May 18th Follow-Up to May 8th Workshop for BP-14 RHWM Process

FY 2014-2015 T1FSCO for RHWM
May Customer Workshop

Tier 1 System Firm Critical Output

Today: Additional Details & Background Material on Canadian Operations & Plant Data

May 8th Workshop Agenda

- Review RHWM Process
- Review T1SFCO Study
  - Explain differences since BP-12 study
  - Present T1SFCO study results
  - Present new annual firm wind methodology
- Provide examples of possible situations for customers, what to expect at June workshop

Today we'll revisit these two areas.

Federal Tier 1 System Firm Critical Output

- HYDSIM Study Updates Since the BP-12 Final ~~Proposal~~ Study

1) Assured Operating Plans

  - Canadian Operations
    - Canadian operations were updated based on 2014 and 2015 ~~Annual~~ Operating Plans (Treaty AOP studies). The Canadian project operations changed based on the loads in the AOP studies.
    - The dry-year provisions from the new Non-Treaty Storage Agreement were reflected in the study. This allows an additional 0.5 maf release from Mica or Arrow during May or June of the driest 20% of years. This provision provides ~8kcfs additional flow in June of 1937.
  - 2010-level Modified Streamflows
    - 2010-level Modified Streamflows were incorporated into the study. The BP-12 studies used 2000-level modified flows. The 2010-level streamflows include less water than the 2000-level streamflows. More details on next slide.
  - Brownlee Operations
    - The Brownlee operations were updated to be consistent with more recent operating assumptions targeting specific elevations each month while meeting minimum flow requirements. The previous rate case study's operating rules for Brownlee produced unreasonable results with the new reduced streamflow data.
  - 2012 PNCA Data

2) factors used to estimate generation & how this relates to efficiency improvements.

    - New Federal project data (H/K, storage tables, rating curves, etc.) and Miscellaneous minor flow requirement changes
    - The last Rate Case studies were based on 2010 PNCA data.
  - Availability Factors
    - Grand Coulee outages are based on 2011 actual average outages with 2 large units out of service in all months (~65% average availability, ~4% lower than BP12).
    - Chief Joseph outages are based on 2010-2011 actual average outages (~90% average availability, ~4% higher than BP-12).
    - Outages at all other federal projects are based on 2007-2011 actual average outages.
    - Reserve assumptions are nearly the same as BP-12 but are updated with the mid-December installed wind fleet forecast and the 3x3 standard for operating contingency reserves.
  - Updated Lack-of-Market Spill Estimates from AURORA Model
    - Used HOSS heavy/light ratios instead of generic AURORA heavy/light assumptions
    - Updated AURORA dispatch optimization logic
    - Higher load in FY14/FY15 than FY12/13 in AURORA
    - Used 30 wind profiles and 200 transmission profiles in AURORA instead of just using 2009 actuals

Canadian Operations in Rate Case & T1SFCO Studies

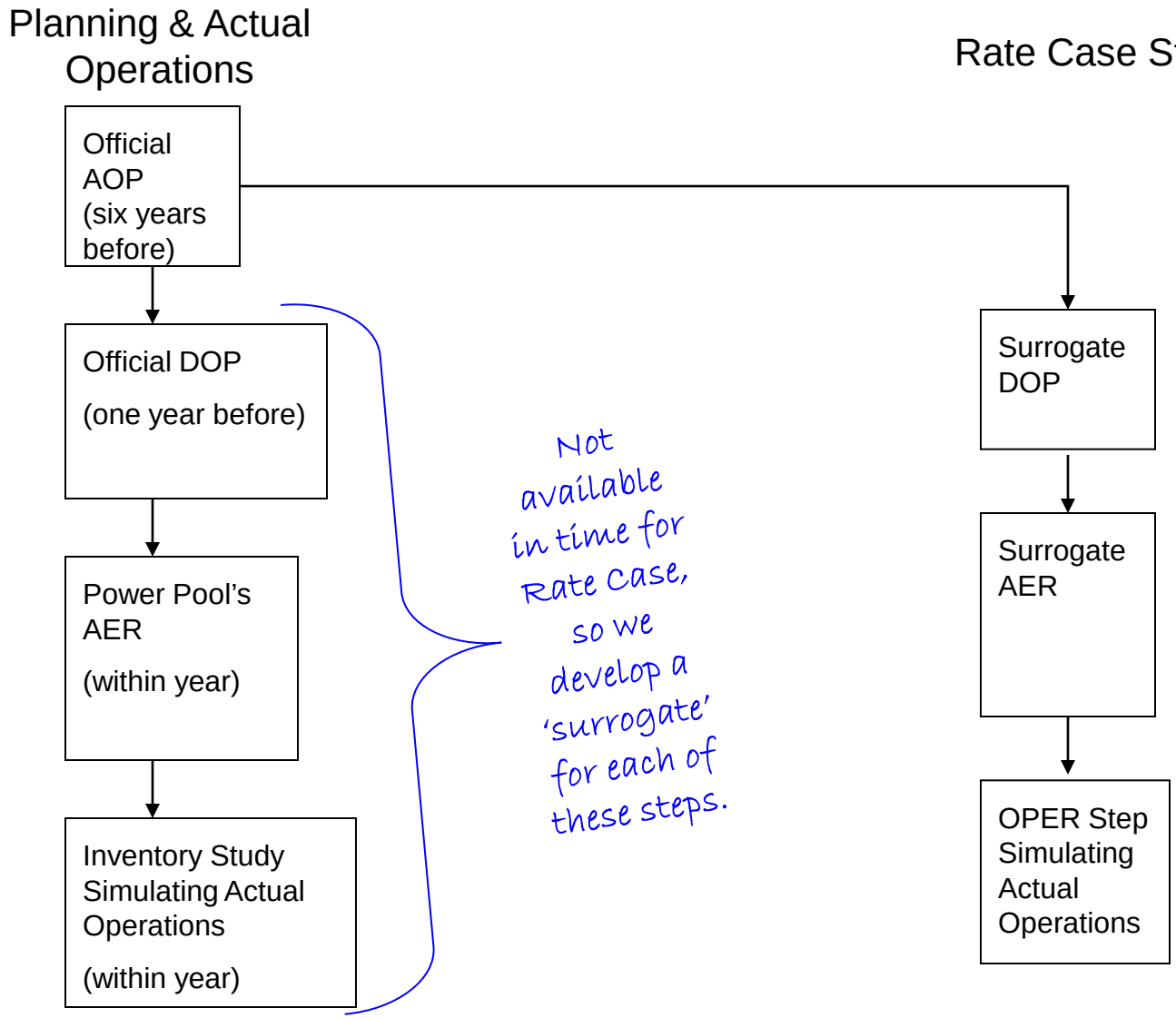
- AOP = Assured Operating Plan
  - The 1964 Columbia River Treaty requires the US & Canada to develop an assured operating plan for operation of Canadian Storage six years in advance every year.
    - AOP14 for 2014 was published Jan 2009. AOP15 for 2015 was published Sep 2010.
    - BPA staff are currently working on AOP18 for 2018.
  - AOP studies follow the protocol defined in the Treaty for an AOP to achieve an optimal power and flood control operation for the US & Canada.
    - The HYDSIM study follows standard utility practice to balance loads and resources.
      - AOP loads are based on Pacific Northwest Area loads as defined in the Treaty.
      - BC Hydro insists that these be our published White Book loads, not just an informal BPA forecast.
      - AOP14 loads came from 2008 White Book
      - AOP15 loads came from 2009 White Book
      - Additional mutually-agreeable adjustments are made to balance loads & resources in the AOP, such as including California imports & exports to balance when the study has surplus & deficits.
    - The study does not include modern non-power requirements, so the AOP does not reflect actual operations.
    - Because the AOP balances loads & resources and does not include non-power constraints, the load assumption significantly affects the AOP.
  - The AOP study results define the monthly operations for Canadian storage, which when combined with flood control operations, determine the actual operations of Canadian storage unless otherwise agreed (i.e., in the DOP or in annual operating agreements).
  - The Canadian Entitlement is also determined in the AOP.
    - Under the Treaty, the Canadians are entitled to half of the downstream power benefits resulting from Canadian Treaty storage operations.
    - The Canadian Entitlement is set by the AOP study and does not change, not even based on differences in the DOP.

Unlike our Rate Case study, which reflects actual operations and is so constrained by non-power operating requirements that the load does not have a significant affect.

Canadian Operations in Rate Case & T1SFCO Studies

- DOP = Detailed Operating Plan
  - DOP is completed the year prior to the operating year.
    - Unfortunately, this means these studies are not available early enough for our T1SFCO studies or Rate Case studies.
    - For instance, BPA staff are currently working on the 2013 DOP, but the Rate Case study for 2013 was initiated in July 2010 and completed in March 2011.
  - DOP is an optional refinement of the AOP
    - Only reflecting mutually agreeable updates
    - Typically only includes minor changes
      - Updated flood control procedures
      - Updated forecast procedures
      - Updated plant data
      - Updated hydro independent data
      - New operating requirements are allowed but are not often included
  - DOP is the study that gets used in the PNCA planning process, i.e. the studies run by the Northwest Power Pool
  - Since the official DOP is not available early enough for the Rate Case studies, we use a surrogate study.

Canadian Operations in Rate Case & T1SFCO Studies



Canadian Operations in Rate Case & T1SFCO Studies

- What really gets input to the Rate Case study?

The DOP Surrogate determines Canadian operations for the AER step.

- Surrogate DOP
  - We need an approximation of the DOP before the official DOP is available, sort of surrogate DOP study that is only for the Rate Case
  - We start with the AOP-- the official AOP is available for the rate period years.
  - We change this to a forecast-based study for fiscal year instead of a perfect knowledge study running August-July.
  - We update Canadian operations following the same process that will be used in the official DOP.
    - Update plant data with most recent PNCA data
    - Use the most recent streamflow data available (80-yr 2010 modified streamflow)
    - Update flood control using most recent assumptions & procedures from the Corps of Engineers

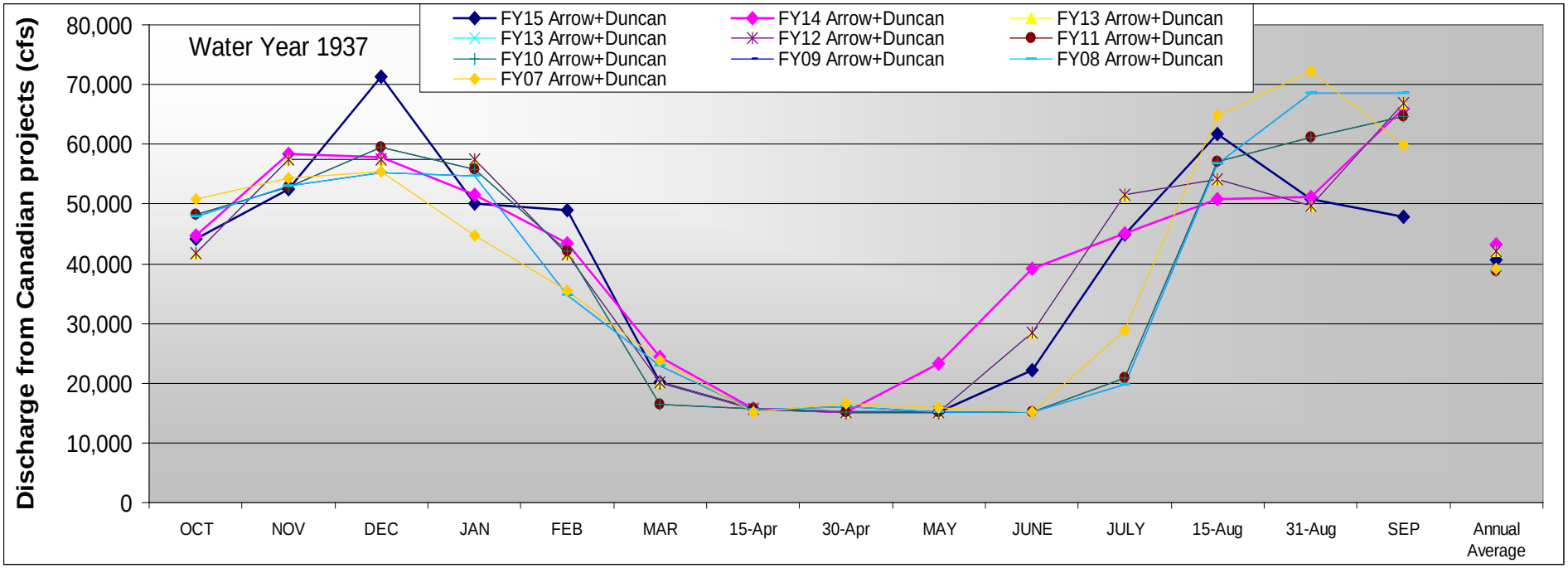
The AER step determines non-Federal operations for the OPER step.

- AER Step
  - We use the resulting Canadian operations from the surrogate DOP study in our AER step.
  - We use the PNCA planning data for all projects.
  - We run this step of the study similar to the Power Pool's AER study used for PNCA planning.
  - This step is used to estimate the operations of all the non-federal projects.
- OPER Step
  - This step is similar to the AER step but includes more refinements to better reflect expected actual operations.
  - We use the resulting US non-federal project operations from the AER step.
  - We add refinements at the federal projects where the PNCA data is either too generic or outdated.
  - We add expected Canadian operations that are not reflected in the DOP
    - Biological Opinion flow augmentation of 1 maf
    - Arrow trout spawning logic
    - Libby Coordination Agreement
    - Whitefish operation at Duncan
    - Non-Treaty Storage Agreement (new agreement)
      - The dry-year provisions from the new NTSA were reflected in the T1SFCO study. This allows an additional 0.5 maf release from Mica or Arrow during May or June of the driest 20% of years. This provision provides ~8kcfs additional flow in June of 1937.
      - The rate case will also reflect the spring-summer NTSA provision which allows us to move water from spring into summer in wet years when spring fish flow targets are being exceeded.
      - The Canadians are entitled to half of the downstream power benefit of non-Treaty storage releases, so we will also need to include that as an obligation in the upcoming Rate Case study.

The OPER step determines Federal operations for the generation estimates used in our Rates & T1SFCO studies.

Canadian Operations in Rate Case & T1SFCO Studies

- How much do the Canadian Operations change in our Rate Case studies?
  - The chart below shows the 1937 critical year Canadian project outflow from our past few rate Case studies and the recent T1SFCO studies for FY14 & FY15.
  - The operations do change from year to year in these studies.
    - The overall shape appears to be relatively consistent with the most variation in June and July.
    - The average annual discharge ranges from about 39,000 to 43,000 cfs.

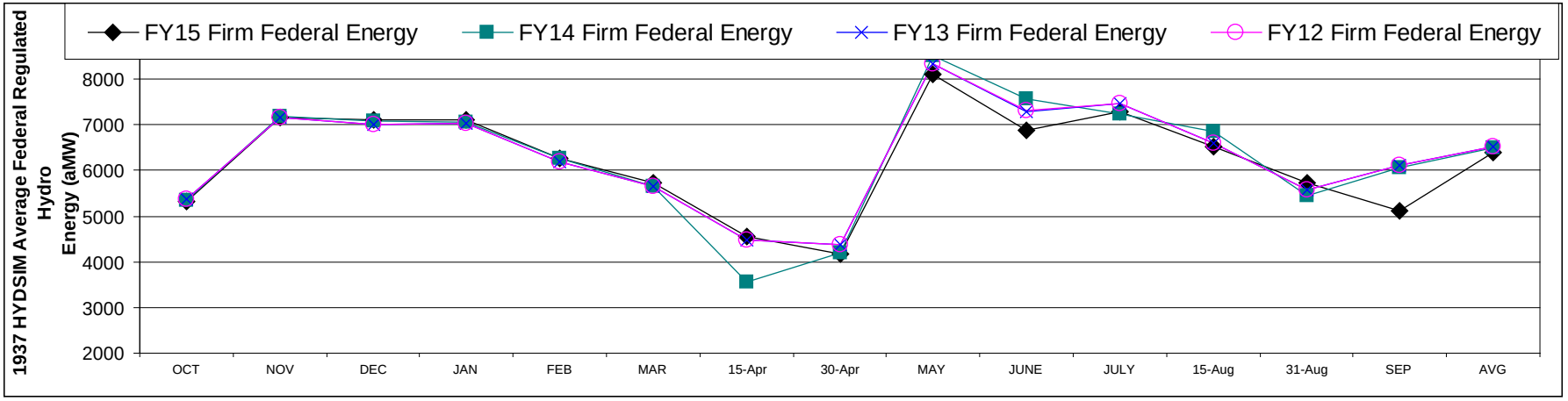


Federal Tier 1 System Firm Critical Output – HYDSIM Results

- The new estimate of FY14 & FY15 firm average annual regulated hydro energy is ~73 aMW lower than FY12 & FY13.
- Differences are primarily caused by the 2010-level Modified Streamflows and updated Canadian operations.
- Also, because the two years of studies include different Canadian operations, their annual average generation and monthly shapes differ more than they did in BP-12.

FIRM REGULATED HYDRO ENERGY FROM HYDSIM (aMW)

	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUNE	JULY	AUG1	AUG2	SEP	AVG.
FY12	5364	7161	7005	7037	6194	5648	4488	4382	8334	7314	7463	6596	5586	6124	6518
FY13	5364	7161	7005	7037	6194	5648	4488	4382	8331	7287	7463	6596	5586	6124	6516
BP12 FY12&FY13 avg	5364	7161	7005	7037	6194	5648	4488	4382	8333	7301	7463	6596	5586	6124	6517
FY14	5350	7195	7091	7057	6275	5654	3555	4203	8503	7568	7245	6849	5461	6052	6506
FY15	5314	7167	7102	7099	6263	5725	4543	4180	8094	6872	7296	6516	5719	5121	6383
New FY14&FY15 avg	5332	7181	7097	7078	6269	5690	4049	4192	8299	7220	7271	6683	5590	5587	6445
difference from FY12&FY13	-32	20	92	41	75	42	-439	-191	-34	-81	-193	87	4	-538	-73



Canadian Operations in Rate Case & T1SFCO Studies

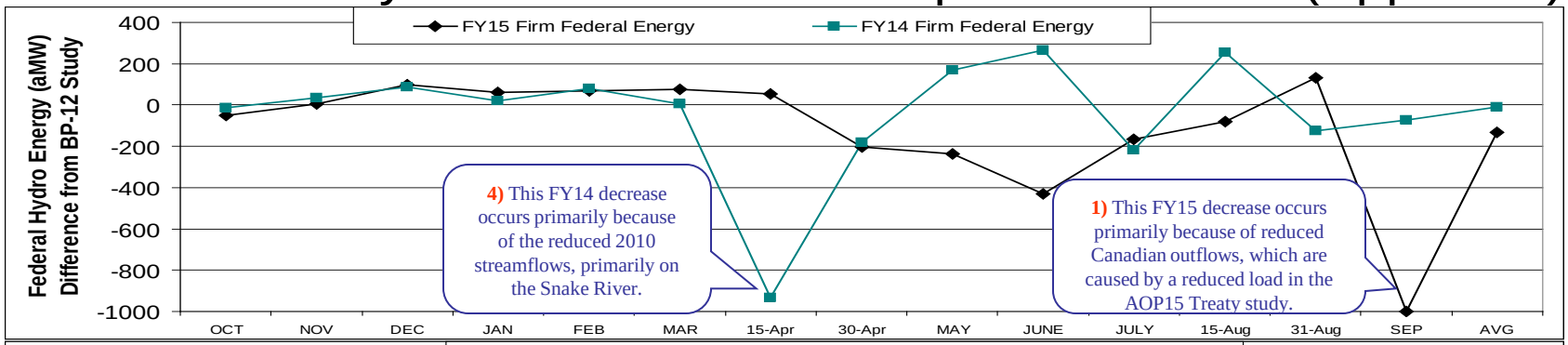
- What about the 2014/2024 Treaty review process?

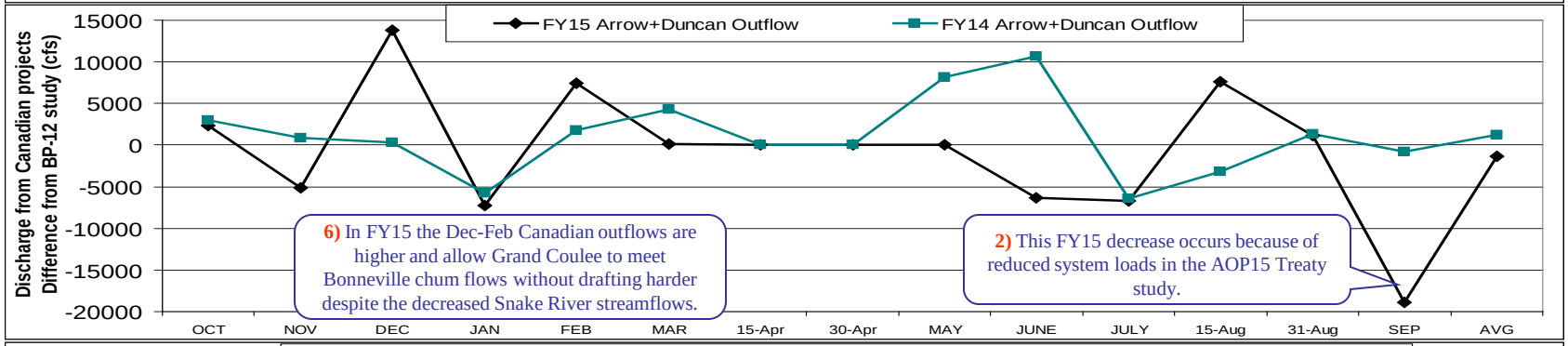
  - The Treaty has no specified ending date, but either nation can terminate most* of the current Treaty in September 2024 with a minimum of 10 years advance notice.
    * There are some stipulations in the Treaty regarding flood control changes starting in 2024 even if the Treaty continues.

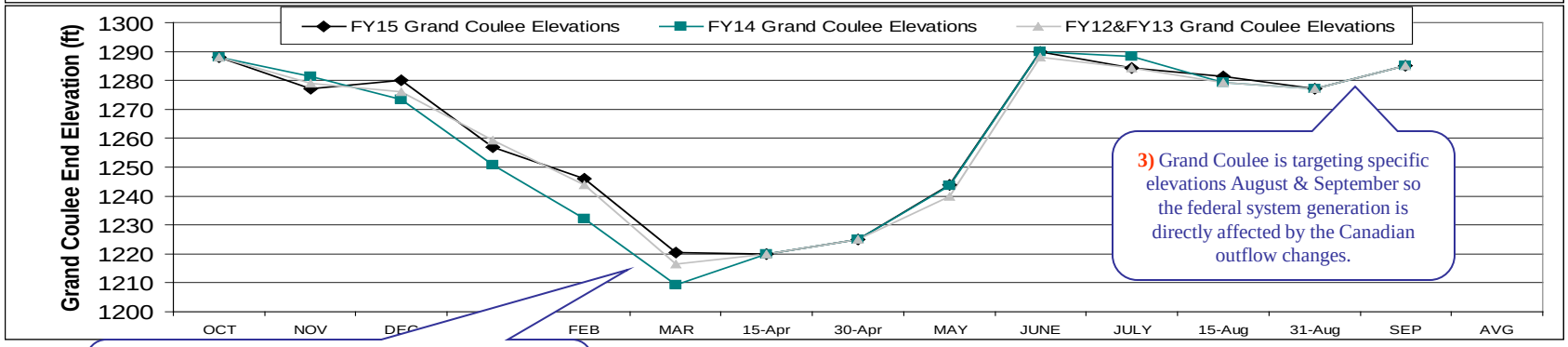
  - The 2014/2024 Treaty Review is currently evaluating a number of potential future scenarios with the goal of determining whether or not to provide the 10-year notice of intent to terminate the Treaty.

  - Additional information: http://www.crt2014-2024review.gov

Federal Tier 1 System Firm Critical Output - HYDSIM (Appendix)

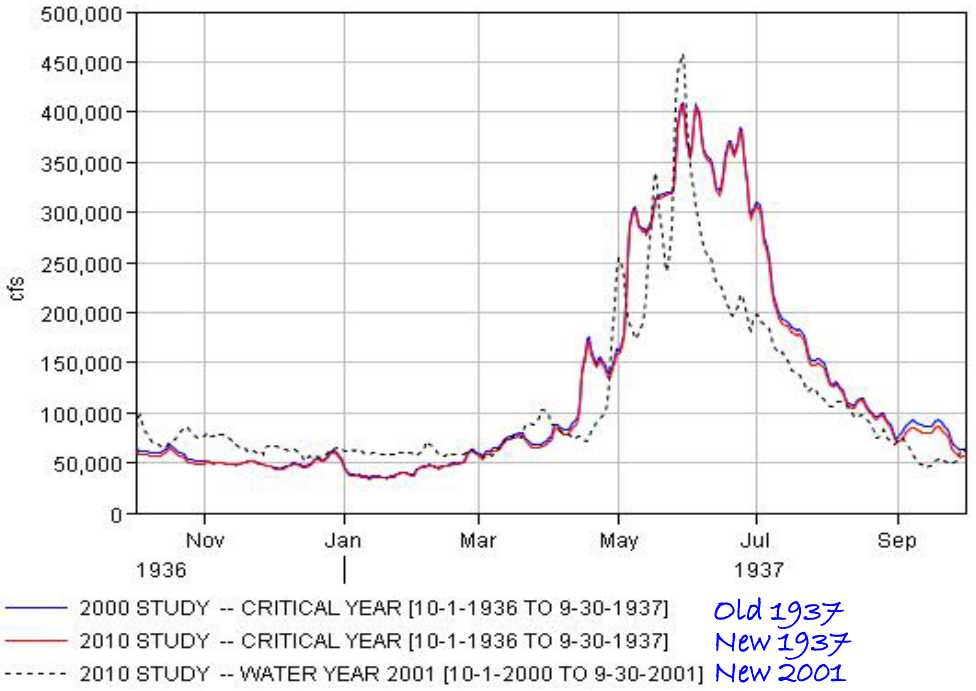






Federal Tier 1 System Firm Critical Output – HYDSIM Study

Unregulated Streamflow at The Dalles



1

2010 Modified Streamflow Data

- New streamflow data were published in Aug 2011.
- New 2010 data includes 80 years: Oct 1928 - Sep 2008, ten new years plus modified data for the first 70 years.
- New 2010 data includes 2% less water on average compared to the previous 2000 data set.
- Changes are mostly due to more accurate USBR calculation of irrigation withdrawals since 2000.
- New forecast data will also be included in HYDSIM study.

2

Critical Year Not Changing from 1937 to 2001

- Overall, 2001 has 8% less water than 1937. (Volume under dashed line is less than volume under red and blue lines across the whole year.)
- However, the critical period is based on drafting the system from fullest point to lowest point, which generally occurs from late summer thru early spring.
- Fall/Winter flows are 33% higher in 2001 compared to 1937. (Volume under dashed line is greater than volume under red and blue lines across the first half of the year.)
- Spring/Summer flows are 17% lower in 2001, but not enough to offset the fall winter increase and cause a change in the critical year.
- The Northwest Power Pool will run studies later this year for an official PNCA determination of the critical period with the new streamflow data, and we expect 1937 to remain the critical year.

3

2010 vs 2000 Streamflows during Critical Year (1937)

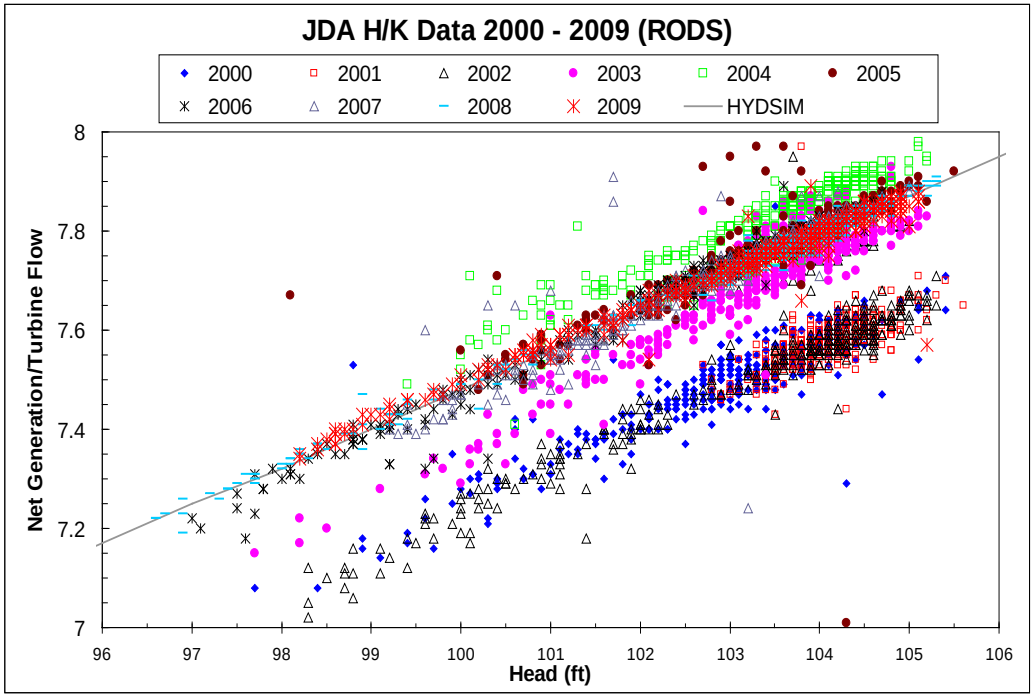
- 1937 has 2% less water in the new streamflow data.
  - In the chart the red line is slightly lower than blue line.
  - 7% less water during the fall and minimal difference throughout rest of year.
  - Most of the difference is in the Snake River Basin.
- This contributes toward reducing the T1SFCO.

Generation Calculations in HYDSIM

Actual Operations Data

H/K Values

- h/k values are used to calculate generation based on flow through a turbine
- h/k varies based on head, which is the difference between the forebay elevation and the tailwater elevation, because that determines the water pressure on the turbine runner.
- h/k multiplied by turbine flow in kcfs equals generation in MW
- New PNCA data in HYDSIM includes updated h/k values based on actual project generation through 2009



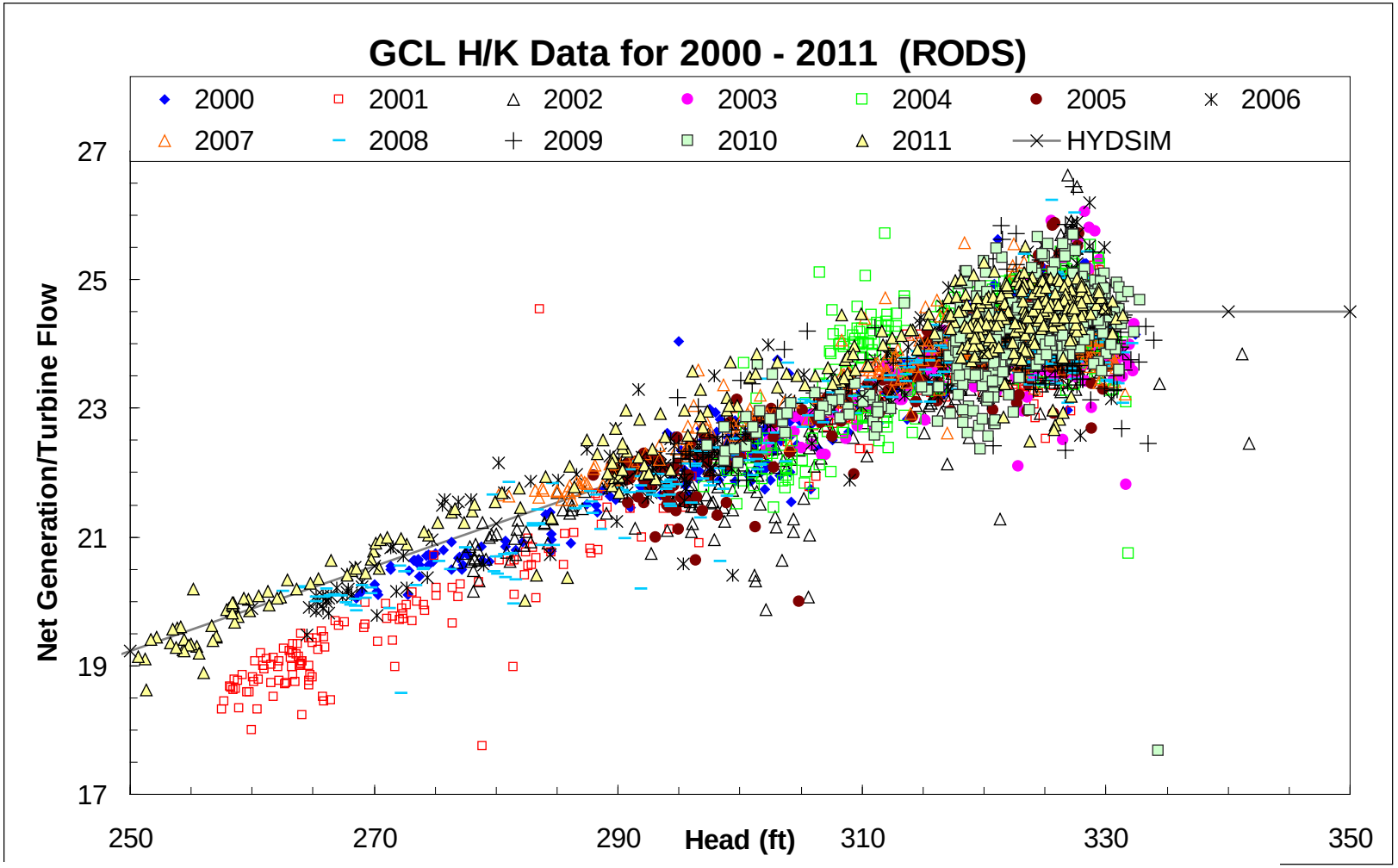
HYDSIM Models Grand Coulee as One Project

- Grand Coulee consists of different turbine units with different generating capability and different h/k values:
  - 18 units with ~125 MW in the Left & Right powerhouse
  - 3 units with ~600 MW in the Third powerhouse
  - 3 units with ~800 MW in the Third Powerhouse
  - 6 pump/generator units with ~50 MW
- HYDSIM treats this all as one project
- h/k values are developed for the whole project instead of using individual turbine h/k values or separate h/k values for each powerhouse
- HYDSIM h/k values currently represent actual operations through 2009 updated via PNCA
- h/k values will be periodically updated to reflect changes in operations or machines

What about the estimated efficiency improvements?

- Efficiency improvements are measured at a finer scale, i.e. one unit or a family of units at a specific operation.
- Over time, the actual project h/k data should show the improvements, but it can be difficult to see small increases in all the 'noise' of actual operations, particularly at Grand Coulee.
- In some cases a change can be made at the project that shows a more obvious change to h/k values as shown above.
- HYDSIM data is updated by project owners periodically through PNCA data submittal and coordination process.

Generation Calculations in HYDSIM



Why does this Grand Coulee h/k data show such a wide range?

- This variation reflects a range in operating conditions other than head.
- The proportion of flow going through each powerhouse varies, and the h/k varies for each powerhouse.
- The turbines can also operate differently for the same head.
- We will periodically monitor the project h/k data and coordinate with the Bureau of Reclamation when the HYDSIM plant data needs to be updated through the PNCA process.