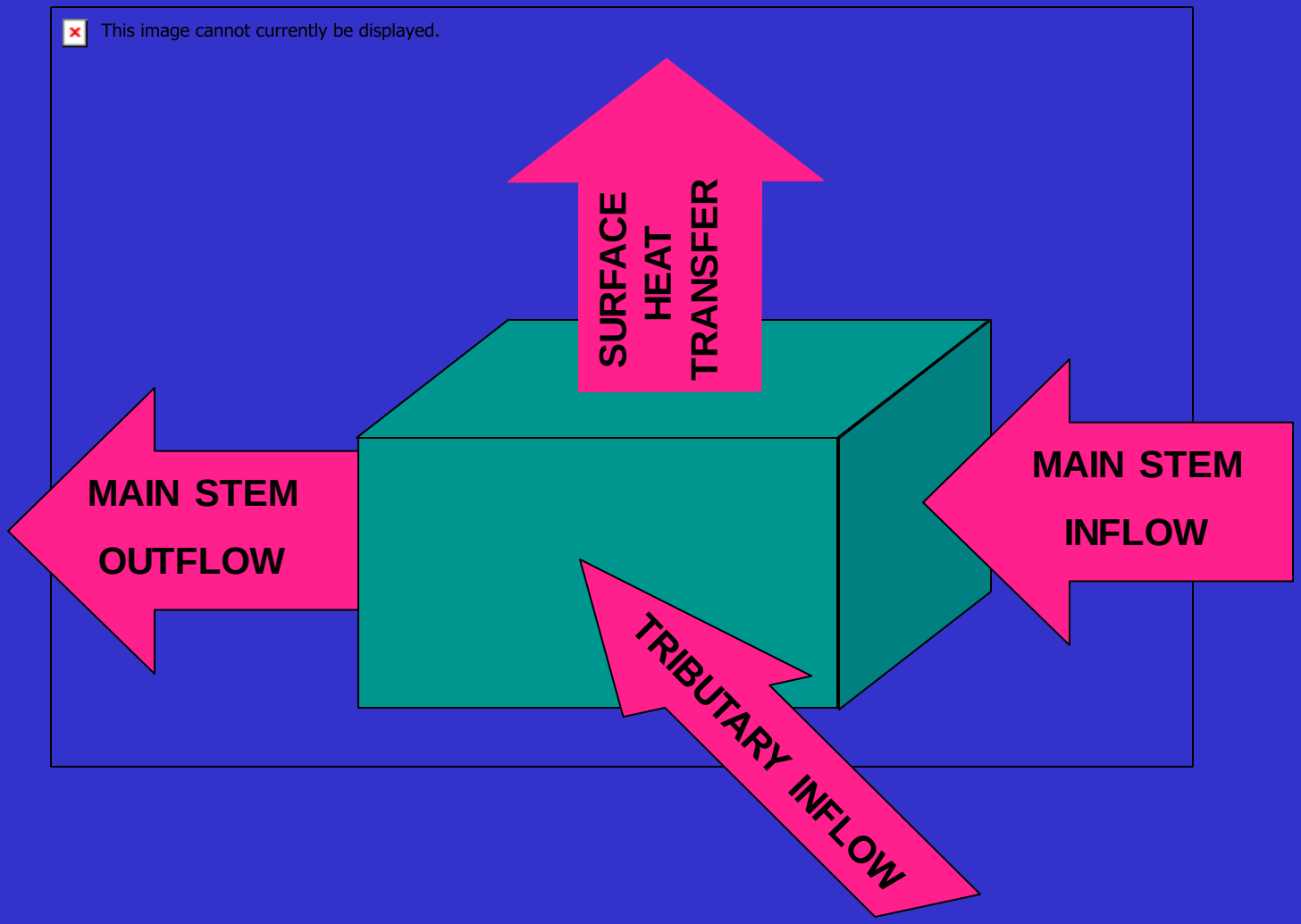
COLUMBIA RIVER TEMPERATURE ASSESSMENT

SIMULATION METHODS

PROJECT GOALS

- ESTIMATE UNCERTAINTY OF TEMPERATURE SIMULATIONS
- ESTIMATE TEMPERATURE IMPACTS OF DAMS IN THE MAIN STEM COLUMBIA AND SNAKE RIVERS
- ESTIMATE TEMPERATURE IMPACTS OF TRIBUTARIES IN THE MAIN STEM COLUMBIA AND SNAKE RIVERS

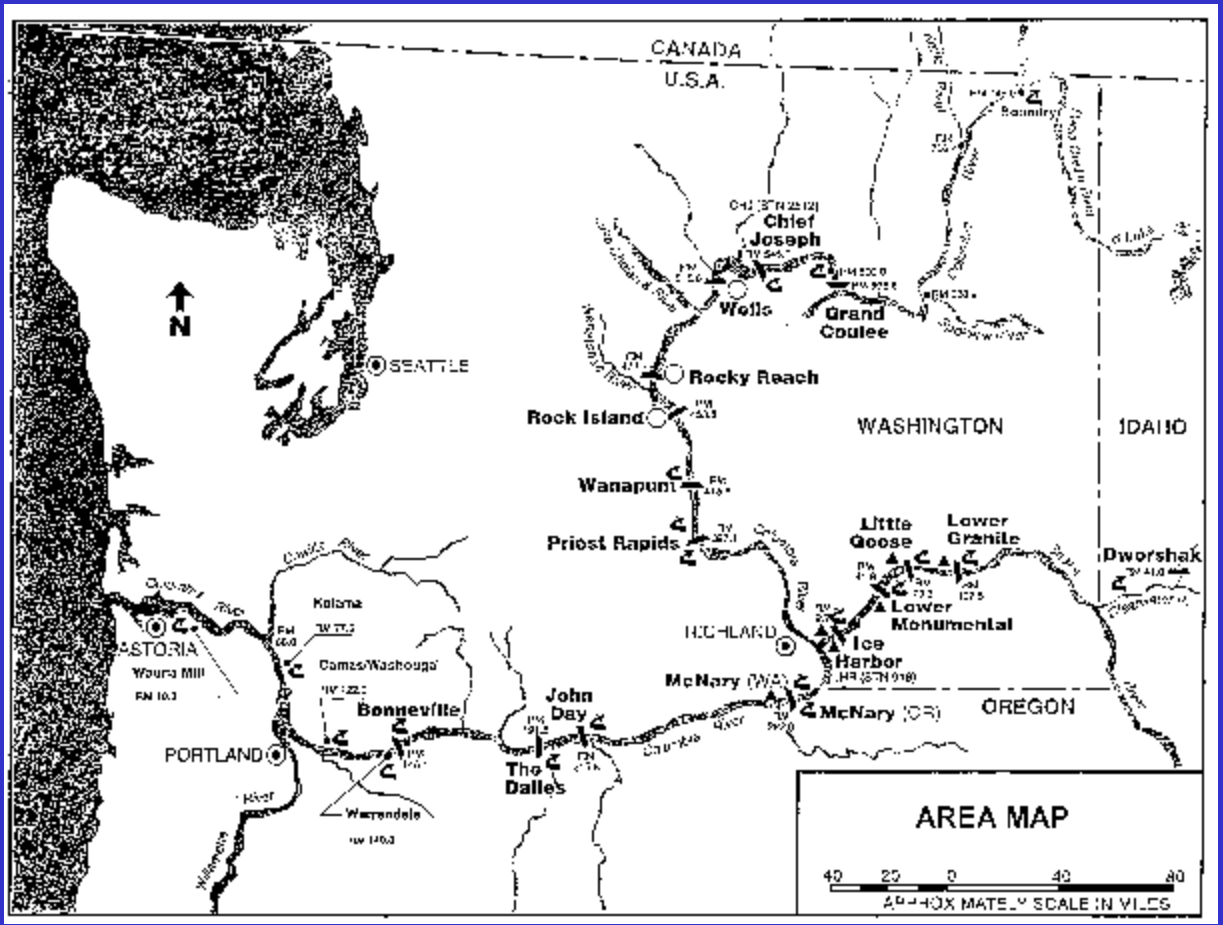
ONE-DIMENSIONAL ENERGY BUDGET MODEL



CONCEPTUAL MODEL

- FREELY-FLOWING RIVER AND RUN-OF-THE-RIVER SEGMENTS
- ENERGY BUDGET METHOD
- ONE-DIMENSIONAL (LONGITUDINAL)
- DAILY AVERAGES
- ADVECTION ONLY

REGIONAL SCALE OF ANALYSIS



[illegible]

[illegible]

$$\frac{\Delta T}{d} = \frac{Q_{in} - Q_{out}}{[illegible]}$$

[illegible] [illegible] [illegible]

[illegible]

$$\frac{Q_{out}}{[illegible]} = \frac{q_{[illegible]}}{[illegible]C_p} + [illegible]$$

[illegible] [illegible] [illegible] [illegible]

MEASUREMENT MODEL

$$T_{OBS} = H\,T_{ACTUAL} + \nu$$

TEMPERATURE	*TRUE STATE OF*	*MEASUREMENT*
MEASUREMENT	*TEMPERATURE*	*ERROR*

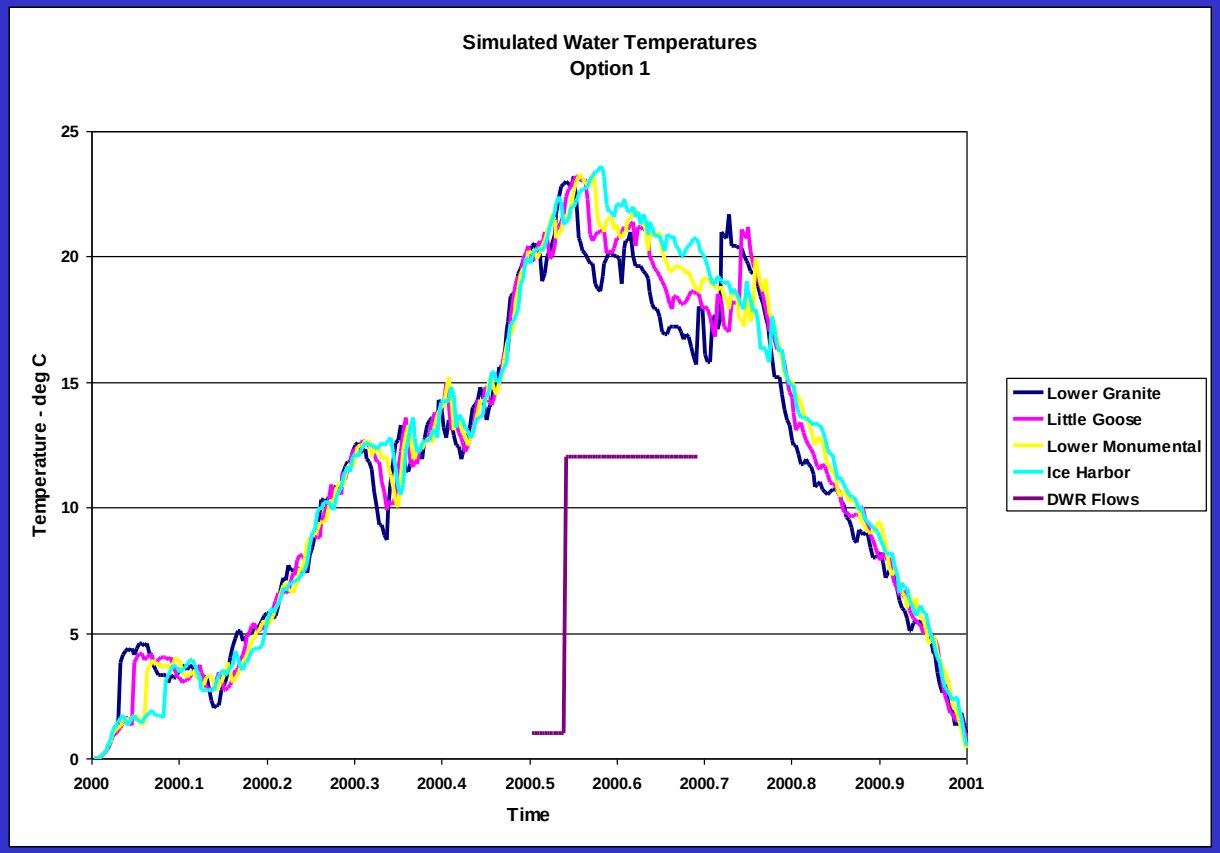
H = MEASUREMENT MATRIX

CONCEPTUAL MODEL

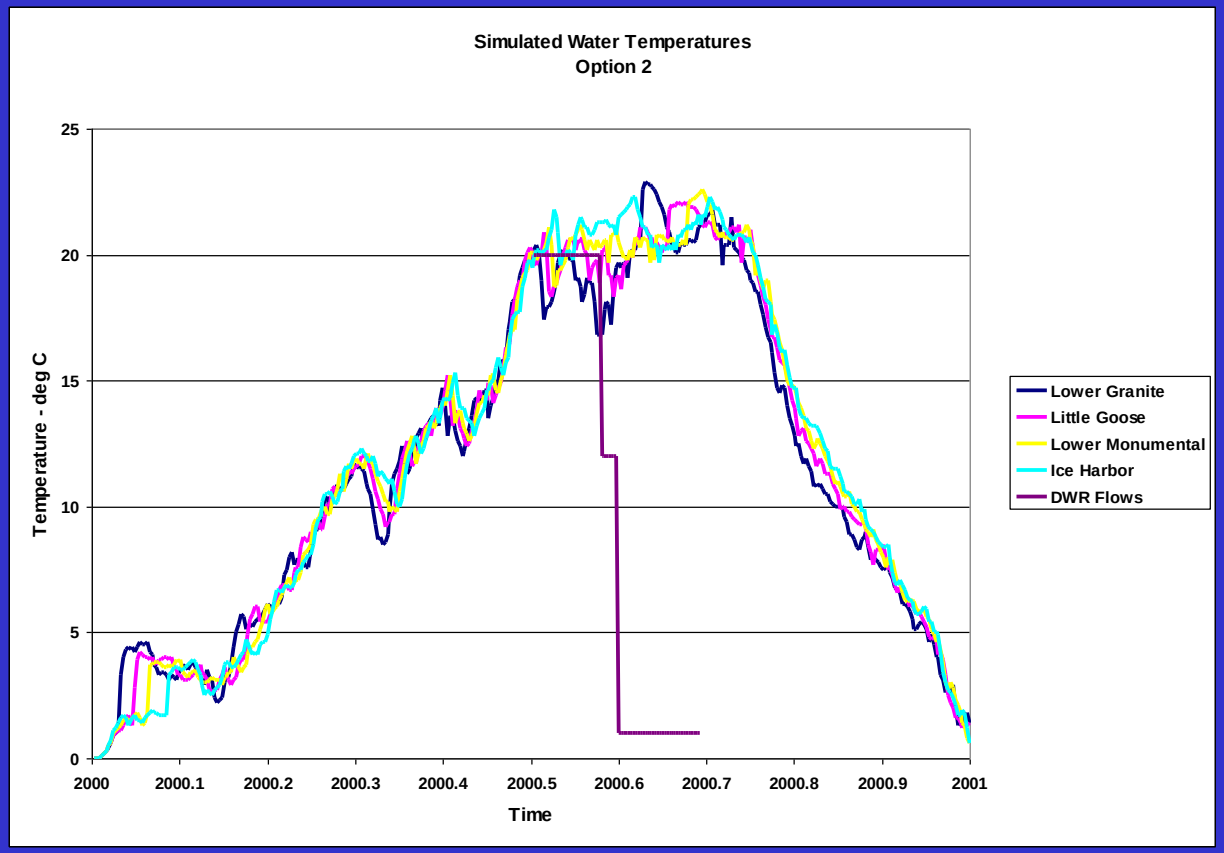
- STRATIFIED RIVER SEGMENTS:

  ENERGY BUDGET METHOD
  TWO-DIMENSIONAL
  (LONGITUDINAL AND VERTICAL)
  DAILY AVERAGES
  ADVECTION AND TURBULENT
  DIFFUSION

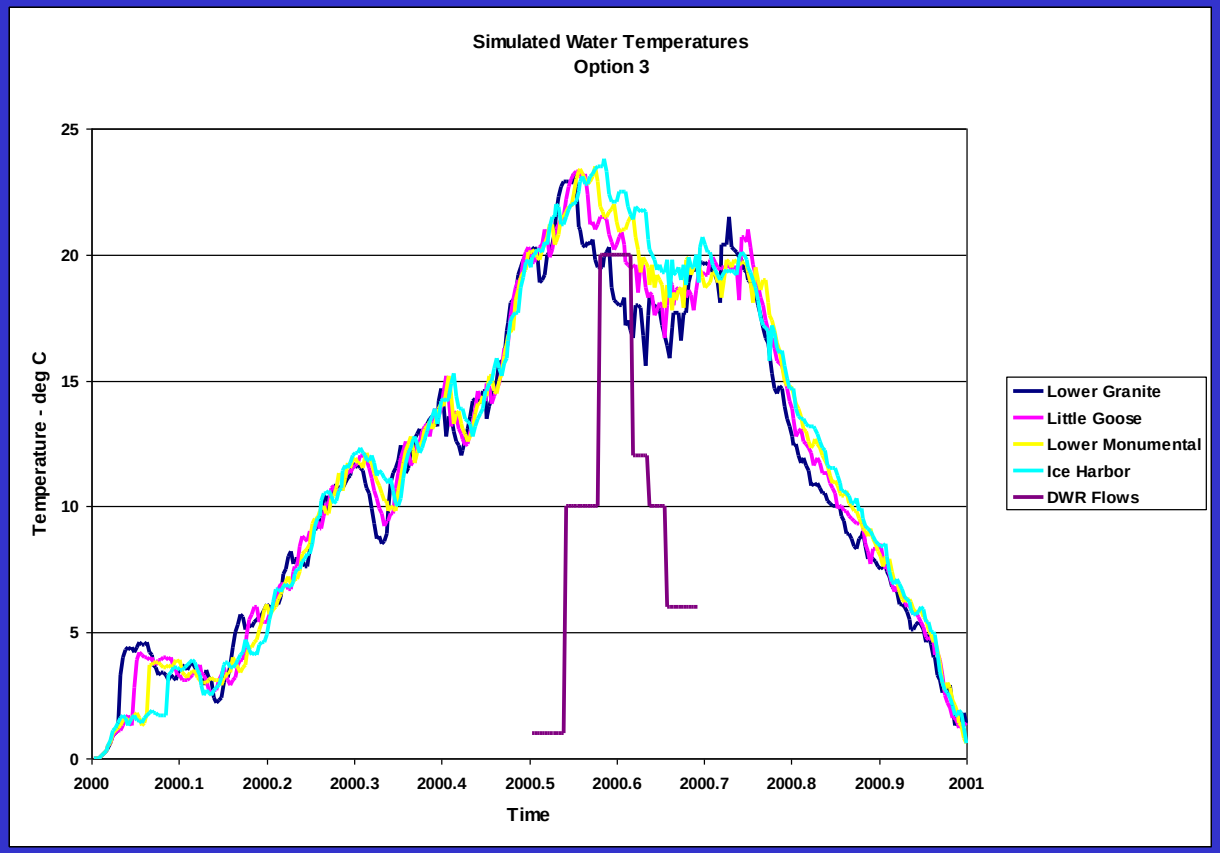
OPTION 1


Simulated Water Temperatures
Option 1
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

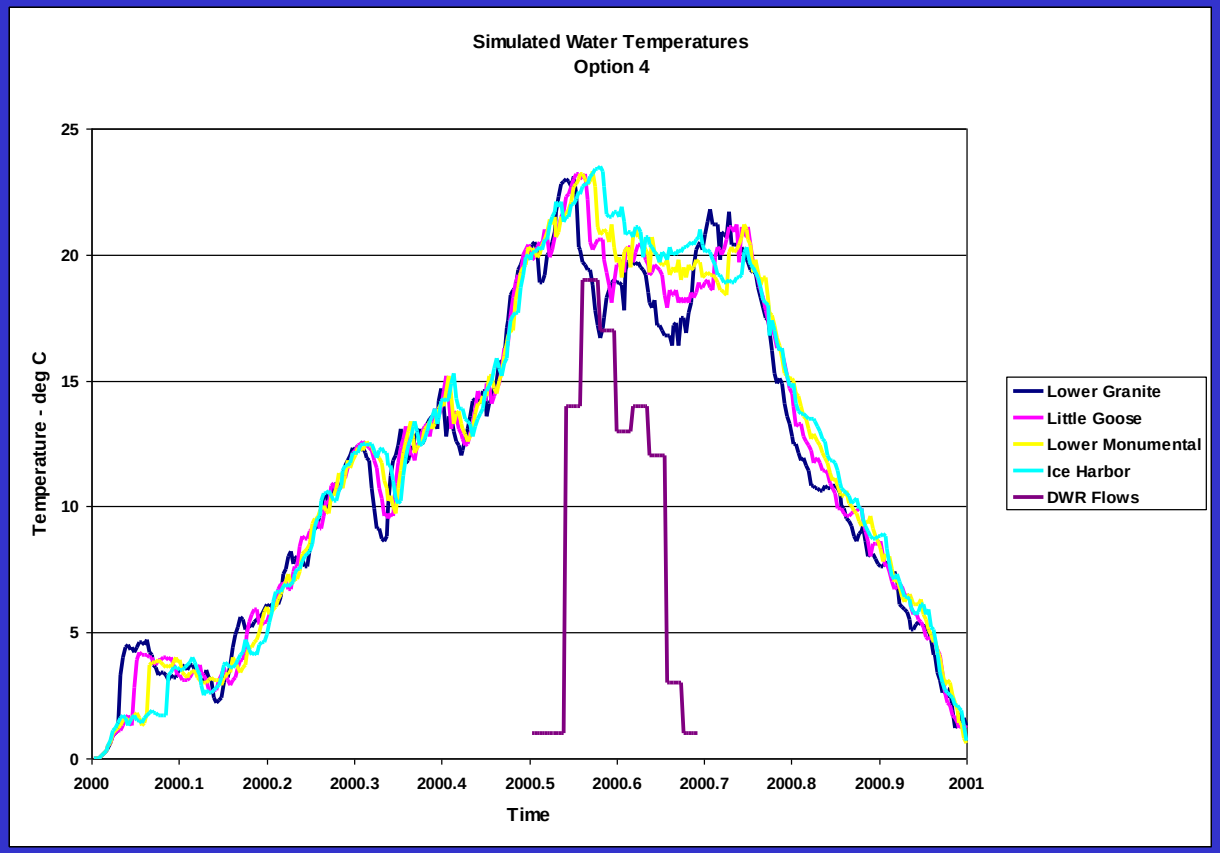
OPTION 2


Simulated Water Temperatures
Option 2
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

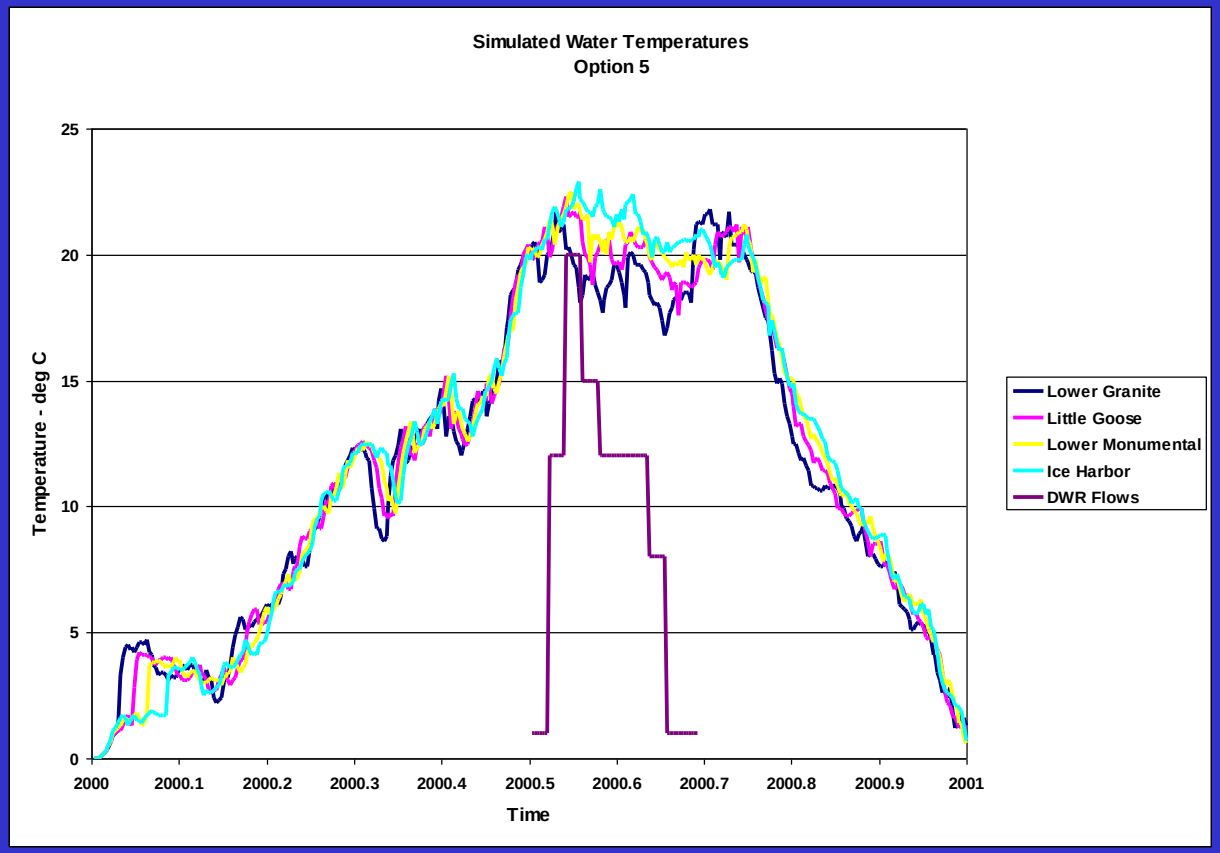
OPTION 3


Simulated Water Temperatures
Option 3
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

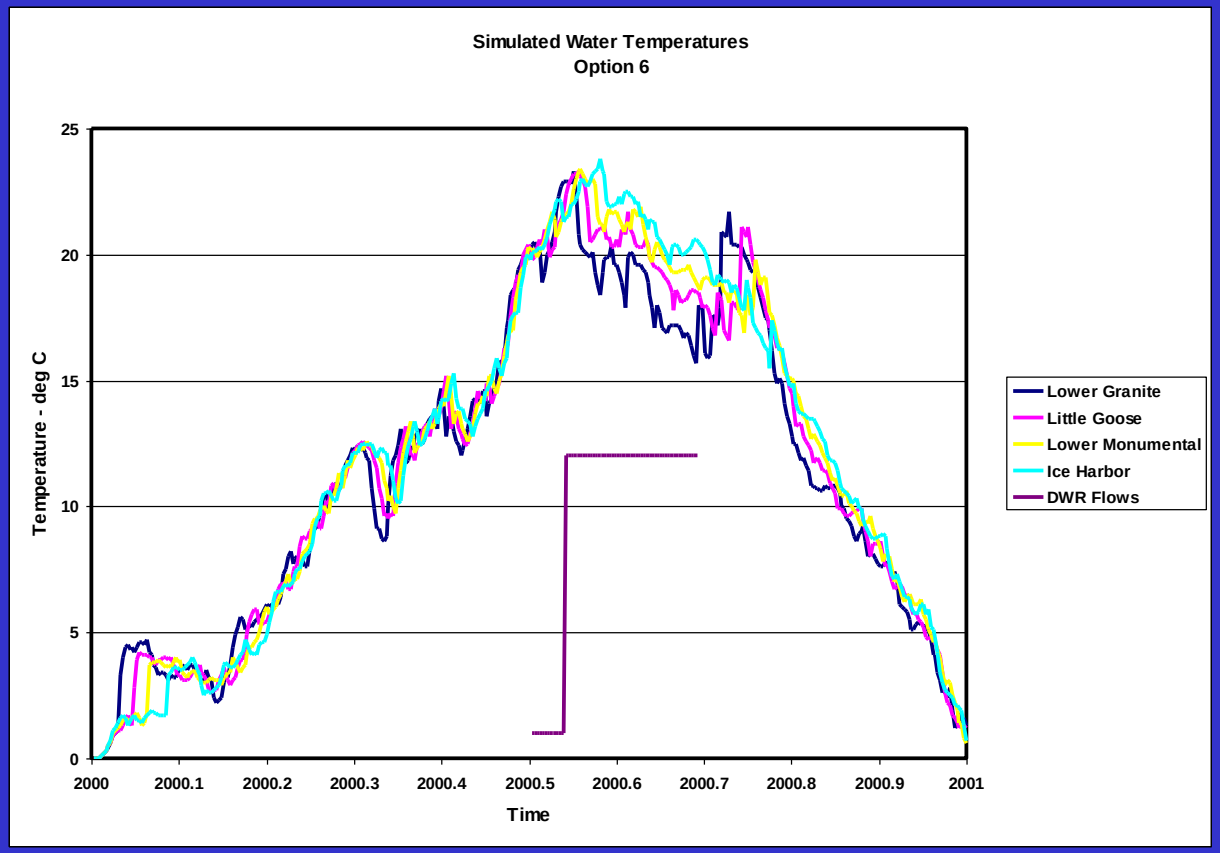
OPTION 4


Simulated Water Temperatures
Option 4
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

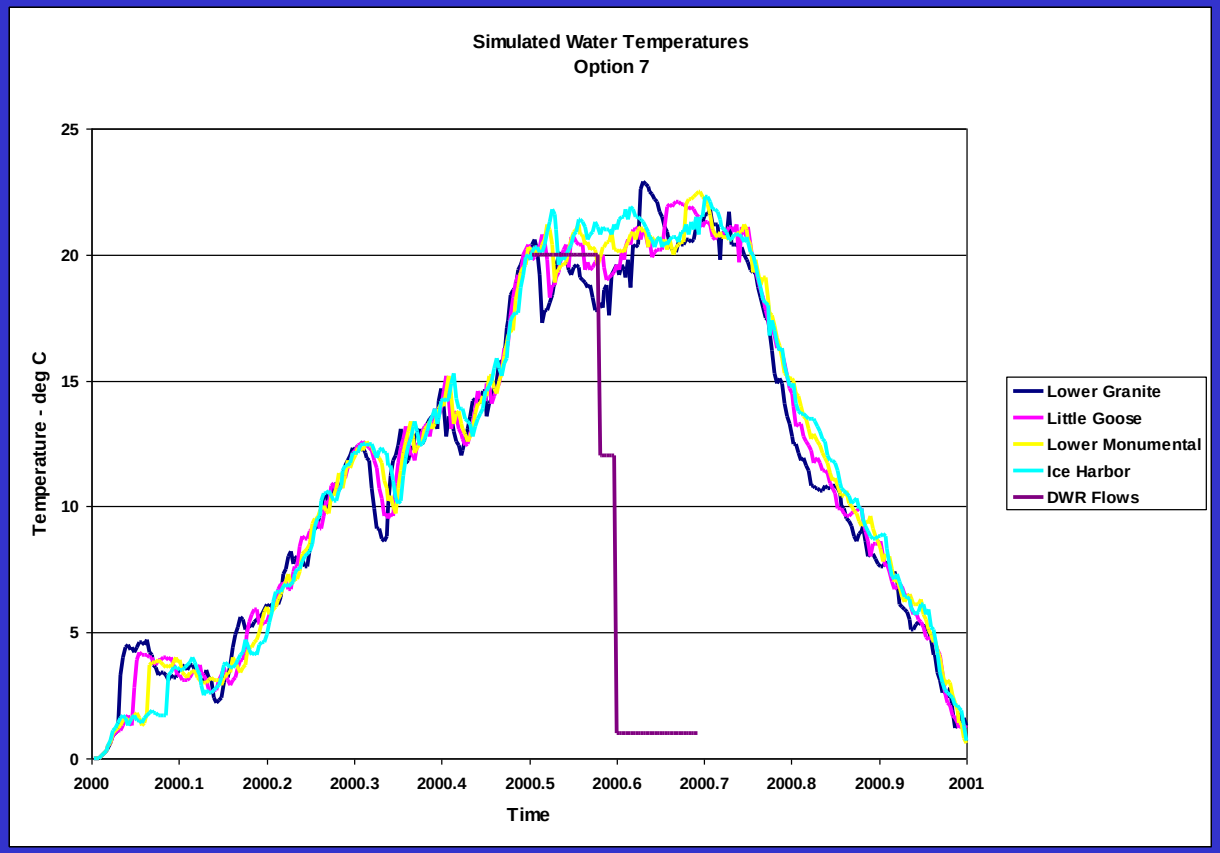
OPTION 5


Simulated Water Temperatures
Option 5
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

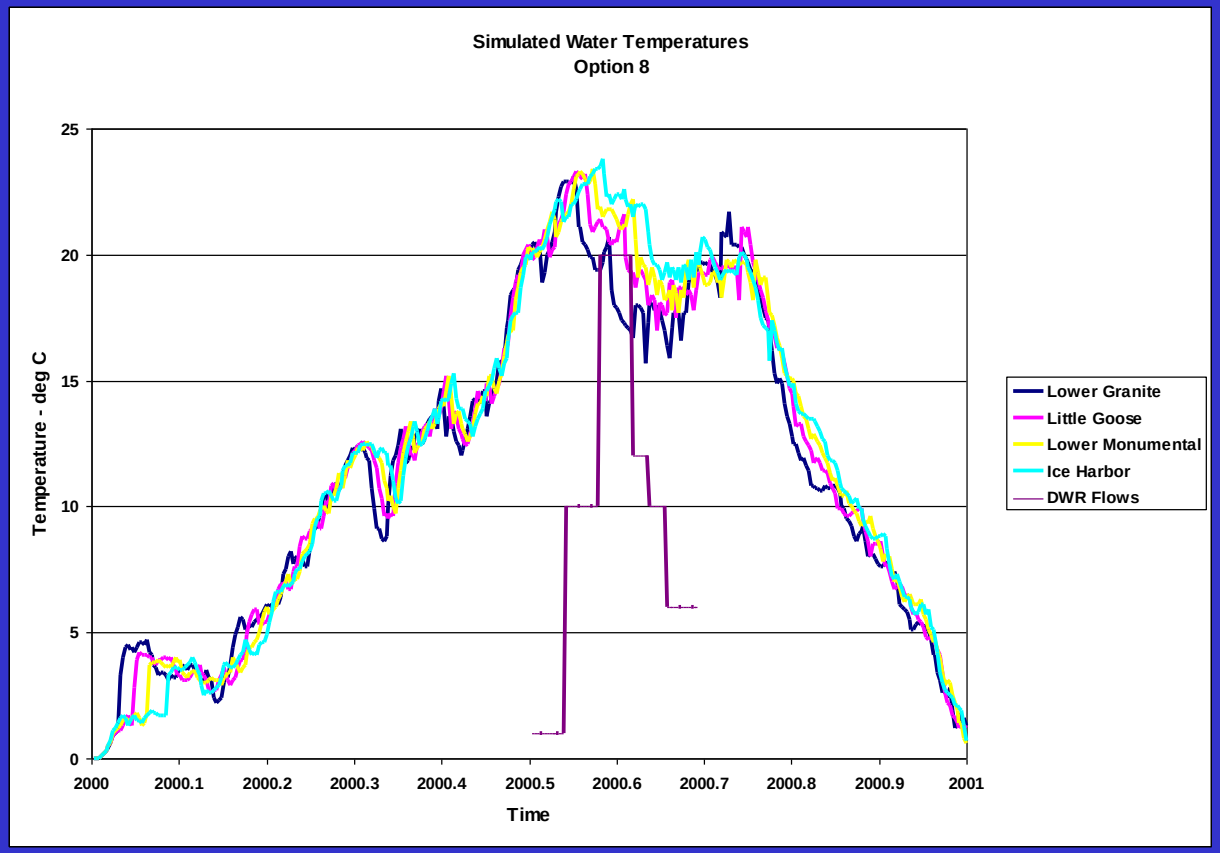
OPTION 6


Simulated Water Temperatures
Option 6
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

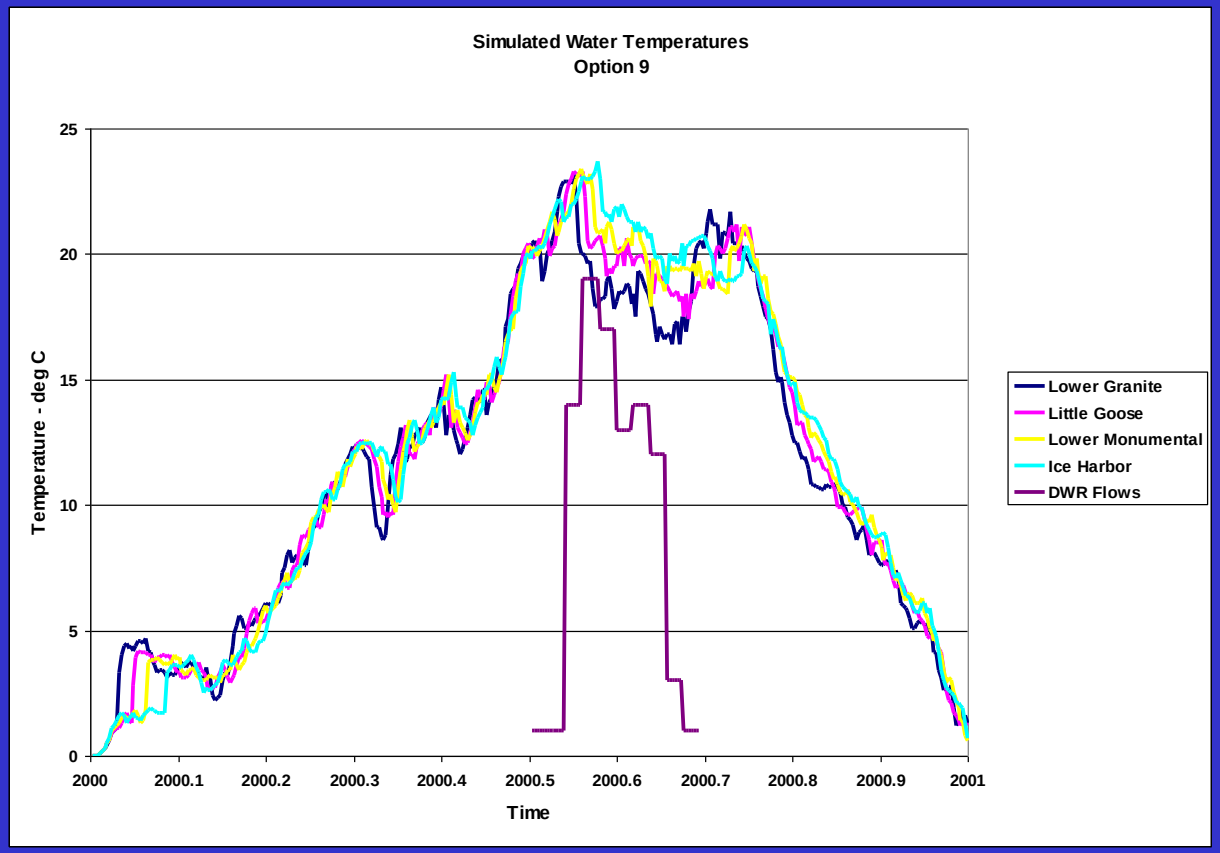
OPTION 7


Simulated Water Temperatures
Option 7
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

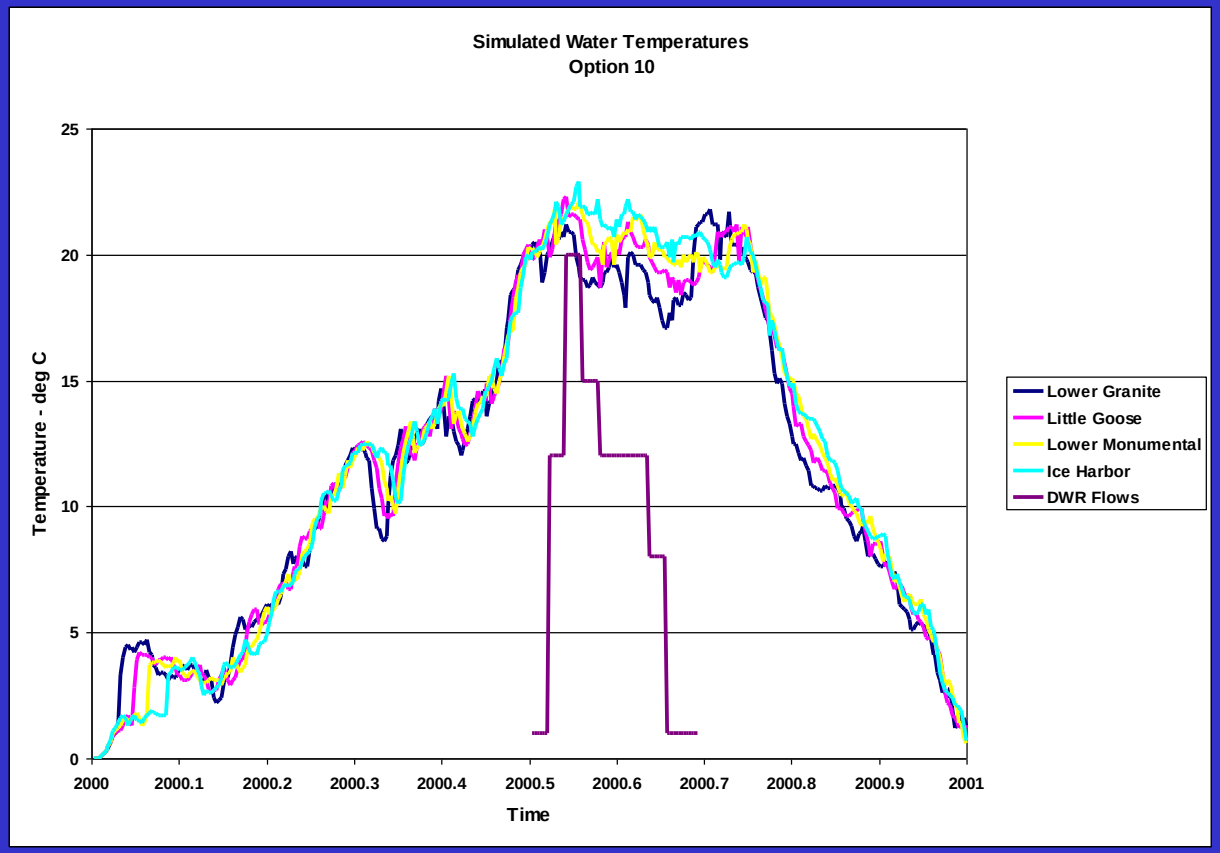
OPTION 8


Simulated Water Temperatures
Option 8
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

OPTION 9


Simulated Water Temperatures
Option 9
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows

OPTION 10


Simulated Water Temperatures
Option 10
Temperature - deg C
25
20
15
10
5
0
2000
2000.1
2000.2
2000.3
2000.4
2000.5
2000.6
2000.7
2000.8
2000.9
2001
Time
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
DWR Flows