IMPACTS OF MODEL GRID RESOLUTIONS

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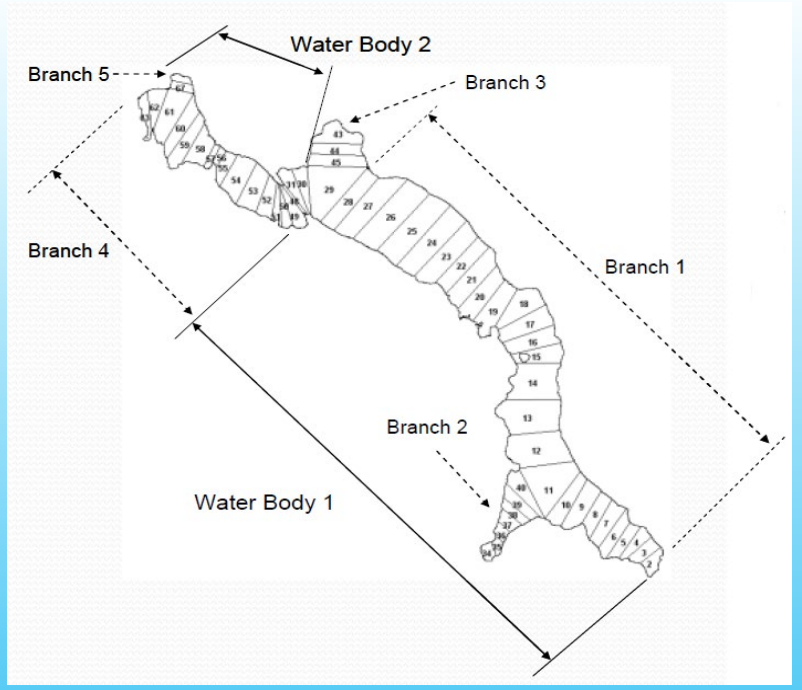
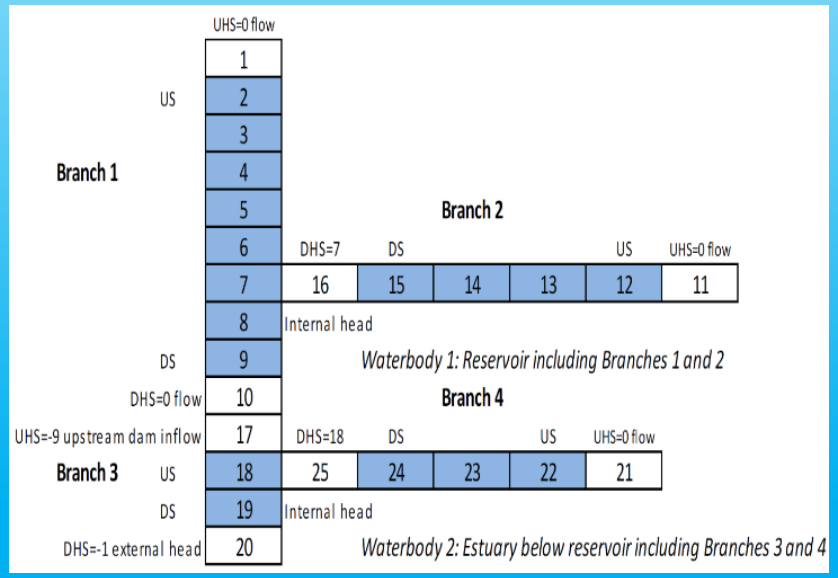
Environmental Systems Modeling Team

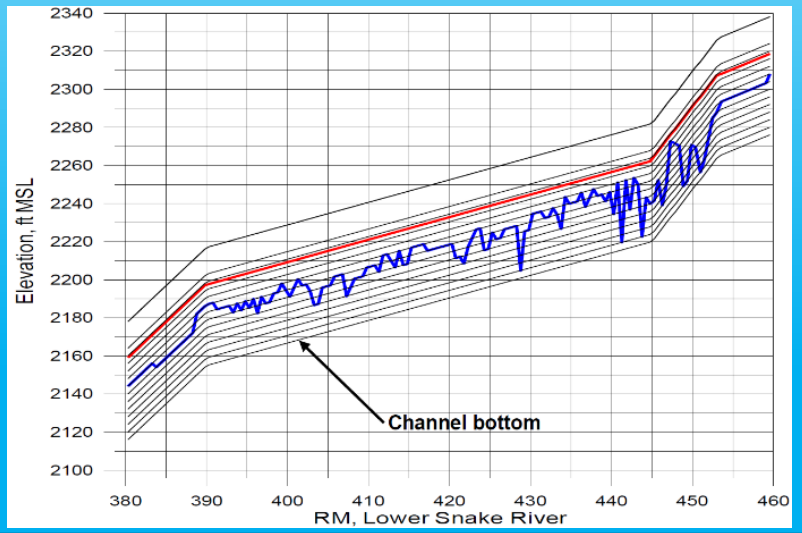
ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

CE-QUAL-W2 Model Grids

- Waterbodies/Branches/Segments/Layers
- Segments (a longitudinal segment of length $\Delta \mathbf{x}$)
- Layers (a vertical layer of height $\Delta \mathbf{z}$).

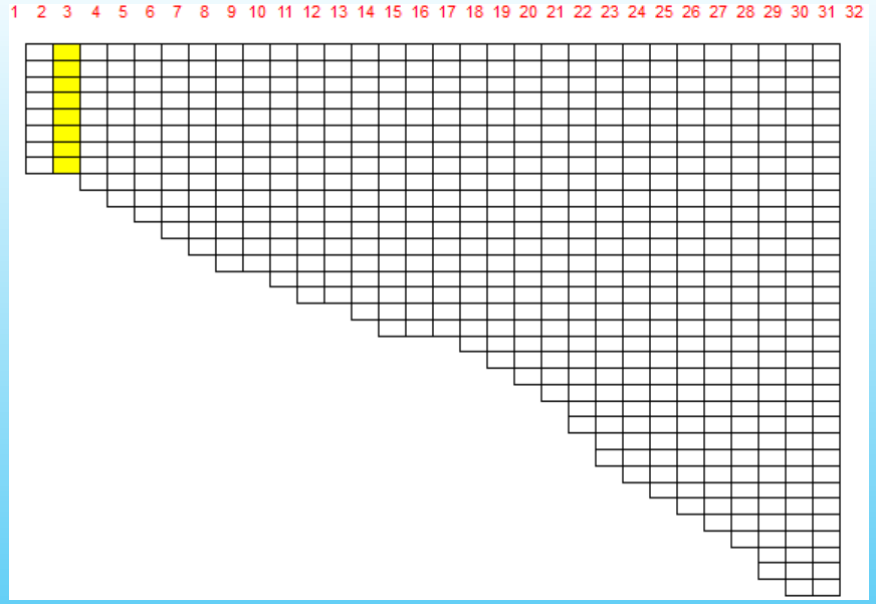


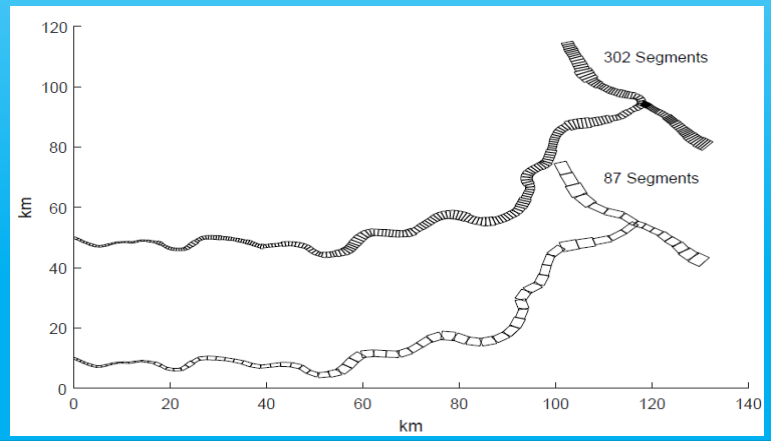


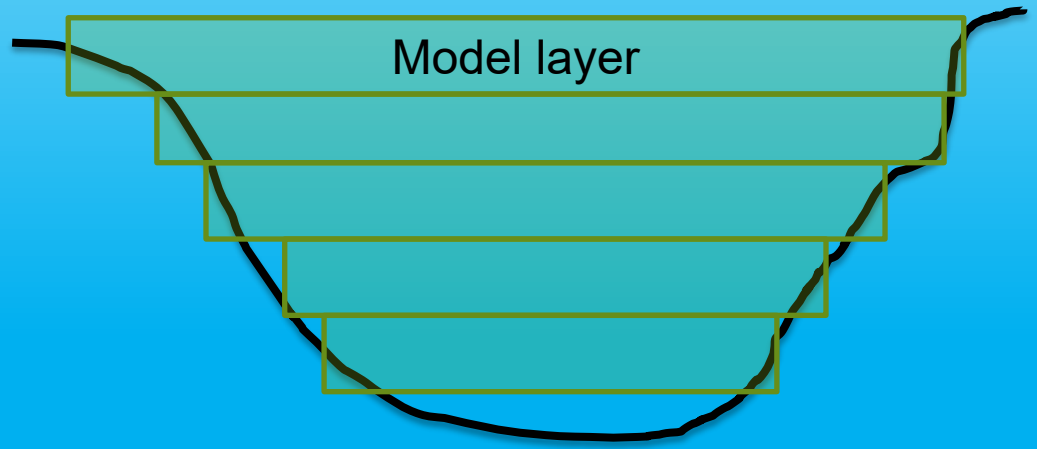


CE-QUAL-W2 Model Grids

- Defining the spatial resolution (Δx and Δz) for the model domain
- Δx = 100 m to 1 km, Δz = 0.5 – 1 m
- Increasing spatial resolution can severe penalty in terms of turnaround time for running the model
- Model results should not be a function of the grid resolution or the model timestep.

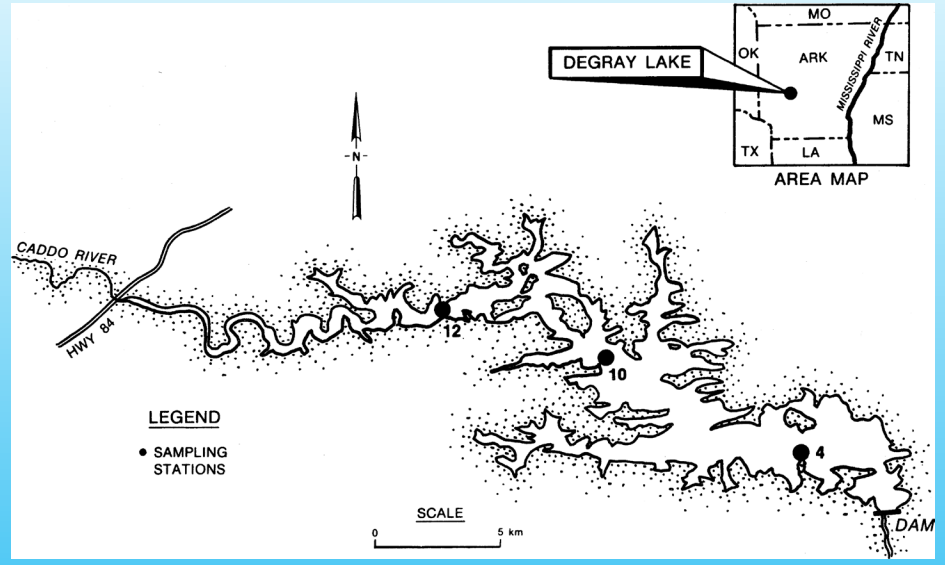


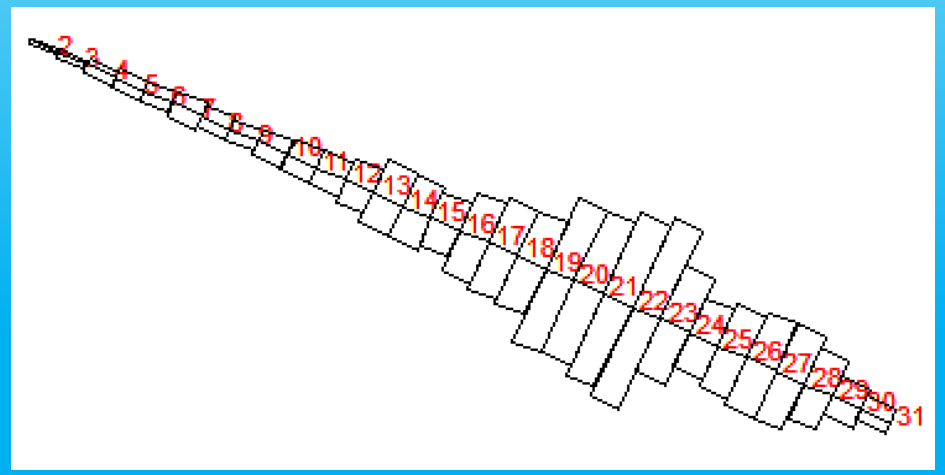


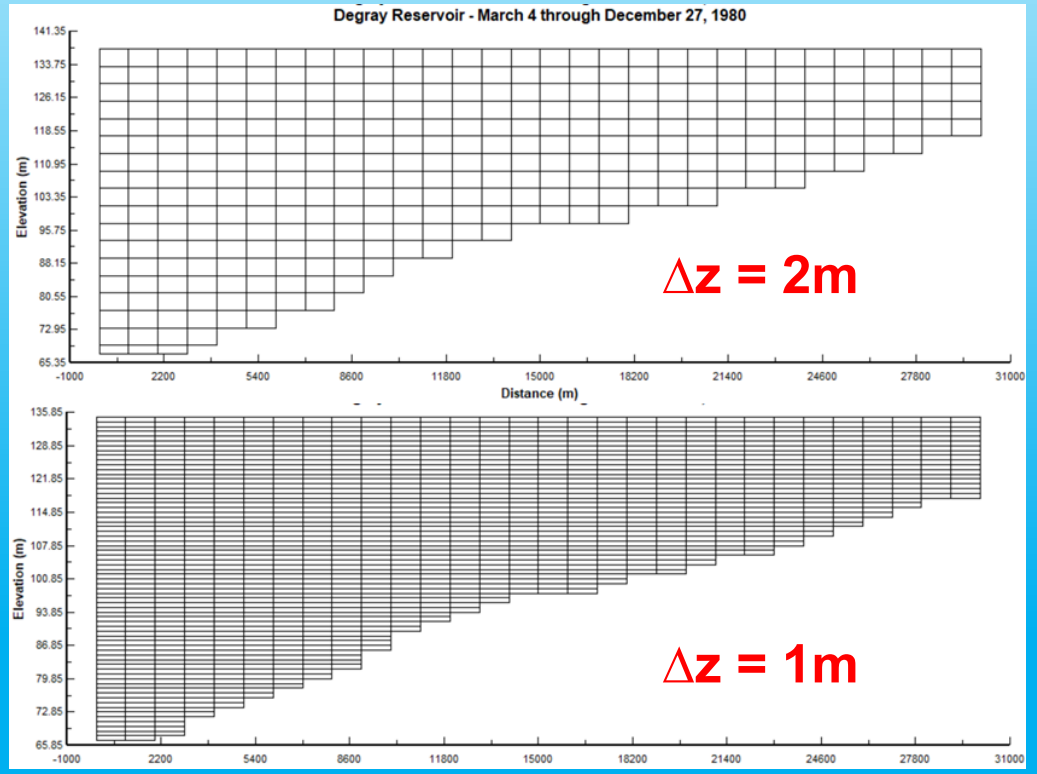


Model Grids - DeGray Reservoir

- Branch length **30 km**
- Segment lengths **1000 m**
- Maximum width **5530 m**
- Layer height **2 m**
- Upstream segment **2**
- Downstream segment **31**







DeGray Bathymetry Files (2m, 1m, 4m)

Segment		1		2		3		4		5		6		7		8		9		10	
DLX		1000		1000		1000		1000		1000		1000		1000		1000		1000		1000	
ELWS		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8	
PHI0		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14	
Friction		70		70		70		70		70		70		70		70		70		70	
Layer	DZ #1	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top
1	2.00	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35	.00	136.35
2	2.00	.00	134.35	171.00	134.35	298.00	134.35	513.00	134.35	645.00	134.35	726.00	134.35	900.00	134.35	799.00	134.35	685.00	134.35	944.00	134.35
3	2.00	.00	132.35	171.00	132.35	298.00	132.35	513.00	132.35	645.00	132.35	726.00	132.35	900.00	132.35	799.00	132.35	684.00	132.35	934.00	132.35
4	2.00	.00	130.35	171.00	130.35	298.00	130.35	513.00	130.35	645.00	130.35	726.00	130.35	900.00	130.35	799.00	130.35	683.00	130.35	920.00	130.35
5	2.00	.00	128.35	159.00	128.35	271.00	128.35	458.00	128.35	581.00	128.35	672.00	128.35	844.00	128.35	751.00	128.35	623.00	128.35	840.00	128.35
6	2.00	.00	126.35	134.00	126.35	212.00	126.35	338.00	126.35	440.00	126.35	558.00	126.35	735.00	126.35	658.00	126.35	608.00	126.35	705.00	126.35
7	2.00	.00	124.35	107.00	124.35	150.00	124.35	214.00	124.35	295.00	124.35	448.00	124.35	658.00	124.35	646.00	124.35	535.00	124.35	624.00	124.35
8	2.00	.00	122.35	79.00	122.35	100.00	122.35	125.00	122.35	183.00	122.35	353.00	122.35	603.00	122.35	624.00	122.35	492.00	122.35	574.00	122.35
9	2.00	.00	120.35	43.00	120.35	70.00	120.35	100.00	120.35	113.00	120.35	265.00	120.35	537.00	120.35	501.00	120.35	343.00	120.35	506.00	120.35
10	2.00	.00	118.35	.00	118.35	.00	118.35	70.00	118.35	90.00	118.35	205.00	118.35	484.00	118.35	453.00	118.35	299.00	118.35	435.00	118.35
11	2.00	.00	116.35	.00	116.35	.00	116.35	.00	116.35	70.00	116.35	154.00	116.35	405.00	116.35	380.00	116.35	257.00	116.35	363.00	116.35
12	2.00	.00	114.35	.00	114.35	.00	114.35	.00	114.35	.00	114.35	70.00	114.35	203.00	114.35	266.00	114.35	208.00	114.35	292.00	114.35
13	2.00	.00	112.35	.00	112.35	.00	112.35	.00	112.35	.00	112.35	.00	112.35	70.00	112.35	127.00	112.35	144.00	112.35	228.00	112.35
14	2.00	.00	110.35	.00	110.35	.00	110.35	.00	110.35	.00	110.35	.00	110.35	.00	110.35	70.00	110.35	100.00	110.35	120.00	110.35
15	2.00	.00	108.35	.00	108.35	.00	108.35	.00	108.35	.00	108.35	.00	108.35	.00	108.35	.00	108.35	70.00	108.35	70.00	108.35
16	2.00	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35	.00	106.35
17	2.00	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35	.00	104.35
18	2.00	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35	.00	102.35
19	2.00	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35	.00	100.35
20	2.00	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35	.00	98.35
21	2.00	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35	.00	96.35
22	2.00	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35	.00	94.35
23	2.00	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35	.00	92.35
24	2.00	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35	.00	90.35

Δz = 2m

1. segment lengths
2. water surface elevations
3. segment orientations
4. bottom friction
5. layer heights for each segment, and
6. average widths for each grid cell.

Segment		1		2		3		4		5		6		7		8		9		10	
DLX		1000		1000		1000		1000		1000		1000		1000		1000		1000		1000	
ELWS		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8	
PHI0		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14	
Friction		70		70		70		70		70		70		70		70		70		70	
Layer	DZ #1	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top
1	4.00	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35	.00	206.35
2	4.00	.00	202.35	171.00	202.35	298.00	202.35	513.00	202.35	645.00	202.35	726.00	202.35	900.00	202.35	799.00	202.35	684.50	202.35	939.00	202.35
3	4.00	.00	198.35	171.00	198.35	298.00	198.35	513.00	198.35	645.00	198.35	726.00	198.35	900.00	198.35	799.00	198.35	684.50	198.35	939.00	198.35
4	4.00	.00	194.35	171.00	194.35	298.00	194.35	513.00	194.35	645.00	194.35	726.00	194.35	900.00	194.35	799.00	194.35	684.50	194.35	939.00	194.35
5	4.00	.00	190.35	171.00	190.35	298.00	190.35	513.00	190.35	645.00	190.35	726.00	190.35	900.00	190.35	799.00	190.35	684.50	190.35	939.00	190.35
6	4.00	.00	186.35	171.00	186.35	298.00	186.35	513.00	186.35	645.00	186.35	726.00	186.35	900.00	186.35	799.00	186.35	684.50	186.35	939.00	186.35
7	4.00	.00	182.35	171.00	182.35	298.00	182.35	513.00	182.35	645.00	182.35	726.00	182.35	900.00	182.35	799.00	182.35	684.50	182.35	939.00	182.35
8	4.00	.00	178.35	171.00	178.35	298.00	178.35	513.00	178.35	645.00	178.35	726.00	178.35	900.00	178.35	799.00	178.35	684.50	178.35	939.00	178.35
9	4.00	.00	174.35	171.00	174.35	298.00	174.35	513.00	174.35	645.00	174.35	726.00	174.35	900.00	174.35	799.00	174.35	684.50	174.35	939.00	174.35
10	4.00	.00	170.35	171.00	170.35	298.00	170.35	513.00	170.35	645.00	170.35	726.00	170.35	900.00	170.35	799.00	170.35	684.50	170.35	939.00	170.35
11	4.00	.00	166.35	171.00	166.35	298.00	166.35	513.00	166.35	645.00	166.35	726.00	166.35	900.00	166.35	799.00	166.35	684.50	166.35	939.00	166.35
12	4.00	.00	162.35	171.00	162.35	298.00	162.35	513.00	162.35	645.00	162.35	726.00	162.35	900.00	162.35	799.00	162.35	684.50	162.35	939.00	162.35
13	4.00	.00	158.35	171.00	158.35	298.00	158.35	513.00	158.35	645.00	158.35	726.00	158.35	900.00	158.35	799.00	158.35	684.50	158.35	939.00	158.35
14	4.00	.00	154.35	171.00	154.35	298.00	154.35	513.00	154.35	645.00	154.35	726.00	154.35	900.00	154.35	799.00	154.35	684.50	154.35	939.00	154.35
15	4.00	.00	150.35	171.00	150.35	298.00	150.35	513.00	150.35	645.00	150.35	726.00	150.35	900.00	150.35	799.00	150.35	684.50	150.35	939.00	150.35
16	4.00	.00	146.35	171.00	146.35	298.00	146.35	513.00	146.35	645.00	146.35	726.00	146.35	900.00	146.35	799.00	146.35	684.50	146.35	939.00	146.35
17	4.00	.00	142.35	171.00	142.35	298.00	142.35	513.00	142.35	645.00	142.35	726.00	142.35	900.00	142.35	799.00	142.35	684.50	142.35	939.00	142.35
18	4.00	.00	138.35	171.00	138.35	298.00	138.35	513.00	138.35	645.00	138.35	726.00	138.35	900.00	138.35	799.00	138.35	684.50	138.35	939.00	138.35
19	4.00	.00	134.35	171.00	134.35	298.00	134.35	513.00	134.35	645.00	134.35	726.00	134.35	900.00	134.35	799.00	134.35	684.50	134.35	939.00	134.35
20	4.00	.00	130.35	165.00	130.35	284.50	130.35	485.50	130.35	613.00	130.35	699.00	130.35	872.00	130.35	775.00	130.35	653.00	130.35	880.00	130.35
21	4.00	.00	126.35	120.50	126.35	181.00	126.35	276.00	126.35	367.50	126.35	503.00	126.35	696.50	126.35	652.00	126.35	571.50	126.35	664.50	126.35

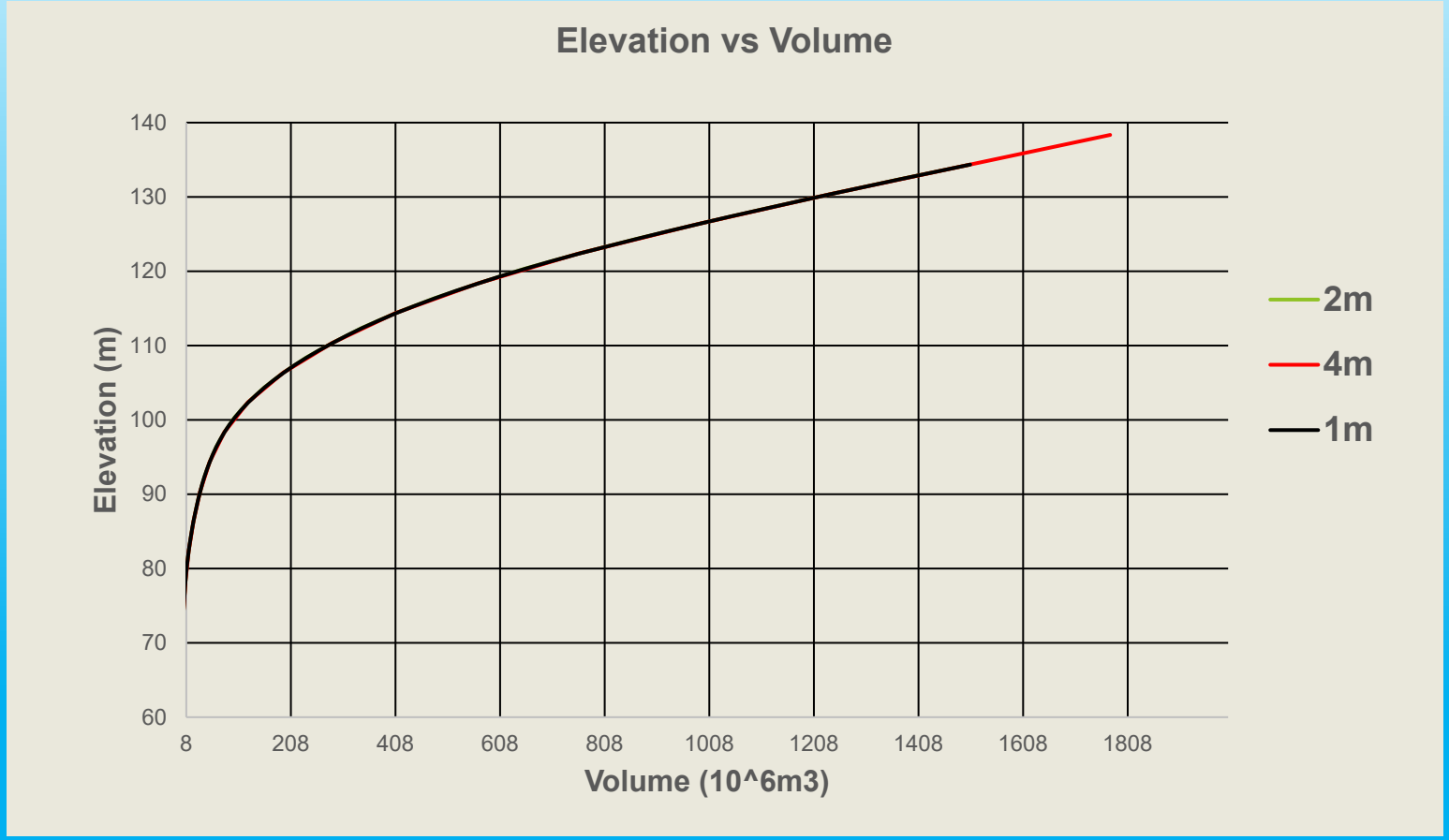
Δz = 4m

Segment		1		2		3		4		5		6		7		8		9		10	
DLX		1000		1000		1000		1000		1000		1000		1000		1000		1000		1000	
ELWS		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8		123.8	
PHI0		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14		5.14	
Friction		70		70		70		70		70		70		70		70		70		70	
Layer	DZ #1	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top	Width	Elev-top
1	1.00	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35	.00	135.35
2	1.00	.00	134.35	171.00	134.35	298.00	134.35	513.00	134.35	645.00	134.35	726.00	134.35	900.00	134.35	799.00	134.35	685.25	134.35	946.50	134.35
3	1.00	.00	133.35	171.00	133.35	298.00	133.35	513.00	133.35	645.00	133.35	726.00	133.35	900.00	133.35	799.00	133.35	684.75	133.35	941.50	133.35
4	1.00	.00	132.35	171.00	132.35	298.00	132.35	513.00	132.35	645.00	132.35	726.00	132.35	900.00	132.35	799.00	132.35	684.25	132.35	936.50	132.35
5	1.00	.00	131.35	171.00	131.35	298.00	131.35	513.00	131.35	645.00	131.35	726.00	131.35	900.00	131.35	799.00	131.35	683.75	131.35	930.50	131.35
6	1.00	.00	130.35	171.00	130.35	298.00	130.35	513.00	130.35	645.00	130.35	726.00	130.35	900.00	130.35	799.00	130.35	683.25	130.35	923.50	130.35
7	1.00	.00	129.35	168.00	129.35	291.25	129.35	499.25	129.35	629.00	129.35	712.50	129.35	886.00	129.35	787.00	129.35	668.00	129.35	900.00	129.35
8	1.00	.00	128.35	162.00	128.35	277.75	128.35	471.75	128.35	597.00	128.35	685.50	128.35	858.00	128.35	763.00	128.35	638.00	128.35	860.00	128.35
9	1.00	.00	127.35	152.75	127.35	256.25	127.35	428.00	127.35	545.75	127.35	643.50	127.35	816.75	127.35	727.75	127.35	619.25	127.35	806.25	127.35
10	1.00	.00	126.35	140.25	126.35	226.75	126.35	368.00	126.35	475.25	126.35	586.50	126.35	762.25	126.35	681.25	126.35	611.75	126.35	738.75	126.35
11	1.00	.00	125.35	127.25	125.35	196.50	125.35	307.00	125.35	403.75	125.35	530.50	125.35	715.75	125.35	655.00	125.35	589.75	125.35	684.75	125.35
12	1.00	.00	124.35	113.75	124.35	165.50	124.35	245.00	124.35	331.25	124.35	475.50	124.35	677.25	124.35	649.00	124.35	553.25	124.35	644.25	124.35
13	1.00	.00	123.35	100.00	123.35	137.50	123.35	191.75	123.35	267.00	123.35	424.25	123.35	644.25	123.35	640.50	123.35	524.25	123.35	611.50	123.35
14	1.00	.00	122.35	86.00	122.35	112.50	122.35	147.25	122.35	211.00	122.35	376.75	122.35	616.75	122.35	629.50	122.35	502.75	122.35	586.50	122.35
15	1.00	.00	121.35	70.00	121.35	92.50	121.35	118.75	121.35	165.50	121.35	331.00	121.35	586.50	121.35	593.25	121.35	454.75	121.35	557.00	121.35
16	1.00	.00	120.35	52.00	120.35	77.50	120.35	106.25	120.35	130.50	120.35	287.00	120.35	553.50	120.35	531.75	120.35	380.25	120.35	523.00	120.35
17	1.00	.00	119.35	32.25	119.35	52.50	119.35	92.50	119.35	107.25	119.35	250.00	119.35	523.75	119.35	489.00	119.35	332.00	119.35	488.25	119.35
18	1.00	.00	118.35	10.75	118.35	17.50	118.35	77.50	118.35	95.75	118.35	220.00	118.35	497.25	118.35	465.00	118.35	310.00	118.35	452.75	118.35
19	1.00	.00	117.35	.00	117.35	.00	117.35	52.50	117.35	85.00	117.35	192.25	117.35	464.25	117.35	434.75	117.35	288.50	117.35	417.00	117.35
20	1.00	.00	116.35	.00	116.35	.00	116.35	17.50	116.35	75.00	116.35	166.75	116.35	424.75	116.35	398.25	116.35	267.50	116.35	381.00	116.35
21	1.00	.00	115.35	.00	115.35	.00	115.35	.00	115.35	52.50	115.35	133.00	115.35	354.50	115.35	351.50	115.35	244.75	115.35	345.25	115.35

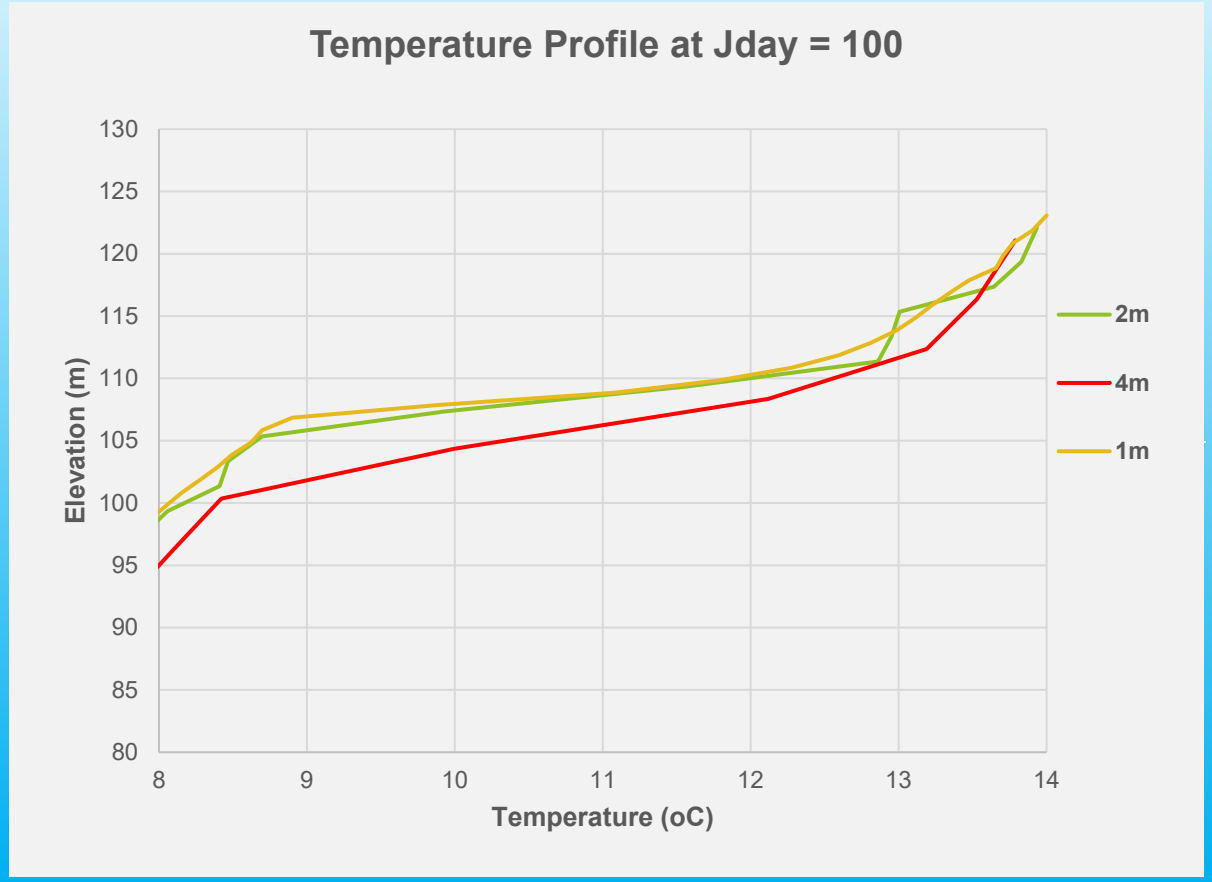
Δz = 1m

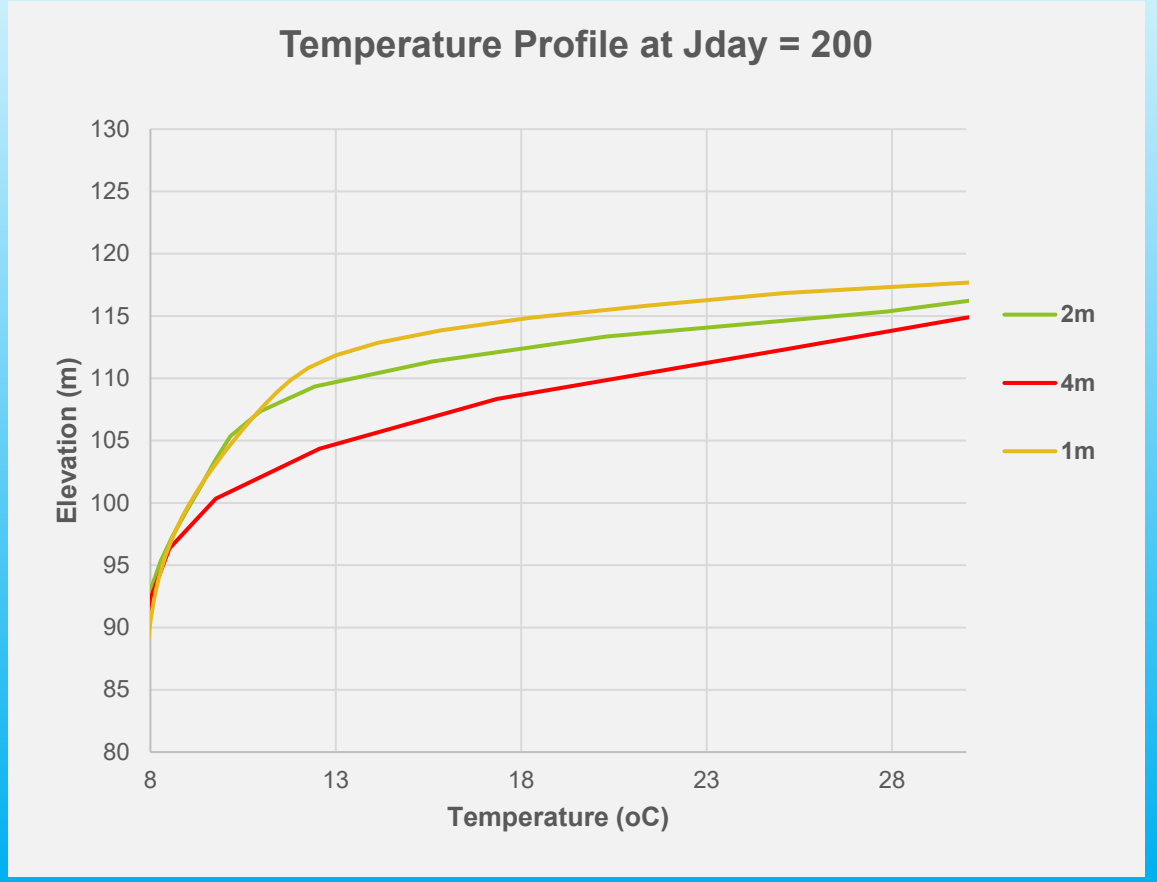
DeGray Reservoir Elevation vs Volume

- **pre.opt** created from the W2 preprocessor contains the model area-volume vs. elevation data.
- Comparison of reservoir stage-volume curves for three model grids.

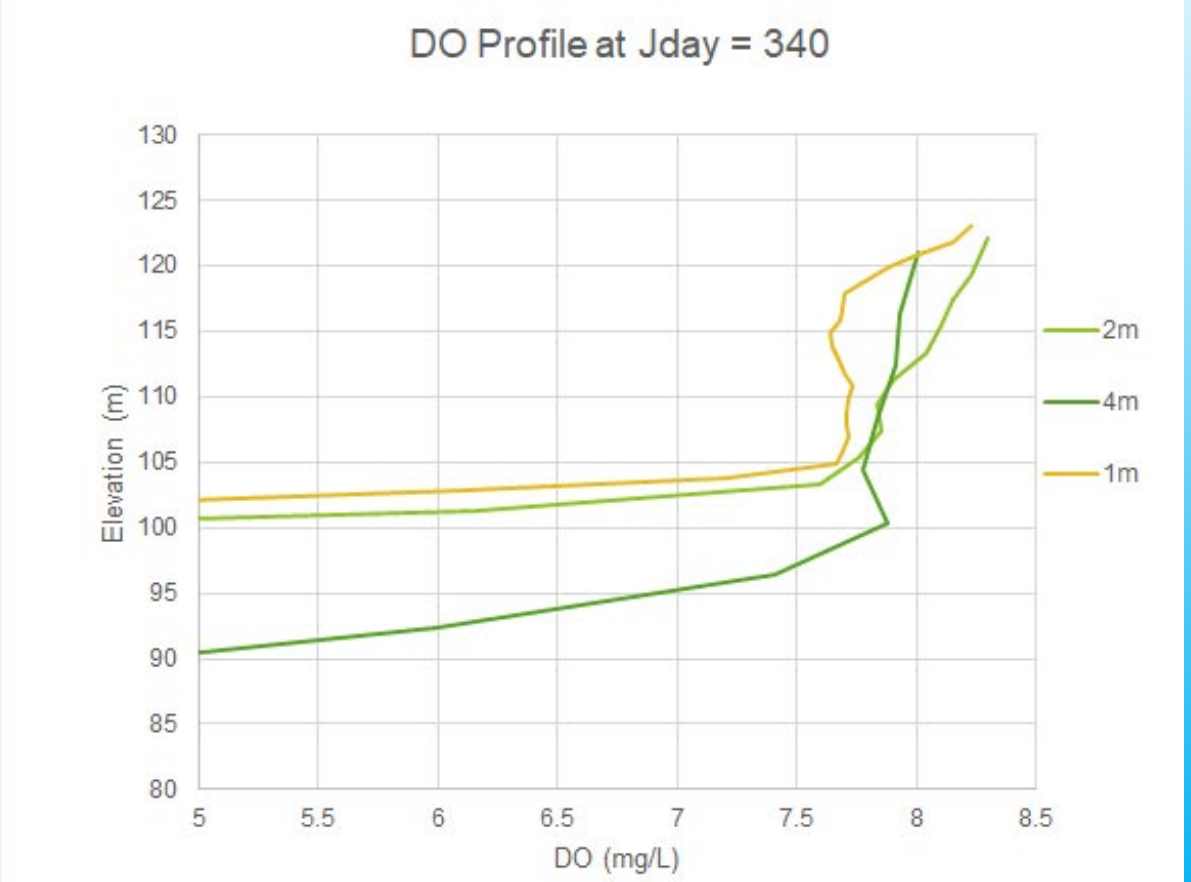


DeGray Modeled Water Temperature Profiles



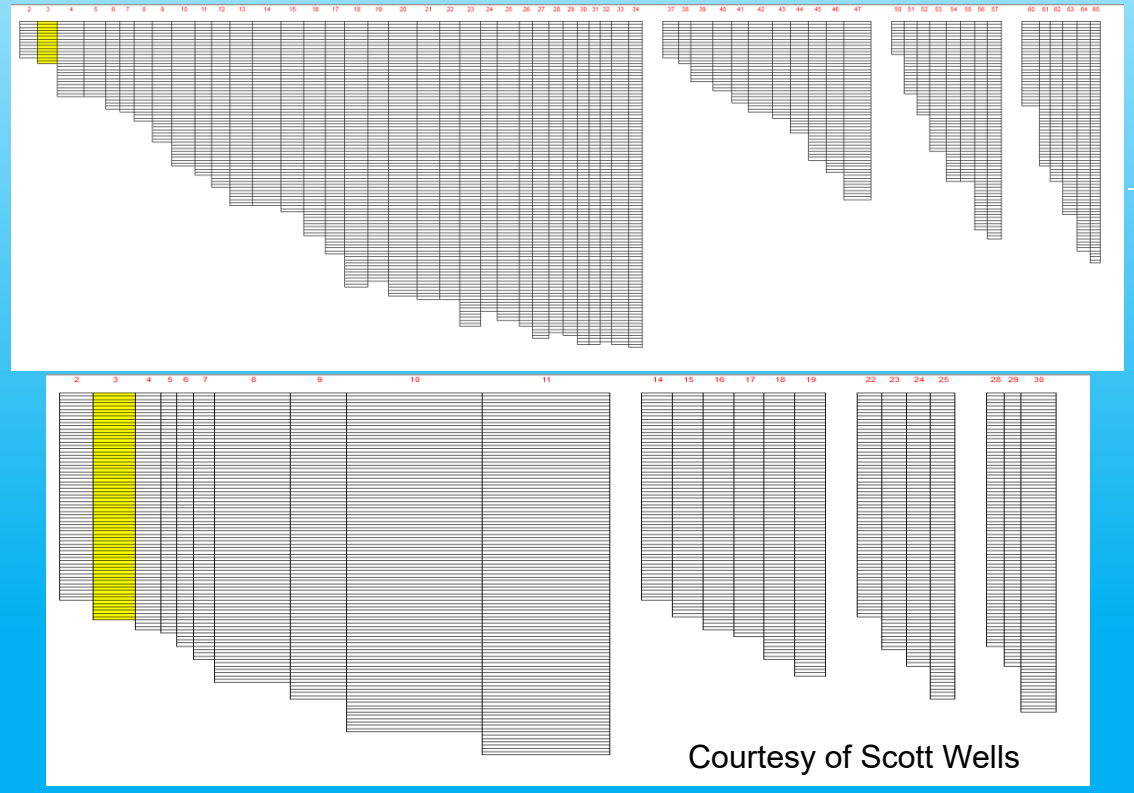


DeGray Modeled Dissolved Oxygen (DO) Profiles



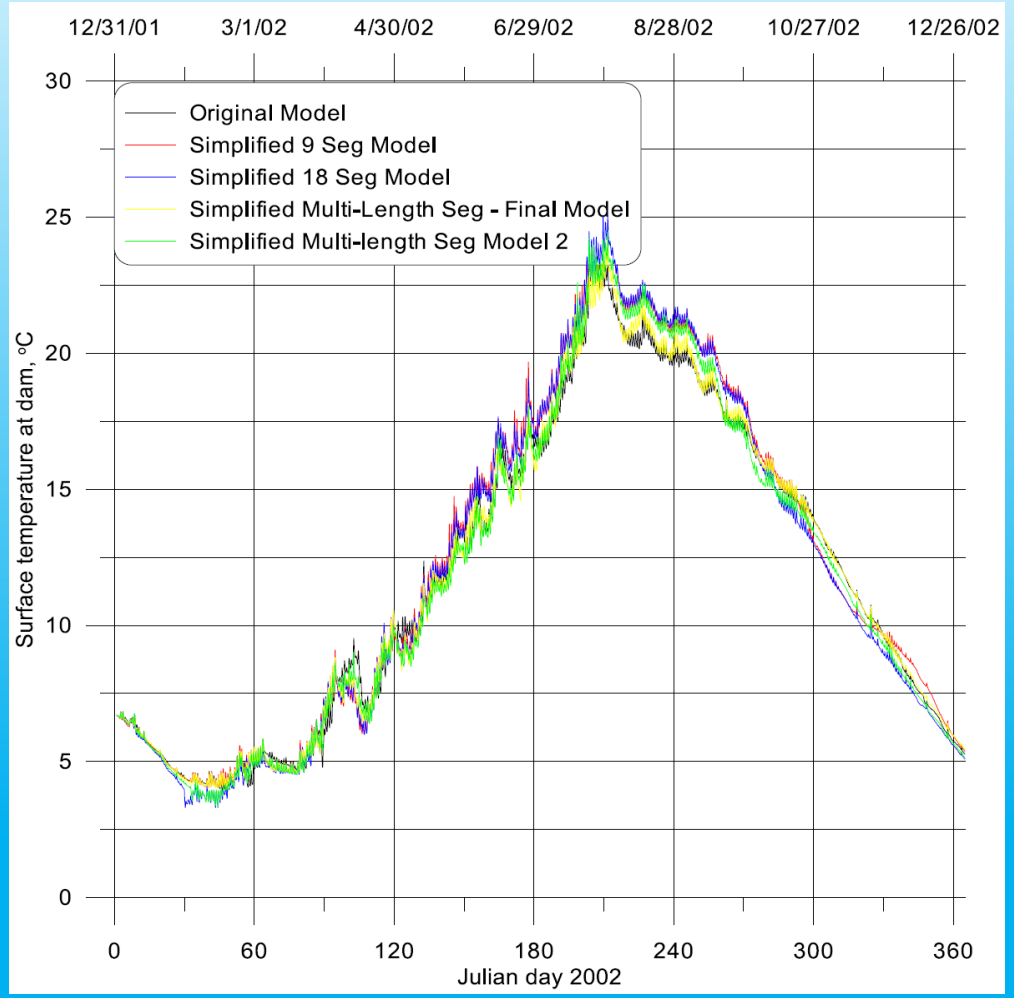
Detroit Lake W2 Model

- The W2 model segments were modified to reduce the total number of segments (66 → 36).
- When significantly coarsening a model grid, some of the finer details of the flow and temperature dynamics were lost.



Courtesy of Scott Wells

The final model chosen (shown in yellow) tracked the original outlet temperatures (shown in black) very well.



Hands-on Exercises

- Review the differences of bathymetry files from "**DeGray W2 Project**"
  - Layer height = 2 m (**bth1.csv**)
  - Layer height = 1 m (**bth1-1m.csv**)
  - Layer height = 4 m (**bth1-4m.csv**)

- Compare the differences of following predicted results for the 2 m, 1 m and 4 m layer heights
  - water temperature and dissolved oxygen profiles (**spr.csv**)
  - withdrawal output (**two_31.csv**)

Questions?