Incubation Flow Analysis

Presented to the
Aquatic Subcommittee
January 11, 2008

Issues

- Moving the outage to August 15 – September 15 with or without a drawdown may result in spill.
- This spill may allow Chinook salmon to spawn at higher flows and higher on the stream margins
- Spawning in these areas may require additional water to protect incubating Chinook eggs.

Objectives

- Determine the duration and magnitude, if any, of spills under various operational scenarios.
- If spill does occur, determine the flows present in Study Site 1 (anadromous zone)
- Determine the flows necessary to protect incubating Chinook eggs if/when spill occurs

Methods

- Analyze operational scenarios to determine if/when spill occurs:
  - No drawdown/1 ft drawdown
  - During low, median and high inflow situations
  - Instream Flows Scenarios
    - 15 cfs in August, 20 cfs in September
    - 15 cfs August 1 – 15; 20 cfs August 16 – September 15; 15 cfs September 16-30
  - Assumes outage from August 15 – September 14

Methods, cont'd

- Once spill is determined, calculate flows (release + spill + accretion) that occurs in Study Site 1.
- Determine Incubation Flows required in SS1, and back-calculate releases from the drop structure using:
  - "Rule of thumb" 70% of spawning flow
  - Using site-specific sensitivity analysis

Results

Analysis of scenarios

		August		September		Starting	Days	Spill		
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	Low	15	20	20	15	N/A	0	0	0	0
2856.50	Low	15	15	20	20	N/A	0	0	0	0
2856.50	Med	15	20	20	15	7-Sep	9	15	13	4
2856.50	Med	15	15	20	20	2-Sep	14	15	14	5
2856.50	High	15	20	20	15	23-Aug	24	76	61	43
2856.50	High	15	15	20	20	22-Aug	25	82	62	9
2855.50	Low	15	20	20	15	N/A	0	0	0	0
2855.50	Low	15	15	20	20	N/A	0	0	0	0
2855.50	Med	15	20	20	15	N/A	0	0	0	0
2855.50	Med	15	15	20	20	N/A	0	0	0	0
2855.50	High	15	20	20	15	27-Aug	20	76	58	43
2855.50	High	15	15	20	20	26-Aug	21	82	59	18

No drawdown, Median Inflows
Split Flows (15/20/15)

		August		September		Starting	Days		Spill	
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**Median**	**15**	**20**	**20**	**15**	7-Sep	9	15	13	4

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Sep	20	13	33	8	41	28.7	
Oct	10		10	8	18		10.7
Nov	7		7	16	23		5.7
Dec	4		4	30	34		-5.3

No drawdown, Median Inflows
15 cfs –Aug/20 cfs Sept

		August		September		Starting	Days		Spill	
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**Median**	**15**	**15**	**20**	**20**	2-Sep	14	15	14	5

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Sep	20	14	34	8	42	29.4	
Oct	10		10	8	18		11.4
Nov	7		7	16	23		6.4
Dec	4		4	30	34		-4.6

No drawdown, High Inflows
Split Flows (15/20/15)

		August		September		Starting	Days	Spill		
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**High**	**15**	**20**	**20**	**15**	23-Aug	24	76	61	43

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Aug	20	61	81	9	90	63	
Sep	20		20	8	28		35
Oct	10		10	8	18		45
Nov	7		7	16	23		40
Dec	4		4	30	34		29
Jan	4		4	41	45		18
Feb	4		4	36	40		23
Mar	4		4	30	34		29

No drawdown, High Inflows
15 cfs –Aug/20 cfs Sept

		August		September					
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**High**	**15**	**15**	**20**	**20**	22-Aug	25	82	62	9

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Aug	20	62	82	9	91	63.7	
Sep	20		20	8	28		35.7
Oct	10		10	8	18		45.7
Nov	7		7	16	23		40.7
Dec	4		4	30	34		29.7
Jan	4		4	41	45		18.7
Feb	4		4	36	40		23.7
Mar	4		4	30	34		29.7

1 ft drawdown, High Inflows Split Flows (15/20/15)

		August		September						
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2855.50	**High**	**15**	**20**	**20**	**15**	27-Aug	20	76	58	43

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Aug	20	58	78	9	87	60.9	
Sep	20		20	8	28		32.9
Oct	10		10	8	18		42.9
Nov	7		7	16	23		37.9
Dec	4		4	30	34		26.9
Jan	4		4	41	45		15.9
Feb	4		4	36	40		20.9
Mar	4		4	30	34		26.9

1 ft drawdown, High Inflows 15 cfs –Aug/20 cfs Sept

		August		September						
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2855.50	High	15	15	20	20	26-Aug	21	82	59	18

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Aug	20	59	79	9	88	61.6	
Sep	20		20	8	28		33.6
Oct	10		10	8	18		43.6
Nov	7		7	16	23		38.6
Dec	4		4	30	34		27.6
Jan	4		4	41	45		16.6
Feb	4		4	36	40		21.6
Mar	4		4	30	34		27.6

Site Specific Transect Analysis

- Used Transect 7 from Instream Flow Study (Pool Tailout) with enhanced substrate
- Let model determine HSI at each cell for the following flows at SS1:
  - 41 cfs - 89 cfs
  - 42 cfs - 90 cfs
  - 88 cfs - 91 cfs

Transect Analysis, cont'd

- Protect those cells that had quality habitat values
  - S (depth) * S (velocity) * S (substrate) $\geq$ 0.4
  - Since S (substrate) = 1,
    - S (depth) * s (velocity)

Chinook Spawning HSI

Velocity	HSI	Depth	HSI
0.00	0.00	0.00	0.00
0.50	0.00	0.50	0.00
1.00	0.10	1.20	1.00
1.30	0.70	3.40	1.00
1.75	1.00	5.00	0.00
3.00	1.00	99.99	0.00
4.00	0.00		
99.99	0.00		

Methods

- RHABSIM used for
  - Bed elevations
  - Stage/Discharge Relationship
  - Combined Suitability Value (0.0 – 1.0) for each cell at the modeled flows.
- If Suitability Value $\geq$ 0.40
  - The width of that cell was counted
- If Suitability Value < 0.40
  - The width of that cell was given a value of 0.0

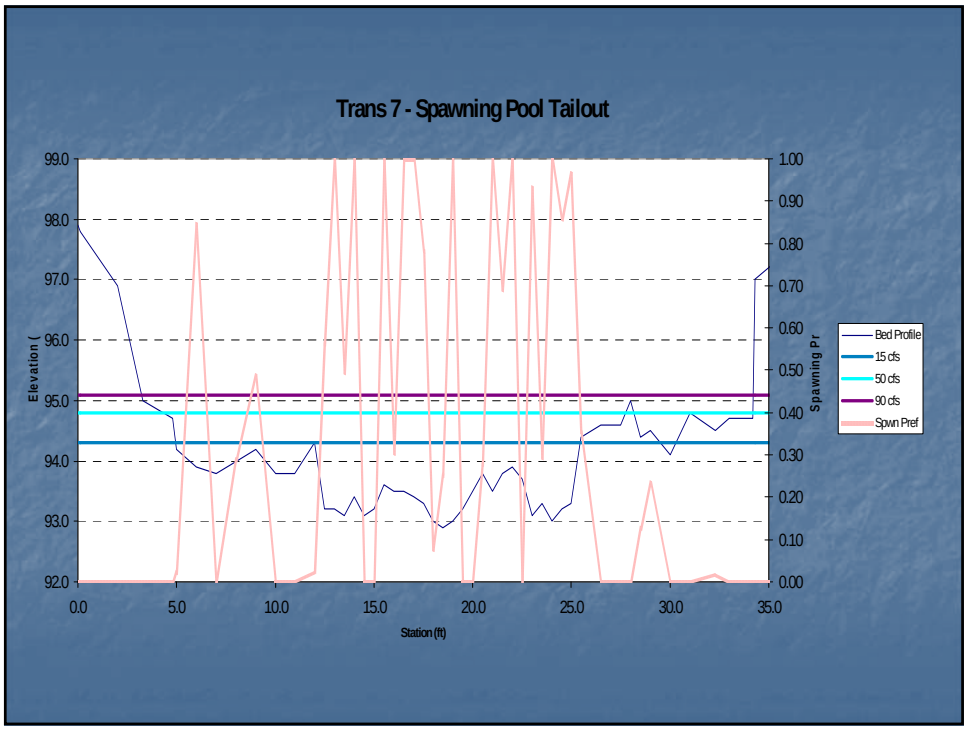
Methods, cont'd

- The water surface elevation was calculated for each modeled flow
- For each modeled flow, the depth of the water over each cell was calculated
- If the water depth $\geq$ 0.10 ft, the value of the width was assigned; otherwise a 0 was used.
- Flows were modeled in 5 cfs increments down from the spawning flow at SS1.

Methods, cont'd

- Analysis was continued until incubation cells no longer had 0.1 ft of water; then flows were modeled in 1 cfs increments to find the flow at which the 0.1 cfs depth was not present.

Go to worksheet



Results

- Flows that protected incubating eggs were less than 70% of the spawning flows across each spawning flow in SS1 resulting from spill

Results, SS1 Spawning and Incubation Flows (from Transect 7)

Spawning Flow	Incubation Flow
41	6
42	7
87	15
88	15
90	15
91	15

Why Is This?

- Spawning depth criteria for Chinook requires a minimum depth of 0.51 ft before there is a value;
- Need to have a depth of 0.78 ft to have a HSI value of 0.4.
- A change in stage of 0.68 ft (at a flow of 91 cfs, leaving a depth of 0.1 ft) equates to a change in flow of 71 cfs

Conclusion

- Using site-specific data, incubation flows required for spawning flows in Study Site 1 [(release + spill at drop structure) + inflow] can be met with the existing proposed flow regime;
- Additional flow releases are not required to meet incubation needs for Chinook eggs.

Results, SS1 Spawning and Incubation Flows (from Transect 7)

Spawning Flow	Incubation Flow
41	6
42	7
87	15
88	15
90	15
91	15

Month	Release	Spill	Total at Top	Inflow	SS1 Flow
August	20		20	9	29
Sep	20		20	8	28
Oct	10		10	8	18
Nov	7		7	16	23
Dec	4		4	30	34
Jan	4		4	41	45
Feb	4		4	36	40
Mar	4		4	30	34