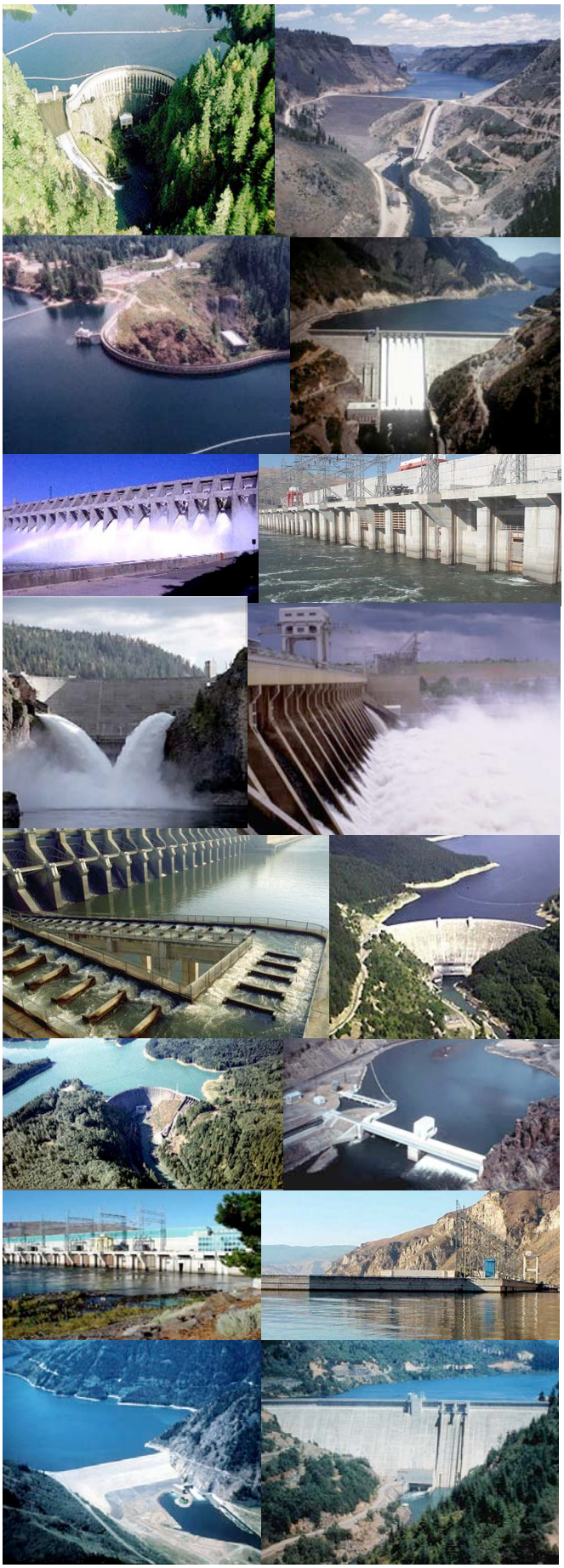

NORTHWEST REGIONAL BENCHMARKING STUDY

A COMPARISON OF HYDRO GENERATING PLANTS IN THE PACIFIC NORTHWEST

MARCH 2006

HJA CONSULTING
Haddon Jackson Associates, Inc.

Contact: Charles Haddon
(770) 993-8778
chaddon@hjaconsulting.com

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EXECUTIVE SUMMARY

The HJA Consulting (HJA) annual HYDRO Benchmarking Program began in 1994 and has benchmarked performance at over 300 hydro plants in North America. Many Northwest hydro stations participate in the HJA benchmarking program or have participated in the past, among them, 30 of the 31 generating stations in the Federal Columbia River Power System (FCRPS). The federal agencies that comprise the FCRPS are the U.S. Army Corps of Engineers (Corps), U.S. Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA).

BPA shared summary-level HJA benchmarking program results with its constituents, who then suggested benchmarking FCRPS stations against other Pacific Northwest regional hydro stations. This study by HJA Consulting is the result.

In total, twenty-two station groups were benchmarked: thirteen from the FCRPS, three from Chelan County PUD, three from Tacoma Power, two from Seattle City Light, and one from Grant County PUD. Due to the time, complexity, and cost associated with undertaking a completely new benchmarking effort, HJA used data provided to it by Pacific Northwest station utilities in previous annual programs, with adjustments, and some further data to improve results.

Overall Observations

All the Northwest (NW) power projects benchmarked share significant similarities, including:

- Hourly wage rates for job classifications within NW power projects are strikingly similar. Wage rates for skilled craft workers – plant mechanics and electricians - averaged about $30 per hour in 2004 for all NW Region participants.

- Actual wage rates are increasing at about the same rate as the inflation adjustments that HJA uses to correct data from past year participants in the program.

- NW station peer group staffing levels are relatively similar, with some notable exceptions discussed within each of the functional benchmarking analyses.

- Most NW stations are experiencing similar age demographics characterized as an aging workforce that is just beginning to be replaced with younger workers.

Conclusions and Opportunities

- The majority of the NW hydro stations benchmarked in this study had similar costs within their relevant peer group and compared favorably to HJA North American panel averages for Operations, Plant Maintenance, Waterways & Dams Maintenance, and Buildings and Grounds Maintenance.

- For the functions where HJA has models to predict expected costs, the vast majority of these stations also compared favorably to the calculated expected cost.

- For the majority of functions benchmarked, costs for FCRPS stations and other NW stations were similar. In most functions, there was no discernable trend where benchmarks showed FCRPS stations were either consistently more costly or less costly than other regional stations. Notable exceptions for FCRPS stations are discussed in detail within each of the functional benchmarking analyses and are summarized below.

- FCRPS stations have a significant opportunity for reducing Operations costs through automation. Many Small and Medium FCRPS stations with staffed controls rooms have significantly higher costs than automated stations in their peer groups. Medium-Large and Large FCRPS stations may also derive some cost improvements from the development of an integrated automation strategy. Other HJA panel participants that have recognized these cost differences have developed plant automation strategies in cooperation with their plant modernization programs.

- Currently, the water management function within the FCRPS resides in three agencies. Similar costs for other organizations in the NW study suggest an integrated three-agency review of the water management function might identify opportunities for process and cost efficiencies..

- In the Plant Maintenance function, most NW stations were at or below HJA panel averages for their peer groups. There was some variability of costs among NW stations benchmarked. The study team recognized that the continued sharing of maintenance practices that began at the study workshops, including site visits within the regional stations represented here, could help all the regional utilities.

- Support costs (such as finance, human resources, and procurement) for all but two Northwest NW stations were below the HJA North American panel average. FCRPS stations were well below the panel average. Lower FCRPS support costs reflect the structural advantage they enjoy where support functions within the Corps and Reclamation organizations support other multiple missions within their organizations.

- Public Affairs & Regulatory costs (including: fish and wildlife, recreation, taxes, and licensing) comprise nearly half of benchmarked costs. Many NW stations are at or above HJA North American panel averages, reflecting significant program costs for fish mitigation, recreation, and visitor operations.

FCRPS stations were first benchmarked in 2000-2001. At that time, it was clear that many of these projects had significantly lower O&M and Investment funding than their peer group stations. Current results show that this gap has been largely eliminated. Most FCRPS stations are now near their peer group averages or their expected cost in expense categories. The challenge for FCRPS projects in the future will be the same as the challenge currently being addressed by many leaders on HJA's North American panel. Leaders are currently engaged in deploying sophisticated, data-driven asset management strategies and reliability centered maintenance practices to optimize asset utilization of hydro plants over the long term.

INTRODUCTION

Benchmarking is an analytical process that compares data from one entity to like information from a peer entity or group to determine areas for potential improvement and to identify best practices. For benchmarking to be relevant, comparisons must be made among peers. The value of benchmarking is not in the numbers themselves, but in perspective that these relative performance comparisons provide and the improved understanding of business processes and practices that drive those numbers.

Within the hydropower industry, HJA Consulting (HJA) provides a well-defined and mature hydropower benchmarking program. The HJA Consulting annual HYDRO Benchmarking Program began in 1994 and to date has benchmarked performance at over 300 hydro plants in North America. Many Northwest hydro stations have participated in the HJA benchmarking program throughout the years. Stations owned by Seattle City Light, Tacoma Power, Chelan County PUD, and Grant County PUD have all been benchmarked by HJA.

The Federal Columbia River Power System (FCRPS) hydro program began participating in HJA benchmarking program in 2000. HJA benchmarked 30 of the 31 FCRPS stations in 2000 and 2001. Some FCRPS hydro stations have been benchmarked again each year since. The federal agencies that comprise the FCRPS are the U.S. Army Corps of Engineers, the US Bureau of Reclamation, and the Bonneville Power Administration.

Bonneville shared summary-level HJA benchmarking program results with its constituents, who then suggested that FCRPS stations should be benchmarked against other Pacific Northwest regional hydro stations. Bonneville engaged HJA Consulting in November 2005 to benchmark FCRPS plants against other northwest regional hydro stations that have participated in the HJA benchmarking program in the past. This Northwest Hydro Benchmarking Study report summarizes the results of this engagement.

The Bonneville Power Administration (BPA) funded this study. Participants included: BPA, the US Army Corps of Engineers (Corps), the US Bureau of Reclamation (Reclamation), Seattle City Light (Seattle), Tacoma Power (Tacoma), Chelan County PUD (Chelan), and Grant County PUD (Grant). Facilities owned by all these entities are compared against their peers in specific cost-categories used as part of HJA's benchmarking methodology.

Not all facilities owned by FCRPS were benchmarked in this study. Instead, HJA selected a representative set of FCRPS facilities, which had comparable peer stations owned by other NW region study participants. FCRPS stations that have no peer facilities within the Northwest (NW), such as Grand Coulee Dam, were excluded.

HJA CONSULTING'S HYDRO BENCHMARKING PROGRAM

Over the first eleven years of the program, HJA has benchmarked 332 hydro stations, comprising 1,254 generating units that represent about 87,000 megawatts of installed capacity. This represents more than 50 percent of the hydro capacity in North America.

HJA benchmarks performance at the business function level, using consistent definitions that allow every participant to account for the cost of performing these functions the same way. This underlying philosophy is key to achieving a fair comparison of performance, which managers can use to understand differences in their business approach compared to other peer group stations.

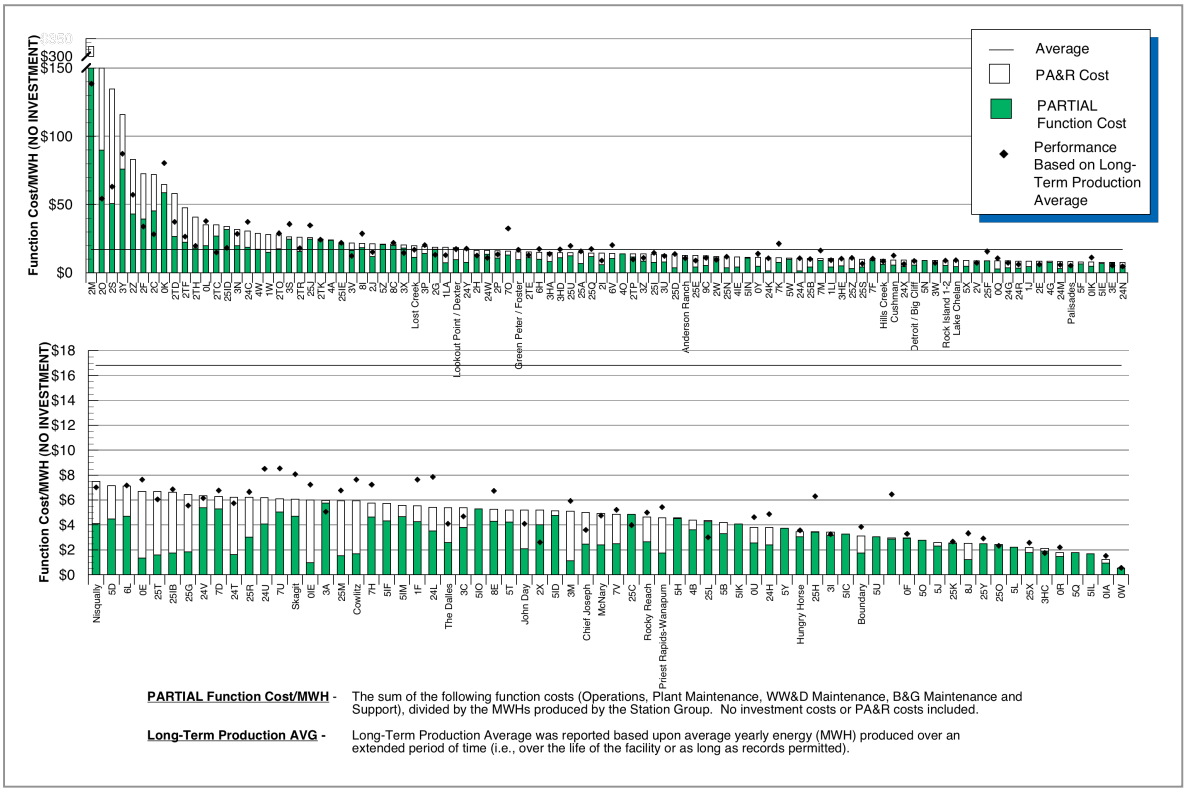
We recognize that benchmarking analyses performed by others use a less detailed approach. It is common to see utility industry benchmarking data that compares nothing more detailed than the total O&M cost per MWH for a group of facilities. It is the simplest measure that is readily available for most facilities in the industry. We believe it is also the least useful for gaining understanding and insight into performance.

This simplistic measure fails to recognize key differences between facilities, many of which are outside of management's influence or control. Differences such as: size of the facility, age of the facility, configuration of the dam and/or reservoir, availability of water, and regulatory requirements are all hidden within the components that make up a total cost per MWH measure of performance. Differences in underlying methods of accounting for the costs reported in a total cost per MWH also skew these types of comparisons. More importantly, we have found that cost per MWH is not a meaningful way to analyze performance of most of the functions performed within the hydro generation business. That is the primary reason we have developed the range of benchmarking measures such as: cost per generating unit for Operations, cost per square meter of building space for Buildings and Grounds Maintenance, and cost per direct FTE at the station for Support. These function-specific benchmarks provide meaningful measures of the activities required to accomplish these different types of work.

Despite the shortcomings of using a total cost per MWH benchmark as a performance measure, we continue to be asked to provide this type of analysis to our program participants, if only to provide the perspective of where the overall costs for a facility fall relative to rest of the group in our program. We call it the "beauty contest" analysis. The way we arrive at the cost per MWH is a bit different (and we think a bit more accurate) than the typical total cost per MWH analysis. We calculate the total annual cost per MWH by adding up the annual costs reported to us for each of the functions we benchmark and then dividing the costs by actual annual MWH for the station. Since we build up the cost by adding the function costs we call the result "Function Cost per MWH." We also calculate a normalized Function Cost per MWH by using the MWH for a normal water year for the facility.

The results of Function Cost per MWH analysis are shown in the following graph, excerpted from the HJA Consulting HYDRO 2005 final report:

Figure 1: HJA Total Function Cost Per MWH



The graph is sorted in descending order based upon total cost per MWH for actual water in the year benchmarked. The diamond in each bar shows what the total cost per MWH would have been, had the station operated in an average water year. Due to the large number of stations shown, the horizontal scale is broken in half and placed one above the other. The vertical scale in the lower half of the graph is expanded to better show cost differences.

Stations benchmarked in the NW Regional Benchmarking Study are named on this display, while the remaining stations in the HJA panel are designated by codes. Total function costs per MWH for NW stations in this study place throughout the range of all stations in the panel.

HJA benchmarks the hydro business in seven distinct functional areas:

- Operations
- Plant Maintenance
- Waterways and Dams Maintenance
- Buildings and Grounds Maintenance
- Support
- Public Affairs and Regulatory
- Investment.

HJA uses statistical analysis of data from each participating hydro generating station to determine its appropriate benchmarking peer groups.

Most hydro stations serve multiple purposes, often with multiple customers. A single business function may span multiple purposes. For instance, a dam structure may benefit flood control, navigation, irrigation and power purposes, and have costs for maintaining the structure allocated to each of these purposes. However, the underlying business function is dam maintenance.

HJA's benchmarking process considers all costs attributable to hydro generation for performing the function benchmarked and does not consider which customer pays for function costs. Its focus is on the business function being addressed, regardless of who pays for the function. As a result, hydro generation customers may not see a direct correlation between benchmarked costs and the costs for which they are responsible. Benchmarked costs for NW hydro stations may include, where present, owners' costs for recreation, program coordination, planning, scheduling, dispatch, flood control, navigation, fish migration, wildlife protection, and cultural resource protection.

HJA requires participants to collect data in a manner that aligns with the business function as defined by HJA's benchmarking rules. This is key to insuring comparability of performance results. HJA has identified peer groups within each of these functional cost categories. These peer groups are driven by the underlying data, and have evolved over time as the HJA database has expanded and been updated. Each participating hydro station is assigned to the relevant peer group so that it is benchmarked against comparable facilities. For most functions, benchmarks are based on cost and operations data taken from a single snapshot data-year. The exception is the investment function, where investment project profiles span the prior five years.

Detailed definitions for each of the seven functional benchmarking areas, the benchmark measure used for the function, and a listing of the peer groups used within the function are presented in the following table.

Table 1: HJA Consulting Benchmarked Functions and Peer Groups

Function (Definition & Measure)	**Activities**	**Peer Groups**
Operations: Day-to-day operations of the station Benchmark Measure: Cost per Generating Unit	Labor and supervision, engineering support, contracts, materials, and station service costs for the following: • Control room operations • Waterway operations • Station operations • Water management • Generation dispatch	Micro Units < 11 MW Small Units 11-20 MW Medium Units 20-64 MW Med-Large Units 65-100 MW Large Units 100-250 MW Super Large Units > 400 MW (All groups segmented Automated or Staffed)
Plant Maintenance: Maintenance of rotating equipment and non-rotating electrical components of the plant, from and including the head gate or final valve up to the generator step-up transformer Benchmark Measure: Cost per MWH	Labor and supervision, engineering support, contracts, and materials for the following: • Protection and controls • Turbines and generators • Civil/mechanical work performed within the plant • Switchgear maintenance	Micro Station < 30 MW Unit < 14 MW Small Station < 150 MW Unit < 55 MW Medium Station 110-402 MW Unit 20-70 MW Med-Large Station 360-642 MW Unit 31-200 MW Large Station >600 MW Unit < 250 MW Super Large Station > 1500 MW Unit > 400 MW Low Use Capacity Factor < 20% (All groups segmented < or > 45 years old)
Waterways and Dams Maintenance: Maintenance of waterways, dams and penstocks upstream of the head gate or final valve Benchmark Measure: Cost per Generating Unit	Labor and supervision, engineering support, contracts, and materials for the following: • Dam maintenance including FERC safety requirements and civil, structural, and environmental repairs • Waterways maintenance including booms, gates, diagnostic testing, penstocks, cleaning trash rack and intake valves, forebay maintenance, and inspections.	Small < 25,000 Square Meters of Surface Area Medium 25,000 to 100,000 Square Meters of Surface Area Large > 100,000 Square Meters of Surface Area
Buildings and Grounds Maintenance: Maintenance of buildings, facilities and grounds Benchmark Measure: Cost per Square Meter of Building Space	Labor and supervision, engineering support, contracts, and materials for the following: • General station housekeeping • Building maintenance and repairs • Landscaping • Trash removal • Road maintenance	All generating stations are in a single peer group

Table 1 - Continued
HJA Consulting Benchmarked Functions and Peer Groups

Function (Definition & Measure)	**Activities**	**Peer Groups**
Support: Services that support operations and maintenance of the station Benchmark Measure: Cost per Direct Station FTE	Labor and supervision, contracts, and materials for the following: • Human resources • Fleet services • Information services • Security • Purchasing • Materials and stores • Safety management • Budgeting and accounting • Training • Legal	All generating stations are in a single peer group
Public Affairs and Regulatory: Managing regulatory, environmental, and community issues required for use of the land or water Benchmark Measure: Cost per MW	Labor and supervision, engineering support, contracts, and materials for the following: • Relicensing • Regulatory fees • Public relations • Visitor centers • Parks and recreation facilities • Real estate management • Operations of fish hatcheries • Fish and wildlife mitigation • Cultural resources	All generating stations are in a single peer group
Investment: Projects undertaken to restore the facility to its original design, expand its capacity, improve operations and maintenance characteristics, create facilities related to PA&R activities (fish, wildlife, recreation, etc.), or deal with new regulatory or relicensing issues that require physical additions to the plant. Benchmark Measure: Cost per MW	Labor and supervision, engineering support, contracts, and materials for the following types of investment projects: • Generating equipment • Control systems • Waterways and dams • Buildings and grounds • Public affairs and regulatory	Stations < 15 Years Old Stations 15 to 40 Years Old Stations 41 to 65 Years Old Stations > 65 Years Old

APPROACH TO NORTHWEST REGIONAL BENCHMARKING

Due to the time, complexity, and cost associated with undertaking a completely new benchmarking effort, HJA was asked to develop a streamlined process that relied on existing HJA benchmarking data for the Northwest Regional Benchmarking effort. HJA used data provided to it by NW utilities in previous annual programs.

Because this data spanned a decade, HJA identified where past data fell short or was of limited value for creating fair comparisons today. HJA identified where adjustments could be made to improve results, short of conducting a complete new data call from the study participants. We presented our proposal to BPA and other regional hydro station owners. They agreed with the proposed approach and to participate in this study effort. Participants also agreed to allow HJA to use their past data in this study.

Stations Benchmarked in the Study

HJA first identified a set of representative FCRPS stations and stations owned by other regional participants. The FCRPS sample included both main-stem Columbia and tributary stations, ranging in size from small to large. Choices of FCRPS projects were limited to those that could be reasonably benchmarked against available projects that had been previously benchmarked by other study participants.

In total, twenty-two station groups were benchmarked: thirteen from the FCRPS, two from Seattle City Light, three from Chelan County PUD, three from Tacoma Power, and one from Grant County PUD. A station group can be a single power station, or several power stations that are benchmarked together as if it were a single power station. Throughout the report we use the term "station" synonymously with "station group". The station groups included in the study and the year the original data was included in the HJA Benchmarking program are shown in the following table.

Table 2: NW Regional Benchmarking Participant Stations

Station Group	Owner	Data Year
Chief Joseph	Corps of Engineers	2001
McNary	Corps of Engineers	2003
John Day	Corps of Engineers	2001
The Dalles	Corps of Engineers	2001
Lost Creek	Corps of Engineers	2004
Hills Creek	Corps of Engineers	2004
Detroit / Big Cliff	Corps of Engineers	2002
Green Peter / Foster	Corps of Engineers	2002
Lookout Point / Dexter	Corps of Engineers	2002
Hungry Horse	Reclamation	1999
Palisades	Reclamation	2004
Roza	Reclamation	2002
Anderson Ranch	Reclamation	2004
Skagit	Seattle City Light	1999
Boundary	Seattle City Light	1999

Station Group	Owner	Data Year
Rocky Reach	Chelan County PUD	2000
Rock Island 1 and 2	Chelan County PUD	2000
Lake Chelan	Chelan County PUD	2000
Nisqually	Tacoma Power	1995
Cowlitz	Tacoma Power	1995
Cushman	Tacoma Power	1995
Priest Rapids / Wanapum	Grant County PUD	1996

Preliminary Results Presented in December 2005

HJA presented the results of its preliminary analysis of past benchmarking data for the selected facilities at a workshop in Seattle on December 1, 2005. The analysis included views of the data not typically presented to all participants in the normal benchmarking program, including expected costs, expected cost trends, and identification of component cost differences in the data. All cost data was adjusted to 2004 price levels.

A key goal of this preliminary analysis was to identify where past data fell short or was limited for creating fair comparisons. HJA made suggestions for improving the analysis that would not require gathering all new data for the stations in the study. Based on the preliminary results and suggestions for further analysis, the participants agreed to gather additional data in eight categories to help improve the comparability of results:

- Updated staffing levels
- Updated wage rates
- Updated generation under average water conditions
- Updated benefit adders
- Updated overhead adders
- Supplemental data for security
- Water management and generation dispatch costs
- Replacement information for major power-train equipment

Some data turned out to be easier to obtain than others. All participants provided updated wage rates, staffing levels, benefit adders and overhead adders, which significantly improved the comparability of benchmarked labor costs. Most also provided updated generation under average water conditions, and water management, generation dispatch, and security costs. While some investment information was provided, it was of varying consistency and had limited value for this effort. As a result, an analysis of the Investment function was excluded from this study following the workshop review.

HJA used this data to update the benchmarking analysis and presented revised results to the study participants at a second workshop in Tacoma on February 1, 2006. These results and the related discussions regarding best practices are the basis for the conclusions and opportunities outlined in this report.

BENCHMARKING RESULTS

This section of the report summarizes the benchmarking results for the Northwest Regional Benchmarking Study. This report focuses on the summary results for each business function benchmarked due to brevity and clarity considerations. Study team participants from each utility have been supplied detailed information supporting each of these summaries.

Overall Observations

Throughout the course of the analysis and during discussions of results and underlying practices at the participant team workshops, we observed some significant similarities among all the NW power projects benchmarked, including:

- Hourly wage rates for job classifications within NW power projects are strikingly similar. Wage rates for skilled craft workers – plant mechanics and electricians - averaged about $30 per hour in 2004 for all NW Region participants.

- Actual wage rates are increasing at about the same rate as the inflation adjustments that HJA uses to correct data from past year participants in the program.

- NW station peer group staffing levels are relatively similar, with some notable exceptions discussed within each of the functional benchmarking analyses.

- Most NW stations are experiencing similar age demographics characterized as an aging workforce that is just beginning to be replaced with younger workers.

Operations

The Operations function includes all in-station operations, as well as the costs for water management and generation dispatch. NW station operations cost average $183,000 per generating unit. Of these costs about $53,000 per unit (29 percent) are associated with water management and generation dispatch functions. A small amount of operations cost also accounts for power used within the station in the course of normal operations (i.e. station service).

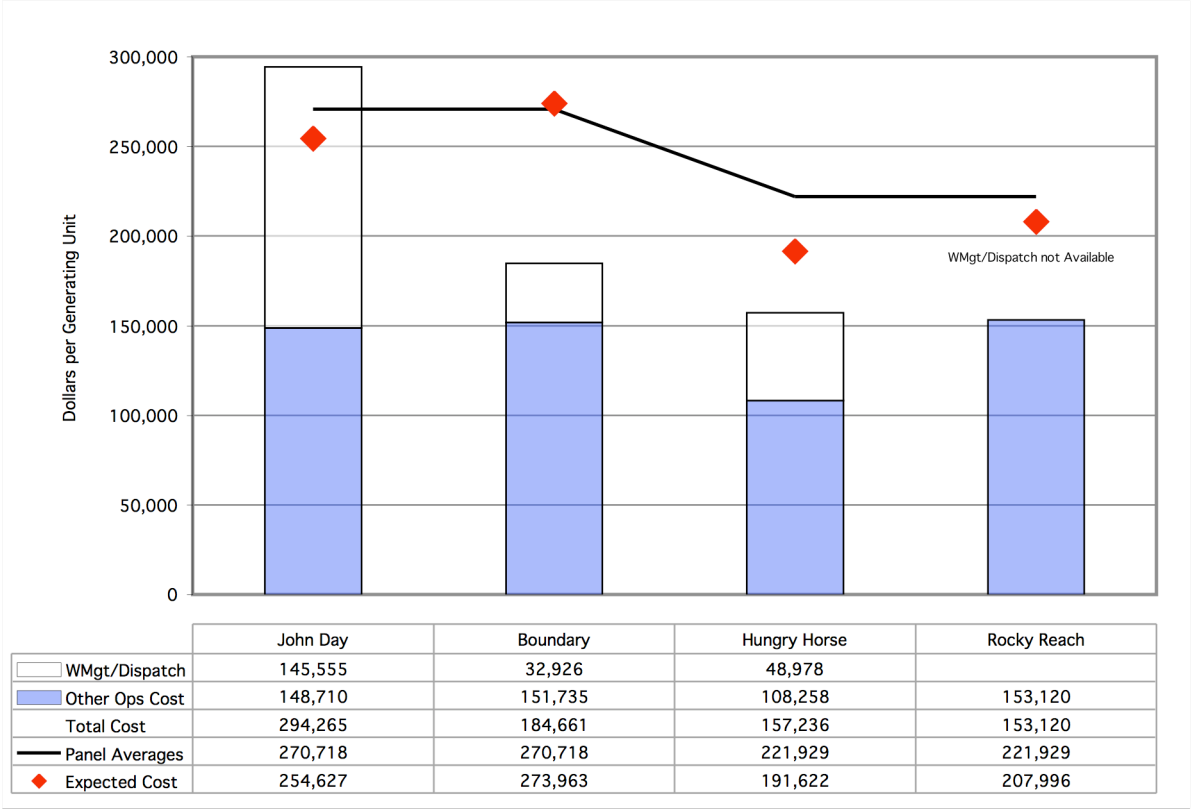
The benchmark for Operations is:

Operating Cost per Generating Unit

Operations represent 11 percent of overall benchmarked expense costs for the panel of NW hydro stations. There are clear economies of scale for operating hydro plants. Therefore, NW stations are separated into four major peer groups: Large stations, Medium-Large stations, Medium stations, and Small stations.

Results, including the actual results for each NW regional station benchmarked, the expected cost for that station, and the HJA panel averages for the peer group are presented and discussed for each of these peer groups.

Figure 2: Operations - Large Stations



	John Day	Boundary	Hungry Horse	Rocky Reach
WMgt/Dispatch	145,555	32,926	48,978	
Other Ops Cost	148,710	151,735	108,258	153,120
Total Cost	294,265	184,661	157,236	153,120
Panel Averages	270,718	270,718	221,929	221,929
Expected Cost	254,627	273,963	191,622	207,996

Each Operations peer group display shows a graph and associated table of results that includes:

- Stacked bars, which show the total actual cost per generating unit broken into two parts: the lighter top part of the bar represents costs for water management and generation dispatch and the darker bottom part of the bar represents all other remaining operations costs, most of which are on-site labor costs.

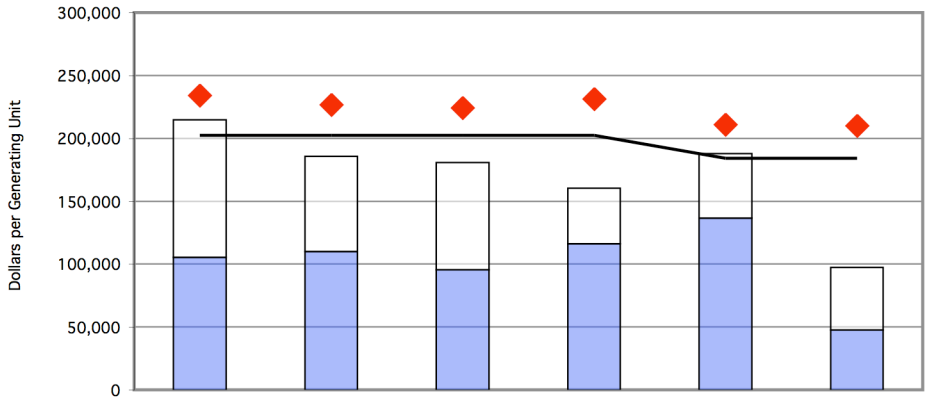
- Diamonds, which show the expected cost for operations. This cost comes from proprietary HJA modeling of the data base and provides a prediction for what the cost per generating unit should be based upon a regression analysis of independent variables including number of units and unit size.

- A bold horizontal line depicting HJA panel averages. Panel averages vary within each group based upon whether the station is fully automated or has a staffed control room.

All NW stations but one in the Large group were below their respective panel averages and expected cost. John Day was about 8 percent above the panel average for stations with staffed control rooms and 16 percent above expected cost. However, non-water management and non-dispatch costs for John Day were at the same level of most other NW stations in the peer group.

For the North American Large panel, automated stations cost about $49,000 per unit less than stations with staffed control rooms. The difference is $82,000 for Northwest stations. However, this difference for Northwest stations is somewhat exaggerated because water management and generation dispatch costs were not available for Rocky Reach.

Figure 3: Operations - Medium-Large Stations



	Chief Joseph	The Dalles	McNary	Priest Rapids-Wanapum	Skagit	Cowlitz
WMgt/Dispatch	109,142	75,579	85,385	44,345	51,365	50,000
Other Ops Cost	105,477	109,997	95,339	116,149	136,566	47,465
Total Cost	214,618	185,576	180,724	160,494	187,930	97,465
Panel Averages	202,403	202,403	202,403	202,403	184,014	184,014
Expected Cost	234,205	226,914	224,437	231,379	210,872	210,247

All NW stations in the Medium-Large group were at or below expected cost and panel averages for the peer group. Cowlitz was a panel leader in operations, primarily due to low labor costs.

FCRPS stations have relatively high water management and generation dispatch costs, but relatively low other operations costs. This is not surprising since BPA, the Corps, and Reclamation jointly provide the bulk of water management services for the region's watersheds, as well as generation coordination for the region as a whole. The difference in water management and generation dispatch costs shows up most dramatically in the Medium-Large and Large peer groups, since these costs are allocated to FCRPS stations based upon capacity.

For the North American Medium-Large panel, automated stations cost about $18,000 per unit less than stations with staffed control rooms. The difference is $137,000 per unit for NW stations.

Figure 4: Operations - Medium Stations

	Detroit / Big Cliff	Green Peter / Foster	Lookout Point / Dexter	Rock Island	Palisades
WMgt/Dispatch	35,699	22,640	30,515		26,295
Other Ops Cost	226,117	173,745	120,642	114,758	30,881
Total Cost	261,817	196,385	151,157	114,758	57,177
Panel Averages	198,898	198,898	198,898	115,027	115,027
Expected Cost	183,563	173,227	179,536	118,714	115,468

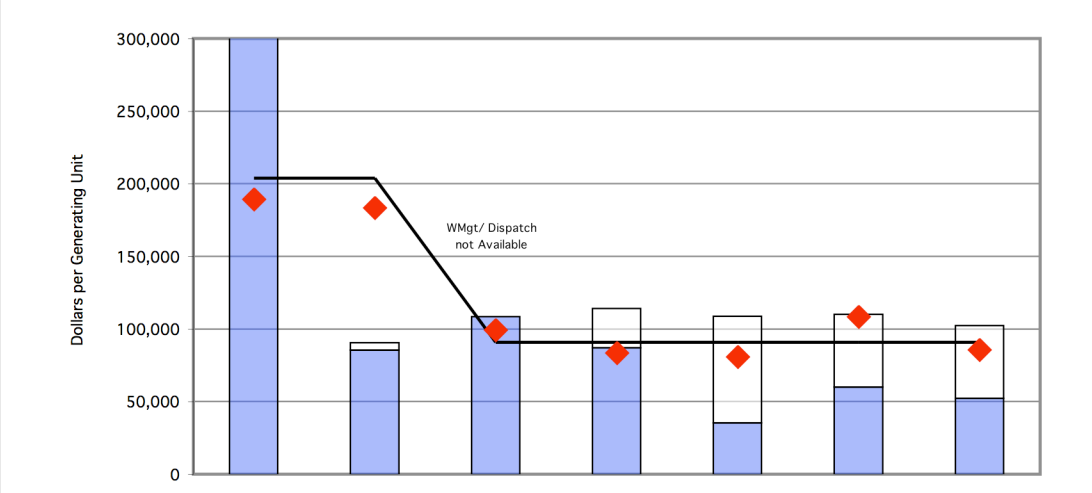
All stations, with the exception of Detroit / Big Cliff, have costs that are at or below panel averages and expected costs. Detroit / Big Cliff costs are about 30 percent above expected cost and 25 percent above the panel average for staffed control room Medium stations, mainly attributable to labor costs.

Palisades is a panel leader with very low labor and non-labor costs.

For the North American Medium panel, automated stations cost about $84,000 per unit less than stations with staffed control rooms. The difference is $155,000 per unit for Northwest stations, exaggerated somewhat by the absence of water management and generation dispatch costs for

Rock Island. The other operations cost component for staffed Corps stations in the Medium peer group averaged $174,000 per unit, nearly $60,000 per unit more than the North American panel average total operations costs for Medium automated stations, which includes water management, generation dispatch, and all other operations costs. These results indicate that an investigation of automating these facilities could identify significant opportunities for long-term cost efficiencies.

Figure 5: Operations - Small Stations



	Lost Creek	Roza	Lake Chelan	Hills Creek	Anderson Ranch	Cushman	Nisqually
WMgt/Dispatch	95,584	5,191		27,168	73,536	50,000	50,000
Other Ops Cost	396,910	85,464	108,467	86,964	35,273	60,037	52,268
Total Cost	492,494	90,655	108,467	114,131	108,809	110,037	102,268
Panel Averages	203,964	203,964	90,673	90,673	90,673	90,673	90,673
Expected Cost	189,423	183,407	99,382	83,556	80,918	108,526	85,817

For most stations, costs were at or below expected cost and panel averages. Operations costs for Lost Creek are more than double the expected cost and panel average for its peer group. This reflects around-the-clock staffing of an operator position at the station. Costs for Lake Chelan are also above the expected cost and panel average, even when excluding water management and generation dispatch costs that were not available.

For the North American Small panel, automated stations cost about $113,000 per unit less than stations with staffed control rooms. The difference is $169,000 per unit for Northwest stations, exaggerated somewhat by the absence of water management and generation dispatch costs for Lake Chelan. In general, more detailed analysis (not shown in these summaries) showed stations with staffed control rooms averaged 1.9 Full Time Equivalent (FTE) per unit compared to 0.9 FTE per unit for automated stations. The difference is larger with small and medium stations - 2.2 and 0.7 FTE per unit, respectively. This staffing level difference is the primary driver of cost differences between stations with staffed control rooms and stations that are automated.

Other HJA benchmarking participants, who have addressed automation advantage, have undertaken focused initiatives to define an appropriate automation strategy for their systems. Often these strategies have been undertaken in concert with plant modernization programs.

Plant Maintenance

The Plant Maintenance function includes all routine and non-routine of plant equipment used to generate power. It typically includes maintenance of hydraulic equipment related to the turbine, the turbine, the generator and associated equipment, switchgear, and the step-up transformer.

The benchmark for Plant Maintenance is:

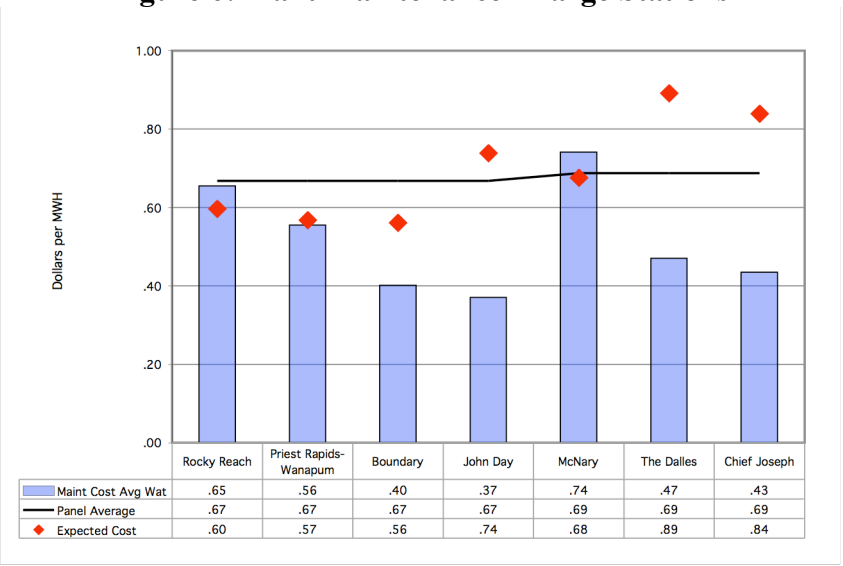
Plant Maintenance Cost per MWH

Plant Maintenance represents 13 percent of overall benchmarked expense costs for the panel of NW Region hydro stations. There are clear economies of scale for maintaining hydro plants. Therefore, NW stations are separated into three major peer groups: Large stations, Medium stations, and Small stations.

HJA's analysis determined that age is a major driver of maintenance costs. Older stations tend to cost more to maintain than newer stations. In recent years, HJA's database shows that the age difference is less of a factor in the Large stations segment. However, stations more than 45 years old still have significantly higher maintenance costs in the Medium and Small segment. Therefore, within each of the peer groups, stations are segmented by those 45 years or less in age, and those with an age greater than 45 years.

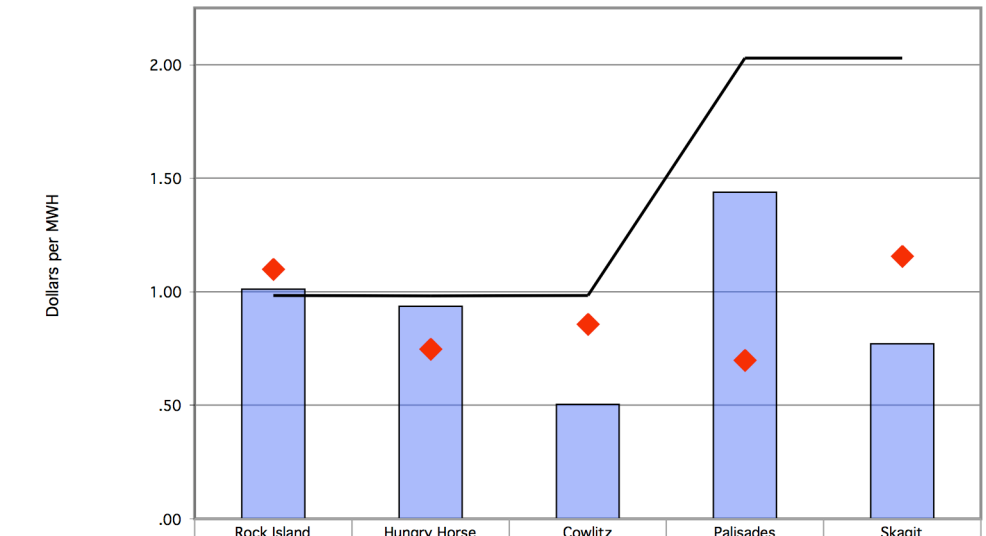
The benchmark for plant maintenance is cost per megawatt hour of generation. Since generation is a function of the amount of water available, the water year in which a station is benchmarked can have a significant effect on the result. Therefore, HJA's analysis in this study shows results based on generation amounts assuming average water conditions. Results for each NW Regional station, the expected cost for that station, and the HJA panel average for the peer group are presented and discussed below for each peer group.

Figure 6: Plant Maintenance - Large Stations



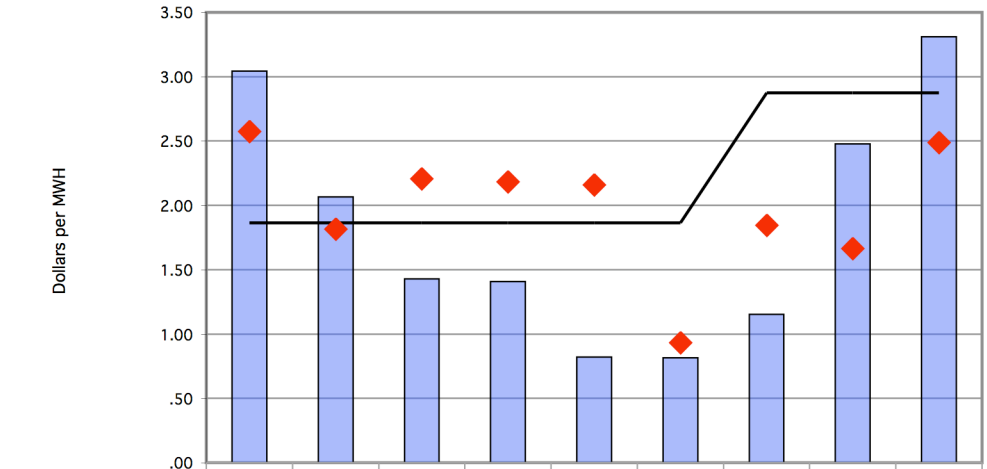
	Rocky Reach	Priest Rapids-Wanapum	Boundary	John Day	McNary	The Dalles	Chief Joseph
Maint Cost Avg Wat	.65	.56	.40	.37	.74	.47	.43
Panel Average	.67	.67	.67	.67	.69	.69	.69
Expected Cost	.60	.57	.56	.74	.68	.89	.84

Figure 7: Plant Maintenance - Medium Stations



	Rock Island	Hungry Horse	Cowlitz	Palisades	Skagit
Maint Cost Avg Wat	1.01	.94	.50	1.44	.77
Panel Average	.98	.98	.98	2.03	2.03
Expected Cost	1.10	.75	.86	.70	1.16

Figure 8: Plant Maintenance - Small Stations



	Lookout Point / Dexter	Anderson Ranch	Cushman	Detroit / Big Cliff	Nisqually	Lake Chelan	Hills Creek	Lost Creek	Green Peter / Foster
Maint Cost Avg Wat	3.04	2.06	1.43	1.41	.82	.81	1.15	2.48	3.31
Panel Average	1.86	1.86	1.86	1.86	1.86	1.86	2.88	2.88	2.88
Expected Cost	2.57	1.82	2.21	2.18	2.16	.93	1.85	1.67	2.49

With few exceptions, costs in all three Plant Maintenance peer groups are at or below HJA North American Panel averages. For the most part, NW hydro plants are also near or below expected costs derived from HJA models.

There are two exceptions:

- Lookout Point/Dexter is 18 percent above expected cost and 63 percent above panel average.

- Green Peter/Foster is 33 percent above expected cost and 15 percent above panel average.

There were also some notably lower-than-expected cost or lower-than-panel average performances in Plant Maintenance:

- For main stem Columbia River stations, The Dalles, John Day, and Chief Joseph are lowest cost and significantly below expected cost levels. This is largely attributable to lower labor expenditures than other Columbia River stations benchmarked.

- Cowlitz is low cost for Medium stations, Nisqually is low cost for Small stations, and Cushman is 23% below the Small station panel average and 35% below expected cost. This performance was attributed to Tacoma's culture that fosters a high level of pride and ownership (i.e. personal responsibility) among the staffs at their smaller stations – a practice that has been noted many times among other small and medium-sized leaders in HJA's North American panel.

- Lake Chelan is lowest cost among the NW panel for small stations. Hills Creek is well below expected cost. Discussions revealed that these stations also exhibit these same type of pride in ownership exhibited by Tacoma's small and medium plants.

These variations from panel averages and HJA expected cost model results led to a spirited discussion among the study participants about the benchmark comparisons and how the results might be translated into lessons learned.

First it was important to understand the difference between the panel average comparison and the comparison to HJA's expected cost. These two numbers often differ significantly (either higher or lower) because expected costs provide a more specific prediction for each station. It is based on the unique station characteristics such as number of units, capacity factor, and number of unit starts. The expected cost provides an additional piece of information of where you would expect a station to be, relative to the peer group average.

The study participants concluded that a positive next step would be to continue maintenance practice sharing discussions among the plant staffs of NW Region stations. Future discussion should focus on practices used by the leaders that others in the group might use. This could be best accomplished by following up the Northwest Regional Benchmarking Study with site visits among the participants.

Note that Reclamation's Roza station is not shown in any of the peer groups for Plant Maintenance, while it is included in the analysis of the other functions. This is because Roza falls in the Micro peer group for Plant Maintenance, the only Micro station for this peer group in the Northwest Regional Benchmarking Study.

Waterways and Dams Maintenance

The Waterways and Dams Maintenance function includes the recurring routine and non-routine maintenance of dams, dykes, spillways, gates, and other water control structures.

The benchmark for Waterways and Dams is:

Waterways and Dams Maintenance Cost per Generating Unit

Waterways and Dams Maintenance represents 4 percent of overall benchmarked expense costs for the panel of NW hydro stations. There are clear economies of scale for waterways and dams maintenance in hydro plants. Therefore, stations are separated into three peer groups:

- Large Dams - greater than 100,000 Square meters in surface area
- Medium Dams - between 25,000 and 100,000 square meters in surface area
- Small Dams - less than 25,000 square meters in surface area

The actual results for each NW regional station benchmarked and the HJA panel average for the peer group are presented and discussed below for each of these peer groups.

Figure 9: Waterways and Dams Maintenance – Large Dams

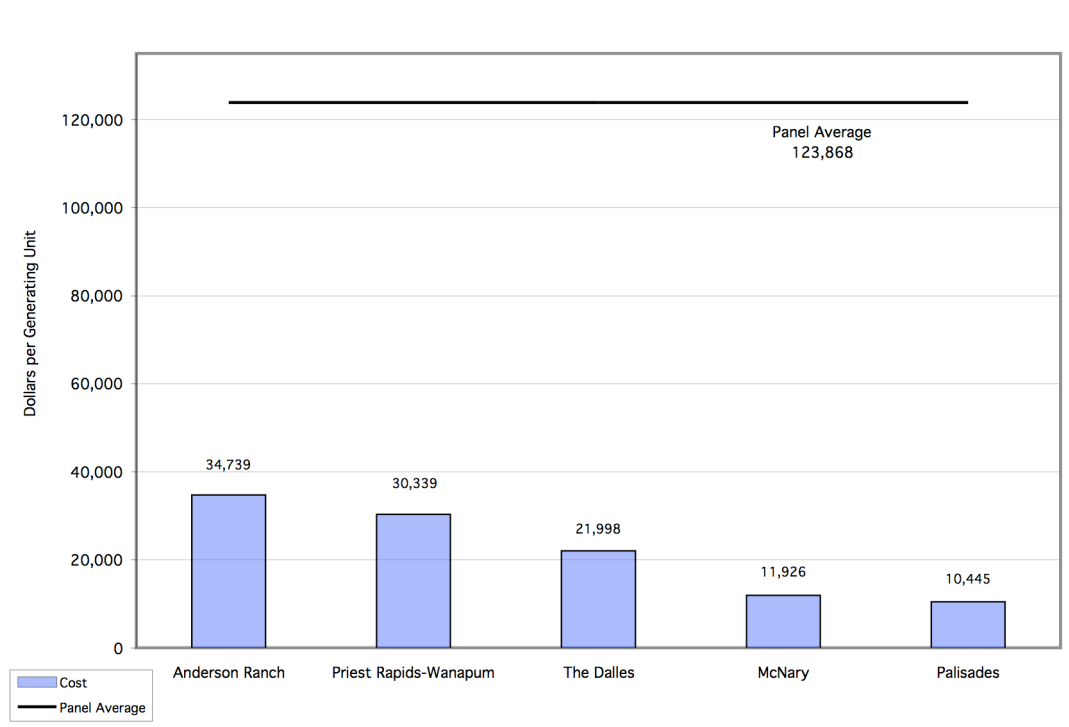


Figure 10: Waterways and Dams Maintenance – Medium Dams

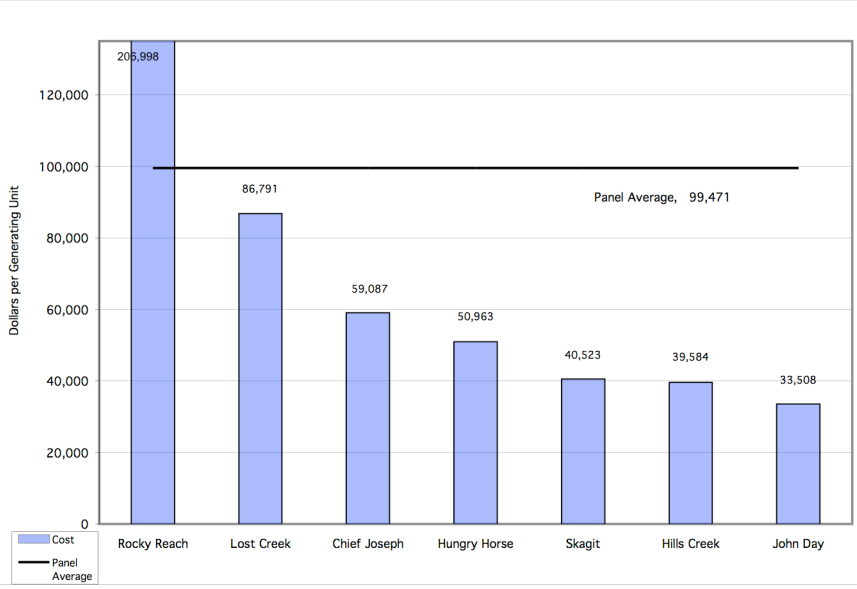
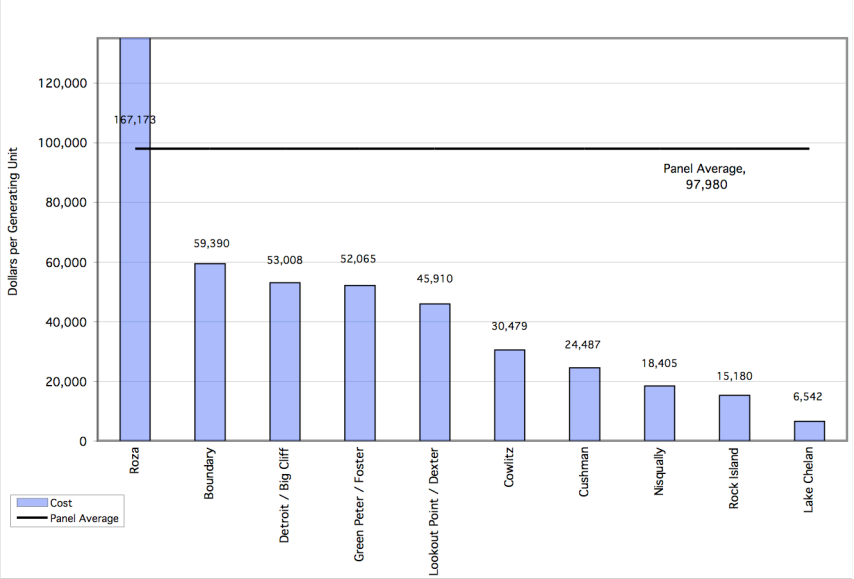


Figure 11: Waterways and Dams Maintenance – Small Dams



With only two exceptions, costs for NW panel stations are at or below HJA North American Panel averages. The exceptions are:

- Rocky Reach is 70 percent higher than the panel average for Medium sized stations.
- Roza is 70 percent higher than the peer group average for Small stations, largely attributable to the extensive canal system for that station.

Typically, when a specific facility has inordinately high costs in this function, it can be traced to large one-time expenditures during the benchmark data year. If expenditures continue at a high level over a longer period of time, it may indicate the need for further examination.

Buildings and Grounds Maintenance

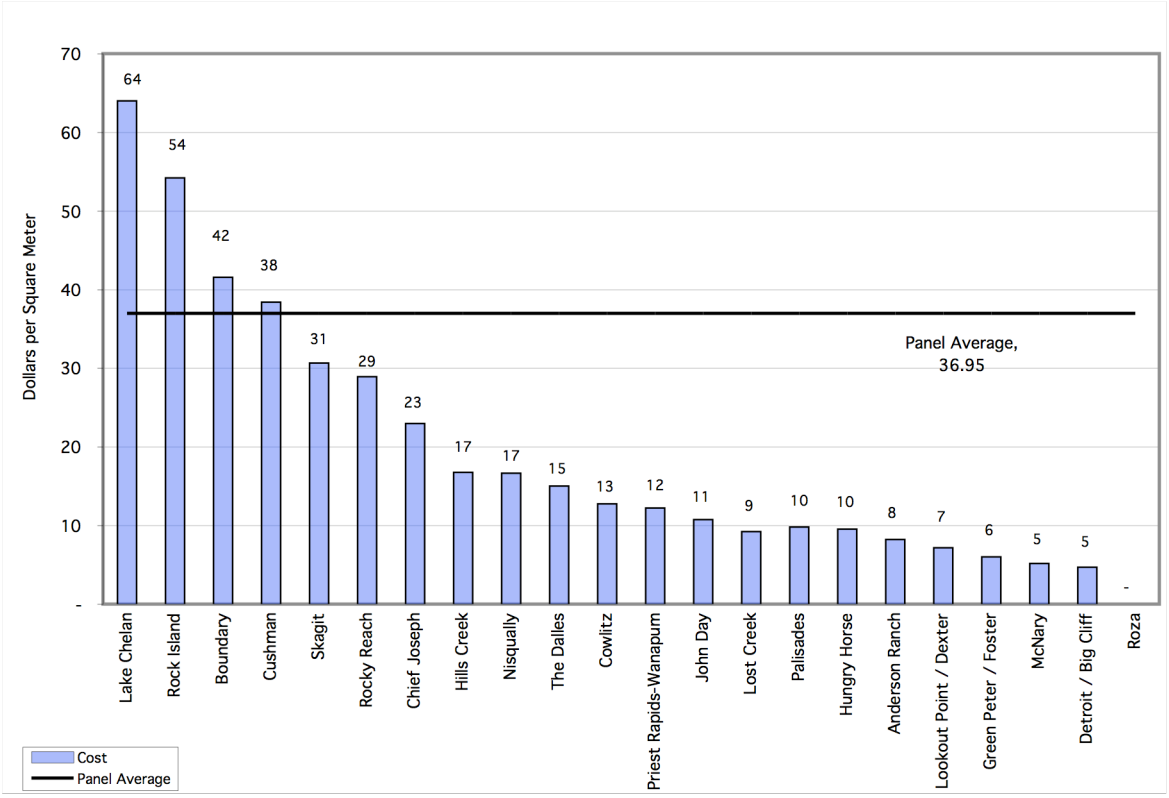
The Buildings and Grounds function includes routine maintenance of the interior and exterior building areas (such as janitorial services and lighting), as well as maintenance of roads and grounds within a plant site compound.

The benchmark for Buildings and Grounds is:

Building & Grounds Cost per Square Meter of Building Space

The Buildings and Grounds function represents about 5 percent of overall benchmarked expense costs for HJA's North American panel of hydro stations. There are no clear economies of scale for maintaining buildings and grounds. Therefore, stations are not separated into peer groups.

Figure 12: Buildings and Grounds Maintenance



All but two of the stations, Lake Chelan and Rock Island, are at or below the HJA North American panel average. Typically, when stations have above average costs in this function it can be attributed to issues unique to the site, such as visitor requirements or significant site-specific issues such as snow removal costs.

Support

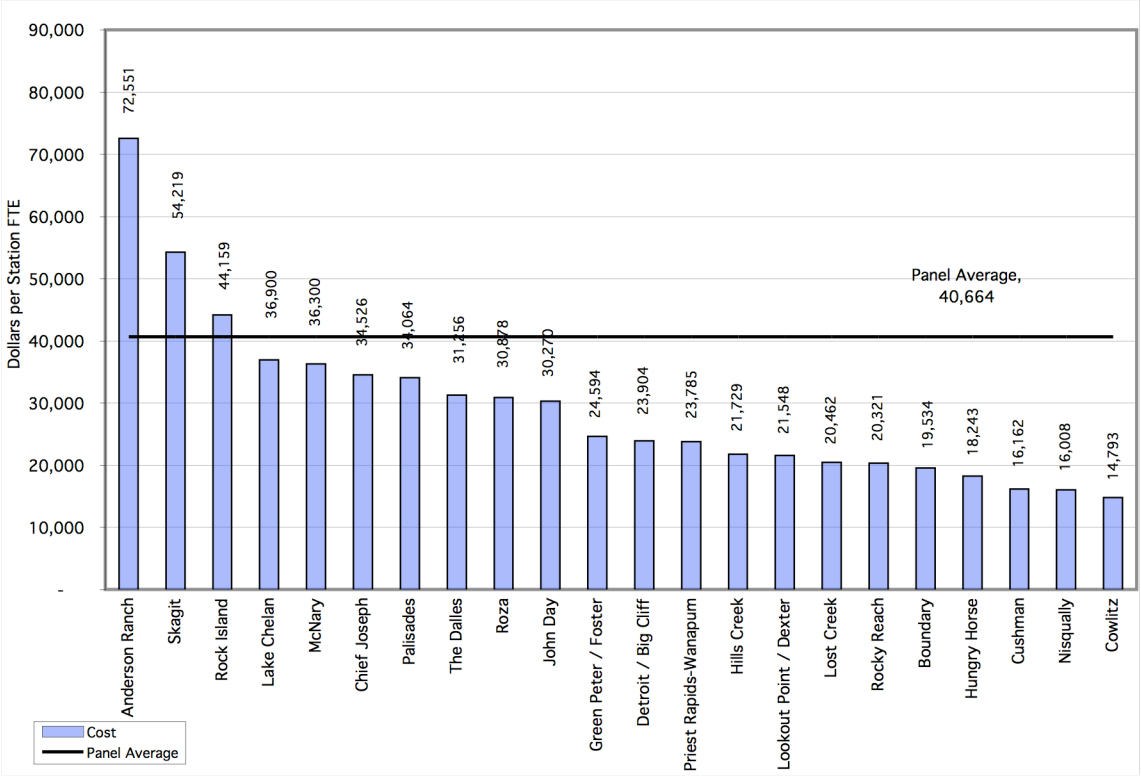
The Support function includes the wide range of administrative activities that are required to support a business, including: accounting, human resources, procurement, materials management, fleet services, telecommunications, information systems, security, training support, and corporate overheads (facilities and senior management).

The benchmark for Support is:

Support Cost per Direct Station FTE

Support represents about 18 percent of overall benchmarked expense costs for the NW panel of hydro stations. There are no clear economies of scale for support functions. Therefore, stations are not separated into peer groups.

Figure 13: Support



All but two NW stations all have lower Support costs than HJA's North American panel. Anderson Ranch likely has such a high Support cost per station FTE because there are so few direct FTE at this small station. One of the clear advantages that Corps, Reclamation, and other NW facilities share in this benchmark is they have robust support organizations that serve many other business functions other than hydropower. This likely lowers the support cost per direct station FTE, while still providing many types of support services for other missions.

Public Affairs and Regulatory

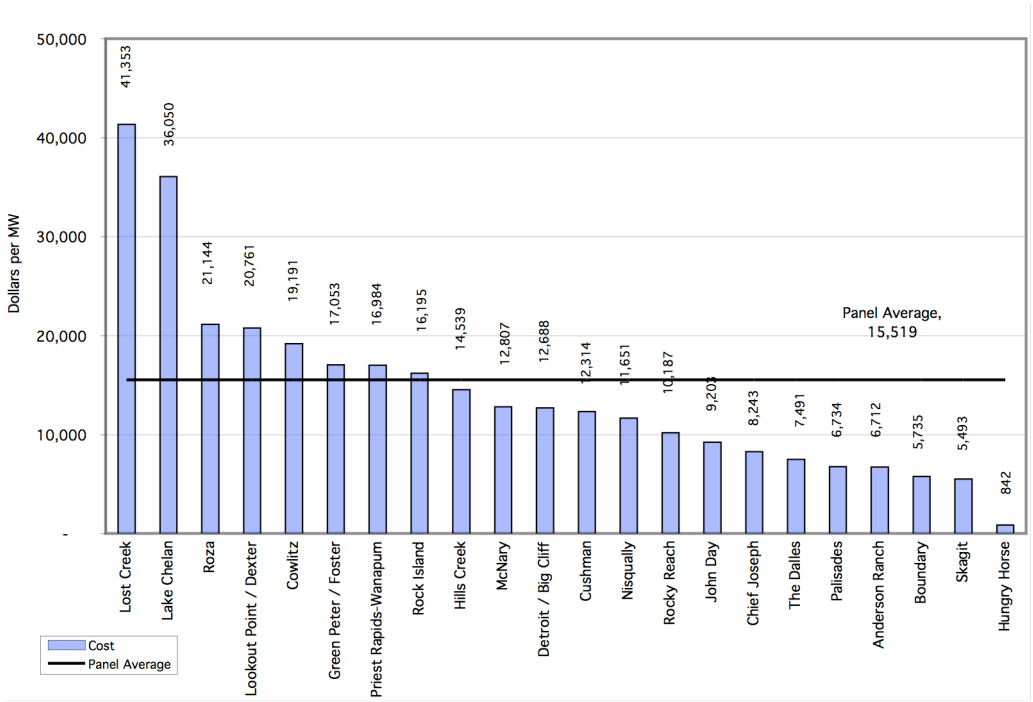
The Public Affairs and Regulatory (PA&R) function includes activities for wildlife management and mitigation, recreation, visitor operations, environmental regulations, and other regulatory requirements such as: licensing costs, taxes, and falling water charges (mainly in Canada).

The benchmark for PA&R is:

Public Affairs and Regulatory Cost per MW

PA&R represents 49 percent of overall benchmarked expense costs for the NW panel of hydro stations. There are no clear economies of scale for PA&R functions. Therefore, stations are not separated into peer groups.

Figure 14: Public Affairs and Regulatory



Forty percent of the NW benchmarking panel stations are near or above HJA's North American panel for PA&R costs. This is not surprising because:

- The BPA direct fish program costs of approximately $160 million per year are allocated to the FCRPS stations. Many of these stations also incur other Corps/Reclamation fish-related costs, as well as costs for recreation and visitor operations.

- Other Non-FCRPS stations also incur costs related to Federal Energy Regulatory Commission fees, fish mitigation, recreation, and/or visitors.

CONCLUSIONS AND OPPORTUNITIES

Benchmarking is, by its very nature, a diagnostic tool for managing an organization's resources. While it provides insights and perspectives on performance of individual facilities vis-à-vis other similar facilities, it does not provide specific answers for the best way to improve performance at a specific facility. With this perspective in mind, HJA identified specific conclusions and opportunities from the study:

- For the majority of the business functions benchmarked – Operations, Plant Maintenance, Waterways & Dams Maintenance, and Buildings and Grounds Maintenance – most of the NW hydro stations benchmarked in this study had similar costs within their relevant peer group and compared favorably to HJA North American panel averages. For the functions where HJA has models to predict expected costs, the vast majority of these stations also compared favorably to HJA's calculation of expected cost.

- For the majority of functions benchmarked, costs for FCRPS stations and other NW stations were similar. There was no discernable trend where benchmarks showed FCRPS stations were either consistently more costly or less costly than other regional stations. In functions where there were differences, we pointed out those differences within the analysis of each individual function. Notable exceptions are where FCRPS stations have:

    - Higher Operations costs at some stations.
    - Lower Plant Maintenance costs at some Large stations.
    - Higher Plant Maintenance costs at many Medium and Small stations.
    - Significantly lower Buildings and Grounds Maintenance costs.

- There is a significant opportunity for reducing Operations costs through automation. Automated Small and Medium stations experience significantly lower costs than stations with staffed control rooms. Results for Lost Creek illustrated this trend most clearly, but other Small and Medium stations also have higher costs than automated stations in their peer groups. Medium-Large and Large station may also derive some cost improvements from development of an integrated automation strategy. Other HJA panel participants that have recognized these differences have developed plant automation strategies in cooperation with their plant modernization programs. These efforts by other utilities required a long term (3 to 5 year) focused analysis and initiative to complete.

- Currently, the water management function within the FCRPS resides in three agencies. Similar costs for other organizations in the NW study suggest an integrated three-agency review of the water management function might identify opportunities for process and cost efficiencies.

- In the Plant Maintenance function, most NW stations were at or below HJA panel averages for their peer groups. There was some variability of costs among NW stations benchmarked. The effort to identify underlying reasons for this variability started a robust discussion among the benchmarking participants from the various NW utilities represented on the team. Best practices sharing began during the workshop reviews of

this data. The study team recognized that continued sharing of maintenance practices, including site visits among the regional stations represented here, could help all the regional utilities improve in this area.

- Support costs (such as finance, human resources, and procurement) for all but two Northwest NW stations were below the HJA North American panel average. FCRPS stations were well below the panel average. Lower FCRPS support costs reflect the structural advantage they enjoy where support functions within the Corps and Reclamation organizations support other non-hydro missions within their organizations.

- Public Affairs & Regulatory costs (including: fish and wildlife, recreation, taxes, and licensing) comprise nearly half of benchmarked costs. Many NW stations are at or above HJA North American panel averages, reflecting significant program costs for fish mitigation, recreation, and visitor operations.

When FCRPS stations were first benchmarked in the 2000 / 2001 timeframe, it was clear that many of these projects had significantly lower O&M and Investment funding than their peer group stations. Current results show that this gap has been largely eliminated. Most FCRPS stations are now near their peer group averages or their expected cost. The challenge for FCRPS projects in the future will be the same as the challenge currently being addressed by many leaders on HJA's North American panel. Leaders are engaged in deploying sophisticated, data-driven asset management strategies and reliability centered maintenance practices. The objective of these initiatives is to focus the deployment of operating, maintenance, and investment resources to optimize asset utilization of hydro plants over the long term.