APPENDIX Q

Whitewater Boating Flow Study Results and Supporting Information for Boatable Flow Ranges

INDIAN BAR RAFTER PUT-IN TO RUCK-A-CHUCKY (TUNNEL CHUTE RUN)

PCWA conducted whitewater boating studies on this reach at two target flows, 600 and 800 cfs. A flow study at 1,000 cfs was scheduled but no boaters committed to participating in the study, asserting that the 1,000 cfs flow study is already well understood. As a result, the 1,000 cfs target flow was not evaluated by a boater study team. Instead, the flow conditions at 1,000 cfs were videotaped from each of the photo-documentation locations for comparison to the 600 and 800 cfs target flows.

600 cfs Target Flow

The 600 cfs flow study was conducted on Tuesday, September 16, 2008. As identified below, a total of 7 boaters participated in the study, all in self-bailing rafts. All but one boater rated the run Class IV. The remaining boater rated this run Class III.

Whitewater Boating Flow Study Team Members

Tunnel Chute Run (Indian Bar Rafter Access to Ruck-a-Chucky)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
600	Brandon Bloodsaw	Self-Bailing Raft	IV	8
	David Stratton	Self-Bailing Raft	V	6
	Thomas Bartos	Self-Bailing Raft	V	20
	Glenn Munshower	Self-Bailing Raft	I	3
	Nicole Doyle	Self-Bailing Raft	IV	24
	Jeremiah Copper	Self-Bailing Raft	V	7
	Robert Townsend	Self-Bailing Raft		10
	Dave Martinez*	Self-Bailing Raft	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

<u>Flow Preferences</u>

- All but two boaters on the study team indicated they would prefer a much higher flow than the target flow. Consistent with this preference, these boaters indicated they were highly unsatisfied with the target flow. The two remaining boaters indicated they would prefer a slightly higher flow. These two boaters indicated they were highly satisfied with the target flow.
- All but two boaters on the study team estimated the minimum acceptable flow to be between 800 and 1,000 cfs. The remaining two boaters identified the minimum acceptable flow to be 600 cfs.
- All but two of the boaters indicated the optimal flow ranged from 1,100 to 1,250 cfs. The remaining two boaters identified the optimal flow to be 800 and 900 cfs.
- All but one boater on the study team identified a maximum acceptable flow range of between 1,500 and 2,500 cfs. The remaining boater estimated the maximum acceptable flow to be 900 cfs. However, this response was considered invalid

because this run is regularly boated both commercially and privately at flows of 1,000 cfs or above.

Other Factors

At the target flow of 600 cfs, the study team rated the overall whitewater challenge, safety, and rate of travel as moderately to highly unacceptable. These concerns were amplified in the post-run group discussion. Most of the study team expressed a concern regarding safety and the potential for injury at this flow. They also indicated that the overall aesthetics were diminished.

800 cfs Target Flow

The 800 cfs flow study was conducted on Tuesday, September 9, 2008. As identified below, a total of 13 boaters participated in the study. All of the study team were in self-bailing rafts. The study leader, Dave Martinez, used a hard-shell kayak. Seven boaters rated the run Class IV and five boaters rated the run Class III. One boater did not provide a rating.

Whitewater Boating Flow Study Team Members

Tunnel Chute Run (Indian Bar Rafter Access to Ruck-a-Chucky)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
800	Stacey Cheu	Self-Bailing Raft		
	Erin Moore-Dempsey	Self-Bailing Raft	V	6
	Grubby	Self-Bailing Raft	V	9
	David Garcia	Self-Bailing Raft	IV	3
	Frank Root	Self-Bailing Raft	V	20
	Bill Deitchman	Self-Bailing Raft		
	Scott Armstrong	Self-Bailing Raft	V	30
	Nicole Doyle	Self-Bailing Raft	IV	24
	Chafic Khalil	Self-Bailing Raft		
	Scott Buckley	Self-Bailing Raft	V	19
	Sedale Turbovsky	Self-Bailing Raft	III	3
	David Lewis	Self-Bailing Raft	V	12
	Jeremiah Copper	Self-Bailing Raft	V	7
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- Most boaters indicated they would prefer a slightly higher flow, and some indicated they would prefer a much higher flow. Satisfaction with the target flow ranged from moderately unsatisfied to moderately satisfied. One boater indicated he/she was highly satisfied with the target flow.

- Nine boaters on the study team indicated 800 cfs would be the minimum acceptable flow. Two boaters indicated 900 cfs would be the minimum acceptable flow and one boater indicated 1,000 cfs would be the minimum acceptable flow. One boater did not provide identify a minimum acceptable flow.
- Estimates of the optimal flow ranged from 1,000 cfs to 1,400 cfs.
- The reported maximum acceptable flow ranged from 1,200 to 1,900 cfs, with one boater indicating that a flow of 4,000 cfs would be the maximum acceptable flow.

1,000 cfs Target Flow

Video footage showing the run at the 1,000 cfs target flow is included on the enclosed DVD. The video was reviewed and the conditions were compared to conditions at the 600 and 800 target flows. At 1,000 cfs, the hydraulics are better defined and more powerful. In addition, the wetted channel is wider and deeper, and prominent boulders are covered or nearly covered. As such, more and/or better routes through the rapids are available. This is particularly noticeable at Chunder Rapid.

Estimated Boatable Flow Ranges

The following table summarizes the boatable flow ranges identified for this reach as determined through PCWA's whitewater flow studies.

	Flow Range as Determined through PCWA Flow Studies
Minimum	800 - 900
Optimum	1,000 -1,250
Maximum	1,500 – 2,500

Minimum Acceptable Flow

The minimum acceptable flow range as determined through the flow study is 800– 900 cfs. Between these flows, the boatability, technical challenge, and overall whitewater challenge of the run was rated as moderately acceptable. The safety rating varied, ranging from moderately unacceptable to highly acceptable. The rate of travel rating also varied, with ratings ranging from highly unacceptable to highly acceptable.

Optimum Flow

The optimum flow was determined to be between 1,000 and 1,250 cfs. In this range, the rate of travel increases, particularly in the flat-water sections, and the overall "whitewater" experience improves. In addition, rocks are covered and safety concerns relative to swims are reduced.

Maximum Acceptable Flow

The maximum acceptable flow was determined to be between 1,500 to 2,500 cfs. This estimate is based primarily on the estimates provided on the flow evaluation form.

RUCK-A-CHUCKY TO MAMMOTH BAR (MAMMOTH BAR RUN)

PCWA conducted whitewater boating studies on this run at target flows of 600, 800, and 1,000 cfs. The boating study team included boaters with a wide variety of skill levels. The characteristics of this run are suited to the beginning (novice) hard-shell and inflatable kayaker. Accordingly, the flow assessment was made with primary consideration given to the novice boater.

600 cfs Target Flow

The 600 cfs flow study was conducted on Wednesday, September 17, 2008. As identified below, a total of 4 boaters participated in the study. Two boaters used inflatable kayaks and the other two used hard-shell kayaks. All of the study participants rated the run Class II.

Whitewater Boating Flow Study Team Members

Mammoth Bar Run (Ruck-a-Chucky to Mammoth Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
600	Patricia Gibbs	Inflatable Kayak	I	
	Lee Leishman	Inflatable Kayak		
	Tom Van Noord	Hard Shell Kayak	I	2
	Dominic Pugliese	Hard Shell Kayak	III	2
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- One boater indicated that the target flow was close to optimum, two preferred a slightly higher flow, and one preferred a much higher flow.
- The minimum acceptable flow was estimated to be between 500 and 600 cfs.
- One boater identified an optimal flow of 1,000 cfs. Another boater identified 1,000 cfs as the maximum acceptable flow.
- Satisfaction ratings were divided. Two boaters were highly satisfied with the study flow and two boaters were moderately unsatisfied with the flow.

800 cfs Target Flow

The 800 cfs flow study was conducted on Wednesday, September 10, 2008. As identified below, a total of 5 boaters participated in the study. Two boaters used inflatable kayaks and the other three were in hard-shell kayaks. Three boaters rated the run Class II and two boaters rated the run Class III.

Whitewater Boating Flow Study Team Members

Mammoth Bar Run (Ruck-a-Chucky to Mammoth Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
800	Steven Boutte	Hard Shell Kayak	IV	2
	Alex Wolfgram	Hard Shell Kayak	V	7
	Patricia Gibbs	Inflatable Kayak	I	
	Jeffrey Hartley	Hard Shell Kayak	V	4
	Lee Leishman	Inflatable Kayak		
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- Two boaters indicated that the study flow was close to optimum. The three other boaters indicated that they would prefer a much higher flow. Satisfaction with the study flow ranged from neutral to highly satisfied.
- The minimum acceptable flow was estimated to be between 400 and 600 cfs.
- The optimal flow ranged from 800 cfs to 2,500 cfs.
- The two boaters in inflatable kayaks, and one boater in a hard-shell kayak indicated that the maximum acceptable flow is between 1,200 cfs and 2,500 cfs, respectively. Two highly skilled boaters in hard-shell kayaks indicated that the maximum acceptable was 25,000 or 30,000 cfs. Flows of this magnitude would only occur during high run-off events and cannot be run safely by class II boaters. As such, the 25,000–30,000 cfs maximum flow estimates were considered invalid.

1,000 cfs Target Flow

The 1,000 cfs flow study was conducted on Thursday, July 31, 2008. As identified below, a total of 9 boaters participated in the study. Three boaters used inflatable kayaks, two boaters used hard hard-shell kayaks, two used catarafts, and two used a self-bailing raft. All of the boaters on the study team rated the run Class II.

Whitewater Boating Flow Study Team Members

Mammoth Bar Run (Ruck-a-Chucky to Mammoth Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
1000	Howard Penn	Hard Shell Kayak	V	20
	Clint Norrell	Inflatable Kayak	III	
	David Garcia	Self-Bailing Raft	IV	3
	Kathy Norrell	Inflatable Kayak		
	Patricia Gibbs	Inflatable Kayak	I	
	Sandra Perry	Hard Shell Kayak	III	10
	Jillian Aldrin	Cataraft	IV	5
	Jesse Carlson	Cataraft	I	
	Joshua Hill	Self-Bailing Raft	V	12
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- Six boaters indicated that the study flow was close to optimum, two preferred a slightly higher flow, and one preferred a much higher flow. All boaters were moderately to highly satisfied with the study flow.
- The minimum acceptable flow was estimated to be between 800 and 1,000 cfs.
- The optimal flow ranged from 1,000 cfs to 1,400 cfs.
- The maximum acceptable flow was estimated to be between 1,500 to 4,000 cfs.

Estimated Boatable Flow Ranges

The following table summarizes the boatable flow ranges identified for this reach as determined through PCWA's whitewater flow studies.

	Flow Range as Determined through PCWA Flow Studies
Minimum	500 - 600
Optimum	800 -1,200
Maximum	1,500 – 2,500

Minimum Acceptable Flow

The minimum acceptable flow range as determined through the flow study is 500 to 600 cfs. At a flow of 600 cfs there was variation in regard to how the boaters rated the boating characteristics, from highly acceptable to highly unacceptable. This indicates that a flow of 600 cfs could be below the minimum acceptable flow for some boaters.

The minimum acceptable flow on this run should be skewed to the lower end of the flow range to accommodate unskilled boaters. This run is primarily suited for relatively unskilled (novice) boaters. For the novice boater, a sense of safety and control is one of their highest concerns. As they progress in skill, other boating characteristics become more important, such as availability of powerful hydraulics or overall whitewater challenge. Until that point, they need a flow that does not create a sense of danger. A flow range between 500 and 600 cfs would accomplish this objective.

Optimum Flow

The optimum flow range was estimated to be between 800 and 1,200 cfs. At the 1,000 cfs target flow, the study participants rated most of the boating characteristics from neutral to highly acceptable.

The exception was in regard to the “whitewater” components such as availability of challenging technical boating and powerful hydraulics, and overall whitewater challenge. These characteristics were rated as moderately to highly unacceptable by the more skilled boaters on the study team. This run may not provide optimal boating conditions for skilled boaters, regardless of flow.

Maximum Acceptable Flow

The maximum acceptable flow range was estimated to be 1,500 to 2,500 cfs. A flow of 2,500 cfs is likely too high for the novice boaters who would utilize this run. Skilled boaters would not be constrained by high flows on this run.

CONFLUENCE RUN

PCWA conducted whitewater boating studies on this run at target flows of 368, 600, 800, 1,000 cfs. The Confluence run flow studies were conducted in conjunction with the Mammoth Bar run flow studies, and most often, utilized the same boating study team. The boating study team included boaters with a wide variety of skill levels. The characteristics of this run are suited to the beginning (novice) hard-shell and inflatable kayaker. Accordingly, the flow assessment was made with primary consideration given to the novice boater.

During the initial study on this run, the boating study team boated to the Oregon Bar Access to take-out. However, there is no vehicular access to the Oregon Bar take-out, which results in a relatively difficult take-out situation (e.g. a long hike with boats and gear to retrieve a vehicle). On the subsequent flow studies the boating study team elected not to continue to the Oregon Bar take-out and instead take-out at the Birdsall River Access, located upstream.

368 cfs Target Flow

The 368 cfs flow study was conducted on Saturday, July 26, 2008. As identified below, a total of 7 boaters participated in the study. Three boaters used inflatable kayaks, three used hard-shelled kayaks, and one used a self-bailing inflatable raft. All of the study participants rated the run Class II and Class III, with the Class III section being between Birdsall River Access and the Oregon Bar River Access.

Whitewater Boating Flow Study Team Members

Confluence Run (Confluence to Oregon Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
368	Lester Lubetkin	Inflatable Kayak	II	28
	Laird Thompson	Hard Shell Kayak	III	10
	Tom Van Noord	Hard Shell Kayak	I	2
	Patricia Gibbs	Inflatable Kayak	I	
	Sandra Perry	Hard Shell Kayak	III	10
	David Garcia	Self-Bailing Raft	IV	3
	Guy Cables	Inflatable Kayak	V	30
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- Two boaters indicated that the target flow was close to optimum, four preferred a slightly higher flow, and one indicated they would like a much higher flow. Four boaters indicated they were highly satisfied with the study flow, two respondents were moderately satisfied, and the remaining respondent was neutral.

- The minimum acceptable flow was estimated to be between 300 and 400 cfs.
- The optimal flow ranged from 700 to 1,200 cfs.
- The maximum acceptable flow ranged from 1,700 to 2,500 cfs.

600 cfs Target Flow

The 600 cfs flow study was conducted on Wednesday, September 17, 2008. As identified below, a total of 5 boaters participated in the study. Three boaters used inflatable kayaks and two used hard-shelled kayaks. The boaters elected to take out at the Birdsall Access instead of the Oregon Bar Access. All of the study participants rated the run Class II.

Whitewater Boating Flow Study Team Members

Confluence Run (Confluence to Oregon Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
600	John Hauschild	Inflatable Kayak	III	15
	Tom Van Noord	Hard Shell Kayak	I	2
	Patricia Gibbs	Inflatable Kayak	I	
	Lee Leishman	Inflatable Kayak		
	Dominic Pugliese	Hard Shell Kayak	III	2
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- Four boaters indicated that they would prefer a slightly higher flow, and one indicated they would prefer a much higher flow.
- Satisfaction with the study flow for divided. Three boaters were highly satisfied with the study flow, one boater was moderately satisfied, and the remaining boater was neutral.
- The minimum acceptable flow was estimated to be between 400 and 600 cfs.
- Two boaters identified an optimal flow of 1,000 cfs.
- Maximum acceptable flow was estimated by two boaters. One indicated a maximum acceptable flow of 1,000 cfs. The other indicated a maximum acceptable flow of 15,000 cfs, which is too high for the novice boaters that would use this run and was therefore considered invalid.

800 cfs Target Flow

The 800 cfs flow study was conducted on Wednesday, September 10, 2008. As identified below, a total of 5 boaters participated in the study. Two boaters used inflatable kayaks and three used hard-shelled kayaks. The boaters elected to take out at the Birdsall Access instead of the Oregon Bar Access. All of the study participants rated the run Class II.

Whitewater Boating Flow Study Team Members

Confluence Run (Confluence to Oregon Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
800	Steven Boutte	Hard Shell Kayak	IV	2
	Alex Wolfgram	Hard Shell Kayak	V	7
	Patricia Gibbs	Inflatable Kayak	I	
	Jeffrey Hartley	Hard Shell Kayak	V	4
	Lee Leishman	Inflatable Kayak		
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- The study participants indicated they would prefer slightly too much higher flow. Satisfaction with the study flow ranged from neutral to highly satisfied.
- Most of the study participants indicated that the minimum acceptable flow is between 400 and 600 cfs. One boater indicated that the minimum acceptable flow of 800 cfs.
- The optimal flow estimates ranged from 1,000 cfs to 2,500 cfs.
- Most of the study participants indicated that the maximum acceptable flow is between 1,000 to 5,000 cfs. One boater indicated that the maximum acceptable flow is 80,000 cfs, which is too high for the novice boaters that would use this run and was therefore considered invalid.

1,000 cfs Target Flow

The 1,000 cfs flow study was conducted on Thursday, July 31, 2008. As identified below, a total of 4 boaters participated in the study. One boater used an inflatable kayak, two used hard-shelled kayaks, and one used a self-bailing inflatable raft. The boaters elected to take out at the Birdsall Access instead of the Oregon Bar Access. All of the study participants rated the run Class II.

Whitewater Boating Flow Study Team Members

Confluence Run (Confluence to Oregon Bar)

Flow (cfs)	Name of Boater	Watercraft	Skill Level	# Years Experience
1000	Patricia Gibbs	Inflatable Kayak	I	
	Howard Penn	Hard Shell Kayak	V	20
	David Garcia	Self-Bailing Raft	IV	3
	Sandra Perry	Hard Shell Kayak	III	10
	Dave Martinez*	Hard Shell Kayak	IV	30

*Dave Martinez was the study leader and is not counted as a study participant.

Flow Preferences

- All boaters were moderately to highly satisfied with the target flow. The study participants indicated they would prefer slightly lower to much higher flow.
- The minimum acceptable flow was estimated to be between 400 and 425 cfs, with the exception of one high-skilled kayaker that rated the minimum acceptable flow at 1,000 cfs.
- Estimates of the optimal flow ranged from 800 cfs to 1,500 cfs.
- The maximum acceptable flow ranged from 1,121 to 3,500 cfs.

Estimated Boatable Flow Ranges

The following table summarizes the boatable flow ranges for this run as identified by the through PCWA's whitewater flow studies.

	Flow Range as Determined through PCWA Flow Studies
Minimum	350 - 600
Optimum	800 – 1,500
Maximum	1,700 – 2,500

Minimum Acceptable Flow

The minimum acceptable Flow range is estimated to be between 350 to 600 cfs. At the study flow of 368 cfs most of the boating characteristics were rated from highly acceptable to neutral and half of the boaters were highly satisfied with the study flow. The other half was moderately satisfied and neutral about the study flow. This run is primarily suited for relatively unskilled boaters and the minimum acceptable flow reflects the lower end of the boatable flow range to accommodate these boaters.

Optimum Flow

The optimum flow range is estimated to be between 800 and 1,500 cfs. At the 1,000 cfs target flow, most of the boating characteristics were rated from neutral to highly acceptable, with the majority of ratings being highly acceptable. Though most of the boaters at the 1,000 cfs were highly satisfied with the flow, two boaters indicated they would like a slightly higher to much higher flow. The two other boaters reported that the 1,000 cfs flow was close to optimum. The range was extended above 1,000 cfs to accommodate more skill boaters, and those progressing in skill level. The range was also extended to below 1,000 cfs to provide additional opportunities for beginning and novice boaters, typical boaters on this run.

Maximum Acceptable Flow

The maximum acceptable flow range was estimated to be 1,700 to 2,500 cfs. A flow of 2,500 cfs is most likely too high for most of the boaters who would use this run due to their skill levels. A flow of 1,700 is a more likely maximum acceptable flow threshold for the typical boater using this run. Skilled boaters have no high flow constraints on this run, and in fact, run this section of river at high flow when powerful hydraulics are present in the lower end of the run between Birdsall River Access and Oregon Bar River Access.