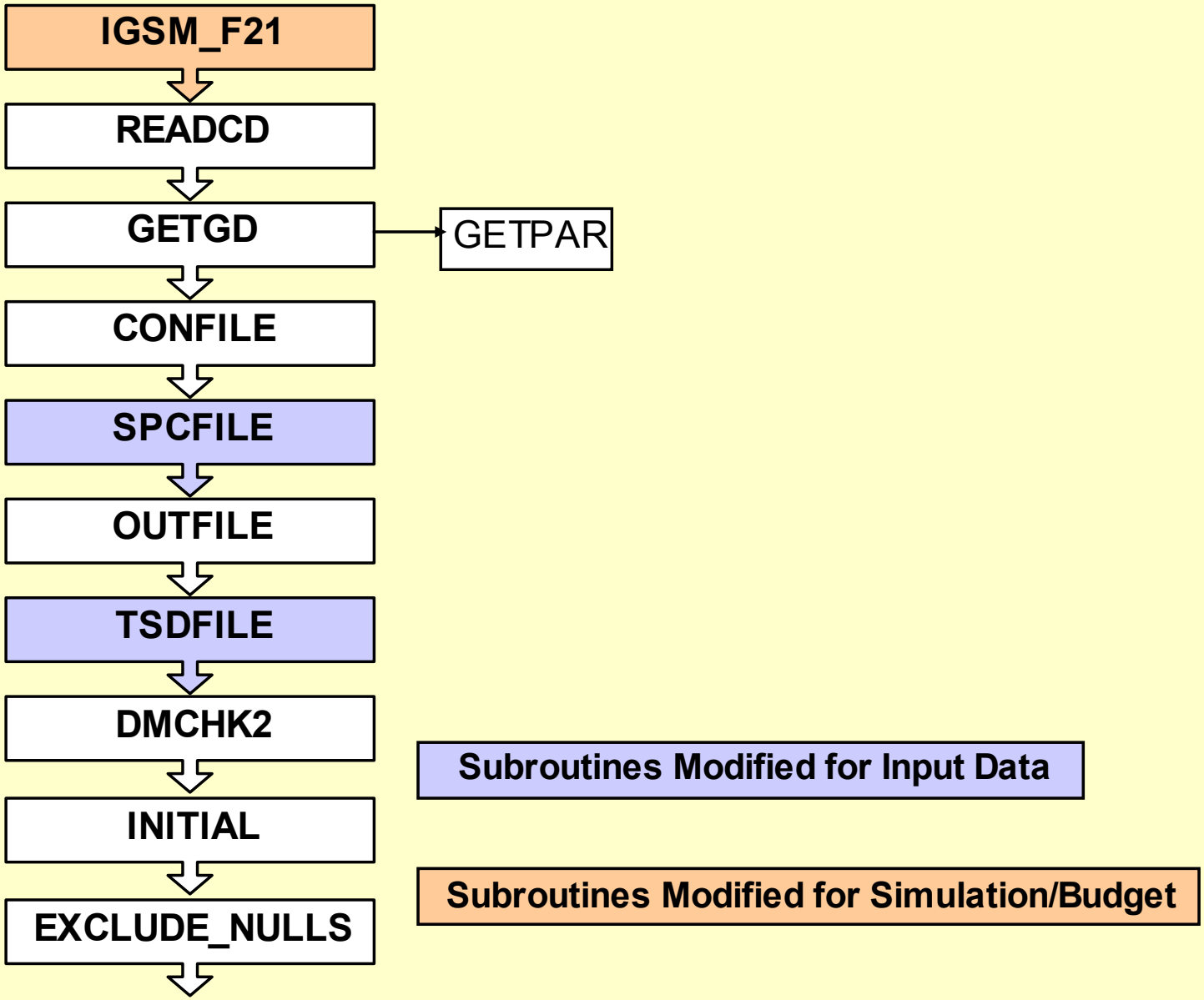
Existing Input Data Files:

- PRECIP.DAT
- INFLOW.DAT

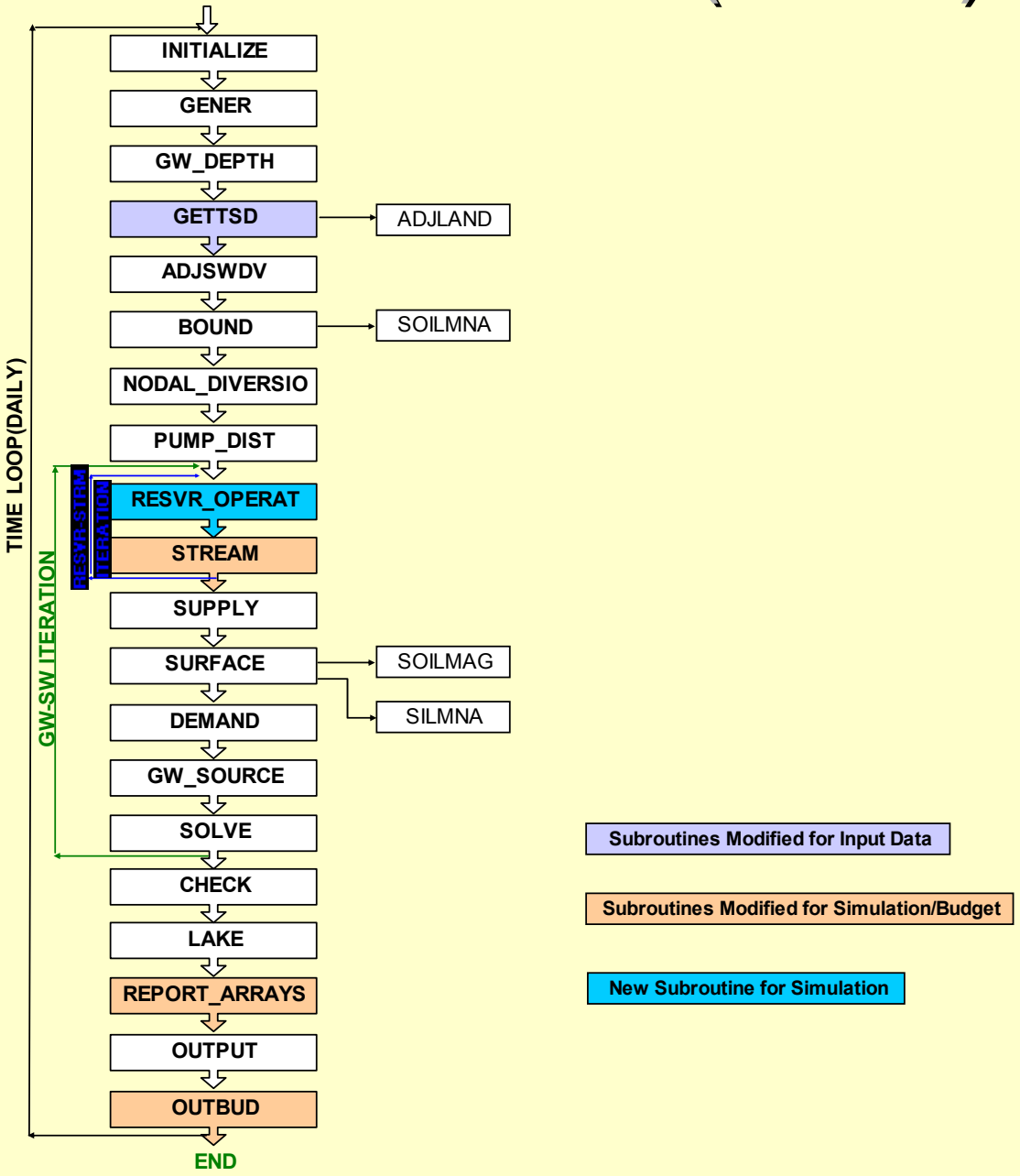
OUTPUT FILE DESCRIPTION

- INFLOW: Amount of water inflow into the reservoir
- EVAP: Net amount of water evaporating from the reservoir
- RELEASE: Amount of water release from the reservoir
- BYPASS/SPILL: Amount of inflow water bypassing the reservoir or water spilled from the reservoir
- ENDING STORAGE: Reservoir ending storage
- ENDING OWNERSHIP: Reservoir ending ownership storage

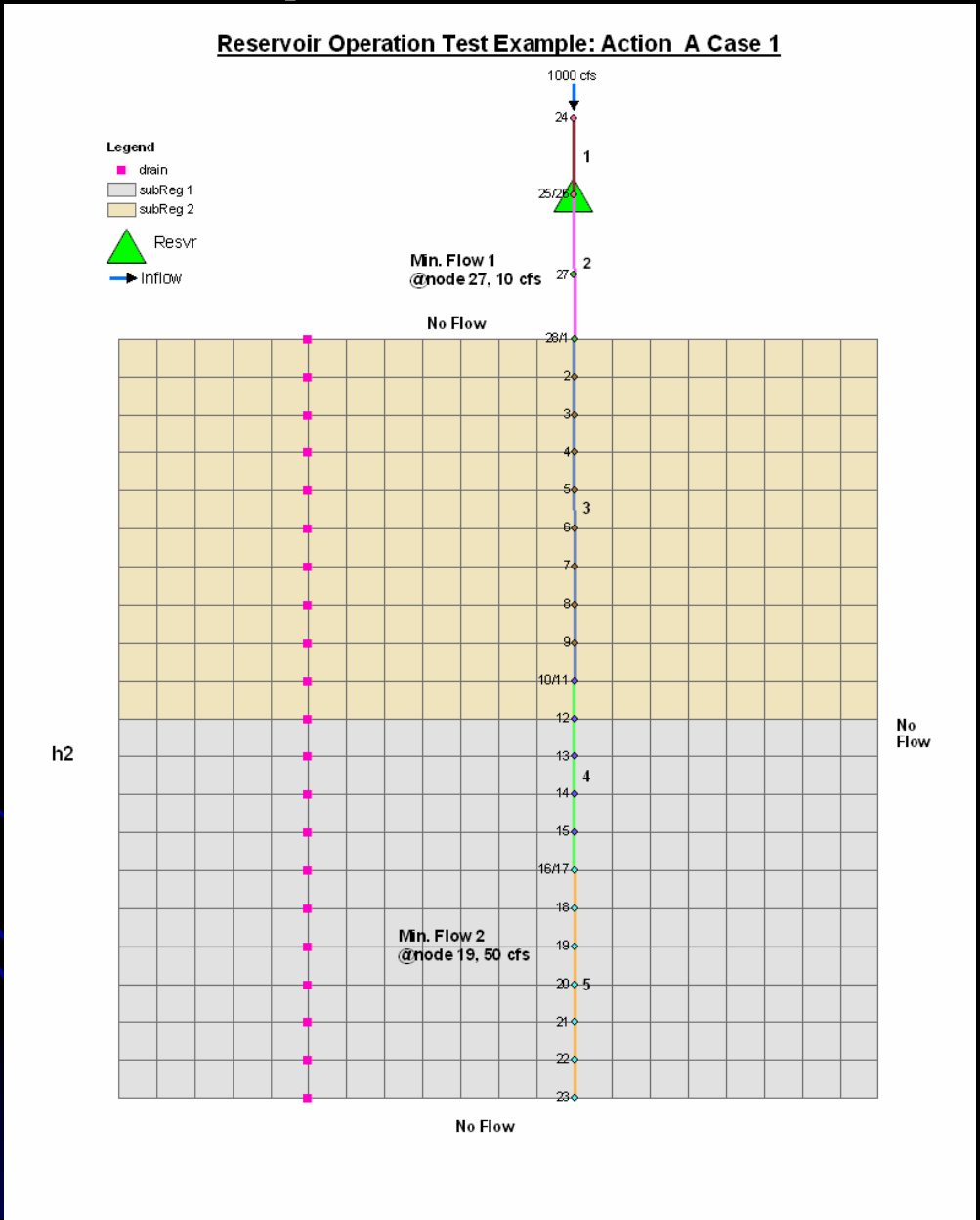
REVISED IGSM2 FLOW CHART



REVISED IGSM2 FLOW CHART(cont'd)

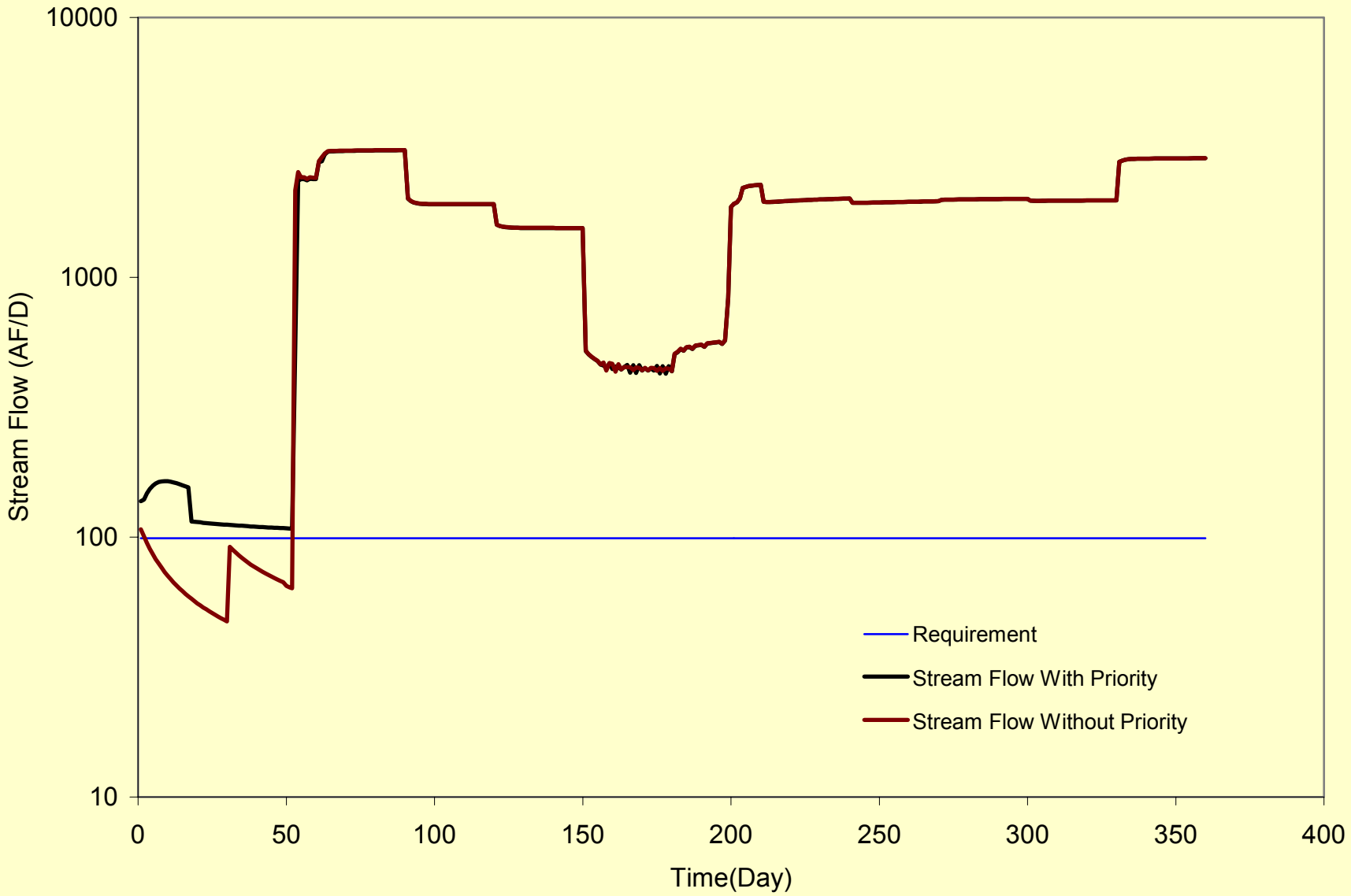


Test Example: Action A Case 1

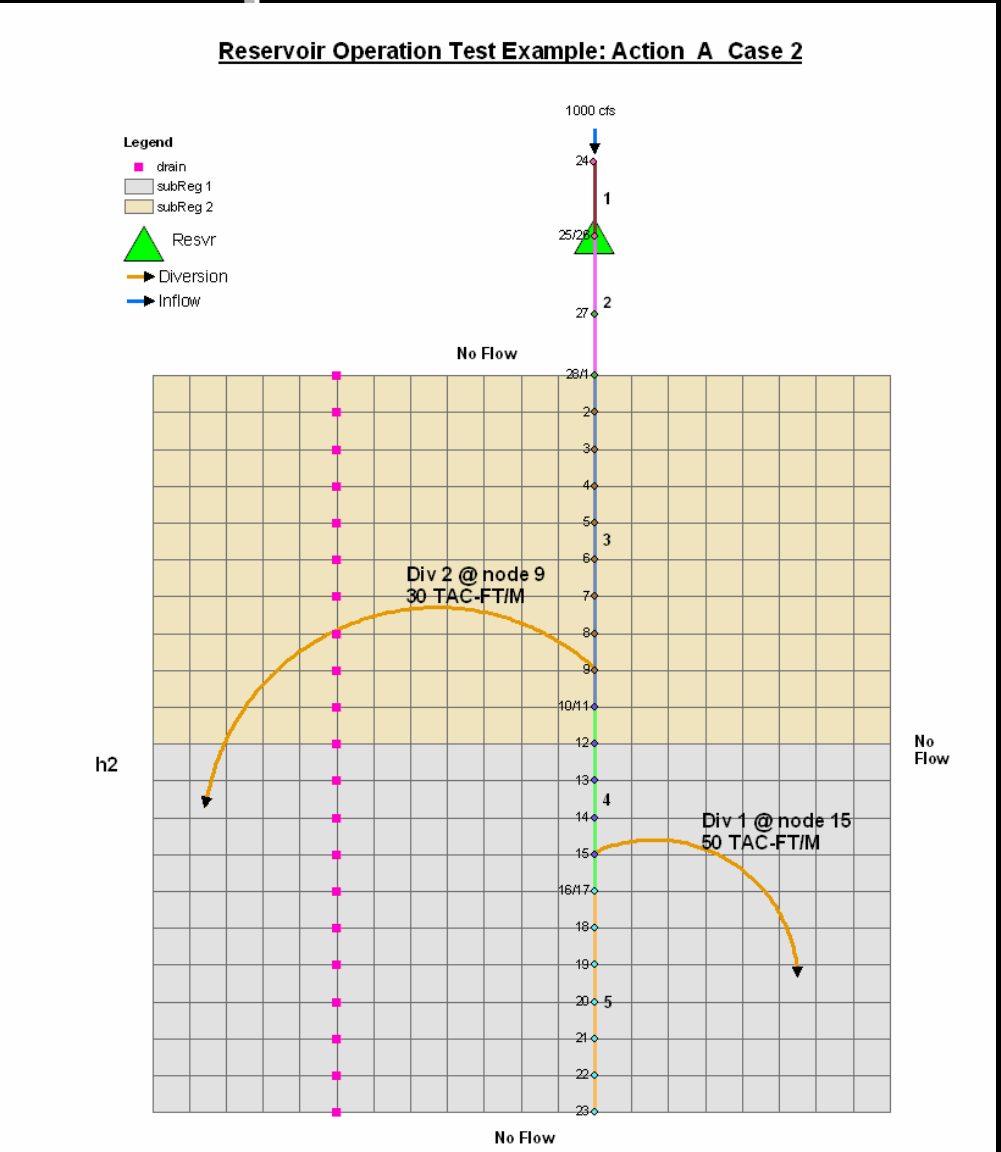


Minimum Flow Priority Combinations (Action A, Case 1)

	MF1 Priority	MF2 Priority	MF1 Meet	MF2 Meet
Minimum Flow_0	NO	NO	NOT	NOT
Minimum Flow_1	NO	P	NO	YES
Minimum Flow_2	P	NO	YES	NOT
Minimum Flow_3	P	P	YES	YES

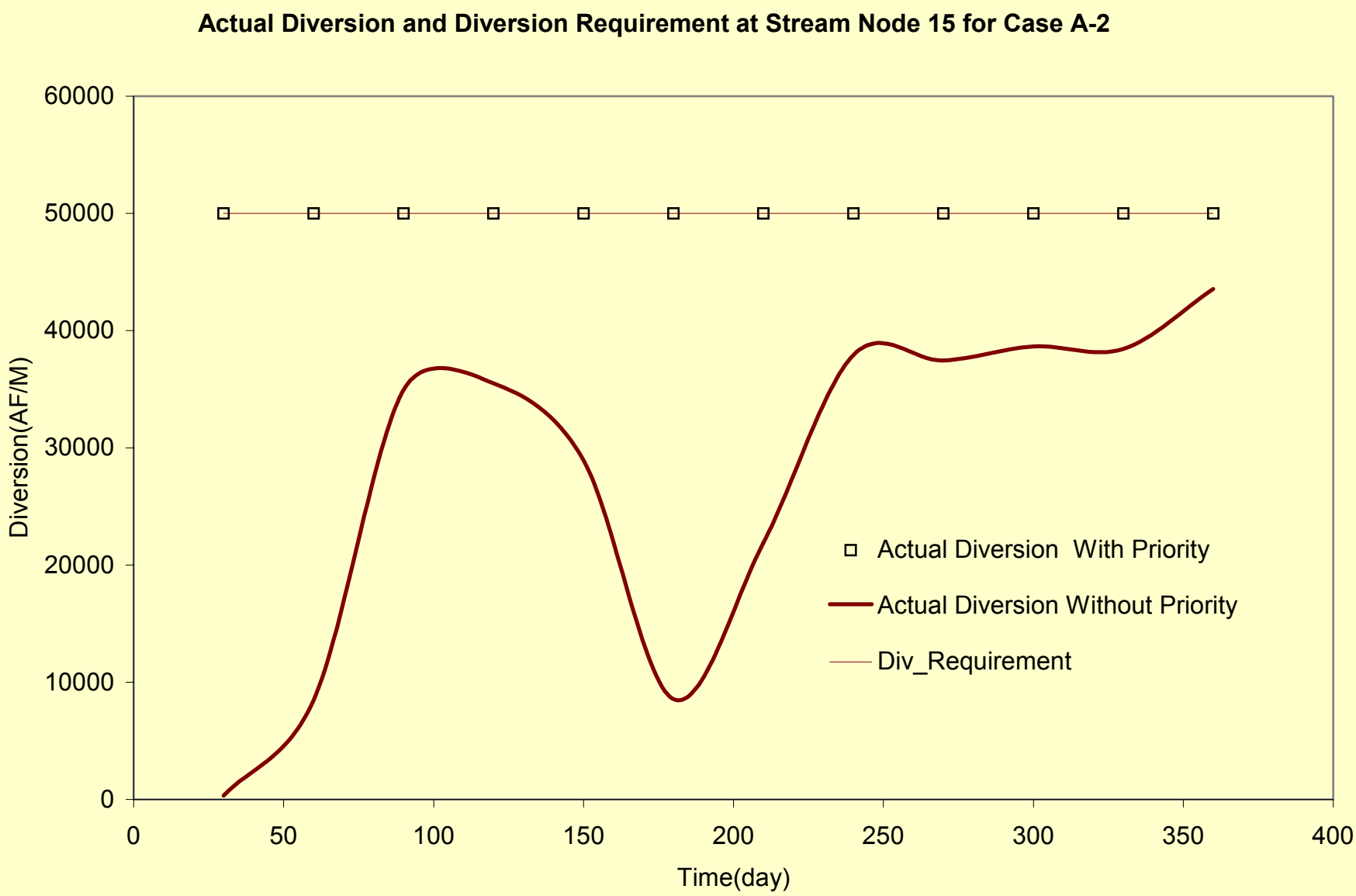

Stream Flow and MF Requirement at Stream Node 19 for Case A-1
10000
1000
100
10
Stream Flow (AF/D)
0
50
100
150
200
250
300
350
400
Time(Day)
Requirement
Stream Flow With Priority
Stream Flow Without Priority

Test Example: Action A Case 2

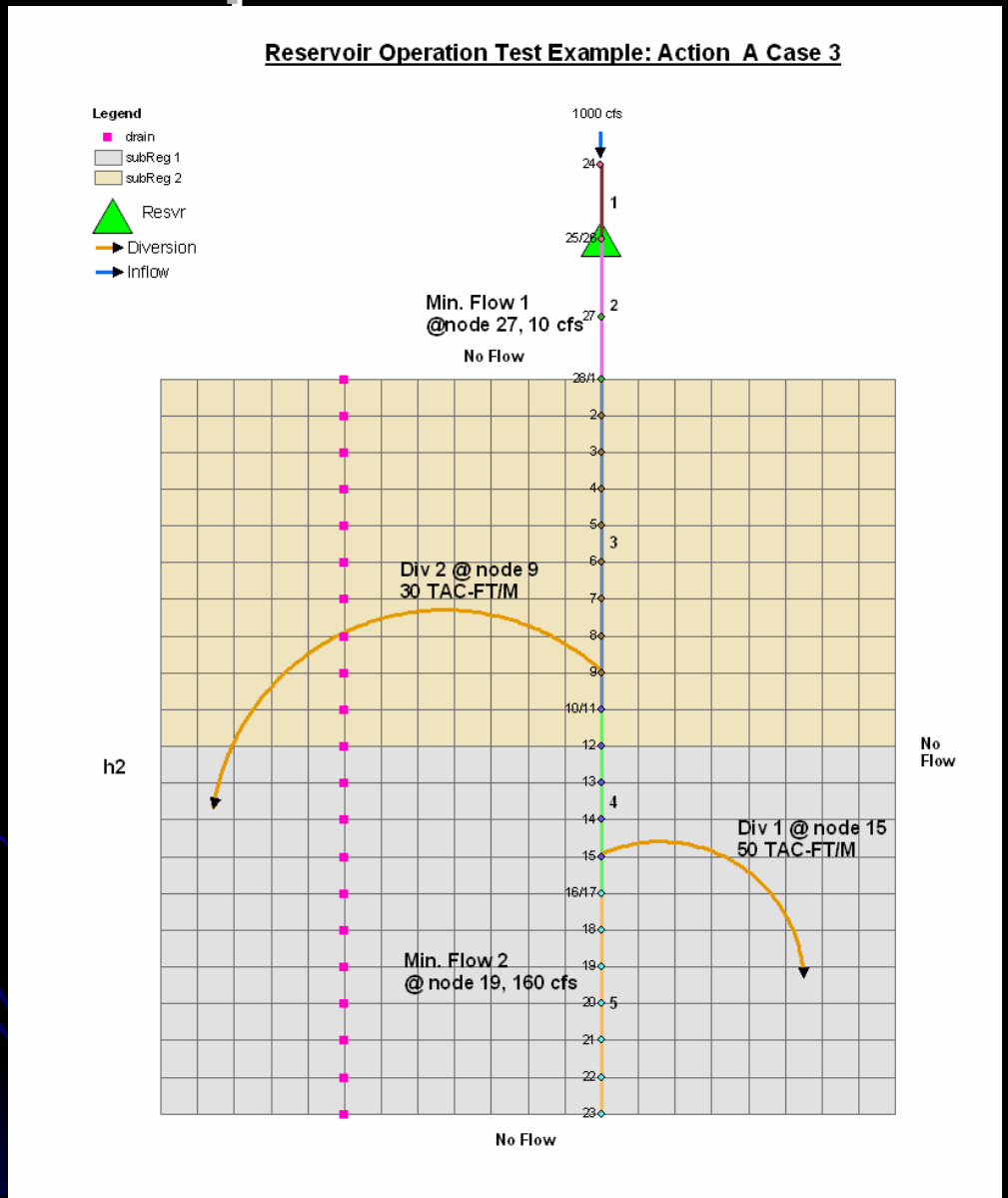


Diversion Priority Combinations (Action A, Case 2)

	MF1 Priority	MF2 Priority	MF1 Meet	MF2 Meet
Diversion_0	NO	NO	NO	NO
Diversion_1	P	NO	YES	NOT
Diversion_2	NO	P	NOT	YES
Diversion_3	P	P	YES	YES


Actual Diversion and Diversion Requirement at Stream Node 15 for Case A-2
60000
50000
40000
30000
20000
10000
0
Diversion(AF/M)
0
50
100
150
200
250
300
350
400
Time(day)
Actual Diversion With Priority
Actual Diversion Without Priority
Div_Requirement

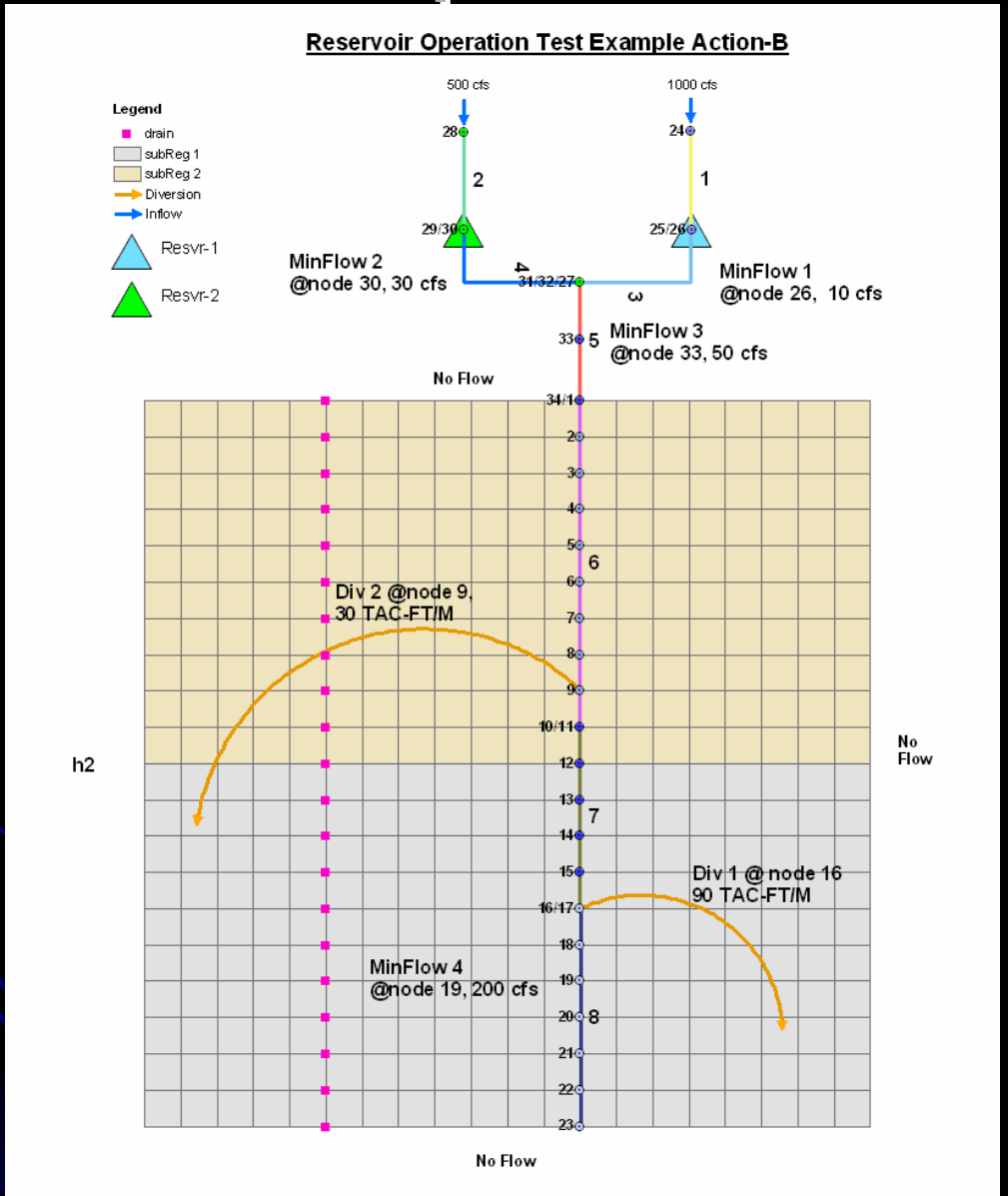
Test Example: Action A Case 3



Multiple Diversions and Minimum Flows (Action A, Case 3)

	Priority				Requirements Met or Not			
	Div 1	**Div 2**	**MF 1**	**MF 2**	**Div 1**	**Div 2**	**MF 1**	**MF 2**
DivMf_0	NO	NO	NO	NO	NOT	NOT	NOT	NOT
DivMf_1	#2	#3	NO P	#1	MET	NOT	MET	MET
DivMf_0	#2	#1	NO P	NO P	MET	MET	MET	NOT
DivMf_0	#2	#1	NO P	#3	MET	MET	MET	MET

Test Example: Action B



Two Reservoirs and Multiple Minimum Flows and Diversions Requirements (Action B)

	Priority						Requirements Met or Not					
	Div 1	**Div 2**	**MF 1**	**MF 2**	**MF 3**	**MF 4**	**Div 1**	**Div 2**	**MF 1**	**MF 2**	**MF 3**	**MF 4**
Priority _**0**	#2	#3	#4	#5	#6	#1	Met	NOT	Met	Met	Met	Met
Priority _1	No P	No P	#3	#1	#2	No P	NOT	NOT	Met	Met	Met	Not

SUMMARY

- The reservoir operations module has been successfully transferred from IGSM 5.0 to IGSM2
- The revised code was successfully tested using a set of test problems