Q. **Reference: Volume II, Exhibit 5 Hatch letter re: Modeling…System Capability**

Page 3 of Exhibit 5: *Hatch letter re: Modeling…System Capability* states…

> "The average annual hydroelectric energy production should be calculated as the average for the years in the study period, not including the warm up years and omitting the last year(s) if it appears that end conditions are affecting the results, as long as at least five years are used for the average".

Please provide the calculation of average annual hydroelectric energy production for the 2013 Test Year together with a detailed explanation justifying the methodology used. (Volume II, Exhibit 5, page 3)

A. The average annual hydroelectric energy production for the 2015 Test Year was estimated using Hydro's Vista DSS model following the approach recommended by Hatch in the referenced document. Vista DSS is the next generation of Hatch's SYSSIM model which was used in the previous GRA. Hydro has been using Vista since 1999 for operational purposes and more recently has used it for the GRA.

Key inputs to the Vista model used for the GRA estimate are as follows:

- System characteristics, Hydro – For the hydroelectric system input includes reservoir storage elevation curves, power curves, operating constraints, spillway and outlet rating tables;
- System characteristics, Holyrood – Holyrood is modeled as a purchase contract. Minimum thermal generation estimates based on the operation of Holyrood for voltage regulation and maximum capacity values are input and Vista will use a value between the two limits, as required;
- System characteristics, NUGS - CBPP cogeneration and the two wind farms are modeled as purchase contracts. Purchases from CBPP and the wind farms are

input as fixed values based on expected values. Newfoundland Power and Deer Lake Power's systems are modeled for completeness but the representation of Newfoundland Power's system is as one pseudo plant the size of all Newfoundland Power's plants combined. The Exploits system is modeled to the same level of detail as Hydro's system;

- Run duration – Each Vista simulation was run for twelve annual sequential hydrological records repeated for every year of the historical inflow record;
- Load Forecast – The load forecast for 2015 was input to each of the 12 simulation years. In this way the model ran for 12 essentially identical years to obtain a long-term average. The loads include Newfoundland Power, Hydro Rural customers, Industrial Customers and system losses;
- Start and end reservoir levels – Actual January 1, 2010 reservoirs levels were used as the start conditions. A Vista option to allow the model to select a reasonable end level based on the energy value of the water in storage at the end of the simulation was used;
- Hydrologic scenarios – Daily inflows for each of Hydro's historic data set are input to the model. Sixty-four hydrologic scenarios, starting in 1950 to 2013, were simulated in each Vista run. If the simulation reached the end of the hydrologic period, it would wrap around and use the early years of data. For instance, the 1960 simulation used the years 1960 to 1971 to simulation 2010 to 2021. The 2010 simulation used 2010 to 2013 for 2010 to 2013 and then wrapped around to use 1950 to 1957 for 2014 to 2021.
- Time step – the GRA model was run using a monthly time-step. The data was then summarized into annual results for presentation.

Table 1, attached as NP-NLH-115 Attachment 1, shows the output from Vista summarized by year. Each value is itself an average of the results from the 64

hydrologic scenarios modeled. The energy value used for the GRA is the average of the results from the last 10 years of the 12 year sequence. The first two years were omitted from the average as they were model 'warm-up' years. Small adjustments (i.e., less than 0.5%) were made to the average energy estimated by the model to reflect the energy value of the water lost from storage between the start and end of the simulations.

Table 1
Summarized Vista Output for GRA Analysis

	Hydro Generation, GWh											
Year	Granite	Upper Salmon	BDE	Cat Arm	Hinds Lake	DLP	NP	Paradise River	Star Lake	Buchans	Grand Falls	Bishops Falls
2010	258	608	2963	800	351	803	428	34	139	10	483	146
2011	261	610	2814	770	368	781	446	35	142	10	481	109
2012	251	590	2762	757	347	785	447	35	142	10	490	105
2013	249	579	2686	767	354	796	448	35	143	10	491	139
2014	248	581	2686	758	357	786	446	35	142	10	483	134
2015	247	575	2665	756	356	790	446	35	142	10	485	143
2016	246	572	2661	760	349	787	447	35	142	10	485	145
2017	247	572	2664	758	354	790	447	35	142	10	484	144
2018	246	569	2644	761	352	791	446	35	142	10	484	145
2019	247	566	2643	774	355	790	446	35	142	10	484	144
2020	247	552	2588	817	351	795	448	35	142	10	486	145
2021	248	508	2492	905	420	644	448	35	142	10	473	143
10yr Avg	**248**	**566**	**2649**	**781**	**359**	**775**	**447**	**35**	**142**	**10**	**485**	**139**

	Hydro Generation, GWh					Thermal and Purchases, GWh						Total Load, GWh		
Year	NLH Hydro	Star Lake	Exploits	NUG Hydro	Total Hydro	Cogen	St. Lawrence	Ferm	HRD	Total Contracts	Total Gen.	DLP	NLH	Total
2010	5013	139	638	1231	7022	51	105	84	1206	1446	8468	917	7550	8468
2011	4858	142	600	1227	6827	51	105	86	1471	1713	8540	925	7615	8540
2012	4743	142	606	1232	6723	51	105	86	1576	1818	8541	925	7616	8541
2013	4671	143	640	1244	6698	51	105	86	1619	1861	8558	925	7633	8558
2014	4665	142	628	1232	6667	51	105	86	1650	1892	8559	925	7633	8559
2015	4634	142	637	1236	6650	51	105	87	1665	1908	8558	925	7633	8558
2016	4622	142	640	1234	6639	51	105	86	1673	1916	8555	925	7630	8555
2017	4631	142	639	1237	6648	51	105	86	1665	1906	8555	925	7630	8555
2018	4607	142	639	1237	6625	51	105	86	1678	1919	8545	925	7619	8545
2019	4620	142	639	1236	6638	51	105	86	1679	1920	8558	925	7633	8558
2020	4591	142	641	1243	6618	51	105	86	1700	1942	8560	925	7635	8560
2021	4607	142	626	1092	6467	51	105	86	1846	2088	8555	925	7630	8555
10yr Avg	**4639**	**142**	**634**	**1222**	**6637**	**51**	**105**	**86**	**1675**	**1917**	**8554**	**925**	**7629**	**8554**

With major NLH Stations adjusted for storage changes

	Hydro Generation, GWh						
Year	Granite	Upper Salmon	BDE	Cat Arm	Hinds Lake	PR	Total
2010	233	503	2572	743	330	34	4416
2011	246	563	2642	753	352	35	4589
2012	246	568	2655	756	353	35	4613
2013	245	567	2643	757	353	35	4601
2014	246	568	2648	757	353	35	4607
2015	246	568	2648	757	353	35	4608
2016	246	570	2657	758	353	35	4619
2017	246	569	2651	757	353	35	4611
2018	246	569	2649	757	353	35	4609
2019	246	568	2649	757	353	35	4608
2020	246	570	2657	754	353	35	4615
2021	246	567	2648	692	326	35	4514
10yr Avg	**246**	**568**	**2651**	**750**	**350**	35	**4601**