EXH. PKW-36C
DOCKETS UE-190529/UG-190530
UE-190274/UG-190275
2019 PSE GENERAL RATE CASE
WITNESS: PAUL K. WETHERBEE

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY,** **Respondent.**	**Docket UE-190529** **Docket UG-190530 (*Consolidated*)**
In the Matter of the Petition of **PUGET SOUND ENERGY** **For an Order Authorizing Deferral Accounting and Ratemaking Treatment for Short-life IT/Technology Investment**	**Docket UE-190274** **Docket UG-190275 (*Consolidated*)**

SECOND EXHIBIT (CONFIDENTIAL) TO THE PREFILED REBUTTAL TESTIMONY OF

PAUL K. WETHERBEE

ON BEHALF OF PUGET SOUND ENERGY

REDACTED VERSION

JANUARY 15, 2020

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

Dockets UE-190529 & UG-190530
Puget Sound Energy
2019 General Rate Case

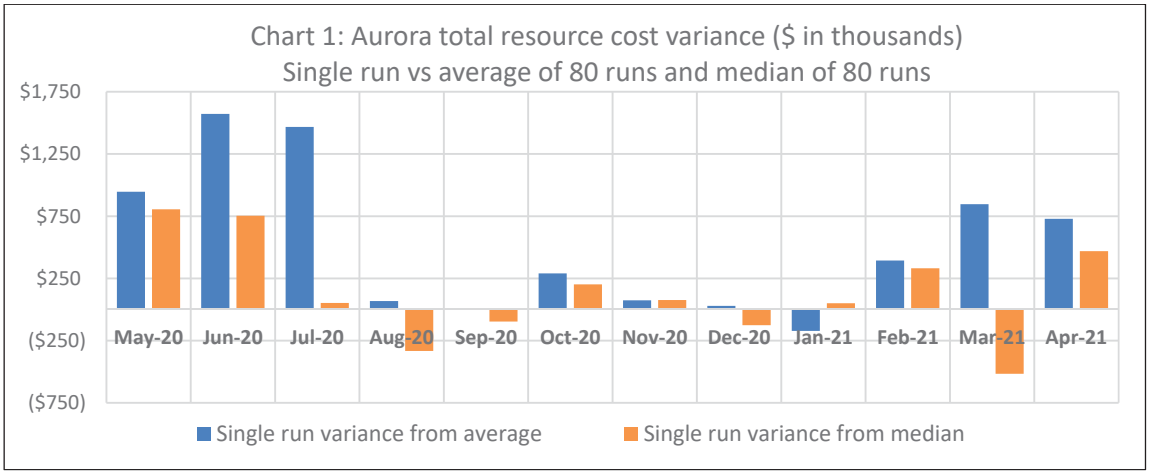
WUTC STAFF DATA REQUEST NO. 202:

Re: Power Cost Estimates – Hydro Resources

Table 11 in Mr. Wetherbee's Direct Testimony (PKW-1CT, page 62) shows a difference of over $6 million in 2019 GRC Aurora Results, using a single run based on average hydro production versus using the average resource costs from 80 runs of historical hydro production. Please explain, to the best of the Company's knowledge and analysis, the reasons for the difference in 2019 GRC result.

Response:

Average resource costs from 80 runs with historical hydro production are lower than resource costs from a single run using average hydro production because the distribution of 80 cost results is skewed toward lower costs. Put another way, the median of the resource costs from 80 runs is higher than the average of the same costs. Using a single run based on average hydro production reduces the impact of individual months with abnormally high or low hydro production in the 80-year data set. Therefore, resource costs using a single run are closer to the median of resource costs from 80 runs than to the average because they are not biased by the extremely high hydro production months that skew the results from 80 runs. A comparison of 80 run average and 80 run median resource costs to single run results is shown in Chart 1 below.



Attached as Attachment A to PSE's response to WUTC Staff Data Request No. 202 please find a worksheet containing Aurora resource cost results by month for the 80 hydro runs along with a comparison of average, median, and single run results. The difference between Puget Sound Energy's ("PSE") Aurora resource cost results using a single run and the median resource costs from 80 runs is less than $1.7 million, or 0.34%.

The skewed distribution of resource costs from 80 Aurora runs can be largely attributed to the model's dispatch logic during periods of extraordinarily high hydro production and relatively low demand. Chart 1 above and Attachment A show that the majority of the total resource cost difference between single run model results and the average of results from 80 runs ($5.6 million out of the total $6.2 million difference) occurs during the spring and summer period between March and July. These months are generally characterized by periods of high hydro production and low demand.

Because Aurora avoids dispatching a resource at less than its marginal cost, it will not generate a negative market energy price[1], effectively imposing an artificial price floor. In order to do this while still matching total generation to input hydro volumes, Aurora must at times relax certain model constraints – specifically, the maximum capacities of certain hydro resources. The model's imposition of a price floor and violation of hydro capacity constraints cause resource costs to be lower than they otherwise would be.

The model enforces its price floor by reducing hydro generation during off-peak hours, when prices and loads are already low, and shifting that generation to on-peak hours, when prices and loads are higher. This results in on-peak hours during which Aurora generation for a specific hydro resource exceeds the resource's maximum capacity. By relaxing the capacity constraints during on-peak hours, Aurora is able to reduce hydro generation in off-peak hours, resulting in artificially high system prices that, without violating constraints, would be lower or negative. PSE's portfolio frequently sells excess energy to the market during off-peak hours, especially during periods of high hydro production. When those sales are valued at the artificially high off-peak price, total resource cost results are unrealistically low. Conversely, higher hydro generation in on-peak hours results in prices that are artificially low during those periods. PSE's portfolio frequently purchases energy from the market during on-peak periods. When those purchases are valued at the artificially low on-peak price, total resource costs are again unrealistically low.

[1] Aurora is capable of generating negative prices if resources are assigned negative marginal costs via the use of bidding adders or negative variable O&M inputs. Default database resource inputs, however, do not include these assumptions. Adding them would involve a subjective process of including and iteratively changing adders for different resources during different periods to align price outputs with expected results given input hydro conditions. Such changes are inconsistent with PSE's use of the Aurora model which relies on "out of the box" resource assumptions but for known changes related directly to PSE's portfolio.

Attached as Attachment B to PSE's response to WUTC Staff Data Request No. 202 please find a chart showing hourly Aurora output and maximum capacity for the Rocky Reach hydroelectric project for the 1929 and 1997 hydro years along with the single run using average hydro production from all 80 years. Output for the Rocky Reach project is included to illustrate Aurora's violation of maximum hydro capacity constraints. Similar constraint violations occur for other hydroelectric resources during periods of high hydro output. Hydro years 1929 and 1997 are shown simply because these are the individual years from 80 model runs with the highest and lowest resource cost results, respectively. Attached as Attachment C to PSE's response to WUTC Staff Data Request No. 202 please find a table showing a count of capacity constraint violations for five Mid Columbia hydroelectric projects for all 80 model runs along with the single run. On average, the capacity limits were violated 750 times per run, or 1.7 percent of hours. In the most extreme case, the capacity limits were violated 3,481 times, or 8 percent of hours.

Attachment C also includes a chart showing the relationship between Aurora resource cost results for a given hydro year and the number of hours during which Aurora violated maximum capacity constraints during the year. This chart shows a highly correlated inverse relationship between the frequency of capacity constraint violations in a given hydro year and the resulting Aurora resource costs for that year.
Any time that a constraint violation occurs, the model's objective function (minimizing total resource costs) improves. This means that in years with many capacity constraint violations, Aurora total resource costs are artificially deflated by a large amount. In years with fewer capacity constraint violations, Aurora total resource costs are still artificially low, but by a smaller amount. In other words, any of the 80 runs in which capacity constraint violations occur contribute to lower Aurora total power costs in the 80-year results than in the single run.

The model violates hydro capacity constraints during months in the 80-year data set with high hydro output, producing artificially low resource costs in these already low-cost months. There are no offsetting artificially high resource costs during periods with very low hydro output. Capacity constraint violations do not occur with a single model run based on average hydro production. Aurora results from the single run, therefore, better represent expected actual resource costs because they do not include the effects of artificially low costs created by the model's violation of constraints in the months in the 80-year dataset with extraordinarily high hydro production.

Shaded information is designated as CONFIDENTIAL per Protective Order in Dockets UE-190529 and UG-190530 as marked in Attachments A, B, and C to Puget Sound Energy's Response to WUTC Staff Data Request No. 202.

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

Dockets UE-190529 & UG-190530
Puget Sound Energy
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WUTC STAFF DATA REQUEST NO. 202

"CONFIDENTIAL" Table of Contents

DR NO.	"CONFIDENTIAL" Material
202	Shaded information is designated as CONFIDENTIAL / HIGHLY CONFIDENTIAL per Protective Order in Dockets UE-190529 and UG-190530 as marked in Attachments A and C to Puget Sound Energy's Response to WUTC Staff Data Request No. 202.

ATTACHMENT A to PSE's Response to WUTC Staff Data Request No. 202

Puget Sound Energy

2019 GRC Workpapers - Staff DR 202 Response

Monthly AURORA Total Costs

Attachment A

REDACTED VERSION

Hydro year	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	Rate year total
1929	[redacted]												
1930													
1931													
1932													
1933													
1934													
1935													
1936													
1937													
1938													
1939													
1940													
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Puget Sound Energy

2019 GRC Workpapers - Staff DR 202 Response

Monthly AURORA Total Costs

Attachment A

REDACTED VERSION

Hydro year	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	Rate year total
1990	[redacted]												
1991													
1992													
1993													
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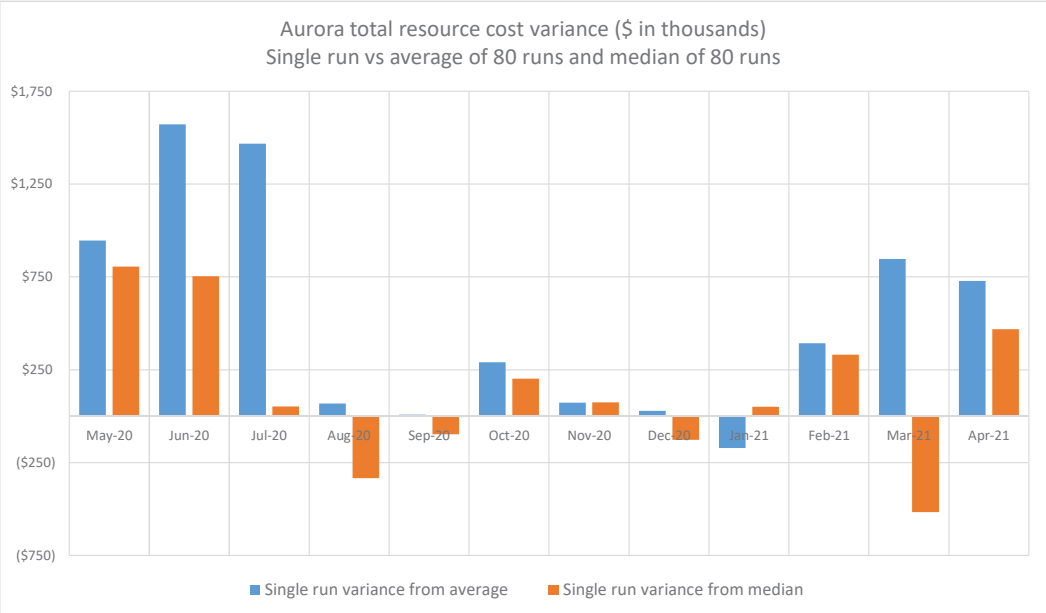
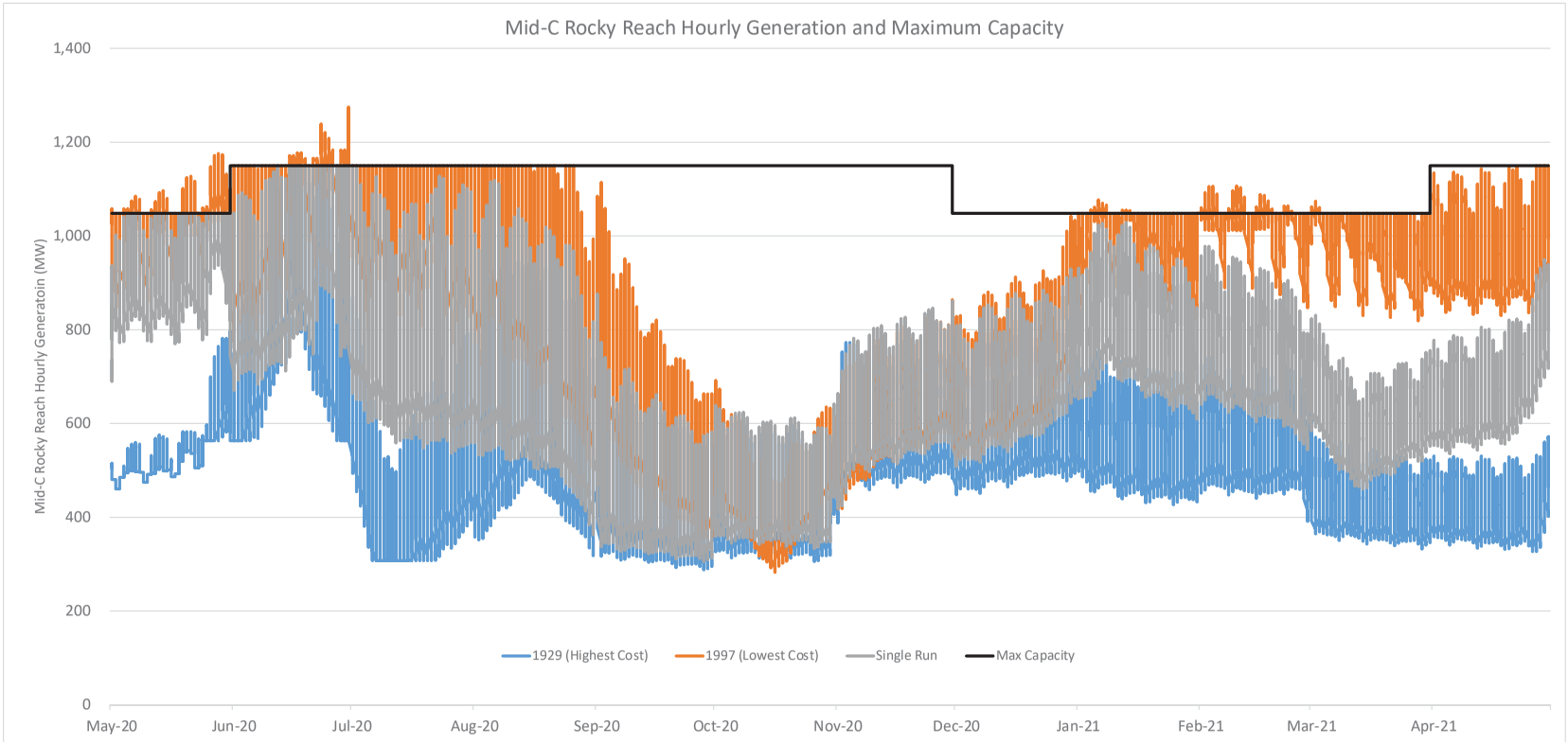
2007													
2008													
Average of 80 runs													
Median of 80 runs													
Single run results													
Difference (Single run - Average)													
Difference (% of Average)													
Difference (Single run - Median)													
Difference (% of Median)													

Puget Sound Energy
2019 GRC Workpapers - Staff DR 202 Response
Monthly AURORA Total Costs
Attachment A



ATTACHMENT B to PSE's Response to WUTC Staff Data Request No. 202

Puget Sound Energy
2019 GRC Workpapers - Staff DR 202 Response
Mid C Rocky Reach Hourly Generation and Max Capacity
Attachment B



ATTACHMENT C to PSE's Response to WUTC Staff Data Request No. 202

Puget Sound Energy

2019 GRC Workpapers - Staff DR 202 Response

Aurora Violation of Hydro Maximum Hydro Capacity Constraints

Attachment C

REDACTED VERSION

Year	Portfolio cost	Count of hours with Mid C hydro capacity violations*
1929	[redacted]	
1930		
1931		
1932		
1933		
1934		
1935		
1936		
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1938		
1939		
1940		
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1965		
1966		

Puget Sound Energy

2019 GRC Workpapers - Staff DR 202 Response

Aurora Violation of Hydro Maximum Hydro Capacity Constraints

Attachment C

REDACTED VERSION

Year	Portfolio cost	Count of hours with Mid C hydro capacity violations*
1967	[redacted]	
1968		
1969		
1970		
1971		
1972		
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1977		
1978		
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1981		
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2003		
2004		

Puget Sound Energy

2019 GRC Workpapers - Staff DR 202 Response

Aurora Violation of Hydro Maximum Hydro Capacity Constraints

Attachment C

REDACTED VERSION

Year	Portfolio cost	Count of hours with Mid C hydro capacity violations*
2005	[redacted]	
2006		
2007		
2008		
Average		
Maximum		

**This is the count of hourly violations for all five Mid Columbia hydro facilities; Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids. Therefore, the number of hourly violations shown is out of 43,800 (8,760 x 5) potential hours.*

Puget Sound Energy
2019 GRC Workpapers - Staff DR 202 Response
Aurora Violation of Hydro Maximum Hydro Capacity Constraints
Attachment C

REDACTED VERSION

**This is the count of hourly violations for all five Mid Columbia hydro facilities; Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids. Therefore, the number of hourly violations shown is out of 43,800 (8,760 x 5) potential hours.*