



U.S. ARMY

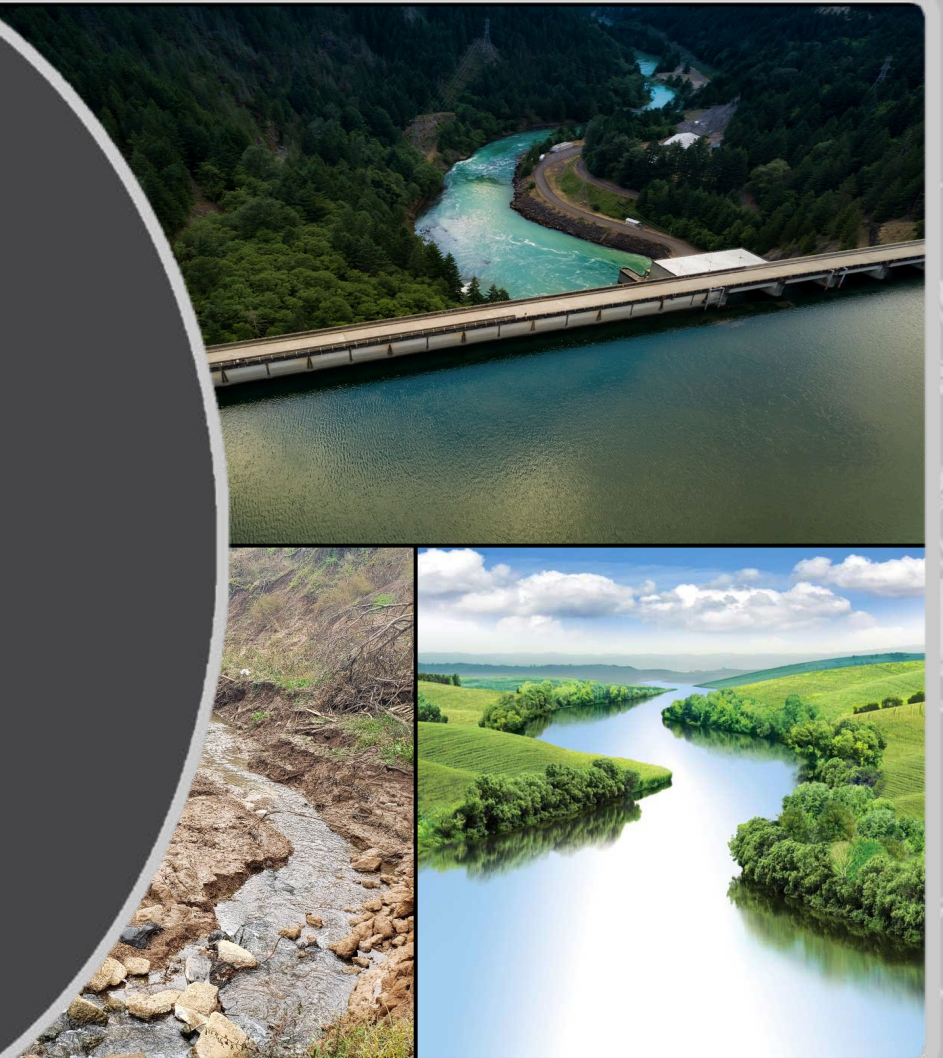
CE-QUAL-W2 PORTS

Barry Bunch, DE, PE, and Zhonglong Zhang, PhD, PE, PH

U.S. Army Engineer Research and Development Center,
Environmental Laboratory

CE-QUAL-W2 Workshop

July 18-20, 2023



US Army Corps
of Engineers



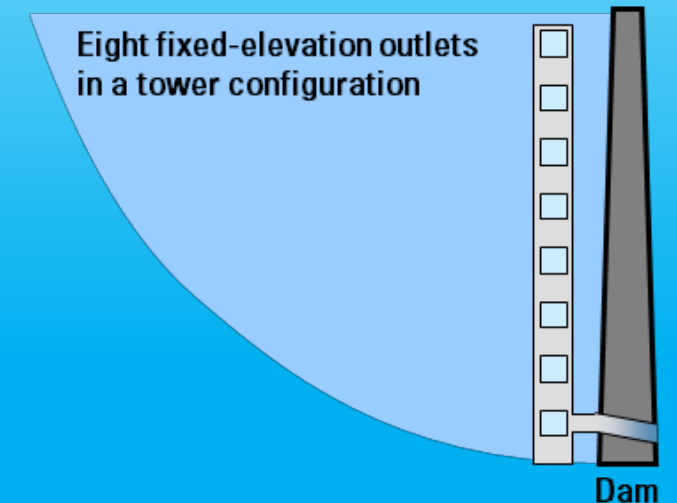
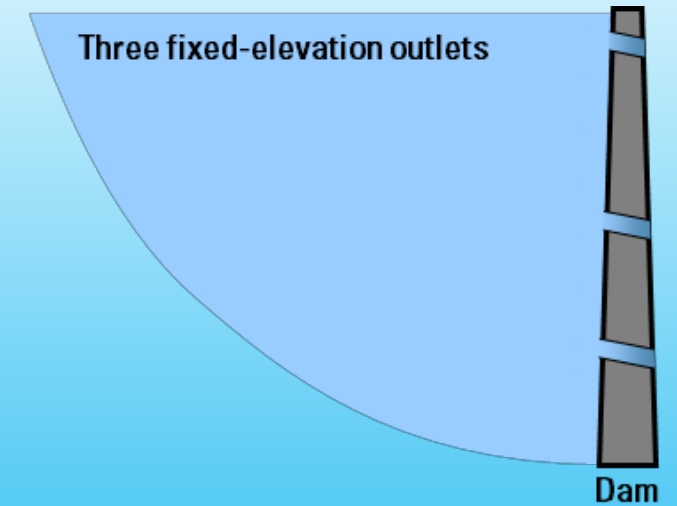
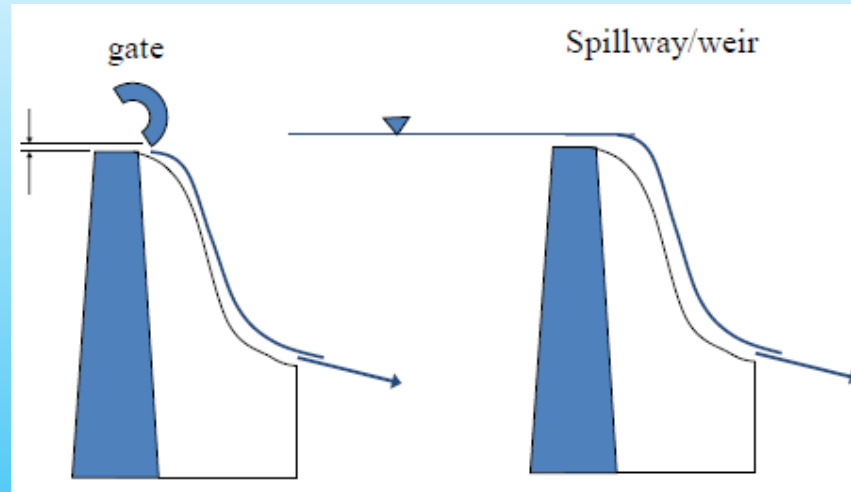
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

Ports

- Ports are means by which water leaves the reservoir and passes through the dam.
- Location of the port determines where water withdrawn originates.
 - Impacts upstream water column thermal and chemical structure.
 - Released water impacts downstream water quality.
- Proper representation of the Port is crucial to obtaining realistic results.
- Required information varies depending upon type of Port.

CE-QUAL-W2 Types of Ports

- Gates
- Spillway/Weir
- Floating Weirs
- Tower Control Devices
- Pipes
- Port type and means of operation impacts both upstream and downstream water quality.



CE-QUAL-W2 Input Requirements for Spillway

$$Q = \alpha_1 \Delta h^{\beta_1}$$

$$Q = \alpha_2 \Delta h^{\beta_2}$$

SPILLWAYS	SP1
IUSP- Upstream segment number, spillway segment location	42
IDSP- Downstream segment number, Downstream segment spillway outflow enters	0
ESP - spillway elevation (crest), m	349.6
A1SP- α_1 , empirical coefficient for free-flowing conditions	45.33
B1SP- β_1 , empirical coefficient for free-flowing conditions	1.5
A2SP- α_2 , empirical coefficient for submerged conditions	34.45
B2SP- β_2 , empirical coefficient for submerged conditions	1
LATSPC-Downstream or lateral withdrawal, DOWN or LAT	DOWN
PUSPC-How inflows enter into the upstream spillway segment, DISTR, DENSITY, or SPECIFY	DISTR
ETUSP-Top elevation spillway inflows enter using SPECIFY option, m	0
EBUSP-Bottom elevation spillway inflows enter using SPECIFY option, m	0
KTUSP-Top layer above which selective withdrawal will not occur	2
KBUSP-Spillway Up Selective withdrawal bottom layer, Bottom layer below which selective withdrawal	178
PDSPC-How inflows enter into the downstream spillway segment, DISTR, DENSITY, or SPECIFY	DISTR
ETUSP-Top elevation spillway inflows enter using SPECIFY option m	0
EBUSP-Bottom elevation spillway inflows enter using SPECIFY option, m	0
KTDSP-Top layer above which selective withdrawal will not occur	2
KBDSP-Spillway Down Selective withdrawal bottom layer bottom layer below which selective withdrawal	178
GASSPC Dissolved gas computations ON or OFF	OFF
EQSP Equation number for computing dissolved gas	2
AGASSP a empirical coefficient	110
BGASSP b empirical coefficient	-0.1
CGASSP c empirical coefficient	-0.1

CE-QUAL-W2 Input Requirements for Gates

File names - global	FILE NAMES
OWD FILE OWDFN - withdrawals	owd.npt - not used
QGT FILE QGTFN - gate	QGT_BON_2011_2015_daily_DSS-scaled.csv
WSC FILE WSCFN - wind sheltering	BON_WSC.npt
SHD FILE SHDFN - shading	BON_SHD_1.npt
VPLFN - W2 post output, DSI W2Post output file	Bonneville1m.w2l

GATES	GATE1	GATE2	GTE3	GATE4	GATE5	GATE6	GATE7	GATE8	GATE9	GATE10
IUGT- Upstream segment number	76	76	76	76	76	76	76	76	76	76
IDGT- Downstream segment number	0	0	0	0	0	0	0	0	0	0
EGT- Gate elevation m	11.7	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
A1GT α1 coefficient in gate equation for free flowing	10	10	10	10	10	10	10	10	10	10
B1GT β1 coefficient in gate equation for free flowing	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
G1GT gamma1 coeff for free flowing conditions	1	1	1	1	1	1	1	1	1	1
A2GT α2 coefficient in gate equation for submerged c	10	10	10	10	10	10	10	10	10	10
B2GT β2 coefficient in gate equation for submerged c	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
G2GT gamma2 coeff for submerged conditions	1	1	1	1	1	1	1	1	1	1
LATGTC downstream or lateral withdrawal LAT or DO	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN
GTA1 α1 in gate equation for free flowing conditions	10	10	10	10	10	10	10	10	10	10
GTB1 β1 in gate equation for free flowing conditions	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
GTA2 α2 in gate equation for submerged conditions a	10	10	10	10	10	10	10	10	10	10
GTB2 β2 in gate equation for submerged conditions a	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
DYNGTC Either 'B', 'ZGT', or 'FLOW'	FLOW	FLOW	FLOW	FLOW	FLOW	FLOW	FLOW	FLOW	FLOW	FLOW
GTIC EITHER ON or OFF interpolate gate file	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
PUGTC Specifies how inflows enter the upstream gate	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR
ETUGT Top elevation gate inflows enter using the SPE										
EBUGT Bottom elevation gate inflows using the SPEC										
KTUGT Top layer above which selective withdrawal w	2	2	2	2	2	2	2	2	2	2
KBUGT-Selective withdrawal bottom layer, Bottom la	55	55	55	55	55	55	55	55	55	55
PDGTC Specifies how inflows enter the downstream g	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR	DISTR
ETDGT Top elevation gate inflows enter using the SPE										
EBDGT Bottom elevation gate inflows using the SPEC										
KTDGT Top layer above which selective withdrawal w	2	2	2	2	2	2	2	2	2	2
KBDGT-Selective withdrawal bottom layer, Bottom la	55	55	55	55	55	55	55	55	55	55
GASGTC Dissolved gas computations ON or OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON	ON
EQGT Equation number for computing dissolved gas	2	2	2	2	2	2	2	2	2	2
AGASGT a empirical coefficient	135	135	135	135	135	135	135	135	135	135
BGASGT b empirical coefficient	-35	-35	-35	-35	-35	-35	-35	-35	-35	-35
CGASGT c empirical coefficient	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

$$Q = \alpha_1 \Delta h^{\beta_1} B^{\gamma_1}$$

$$Q = \alpha_2 \Delta h^{\beta_2} B^{\gamma_2}$$

CE-QUAL-W2 Input Requirements for Structures

STRUCTURES for each branch. These are known outflows at the end of a branch	BR1	BR2
NSTR - Number of branch outlet structures	1	
DYNSTRUC - Dynamic elevation of structure control ON or OFF - reads input	OFF	
STRIC1-Turns ON/OFF interpolation of structure outflows for structure 1	ON	
STRIC2-Turns ON/OFF interpolation of structure outflows for structure 2		
STRIC3-Turns ON/OFF interpolation of structure outflows for structure 3		
STRIC4-Turns ON/OFF interpolation of structure outflows for structure 4		
STRIC5-Turns ON/OFF interpolation of structure outflows for structure 5		
KTSTR1-Top layer above which selective withdrawal will not occur for structure 1	2	
KTSTR2-Top layer above which selective withdrawal will not occur for structure 2		
KTSTR3-Top layer above which selective withdrawal will not occur for structure 3		
KTSTR4-Top layer above which selective withdrawal will not occur for structure 4		
KTSTR5-Top layer above which selective withdrawal will not occur for structure 5		
KBSTR1-Bottom layer below which selective withdrawal will not occur for structure 1	35	
KBSTR2-Bottom layer below which selective withdrawal will not occur for structure 2		
KBSTR3-Bottom layer below which selective withdrawal will not occur for structure 3		
KBSTR4-Bottom layer below which selective withdrawal will not occur for structure 4		
KBSTR5-Bottom layer below which selective withdrawal will not occur for structure 5		
SINKC1 - Sink type used in the selective withdrawal algorithm, LINE or POINT	POINT	
SINKC2 - Sink type used in the selective withdrawal algorithm, LINE or POINT		
SINKC3 - Sink type used in the selective withdrawal algorithm, LINE or POINT		
SINKC4 - Sink type used in the selective withdrawal algorithm, LINE or POINT		
SINKC5 - Sink type used in the selective withdrawal algorithm, LINE or POINT		
ESTR1-Centerline elevation of structure 1, m	115	
ESTR2-Centerline elevation of structure 2, m		
ESTR3-Centerline elevation of structure 3, m		
ESTR4-Centerline elevation of structure 4, m		
ESTR5-Centerline elevation of structure 5, m		
WSTR1 - Structure 1 width if "LINE" chosen, Width of structure (line sink), m	0	
WSTR2- Structure 2 width if "LINE" chosen, Width of structure (line sink), m		
WSTR3- Structure 3 width if "LINE" chosen, Width of structure (line sink), m		
WSTR4- Structure 4 width if "LINE" chosen, Width of structure (line sink), m		
WSTR5- Structure 5 width if "LINE" chosen, Width of structure (line sink), m		

CE-QUAL-W2 Control File

- Specification of Number and Type of Ports in W2 Control File (w2_con.csv)

NST	NIW	NWD	NGT	NSP	NPI	NPU
1	0	0	1	0	0	0

- NST - Structures
- NGT – Gates
- NSP – Spillways
- By specifying operation of these Ports, all aspects of reservoir operation and conditions are impacted.
- CE-QUAL-W2 has option to enable model to choose port operation based upon specified temperature constraints – w2_selective.npt.

NDAY	SELECTC	HABTATC
100	ON	OFF

Selective Withdrawal Controls – w2_selective.npt

Selective input control file

Temperature outlet control - frequency of output for temperature

OUTFREQ TFRQTMP

	0.125
--	-------

Structure outlet control based on time and temperature and branch

DYNSTR1	CONTROL	NUM	FREQ
	ON	4	1

DYNSTR2	ST/WD	JB	JS/NW	YEARLY	TSTR	TEND	TEMP	NELEV	ELEV1	ELEV2	ELEV3
1	ST	1	1	ON	1	151	5	2	115	110	
2	ST	1	1	ON	151.1	181	12	2	115	100	
3	ST	1	1	ON	181.1	273	16	2	115	95	
4	ST	1	1	ON	273.1	365	10	2	115	92.5	

MONITOR	ISEG	ELEV	DYNCEL
1	0	-185	OFF
2	0	-185	OFF
3	0	-185	OFF
4	0	-185	OFF

CE-QUAL-W2 Outputs Related to Ports

- Withdrawal outflow files include outflow, outflow temperature, outflow constituent concentrations, and outflow derived constituent concentrations:
- If there is a structure, gate, spillway, and pipe, and withdrawal at the segment (XX), the combined flows and flow-averaged temperature and concentrations will be written to following output files.
- In addition, output files are written for each separate outlet.

qwo_segXX.csv
two_segXX.csv
cwo_segXX.csv
dwo_segXX.csv

qwo_wd1_segXX.csv
two_wd1_segXX.csv
cwo_wd1_segXX.csv
dwo_wd1_segXX.csv

qwo_str1_segXX.csv,	qwo_gate1_segXX.csv
two_str1_segXX.csv,	two_gate1_segXX.csv
cwo_str1_segXX.csv,	cwo_gate1_segXX.csv
dwo_str1_segXX.csv,	dwo_gate1_segXX.csv

Hands-On Exercises

- DeGray W2 model, included in release, includes 1 gate and 1 port withdrawal at 104 m.
- In this workshop, add additional three ports at 110 m, 107 m, and 72 m.
- Update the W2 control file and rerun the model.
- Review and compare following model outputs:

qwo_31.csv, two_31.csv
 qwo_gateX_seg31.csv, two_gateX_seg31.csv
 qwo_str1_seg31.csv, two_str1_seg31.csv
 qwo_str2_seg31.csv, two_str2_seg31.csv
 qwo_str3_seg31.csv, two_str3_seg31.csv
 qwo_str4_seg31.csv, two_str4_seg31.csv

STRUCTURES for each branch. These are known outflows		BR1
NSTR - Number of branch outlet structures		4
DYNSTRUC - Dynamic elevation of structure control ON or OFF		OFF
STRIC1-Turns ON/OFF interpolation of structure outflows		ON
STRIC2-Turns ON/OFF interpolation of structure outflows		ON
STRIC3-Turns ON/OFF interpolation of structure outflows		ON
STRIC4-Turns ON/OFF interpolation of structure outflows		ON
STRIC5-Turns ON/OFF interpolation of structure outflows		
KTSTR1-Top layer above which selective withdrawal will not occur		2
KTSTR2-Top layer above which selective withdrawal will not occur		2
KTSTR3-Top layer above which selective withdrawal will not occur		2
KTSTR4-Top layer above which selective withdrawal will not occur		2
KTSTR5-Top layer above which selective withdrawal will not occur		
KBSTR1-Bottom layer below which selective withdrawal will not occur		35
KBSTR2-Bottom layer below which selective withdrawal will not occur		35
KBSTR3-Bottom layer below which selective withdrawal will not occur		35
KBSTR4-Bottom layer below which selective withdrawal will not occur		35
KBSTR5-Bottom layer below which selective withdrawal will not occur		
SINKC1 - Sink type used in the selective withdrawal algorithm		POINT
SINKC2 - Sink type used in the selective withdrawal algorithm		POINT
SINKC3 - Sink type used in the selective withdrawal algorithm		POINT
SINKC4 - Sink type used in the selective withdrawal algorithm		POINT
SINKC5 - Sink type used in the selective withdrawal algorithm		
ESTR1-Centerline elevation of structure 1, m		104
ESTR2-Centerline elevation of structure 2, m		110
ESTR3-Centerline elevation of structure 3, m		107
ESTR4-Centerline elevation of structure 4, m		72
ESTR5-Centerline elevation of structure 5, m		
WSTR1 - Structure 1 width if "LINE" chosen, Width of structure		0
WSTR2- Structure 2 width if "LINE" chosen, Width of structure		0
WSTR3- Structure 3 width if "LINE" chosen, Width of structure		0
WSTR4- Structure 4 width if "LINE" chosen, Width of structure		0
WSTR5- Structure 5 width if "LINE" chosen, Width of structure		

Questions?

