CT-2021-002

THE COMPETITION TRIBUNAL

IN THE MATTER OF the *Competition Act,* R.S.C. 1985, c. C-34, as amended**;**

AND IN THE MATTER OF the acquisition of Tervita Corporation by SECURE Energy Services Inc.;

AND IN THE MATTER OF an Application by the Commissioner of Competition for an order pursuant to section 92 of the *Competition Act***.**

BETWEEN:

THE COMMISSIONER OF COMPETITION

Applicant

- and -

SECURE ENERGY SERVICES INC.

Respondent

AFFIDAVIT OF ADONIS YATCHEW
(Sworn March 25, 2022)

I, **Adonis Yatchew** of the City of **Toronto**, in the Province of Ontario, **MAKE OATH AND SAY**:

1. I am a Professor of Economics at the University of Toronto, and Editor-in-Chief of *The Energy Journal*, a leading peer-reviewed publication focusing on energy economics and related areas. I have been retained by Blake, Cassels & Graydon LLP, counsel for the respondent, to provide my expert opinion regarding the responsiveness of demand for waste services in the Western Canadian Sedimentary Basin's hydrocarbon industries to changes in the prices of such services (i.e. the price elasticity of demand).

2. Attached as Exhibit “A” to my affidavit is my expert report in this matter dated March 24, 2022.

3. Included as Exhibit “A” to my report is my curriculum vitae.

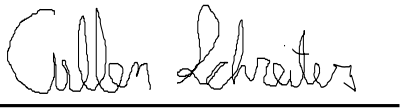
4. Included as Exhibit “G” to my report is my acknowledgement of expert witness.

5. I swear this affidavit for the purposes of the within application and for no other purpose

SWORN remotely by)
Adonis Yatchew)
in the City of Toronto in the Province)
of Ontario, before me in the City of)
Toronto in the Province of Ontario,)
on March 25, 2022 in accordance)
with O. Reg 431/20, Administering)
Oath or Declaration Remotely)

A commissioner for taking affidavits

Adonis Yatchew



This is Exhibit "A" to the Affidavit
of
Adonis Yatchew
Affirmed on March 25, 2022

THE COMPETITION TRIBUNAL

IN THE MATTER OF the *Competition Act*, R.S.C. 1985, c. C-34, as amended;

AND IN THE MATTER OF the acquisition by Secure Energy Services Inc. of Tervita Corporation;

AND IN THE MATTER OF an application by the Commissioner of Competition for one or more orders pursuant to section 92 of the *Competition Act*.

B E T W E E N :

THE COMMISSIONER OF COMPETITION

Applicant

- and -

SECURE ENERGY SERVICES, INC.

Respondents

AFFIDAVIT OF ADONIS YATCHEW

SWORN MARCH 25, 2022

I, **ADONIS YATCHEW**, of the City of Toronto, Province of Ontario, MAKE OATH AND SAY:

A. Introduction and Qualifications

1. I am a Professor of Economics at the University of Toronto and Editor-in-Chief of *The Energy Journal*, a leading peer-reviewed publication focusing on energy economics and related areas.

2. Since completing my Ph.D. at Harvard University, I have taught at the University of Toronto. I have also held visiting appointments at other institutions, including Trinity College, Cambridge and the University of Chicago. I am a Senior Fellow of the United States Association for Energy Economics. In 2018, I received the International Association for Energy Economics Award for "outstanding contributions to the field of energy economics and its literature."

3. I have written a graduate level econometrics text, published by Cambridge University Press. I have served in various editorial capacities at *The Energy Journal* since 1995 where I have reviewed and adjudicated numerous energy industry analyses.

4. I have advised regulators, public and private sector companies on energy, regulatory and other matters for over 35 years and have provided analyses and testimony in a range of regulatory and litigation proceedings.

5. I currently teach PhD. level courses in econometrics, M.A. and undergraduate level courses on energy in the University of Toronto Department of Economics and in the School of Environment. The energy courses I teach are interdisciplinary, spanning economics, the environment and sustainability, politics, geopolitics and security. I have also taught short courses covering these areas at international conferences. Attached hereto as Exhibit "A" is a copy of my curriculum vitae.

6. I have been asked by counsel to Secure Energy Services Inc. to provide my opinion on the responsiveness of demand for Waste Services[1] in the Western Canadian

[1] Waste Services include treatment and disposal services provided at landfills (LFs), full-service terminals (FSTs), and water disposal facilities (WDs).

Sedimentary Basin's hydrocarbon industries to changes in the prices of such services. This responsiveness is measured by the 'price elasticity of demand'.[2]

7. The elasticity of demand comprises an important element in conducting widely used standard analyses of the impacts of structural and policy changes within an industry, in particular, analyses of 'deadweight loss'.[3]

8. I have also been asked to respond to the Expert Report of Nathan H. Miller, Ph.D., (hereafter referred to as the "Miller Report") filed on behalf of the Commissioner of Competition ("Commissioner").[4]

9. To prepare this affidavit, I have relied on the materials, data and other information listed in Exhibit "F," attached hereto.

B. Summary of My Opinion

10. Demand for Waste Services in hydrocarbon industries is driven primarily by the levels of exploration, production, extraction and closure of oil and natural gas sites and facilities. [redacted].[5]

11. Alberta's oil and gas sectors are affected by a range of global, continental, national, and provincial factors. The most important are oil prices, oil pipeline capacity and constraints, and the demand and supply of natural gas in Canada and the U.S.

12. Uncertainties and risks in hydrocarbon markets increased significantly beginning in mid-2014. In 2022 they have increased much more dramatically. The sources of

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[2] The price elasticity of demand is the percentage change in waste disposal services demanded by customers when the price changes. For example, an elasticity of -0.5 means that a 10% increase in the price of Waste Services would see a 5% decline in the total quantity of waste delivered. Demand is inelastic if the elasticity is less than 1.0 in absolute value. It is elastic if the elasticity is greater than 1.0.

[3] In the present context, a key question is whether the acquisition of Tervita Corporation by Secure Energy Services is likely to lead to material changes in the level of Waste Services resulting from a potential increase in price.

[4] Expert Report of Nathan H. Miller, Ph.D., Exhibit A to the Affidavit of Nathan H. Miller, affirmed/sworn February 25, 2022 [hereafter referred to as the "Miller Report"].

[5] [redacted]

uncertainty are multi-dimensional: geopolitical, environmental, technological, economic, and regulatory/political. All of these have elevated challenges faced by hydrocarbon industries in Alberta, potentially strengthening the rationale for consolidations. These uncertainties are likely to persist for the longer term.

13. In order to examine the responsiveness of demand for Waste Services to prices I have relied upon a range of direct and indirect approaches. These included econometric analyses, and nonstatistical approaches to arrive at a reasonable range for the elasticity of demand.

14. In the course of my investigations, I conducted three types of econometric analyses. The first two analyses provide indirect evidence on the demand elasticity while the third provides a direct measure.

    a. The first assesses whether Waste Services prices impact the levels of production of oil and gas in Alberta. [redacted]

    b. The second is a causality analysis in which I assess whether past Waste Services prices have a causal impact on the levels of demand for such services. [redacted]

    c. In the third analysis, the demand elasticity is estimated directly. [redacted][6]

[6] Statistical significance refers to standard criteria for assessing whether a factor or variable has a high likelihood of having an impact. The modifier 'statistical' is often dropped and the variable is described as being significant. A finding of statistical significance does not imply that the factor has a material impact. For example, consumption of chocolate may have a statistically significant effect of reducing blood pressure, on average, by two points (say less than two percent). However, such a small reduction would generally be judged as immaterial from

15. Importantly, these econometric analyses support the proposition that Waste Services prices do not help to explain overall activity in the oil and gas industry, or the aggregate levels of services that are consumed by industry participants.[7]

16. I also conducted separate analyses for three service groups: landfill services (LF), full-service terminals (FST), and water disposal services (WD)[8]. [redacted]

17. [redacted]

18. There are additional reasons that are indicative of a low price elasticity of demand.

    a. First, the costs of Waste Services comprise a small fraction of industry costs, with little if any material impact on industry activity and therefore on the demand for Waste Services. A number of industry participants which make use of disposal services have indicated that the costs of such services are not a material consideration in their production decisions. In some cases, these services comprise less than, and sometimes significantly less than 5% of costs.[9] [redacted]

the perspective of treatment. On the other hand, a medication may be found to have a statistically significant impact of reducing blood pressure by 20 points in a test group, which would be a material amount (say 15%).

[7] More precisely, there is minimal, if any improvement in 'goodness of fit' statistics when disposal prices are included in the models.

[8] This group includes water disposal services offered at FST facilities.

[9] For example, third party disposal represents 0.61% of IPC Canada's operating expenses in 2021, Affidavit of Chris Hogue (IPC Canada) at ¶16. Secure and Tervita represents approximately 2% of Athabasca Oil's capital expenditures in 2019-2021, Affidavit of Robert Broen (Athabasca) at ¶14. [redacted]

[redacted][10]

b. Second, the above statistical elasticity estimates are based on firm-specific data and are therefore best interpreted as firm-specific elasticities. Economic theory strongly suggests that the overall market demand elasticity is significantly lower than a firm-specific elasticity. This is because the alternatives available to a purchaser of these services when a firm increases its prices are generally broader than if the market price increases by the same amount.

19. Based on these various analyses, it is my opinion that demand is highly inelastic. [redacted]

20. In his report, Dr. Miller does not attempt to estimate this elasticity, stating that he is not aware of data that would allow him to do so.[11] He asserts, without statistical analysis, an elasticity range of -0.20 to -0.87. The -0.87 was used by another expert witness in a proceeding over a decade ago and is based on a financial projection at a single proposed landfill facility from 2010. Dr. Miller provided no analysis of his own to justify the

[redacted].

[10] [redacted]

[11] Miller Report, ¶163.

estimated value of -0.87. His low-end estimate of -0.2, which is not based on any analysis of either the data or documentary evidence, is closer to my opinion.

Background

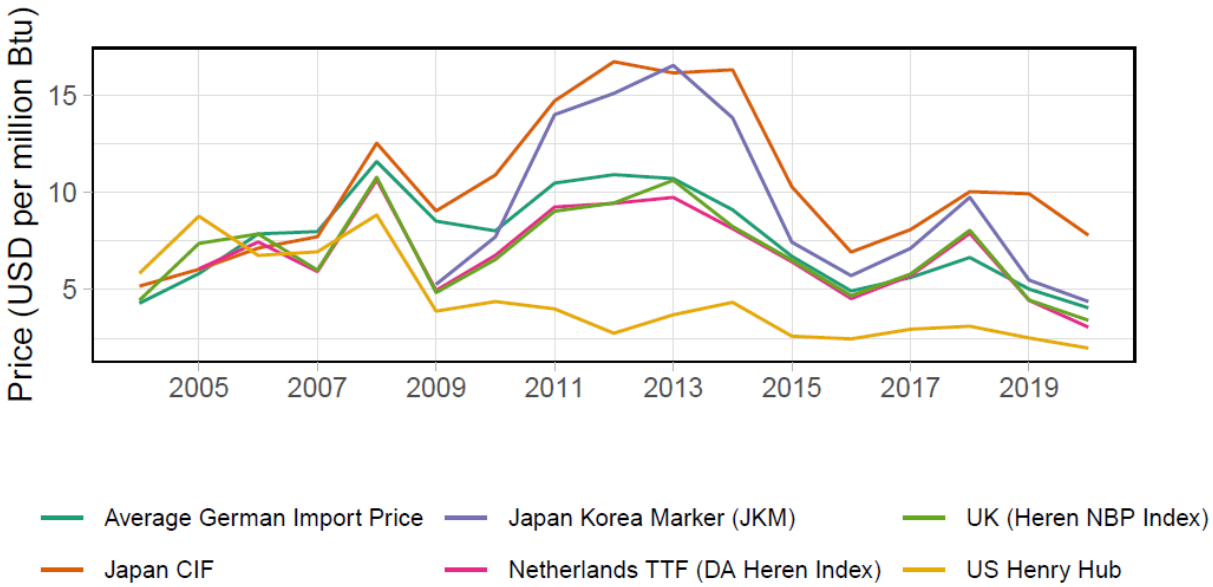
21. Investment and activity levels in oil and gas industries have been driven by diverse long-term and short-term factors. Expectations about future demand for hydrocarbons, prices, and transportation capacity are critical, particularly in influencing investment in capital intensive projects which require lengthy recovery periods.[12]

22. Natural gas markets are continental. That is, prices are largely determined by continental demand and supply conditions and may differ widely across continents, as is evident in Figure 1 below.[13]

[12] This is a well-accepted economic principle. As the OECD (The Organization for Economic Co-operation and Development) noted in a discussion of the global energy market, "Investment decisions, however, are driven to a very large extent by expectations. … Such decisions are driven by expectations of future prices, not by future prices. … long-term investment decisions are governed not by price mechanisms, but by expectations of how price mechanisms will work out. How, then, are these expectations formed? Financial as well as industrial investors have no choice but to make guesses based on their gut feelings combined with whatever information they may be able to gather from the rest of the world and from each other. One of the most important inputs in this process of expectation formation is provided by the scientific community. Nevertheless, what emerges from the process is by no means a scientific forecast, but rather a willingness to bet on certain developments." OECD, "Energy: The Next Fifty Years," 1999, available at https://www.oecd.org/futures/17738498.pdf.

[13] Although trade in liquified natural gas is intercontinental and has been growing rapidly in recent years, the costs of liquefaction, transportation by LNG tanker, and regasification is high, limiting global price convergence. In contrast, oil markets are global because shipping costs represent a much smaller share of total costs.

Figure 1: Natural Gas Prices ($/mmBtu)[14]



23. From 1985 to 2005, U.S. natural gas production remained essentially flat, at the same time that demand was growing.[15] This expanded export markets for Canada's natural gas production which roughly doubled over this period.[16] In 2005, U.S. natural gas prices exceeded those in Europe and Asia (see Figure 1). The expectation was that demand for Alberta gas would continue to grow.

24. The shale revolution which enabled the extraction of large quantities of natural gas from soft sedimentary rock by combining horizontal drilling with hydraulic fracturing (fracking) fundamentally altered North American natural gas markets.[17] U.S. domestic natural gas production began to grow rapidly and by 2009, U.S. and Canadian natural gas prices dropped by more than 50% (see Figure 2). This, in turn, left Alberta with

[14] BP, "BP Statistical Review of World Energy," (tab "Gas Production – Bcf"), available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2021-all-data.xlsx

[15] *Ibid.*

[16] *Ibid.*

[17] See, for example, X. Zheng (2017) "The Impact of Shale Boom on North American Natural Gas Market," *International Association for Energy Economics*, Page 1.

excess production and pipeline capacity as U.S. demand did not fulfill previous expectations.[18]

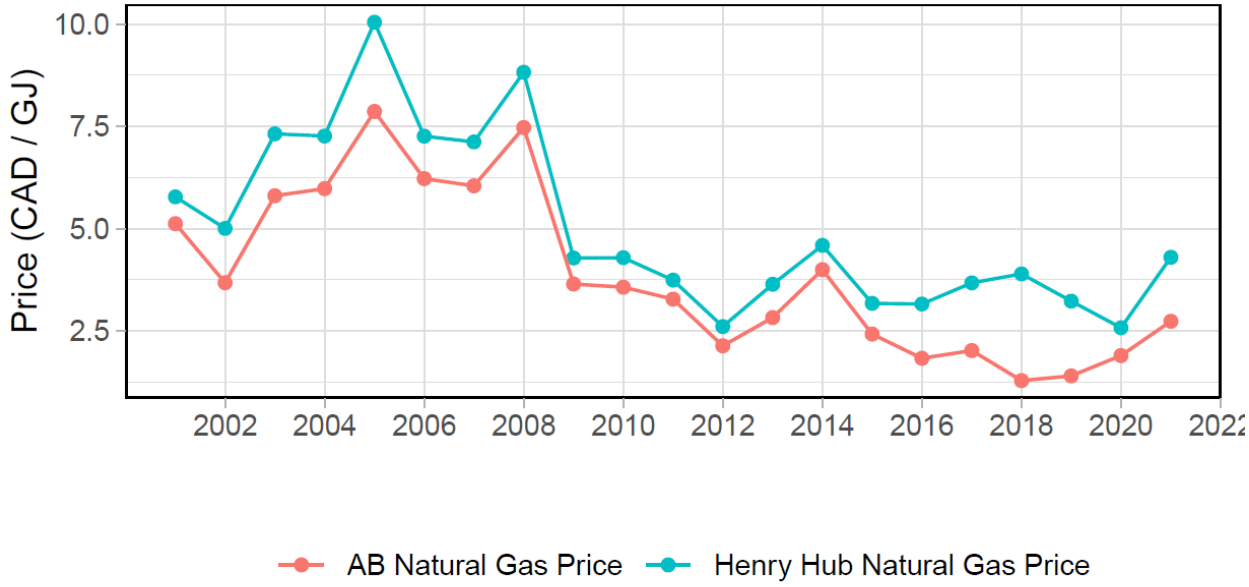
25. From 2010, throughout the following decade, North American natural gas prices were far below European and Asian reference prices, a clear manifestation of the fracking revolution (see Figure 1). By the later part of the decade, the U.S. rapidly ramped up its LNG exports.[19] While this created an increased demand for North American natural gas, conditions of excess supply persisted.

26. To make use of surplus Canadian natural gas pipeline capacity, proposals were put forth for converting some to oil shipping. The TransCanada Energy East project would have shipped one million barrels per day of crude oil to Canadian refineries in Quebec and New Brunswick. The initial plans were made in 2013, the project was cancelled in 2017.

[18] Canada Energy Regulator, "Canada's Pipeline Transportation System 2016," January 28, 2022, available at https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/2016/canadas-pipeline-transportation-system-2016-pipeline-capacity.html#s32

[19] BP, "BP Statistical Review of World Energy," (tab "Gas: LNG exports"), July 2021, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2021-all-data.xlsx

Figure 2: US Henry Hub and Alberta Natural Gas Prices
2001-2021[20]



27. Global oil markets experienced a sea-change in mid-2014: while the price of West Texas Intermediate (WTI) had averaged more than 90 USD/barrel over the previous five years, it then dropped dramatically with no clear stabilizing price. (See Figure 3.) The shale revolution was the most likely cause of these changes, not principally because U.S. shale oil producers increased global supply,[21] but more importantly, fracking triggered a change in strategic behaviour by OPEC which focused more on volumes than on influencing prices.[22]

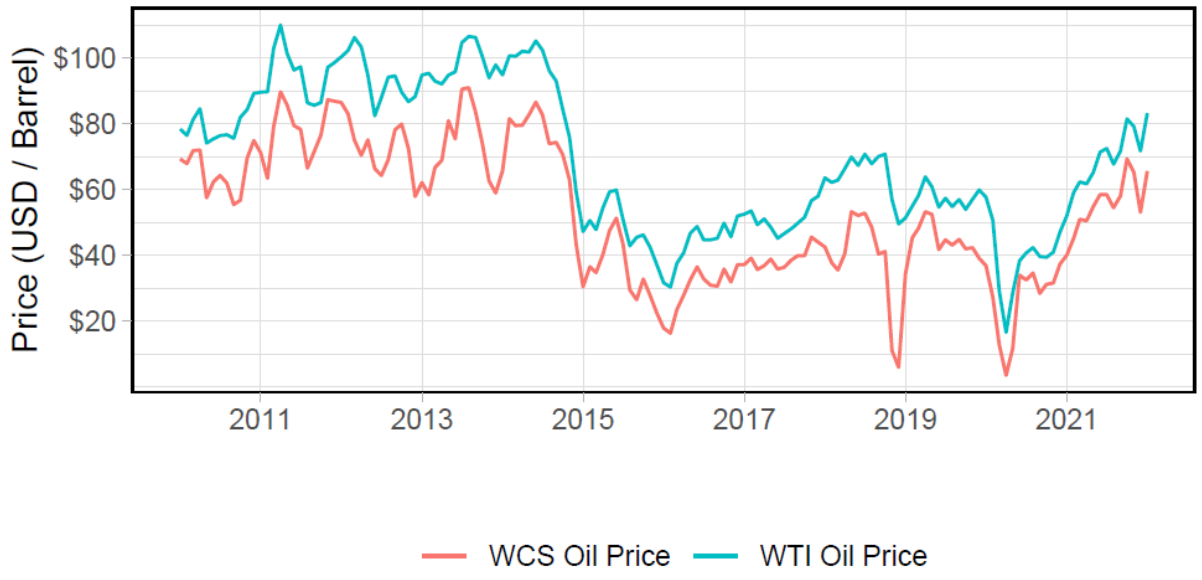
[20] BP, "BP Statistical Review of World Energy," (tab "Gas - Prices"), July 2021, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2021-all-data.xlsx

[21] The U.S. is now one of the three top oil producers, along with Saudi Arabia and Russia. See, for example, BP, "BP Statistical Review of World Energy," (tab "Oil Production - Barrels"), July 2021, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2021-all-data.xlsx

[22] See, for example, A. Behar and R.A. Ritz (2017) "OPEC vs US Shale: Analyzing the Shift to a Market-Share Strategy," *Energy Economics*, vol 63, 185-198 ("In November 2014, OPEC announced a new strategy geared towards improving its market share. Oil-market analysts interpreted this as an attempt to squeeze higher-cost producers, notably US shale oil, out of the market. Over the next year, crude oil prices crashed, with large repercussions for the global economy.")

28. Previous OPEC pricing strategies—to discourage long-term investment in major projects elsewhere—would no longer work against shale producers because this technology is highly scalable, necessitating much lower levels of investment and shorter time horizons for return of investment.[23]

Figure 3: WTI and WCS Oil Prices
2010- Jan 2022[24]



29. Covid-19 has buffeted hydrocarbon markets, at one time driving WTI prices briefly into negative territory, due to rapid shrinkage of demand for transportation fuels as well as a brief price war between Russia and Saudi Arabia. Prices have recovered significantly and recently have exceeded $100 US / barrel[25], though the outlook remains highly uncertain.

30. For Alberta oil producers, an ongoing constraint is available pipeline capacity. Cancellation of Keystone XL, which would have taken oil south, the Northern Gateway project which would have shipped oil to the British Columbia coast, and the previously

[23] Minimum efficient scale for shale supply is *three orders of magnitude lower* than for traditional oilfields. See, for example, D. Dimitropoulos and A. Yatchew (2017), "Discerning Trends in Commodity Prices," *Macroeconomic Dynamics*, 22.3: 683-701.

[24] Alberta Economic Dashboard, "Oil Prices," March 23, 2022, available at https://economicdashboard.alberta.ca/oilprice

[25] See, March 1-18 2022 daily prices from FRED, "Crude Oil Prices: West Texas Intermediate (WTI)," March 24, 2022, available at https://fred.stlouisfed.org/series/DCOILWTICO

mentioned Energy East, have caused the shipping outlook to deteriorate. In 2019, the Government of Alberta imposed quota reductions on producers because of insufficient pipeline capacity.[26] Furthermore, in parts of the world, Alberta bitumen is considered to be inferior from an environmental perspective because of its high carbon footprint.[27]

C. UNCERTAINTY IN ENERGY MARKETS[28]

31. Decarbonization of energy systems has been an objective advanced by many governments. Canada's initiatives have been both at the Federal and Provincial levels. Alberta brought in regulations on carbon emissions in 2007.[29] British Columbia introduced a carbon tax in 2008[30] and Ontario implemented aggressive electricity decarbonization programs beginning in 2009.[31] In 2018, the Federal Government passed the *Greenhouse Gas Pollution Pricing Act* which was contested by some provinces. In 2021, the Supreme Court of Canada upheld the constitutionality of the *Act*.[32]

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[26] While oil-by-rail remains an alternative, it is more expensive, putting further downward pressure on prices received by Alberta producers.

[27] BP, "BP Energy Outlook 2022," page 54, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2022.pdf.

[28] In his classic 1921 work *Risk, Uncertainty and Profit*, Frank Knight distinguished between risk and uncertainty. The former involves a circumstance where the specific outcome is not predictable, but the set of possible outcomes is known, along with the respective probabilities. For example, in flipping a fair coin, one does not know whether a head or a tail will appear, but one knows that the probability of each is 50%. Uncertainty, on the other hand, involves a circumstance where it is not possible to accurately assign probabilities to outcomes, and indeed the full range of outcomes may not even be known. An example of a major source of uncertainty facing hydrocarbon industries is technological innovation, i.e., even the range of technologies which may bring about decarbonization is not fully known, and the likelihood that one or another will reach a 'tipping point' is even more difficult to predict.

[29] The *Specified Gas Emitters Regulation* in 2007 was subsequently ramped up. In 2018, this program was replaced with *Carbon Competitiveness Incentive Regulation*, with immediate impacts on carbon intensity in the province. See, for example, Government of Alberta, "Carbon Competitiveness Incentive Regulation," 2022, available at https://www.alberta.ca/carbon-competitiveness-incentive-regulation.aspx

[30] Government of British Columbia, "British Columbia's Carbon Tax," available at https://www2.gov.bc.ca/gov/content/environment/climate-change/clean-economy/carbon-tax

[31] In 2009, the *Green Energy and Green Economy Act* accelerated the proliferation of renewable technologies. Coal was eliminated as a source of electricity generation by 2014. See, for example, Green Energy and Green Economy Act, 2009 (S.O. 2009, c. 12). Ontario Government, "The End of Coal," December 15, 2017, available at https://www.ontario.ca/page/end-coal

[32] Greenhouse Gas Pollution Pricing Act (S.C. 2018, c. 12, s. 186).

32. Globally, there has been wide variation in the adoption of decarbonization programs. Approximately 80% of energy worldwide comes from carbon sources (coal, oil and natural gas).[33] Although historic energy transitions have been relatively slow, the urgency of dealing with global warming is likely to result in a much more rapid transition. Accumulating data on the progression of global warming and better understanding of the interaction of various climate systems (such as temperature and precipitation and the severity of such events), have injected increased environmental uncertainty with respect to continued reliance on hydrocarbons in the absence of mitigating measures.[34,35] As discussed below, European decarbonization is likely to accelerate. Electricity storage[36] is key to enabling a 'tipping point' for renewable technologies such as wind and solar.

33. The on-going Russia-Ukraine conflict has driven geopolitical uncertainty to new heights with uncertainty cascading into global economies, commodities, food supplies and into energy markets. Geopolitically, the division between liberal democracies and autocracies is crystallizing and becoming more pronounced. NATO appears to be strengthening and there will likely be increased cohesion among liberal democracies. Russia and China have become more closely aligned, not just because of their autocratic nature, but because of Russia's oil and natural gas wealth and China's need for these resources.

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[33] BP, "BP Energy Outlook 2022," page 28, graph entitled "Fossil fuels, Share of primary energy", 2022, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2022.pdf.

[34] IPCC, "Climate Change 2022: Impacts, Adaptation and Vulnerability," March, 2022, available at https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii

[35] Carbon capture and storage, which is potentially promising, has made limited progress over the last 15 years, though recently there are renewed efforts in this direction. Methane pyrolysis, combined with renewable energy to produce hydrogen, has recently received increased attention. See, for example, IEA "A new era for CCUS," 2022, available at https://www.iea.org/reports/ccus-in-clean-energy-transitions/a-new-era-for-ccus. Pacific Northwest National Laboratory, "New Clean Energy Process Converts Methane to Hydrogen with Zero Carbon Dioxide Emissions", March 18, 2021, available at https://www.pnnl.gov/news-media/new-clean-energy-process-converts-methane-hydrogen-zero-carbon-dioxide-emissions

[36] Storage technologies include batteries, thermal, mechanical, pumped water and hydrogen storage. See, for example, Energy, Breakthrough (2019), *Advancing the Landscape of Clean Energy Innovation*.

34. Europe is heavily dependent on Russian natural gas and to a lesser degree oil. Presently, Europe imports about 40% of its natural gas from Russia and 25% of its oil.[37] In view of Russia's invasion of Ukraine, Europe has vowed to wean itself from this dependency. There are two primary mechanisms for accomplishing this objective.[38] The first is to purchase hydrocarbons from other exporters, the second is to decarbonize. With respect to the latter the European Commission has stated:

> "The new geopolitical and energy market reality requires us to drastically accelerate the clean energy transition and increase Europe's energy independence from unreliable suppliers and volatile fossil fuels. … Following the invasion of Ukraine, the case for a rapid clean energy transition has never been stronger and clearer."[39]

35. The global economy is also likely to be seriously affected by the invasion. There may be a slowing (or even reversal) of globalization and volumes of global trade, which have grown so rapidly in recent decades. This effect may be reinforced by the Covid-19 pandemic which alerted many countries to the precarious nature of supply chains spanning the globe.[40]

36. The impact on overall economic activity is unclear, though several post-WWII recessions have been preceded by an oil price shock.[41] Currently high oil prices may

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[37] European Commission, "REPowerEU: Joint European action for more affordable, secure and sustainable energy," March 8, 2022, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511

[38] A third possibility is the imposition of high taxes on Russian oil and gas. Ricardo Hausmann, "The Case for a Punitive Tax on Russian Oil," February 26, 2022, available at https://www.project-syndicate.org/commentary/case-for-punitive-tax-on-russian-oil-by-ricardo-hausmann-2022-02

[39] European Commission, "REPowerEU: Joint European action for more affordable, secure and sustainable energy," March 8, 2022, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511

[40] Willy C. Shih, "Global Supply Chains in a Post-Pandemic World," Harvard Business Review, September-October 2020, available at https://hbr.org/2020/09/global-supply-chains-in-a-post-pandemic-world

[41] Recessions beginning in December 1973, February 1980, August 1981 and August 1990 all followed major oil supply shocks. James D. Hamilton, "Sanctions, Energy Prices and the Global Economy," Princeton University Bendheim Center for Finance, March 17, 2022, available at https://bcf.princeton.edu/events/james-hamilton-on-sanctions-energy-prices-and-the-global-economy/, slide 15.

have this kind of adverse macroeconomic impact. Furthermore, stagflation is now seen to be a real risk.[42]

37. The oil price shocks of the 1970's were followed by a period of much lower prices in the 1980's as new sources of supply emerged.[43] While recent events may lead to an increase in production by OPEC which has spare capacity, or through expansion of fracking in the U.S., pipeline constraints may diminish any additional expansion in Alberta.

38. Prior to the recent events in Ukraine, four factors have had important impacts on Alberta oil and gas industries – the shale revolution, pipeline capacity, decarbonization pressures, and Covid-19.[44] Each of these contributed to the risks and uncertainties facing Alberta producers. Indeed, the shale revolution dramatically and unexpectedly also changed demand for Canadian natural gas.

39. In present circumstances, uncertainty in energy industries has risen to levels not seen in decades. Acceleration of decarbonization is likely, particularly in Europe, and could lead to a technological tipping point. In order to support energy security, global LNG trade will grow. Currently, Canada has neither the pipelines nor the export facilities to

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42 C. Giles and M. Arnold, "The Global Economy's Growing Risks: Stagflation, Refugees and Lockdowns," Financial Times, March 18, 2022, available at https://www.ft.com/content/0f7945f5-b269-4d13-9151-c1ac9ec6fddc

43 Oil prices roughly tripled between 1973 and 1974 and nearly doubled again between 1978 and 1979. BP, "BP Statistical Review of World Energy," (tab "Oil – Crude prices since 1861"), July 2021, available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/xlsx/energy-economics/statistical-review/bp-stats-review-2021-all-data.xlsx

44 For the importance of pipeline capacity, see, for example, Canada Energy Regulator, "Canada's Energy Future 2021," February 14, 2022, available at https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/results.html ("A key issue for Canada's energy system over the last number of years was the availability of crude oil export pipeline and rail capacity. This has implications for Canadian oil pricing and production trends."). For the decarbonation pressure, see, for example, Government of Canada, "Net-Zero Emissions by 2050," January 31,2022, available at https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html ("The transition to a cleaner, prosperous economy needs to be both an immediate priority and a sustained effort over the years and decades ahead. Canada must keep innovating to meet this long-term goal, strengthening and building on existing measures that fight climate change and transform the economy."). For the effect of Covid 19, see, for example, Canada Energy Regulator "Energy Supply and Demand in a Pandemic: Effects of COVID-19," January 26, 2022, available at https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/covid/index.html ("The impact on Canada has been significant.")

directly participate in this trade. Regulatory and political uncertainty will continue to surround the possibility of expansion in this dimension.[45]

40. The sources of uncertainty facing Canada's energy industries are multi-dimensional: geopolitical, environmental, technological, economic and regulatory/political.[46] Russia's attack on Ukraine has increased the potential for geopolitical instability to levels not seen in decades and may lead to a changed world political order and to a new world energy order.[47] All of these have dramatically elevated challenges to hydrocarbon industries in Alberta, potentially increasing the rationale for consolidations.

D. EMPIRICAL ANALYSIS OF DEMAND ELASTICITY

41. An empirical analysis of the Waste Services industry in the Western Canadian Sedimentary Basin (WCSB) requires an understanding of these global, national and provincial factors. Estimation of the responsiveness of demand for these services to price – i.e., the demand elasticity -- is not amenable to simple correlation analysis. Careful parsing of the data, however, can inform one's understanding and provide estimates of this elasticity.

42. My empirical approach is defined by three questions:

a. Do Waste Services prices affect Alberta oil and gas production?

b. Are Waste Services prices a causal factor determining Waste Services quantities?

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[45] The liquefaction terminal at Kitimat BC and the Coastal Gaslink Pipeline which would supply it with natural gas remain to be completed. Brent Jang, "LNG Canada terminal in British Columbia enters peak construction phase," *Globe and Mail*, March 15, 2022, available at https://www.theglobeandmail.com/business/article-lng-canada-terminal-in-british-columbia-enters-peak-construction-phase/

[46] See, for example, Canada Energy Regulator, "Canada's Energy Future 2021," February 14, 2022, available at https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/results.html

[47] See, for example, IEA, "Russia's War on Ukraine: Analyzing the Impacts of Russia's invasion of Ukraine on Global Energy Markets," available at https://www.iea.org/topics/russia-s-war-on-ukraine

c. Do price and quantity data on Waste Services permit direct estimation of the demand elasticity for Waste Services and if so, what is the estimated range for the elasticity?

43. [redacted]

[redacted]

44. [redacted]

[48] Technical details are in Exhibit B.

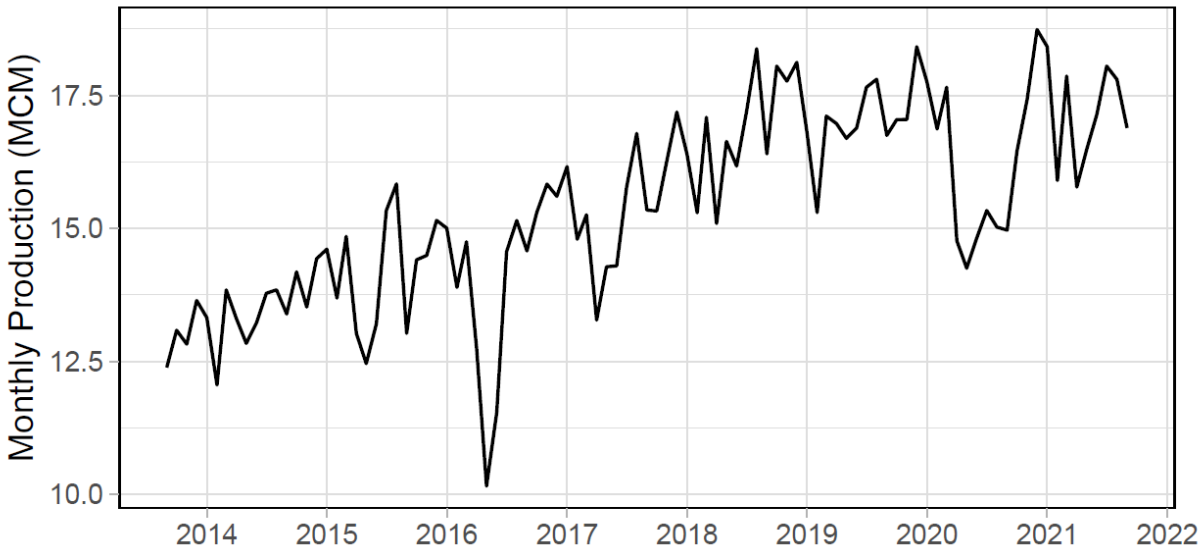
[redacted]

E.1 Analysis of Provincial Production of Oil and Gas

45. Figure 6 illustrates total Alberta oil production from late 2013 through 2021.[49] There is a clear upward trend until 2019. (The steep plunge in production in May and June 2016 is due to the Fort McMurray wildfires.) Month-to-month volatility is high, and there are also seasonal effects. During 2019, pipeline constraints led the Alberta Government to impose production quotas, with a consequent flattening of production. Depressed levels of production over the period April through September 2020 were the result of the Covid-19 pandemic and a brief price war between Saudi Arabia and Russia.

[49] [redacted]

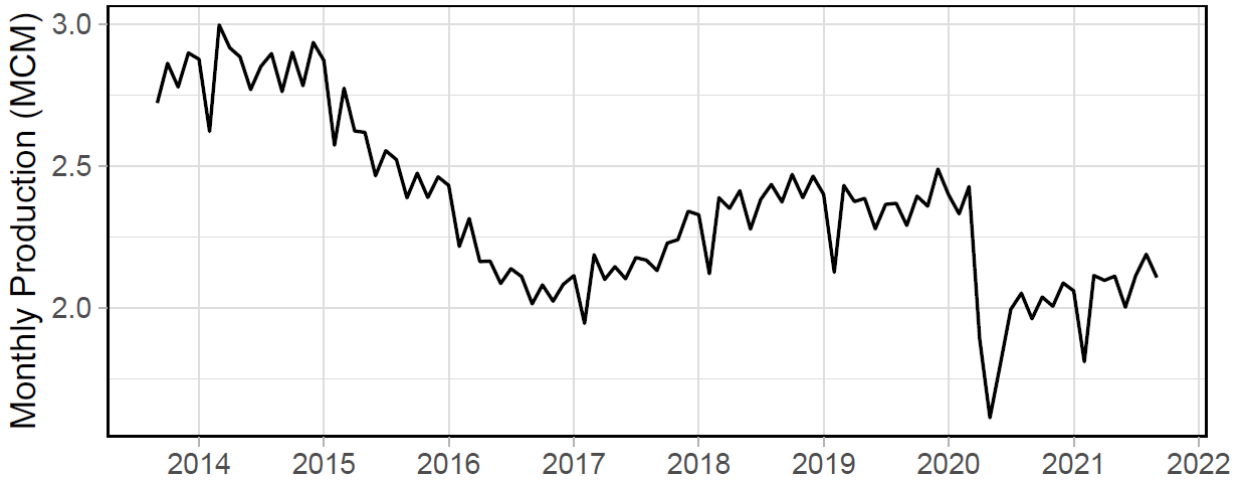
Figure 6: Total Oil Production
Alberta



46. To determine whether prices of Waste Services affect oil production I estimate a model which relates current production to the previous month's production, a trend variable, oil prices and the Waste Services price index. If the price of Waste Services were an important determinant of oil production and therefore the production of waste, then one would expect a statistically significant effect. Put another way, a statistically significant negative elasticity would suggest that increased Waste Services prices lead to reductions in oil output and therefore reduced demand for Waste Services. If this hypothesis were to hold, an increase in Waste Services prices would impact costs adversely and materially, and influence output levels. [redacted]

47. Figure 7 displays Alberta conventional oil production. [redacted] During the period 2014-2016, production declines substantially, recovers from 2017 through 2019, and then drops dramatically in early 2020.

Figure 7: Conventional Oil Production
Alberta



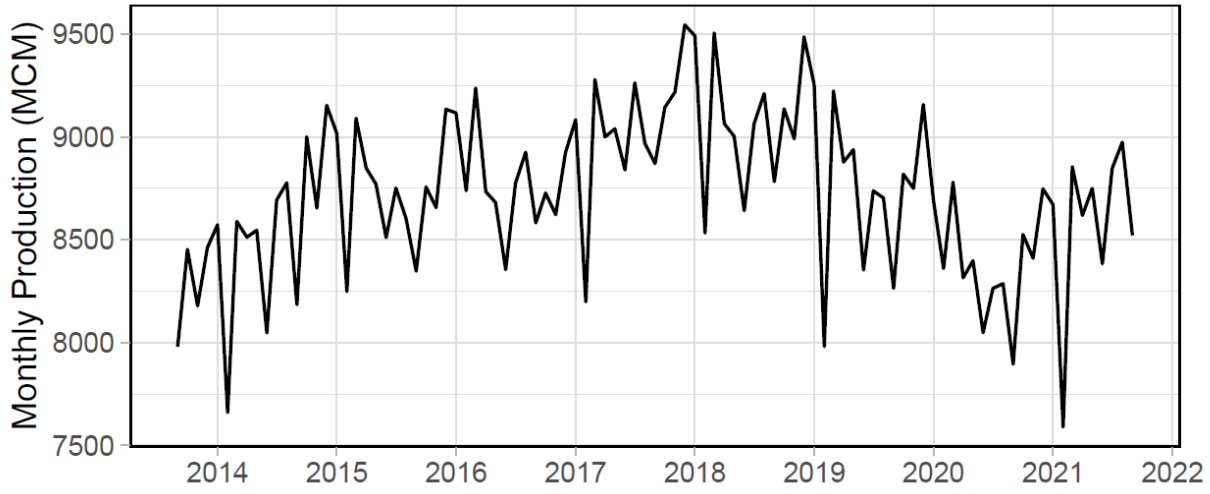
Notes:
[1] Conventional Oil Production excludes oil sands production.
[2] Production is measured in MCM, million cubic meters.
Sources:
[a] AER oil production data

48. [redacted][50]

49. Figure 8 illustrates natural gas production in Alberta. There is considerable month-to-month volatility as well as a Covid effect in 2020. Production exhibits an upward trend from 2014 to 2018, then appears to trend downward in subsequent years.

[50] [redacted]

Figure 8: Natural Gas Production
Alberta



Notes:
[1] Production is measured in MCM, million cubic meters.
Sources:
[a] Alberta Economic Dashboard natural gas production data

50. [redacted]

E.2 Causality Analysis

51. Nobel Prize recipient Clive Granger pioneered a methodology which permits identification of factors that have a causal effect on future outcomes.[51] The underlying idea is that effects are temporally preceded by causes. For example, if oil price shocks are typically followed by macroeconomic downturns, then oil prices constitute a causal factor in determining economic activity. Significant causal variables should therefore

[51] See, for example, James Hamilton (1994), *Time Series Analysis*, (Princeton University Press), page 303.

have a statistically discernible impact on the future values of variables that they influence.

52. In the current setting, the objective is to determine which variables have an impact on Waste Services quantities. Possible influences on current quantities include past oil and natural gas prices, past Waste Services quantities, and past Waste Services prices. If higher past Waste Services prices have a material negative impact on Waste Services quantities, then this could constitute evidence of a negative price elasticity.

53. [redacted]

54. [redacted]

55. [redacted][53]

E.3 Demand Analysis

56. Direct estimation of the demand elasticity using price and quantity data requires separating demand and supply effects because both can simultaneously influence market outcomes. In other words, to estimate how the quantity of Waste Services demanded changes with price, the model must control for changes to supply conditions so that estimation isolates "demand side" influences from other factors. This type of 'structural' econometric analysis is common.[54]

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[52] See, for example, Energy Job Shop, "What Is Spring Break-Up & What Does It Mean For Oilfield Workers?", available at https://www.energyjobshop.com/articles/what-is-spring-break-up-what-does-it-mean-for-oilfield-workers

[53] Modeling details may be found in Exhibit C.

[54] See, for example, William H. Greene (2012), *Econometric Analysis*, 7th edition, (Pearson), Chapter 10.

57. In the present circumstances, controlling for supply side influences is complicated by the changing economic and policy environment, and by global, national and provincial factors described above. Data from year to year, and even month to month, are not directly comparable without taking these external influences into account.

58. I estimate a model which controls for the joint determination of prices and quantities using standard techniques. The procedure requires two stages. In the first stage, the price variable is related to various factors that may affect costs of supplying Waste Services. A predicted price is obtained from this stage and inserted in the second stage which directly estimates the demand elasticity.

59. [redacted][55]

60. [redacted][56]

61. [redacted]

E.4 Additional Reasons Supporting a Low Elasticity of Demand

62. There are additional reasons that are indicative of a low price elasticity of demand. First, the costs of Waste Services comprise a small fraction of industry costs, with little if any material impact on industry activity and therefore on the demand for Waste Services. [redacted]

[55] Details of the econometric analyses are in Exhibit D: Models and Empirical Results, Section III. Demand Analysis, Table D.5.

[56] Details of the econometric analyses are in Exhibit E: Models and Empirical Results by Service Group, Tables E.2, E.4 and E.6.

[redacted]

63. Second, the above statistical elasticity estimates are based on firm-specific data and are therefore best interpreted as firm-specific elasticities. Economic theory strongly suggests that market demand is significantly less elastic than demand for an individual firm's product. lower than a firm-specific elasticity. This is because the alternatives available to a purchaser of these services when a firm increases its prices are generally broader than if the market price increases by the same amount.[57]

64. [redacted]

E. ANALYSIS OF THE MILLER REPORT

65. Dr. Miller does not provide empirical estimates of the demand elasticity stating that he "is not aware of data or elasticity estimates" that would allow him to fully quantify the deadweight loss (DWL).[58] Instead, he has relied on an analysis conducted by Dr. Henry J. Kahwaty, the CCS Corporation's expert witness in Commissioner of Competition v. CCS Corporation et al. Dr. Miller took four numbers from this earlier matter: the volume in 2010 at the Babkirk landfill of 77,820 tons, a projected incremental volume of 14,000 tons ("market expansion" in Dr. Miller's backup material), the average price of $28.37 in 2010 at the same location, and an estimated reduction in transportation

[57] Formal economic modeling yields this type of conclusion under various assumptions. For example, in a standard Cournot competition where firms produce a homogenous goods, have constant marginal cost, and compete on quantities, economic theory implies that the market elasticity is equal to the firm elasticity multiplied by the Herfindahl-Hirschman index (HHI) which measures the degree of concentration in an industry. The HHI is always less than or equal to 1. See, for example, Jeffrey Church and Roger Ware (1999) *Industrial Organization: A Strategic Approach*, (McGraw-Hill), page 239, (8.17). In a model with a dominant firm and a competitive fringe, the demand elasticity faced by the dominant firm is also higher than the market demand. See, for example, Jeffrey Church and Roger Ware (1999) *Industrial Organization: A Strategic Approach*, (McGraw-Hill), page 126. ("The presence of a competitive fringe increases the elasticity of the dominant firm's demand relative to a monopolist…")

[58] Miller Report, ¶163.

costs of $5.84. Dr. Miller reports an elasticity of -0.87 based on the assumption that the projected incremental volume of 14,000 tons is due to the 5.84 cost reduction alone.[59]

66. Dr. Miller's -0.87 is unreliable for several reasons and in my opinion significantly overstates the true elasticity.

67. First, Dr. Kahwaty's analysis, which forms the basis of Dr. Miller's value of -0.87, was conducted over a decade ago. It was based on a single financial projection at a single landfill (Babkirk).

68. Second, a closer examination of the underlying financial projection strongly suggests that the incremental volume of 14,000 tons is not due to cost reduction alone. Leading up to the projected 14,000 tons, the document indicates that the location in question has been seeing "very large crown land sales since 2007 and the start of increased drilling."[60] Therefore, there are reasons to believe that the projected 14,000 tons may have factored into the increased drilling even without any cost changes on the part of the customers. Notably, Dr. Miller did not explain why 14,000 is the appropriate number to use, and in fact did not even cite to this financial projection document in his report.

69. Third, in his evidence, Dr. Miller refers to a range of -0.20 to -0.87 but he does not provide, nor purport to provide any analysis which would support this range. As my multi-prong analyses demonstrate, there is a considerable body of empirical and economic evidence to support my conclusion that the elasticity is much lower. My opinion is that the elasticity is in a range from close to zero to -0.25.

70. Dr. Miller has also argued, on theoretical grounds that, "The second source of DWL may come from oil and gas producers choosing to drill fewer wells and thus producing less waste…. Economically, wells that are minimally profitable – the "marginal wells" – are less likely to be drilled when any part of the costs increase. "[61] Dr. Miller did not provide any empirical or documentary support. Indeed, Dr. Miller admitted that he is "not aware

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59 $-0.87 = \frac{14{,}000}{77{,}820} / \frac{-5.84}{28.37}$.

60 Babkirk Proposed Landfill Financial Analysis, 31 March 2010, CCS012737.00I.

61 Miller Report, ¶164. Dr. Miller's illustrative depiction in Exhibit 26, ¶160 of market demand for waste services suggests a high elasticity of response and a large quantity effect, without any supporting evidence.

of data or estimates" that would allow him to quantify this DWL. Instead, he based this hypothesis on the observation that "drilling activity is responsive to changes in oil prices" and that "since costs and prices both affect profits from drilling activity, economics suggests that cost increase will also impact the number of wells drilled."[62] Again, he failed to recognize the small share that disposal costs represent as a proportion of costs (less than 5% based on the evidence I have reviewed).

71. Moreover, the decision to drill is fraught with uncertainties, among these are the price of oil, the productivity of the site and cost uncertainties.[63] While some of these may be hedged, the likelihood that a price-certain cost component comprising less than 5% of costs is a significant decision factor is unlikely. There is no statistical evidence that Waste Service prices have had any material impact on oil or gas extraction, even for marginal suppliers.

Adonis Yatchew, Ph.D.
March 25, 2022

62 *Ibid*.

63 This is a stochastic decision problem. That is, the decision process not only incorporates projections of relevant variables, but also the uncertainties associated with them.

Exhibit A: Curriculum Vitae

ADONIS YATCHEW

Professor of Economics, University of Toronto
Editor-in-Chief, The Energy Journal
Senior Consultant, Charles River Associates

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150 St. George Street, Toronto, Canada M5S 3G7
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Ph.D. Economics 1980
Harvard University

M.A. Economics 1975
University of Toronto

B.A. Mathematics and
Economics 1974
University of Toronto

Adonis Yatchew's research focuses on energy, regulation and econometrics. Since completing his Ph.D. at Harvard University, he has taught at the University of Toronto. He has also held visiting appointments at Trinity College, Cambridge University and the University of Chicago, among others. He has written a graduate level text on semiparametric regression techniques published by Cambridge University Press. He has served in various editorial capacities at The Energy Journal since 1995 and is currently the Editor-in-Chief. He has advised regulators, public and private sector companies on energy, regulatory and other matters for over 35 years and has provided testimony in numerous regulatory and litigation procedures. He currently teaches PhD. level courses in econometrics, and M.A. and undergraduate level courses on energy in the University of Toronto Department of Economics and our School of Environment. The energy courses are interdisciplinary, spanning economics, the environmental and sustainability, politics, geopolitics and security. He has also taught short courses covering these areas at international conferences.

ACADEMIC EXPERIENCE

Current Position	Professor of Economics, University of Toronto
2008	Visiting academic, Department of Mathematics and Statistics, University of Melbourne
2008	Visiting academic, School of Economics and Finance, Queensland University of Technology
2008	Visitor, National Center for Econometric Research, Queensland University of Technology
2005	Visiting Fellow, ARC Center of Excellence for Mathematics and Statistics of Complex Systems, Mathematical Sciences Institute, Australian National University
2001	Visiting Fellow, School of Mathematical Sciences, Australian National University
1986 to 2004	Associate Professor, Economics, University of Toronto
1989, 1990, 1991	Visiting Research Associate, Harvard University

1986	Visiting Fellow Commoner, Trinity College, Cambridge U.K.
1980 to 1986	Assistant Professor, Economics, University of Toronto
1984	Visiting Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts
1982 to 1984	Visiting Assistant Professor, University of Chicago
1976	Lecturer, University of Toronto, Scarborough College

EDITORIAL AND PROFESSIONAL ACTIVITIES

Current
Editor-in-Chief, The Energy Journal (2006-present) http://www.iaee.org/en/publications/journal.aspx
Member, Board of Editors, Economics of Energy and Environmental Policy
Member, Editorial Board, Foundations and Trends in Econometrics
Member, Council, International Association for Energy Economics
Member, National Center for Econometric Research, Econometrics of Energy and the Environment, Australia

Past
Editor, The Energy Journal, (2006)
Joint Editor, The Energy Journal (1995-2005)
Associate Chair for Graduate Studies, University of Toronto, 2006-2009
Advisory Editor, Economics Letters (1985-1997)
Member, Advisory Board, *Eurasia Foundation*, 1995-2007

AWARDS AND DISTINCTIONS

Award for Outstanding Contributions to the Profession, International Association for Energy Economics, http://www.iaee.org/en/inside/award-profession.aspx, June 2018.

Senior Fellow Award, US Association for Energy Economics, https://www.usaee.org/awards.aspx, June 2014.

SAC APUS Teaching Award for the Social Sciences 1987, University of Toronto

SELECTED PRESENTATIONS

2020, Auckland, Pre-Conference Workshop, "Ten Big Ideas in Energy: What Everyone Needs to Know", International Association for Energy Economics.

2019, Buenos Aires, Invited Plenary Lecture, Latin American Energy Economics Conference, "Fake News, Big Ideas – What Everyone Needs to Know About Energy".

2018, Waterloo Institute for Sustainable Energy Public Lecture Series, University of Waterloo, "Energy: Ten Big Ideas on Energy (What Everyone Needs to Know)"

2016, Montebello Quebec: presentation entitled "Rational Carbon Policy and Regulation", Canadian Energy Law Forum.

2016, Paris: Keynote Address "Subsidiarity and Separation", 4th International Symposium on Energy and Finance Issues.

2015, Panelist, "Outlook on Oil", University of Toronto Energy Network, University of Toronto.

2015, Milan: "Discerning Trends in Commodity Prices", Invited presentation, Fondazione Eni Enrico Mattei, International Workshop on Recent Evolutions of Oil and Commodity prices.

April 2015, Bank of Canada, Workshop on Commodity Super-Cycles, "Discerning Trends in Commodity Prices.

2014, Beijing: Keynote address entitled "The Economics of Energy, Big Ideas for the Non-Economist", Chinese Academy of Sciences, International Association for Energy Economics 4th IAEE Asian Conference.

2014, Hong Kong: Invited presentation entitled "Renewable Energy", Hong Kong's Electricity Future: Balancing Reliability, Environment and Cost, Hong Kong Baptist University.
July 2012, Hong Kong: Invited Speaker on "Climate Change and Electricity Generation", Hong Kong Baptist University.

2010, Hong Kong: Invited paper on renewable energy, Fourth Asian Energy Conference.

2010, Berlin: Invited paper on quantile regression, Workshop on Quantile Regression Methods, Humboldt University.

2008, Gold Coast, Queensland: Keynote speaker, Australian Conference of Economists. Title of presentation: "Economics, Econometrics and Regulation".

2007, Lisbon: Keynote speaker, Cemapre Conference on Advances in Semiparametric Methods and Applications. Title of presentation: "Data on Derivatives, Nonparametric Regression and the Curse of Dimensionality".

BOOKS, EDITED VOLUMES

Yatchew, A., 2003, Semiparametric Regression for the Applied Econometrician, 213 pages, Themes in Modern Econometrics, Cambridge University Press.

Chinese Energy Economics, Special Issue of The Energy Journal, Edited by Ying Fan and Adonis Yatchew, 2016.

Distributed Resources: Toward A New Paradigm ff The Electricity Business, Special Issue of The Energy Journal, Edited by Yves Smeers and Adonis Yatchew, 1997.

REFEREED PUBLICATIONS

Olmstead, D.E.H. and A. Yatchew, 2022, "Carbon Pricing and Alberta's Energy-Only Electricity Market", forthcoming, Electricity Journal.

Yatchew, A. 2019, "How Scalability is Transforming Energy Industries" Energy Regulation Quarterly, 7:2, 35-44.

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Y.S. Cheng, K.H. Cao, C.K. Woo and A. Yatchew 2017, "Residential willingness to pay for deep decarbonization of electricity supply: Contingent valuation evidence from Hong Kong", Energy Policy 109, 218–227.

Dimitropoulos, D. and A. Yatchew 2017, "Is Productivity Growth in Electricity Distribution Negative? An Empirical Analysis Using Ontario Data", The Energy Journal, 38:2,175-200.

Rivard, B. and A. Yatchew 2016, "Integration of Renewables into the Ontario Electricity System", The Energy Journal, vol. 37, Special Issue 2, 221-242.

Yatchew, A. 2016, "Rational vs. 'Feel-Good' Carbon Policy – Transferability, Subsidiarity and Separation" Energy Regulation Quarterly, 4:3, 31-40.
Available at http://www.energyregulationquarterly.ca/articles/rational-vs-feel-good-carbon-policy-transferability-subsidiarity-and-separation#sthash.u6jtvAJI.dpbs.

John Colton, Kenneth Corscadden, Stewart Fast, Monica Gattinger, Joel Gehman, Martha Hall Findlay, Dylan Morgan, Judith Sayers, Jennifer Winter, Adonis Yatchew 2016, Energy Projects, Public Acceptance and Regulatory Systems in Canada: A White Paper

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http://english.cas.cn/bcas/2014_4/201411/P020141121529033572162.pdf

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Green, R. and A. Yatchew 2012:"Support Schemes for Renewable Energy: An Economic Analysis", Economics of Energy & Environmental Policy, 1, 83-98.

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Hall, Peter and A. Yatchew 2010: "Nonparametric Least Squares in Derivative Families", Journal of Econometrics, 157, 362-374.

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Epstein, L., and A. Yatchew, 1985, "The Empirical Determination of Technology and Expectations: A Simplified Procedure:, Journal of Econometrics, Vol. 27, 235-258.

Bird, R., M. Bucovetsky and A. Yatchew, 1985, "Tax Incentives for Film Production: The Canadian Experience", Public Finance Quarterly, Vol. 13, 396-421.

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Yatchew, A., 1981, "Further Evidence on 'Estimation of a Disequilibrium Aggregate Labor Market"', Review of Economics and Statistics, 142-144.

Griliches, Z. and A. Yatchew, 1981, “Sample Selection Bias and Endogeneity in the Estimation of the Wage Equation: An Alternative Specification, Annales de l’Insee, 43, 35-46.

Pesando, J., and Yatchew, A., 1977, "Real vs. Nominal Interest Rates and the Demand for Consumer Durables in Canada", Journal of Money, Credit, and Banking, 28-436.

OTHER PAPERS / STUDIES

Yatchew, A. 1995, "The Distribution of Electricity on Ontario: Restructuring Issues, Costs and Regulation", Ontario Hydro at the Millennium, University of Toronto Press, 327-342,353-354.

Yatchew, A. 1995, "Comments on The Regulation of Trade in Electricity: A Canadian Perspective", Ontario Hydro at the Millennium, University of Toronto Press, 165-7.

Yatchew, A., 1999, "Differencing Methods in Nonparametric Regression: Simple Techniques for the Applied Econometrician", 86 manuscript pages.

Yatchew, A. 2001: "Incentive Regulation of Distributing Utilities Using Yardstick Competition", Electricity Journal, Jan/Feb, 56-60.

Littlechild, Stephen and A. Yatchew, 2002: "Hydro One Transmission and Distribution: Should They Remain Combined or be Separated", www.chass.utoronto.ca/~yatchew .

CURRENT AND RECENT SUPERVISIONS

Ph.D.

Joseph Groga Bada (2021 to present): Essays in Productivity Analysis, Thesis Supervisor, Economics Department, University of Toronto.

Dhruv Sinha (completed 2021): Essays in Energy, Thesis Supervisor, Economics Department, University of Toronto.

Alexander H. Hay OBE (completed 2019) Post-Conflict Infrastructure Rehabilitation, Thesis committee member, School of Engineering, University of Toronto.

Dimitrios Dimitropoulos (completed 2015): Three Essays in Energy Economics and Industrial Organization, Thesis Supervisor, Economics Department, University of Toronto.

Adam Found (completed 2014): Essays in Municipal Finance, Thesis Supervisor, Economics Department, University of Toronto.

M.A.

Daniel Edgel (2017-2018): Fulbright Scholar, M.A. Economics

Nathan Warkentin (2015-2016): Master of Science in Sustainability Management. "Integration of Renewable Wind Energy Sources in Ontario"

Sean Lemon (2013): M.Sc.Pl., Planning Program, Geography. An Evaluation of Ontario's Global Adjustment Mechanism (GAM). Thesis Committee.

Undergraduate

Wei, Max (2016-2017) Engineering Science. Undergraduate thesis: "Wind Energy Intermittency, Diversity and Interconnections in Ontario". Thesis Supervisor.

Shaker, Youssef (2016-2017) Engineering Science. Undergraduate thesis: "Analyzing the Effectiveness of Conservation Programs in Ontario". Thesis Supervisor.

Wilbur Li, (2012) Engineering Science. Undergraduate thesis: "Ontario's Feed-In-Tariff Program. Analysis of PV Solar Feed-In-Tariff Rates". Thesis Supervisor.

SELECTED EXPERT EVIDENCE:

(2020-2021) Prepared testimony in litigation on allocation of electricity costs in Ontario.

(2020) Prepared statistical analysis of competitiveness in refined product markets for a major hydrocarbon industry merger.

(2018-2020) Prepared analyses and testified in proceedings for the *Alberta Market Surveillance Administrator*.

(2019) Prepared statistical analyses on competitiveness in retail wireless services for *Bell Canada*.

(2018) Prepared statistical analyses in the T-Mobile / Sprint merger proceedings.

(2017-18) Independent Expert Consultant to the *Manitoba Public Utilities Board*, prepared report and testified on the Manitoba Hydro General Rate Application

(2017) Prepared expert testimony on regulatory costing of railway transportation services, filed before the *Canadian Transportation Agency*.

(2017) Prepared analyses on the degree of integration of natural gas hub prices in a major North American acquisition of pipeline and storage facilities (*Enbridge, Union/Spectra*).

(2016) Prepared analyses on price determination in West Coast gasoline and diesel markets as part of an asset acquisition evaluation.

(2016) Prepared statistical analyses of market power in the acquisition of *MTS* by *Bell Canada*.

(2016) Testified before the *Ontario Energy Board* on behalf of EPCOR Utilities Inc. in a proceeding relating to natural gas expansion in Ontario, EB-2016-04.

(2016) Conducted 'extent of the market' and market power analyses for a major hydrocarbon company seeking to acquire additional refining capacity.

(2015) Conducted analyses of utility benchmarking for a large electricity distributor as part of a regulatory rate proceeding before the *Ontario Energy Board*.

(2015) Co-authored study of integration of renewables for the *Alberta Market Surveillance Administrator*.

(2014) Conducted econometrics analyses of spot and forward prices in Alberta electricity markets in a major electricity acquisition evaluation.

(2013) Testified before the *Ontario Energy Board* on behalf of the Electricity Distributors Association on electricity rates and incentive regulation.

(2012) Prepared expert damages testimony in *Oracle America Inc. v. Micron Technology, Inc., U.S. District Court, Northern District of California, Oakland Division*.

(2011) Coauthored study for the *Alberta Market Surveillance Administrator* on electricity market transparency and bidding.

(2011) Prepared Ontario electricity sector review for the Electricity Distributors Association.

(2011) Appointed sole representative of a major Canadian electrical utility in infrastructure pricing negotiations with an incumbent telecom carrier.

(2011) Prepared testimony on behalf of Toronto Hydro on the pricing of attachment space for wireless facilities on joint-use-poles, filed before the *Ontario Energy Board*.

(2010) Prepared testimony on behalf of Noranda Aluminum, Inc. Filed before the *Public Service Commission of the State of Missouri*.

(2009) Prepared study for major generating company on sufficient competition tests for boundary entities in the Ontario electricity market.

(2009) Prepared testimony on worldwide paraxylene markets *Interquisa Canada L.P. and Parachem Chemicals L.P.*, International Court of Arbitration of the International Chamber of Commerce.

(2008) Prepared analysis of incentive regulation of capital and operating costs and productivity growth for electricity distributors. Filed before the *Ontario Energy Board*.

(2007) Prepared analysis of distributor benchmarking of capital and operating costs on behalf of the Electricity Distributors Association. Filed before the *Ontario Energy Board*.

(2007) Prepared evidence on market power in Ontario electricity markets.
(2005-2007) Prepared analyses of pricing of investor communications services.

(2007) Prepared testimony on behalf of the Electricity Distributors Association on utility benchmarking of capital and operating costs. Filed before the Ontario Energy Board.

(2004-2007) Prepared various analyses in a class action and settlement proceeding involving billing of natural gas. Participated in settlement proceedings.

(2004, 2005, 2006) Prepared odds of winning prizes in promotions by a leading U.S.-based international fast-food chain.

(2006) Prepared testimony on incentive regulation. Filed before the *Ontario Energy Board*.

(2006) Prepared testimony on cost-sharing of capital and operating costs of joint-use power poles. Filed before the *New Brunswick Board of Commissioners of Public Utilities.*

(2005) Prepared testimony on cost-sharing of power poles by cable companies on behalf of Thunder Bay Hydro.

(2004) Prepared testimony on cost-sharing of capital costs of power poles by cable companies. Filed before the *Ontario Energy Board*.

(2003) Prepared testimony on behalf of large Ontario electricity distributors on distributor service area amendments. Filed before the *Ontario Energy Board*.

(2003) Prepared testimony on behalf of J.D. Irving Ltd. on rates of return, performance-based regulation and benchmarking. Filed before the *New Brunswick Board of Commissioners of Public Utilities*.

(1982-1994) Participated in numerous Ontario Hydro rate hearings before the *Ontario Energy Board* on behalf of Ontario electricity distributors.

(1989-1991) Filed testimony before the *Ontario Environmental Assessment Board* in connection with the Ontario Hydro long-term demand supply plan.

Exhibit B: Data Aggregation Methodology

1. My empirical analyses use aggregated price and quantity indices. I constructed a standard Fisher Index using company transaction data across facilities and service types. The Fisher index has a lengthy history and is widely used in academic research and by government statistical agencies including Statistics Canada.[64] It is also known as the Fisher Ideal Index and is known to have a number of desirable properties.[65]

2. Its main advantage over other price indices such as simple or weighted average price is that it accounts for changes in the composition of the product over time. To illustrate, suppose there are two products, A and B, and that there are two time periods. In both periods, A is priced at $4 and B at $10. In period one, 1 unit of product A and 2 units of product B are sold. As a result, the weighted average price index in period 1 would be given by $\frac{1\times\$4+2\times\$10}{1+2}=8$. In period two, suppose 2 units of product A and 1 unit of product B are sold. The weighted average price index in period 2 would be equal to $\frac{2\times\$4+1\times\$10}{1+2}=6$. This would imply a 25% price drop between periods 1 and 2, even though the prices of each product are constant. The weighted price index reflects this composition change over time but fails to capture the true underlying price changes. The Fisher index corrects for this distortion.

3. I have used the fixed-base Fisher Index, constructed as follows. For the first period, $F_1 = 1$ after which $F_t = \sqrt{Lasp_t \times Paas_t}$ for $t = 2, \ldots, T$. The terms in this formula are defined as follows:

$$Lasp_t = \frac{\sum_i p_t^i \times q_1^i}{\sum_i p_1^i \times q_1^i}$$

[64] Irving Fisher (1922), *The Making of Index Numbers*, (Houghton Mifflin Company). For example, a monthly commodity price index published by Statistics Canada is an example of a Fisher index, see https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1010013201.

[65] DW. Erwin (1992), "Fisher ideal output, input, and productivity indexes revisited," *Journal of Productivity Analysis*, 3.3: 211-248.

$$Paas_t = \frac{\sum_i p_t^i \times q_t^i}{\sum_i p_1^i \times q_t^i}.$$

where p_t^i and q_t^i are the price and quantity of product i in month t and p_1^i and q_1^i are the price and quantity of product i in the first, i.e., base period. The Fisher Quantity Index is defined analogously.

4. In circumstances when a facility-service product has a gap of up to 12 months, observations are imputed with zero quantity and the last available price. This ensures that quantity decreases resulting in zero sales are captured in the quantity index.

Exhibit C: Description of Data

1. [redacted]

2. [redacted]

3. [redacted]

4. [redacted]

5. [redacted]

Exhibit D: Models and Empirical Results

I. Analysis of Provincial Production of Oil and Gas

1. To estimate the effects of third party Waste Services prices on Alberta oil and gas production, I performed a standard regression analysis using the equation:

$$Q_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 Q_{t-1} + \gamma X_t' + \epsilon_t \quad (1)$$

where:

- Q_t and Q_{t-1} are total Alberta oil production in the present month and previous month;
- P_{t-1} is the Waste Services price in the previous month;
- X_t is a vector of control variables such as
    - West Texas Intermediate (WTI) crude oil prices,
    - time trend;
- $\beta_0, \beta_1, \beta_0$ and γ are unknown parameters to be estimated by the statistical procedure;
- ϵ_t is the statistical disturbance term, capturing other idiosyncratic factors that affect measured levels of production.

All variables, except for time trend are in logarithmic form.

2. [redacted]

3. [redacted]

[redacted]

4. [redacted]

[redacted]

II. Causality Analysis

5. [redacted]

6. [redacted].[66]

7. The regression model that forms the basis of my Granger Causality analysis has the following standard specification:

$$Q_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 Q_{t-1} + \gamma_2 X_t + \epsilon_i \qquad (2)$$

where:

- Q_t and Q_{t-1} are Waste Services volumes in the current and preceding month as measured by the quantity index;
- P_{t-1} is the Waste Services price index in the previous month;[67]
- X_t is a vector of control variables including:
  - an indicator variable which is 1 for the period 2016 to 2021 and zero otherwise; it reflects the structural change in oil industries that began in mid-2014;
  - an indicator variable to capture the decrease in waste deliveries in April and May as a result of the regular spring road closures in Alberta;[68]
- $\beta_0, \beta_1, \beta_2$ and γ are unknown parameters to be estimated by the statistical procedure;
- ϵ_t is the statistical disturbance term.

8. [redacted]

[66] Granger Causality is a standard econometric concept pioneered by Nobel Prize winning econometrician Clive Granger. See, for example, James D. Hamilton (1994), *Time Series Analysis*, (Princeton University Press), page 303.

[67] Third party Waste Services prices are captured using a price index across Tervita's facilities and services. This is described in more detail in Exhibit B

[68] Additional details on seasonal road restriction are provided on the Alberta government website. Government of Alberta, "Road restrictions and bans – Overview," available at https://www.alberta.ca/road-restrictions-and-bans-overview.aspx

[redacted]

[redacted]

[redacted]

III. Demand Analysis

9. [redacted]

10. [redacted].

11. The econometric model has the following standard structure:

$$Q_t = \beta_0 + \beta_1 P_t + \beta_2 X_t' + \epsilon_t \qquad (4)$$

The coefficient β_1 is the measure of the demand elasticity; X_t consists of indicator variables for the post-2015 period and a seasonal effect.

12. An important difference between this model and the models above is that the price variable P_t is contemporaneous with the quantity variable Q_t. Because prices and quantities in the same month are determined simultaneously by supply and demand, the variable P_t is "endogenous" and standard OLS technique could lead to biases in estimating the price elasticity β_1. To resolve these issues, I adopted a standard approach known as the instrumental variable methodology.[70]

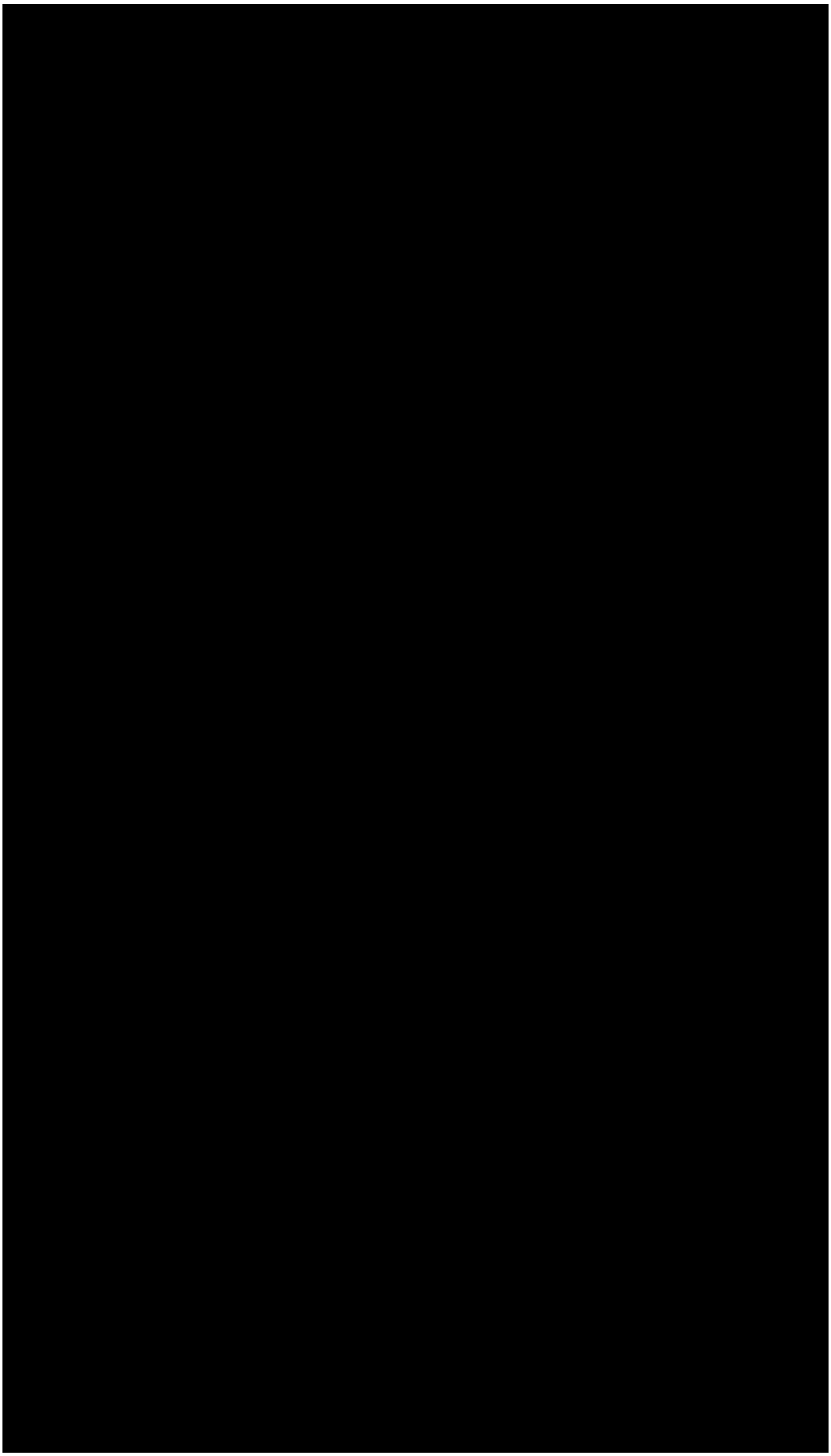
13. A key step in an application of this methodology is to identify a set of economic factors known as instrumental variables. These instrumental variables should influence prices through the supply side but not through demand. Commonly used variables in this type of setting are cost factors.[71] Specifically, I considered the following:

- oil and gas capital expenditure in Canada;
- construction cost price index in Alberta;
- oil and gas wage index in Alberta;
- equipment rental price index in Canada;
- transportation cost index in Alberta;

[69] This is because the alternatives available to the purchaser when a firm increases its prices are generally broader than if all suppliers raise their price by the same amount.
[70] See, William H. Greene (2012), *Econometric Analysis*, 7th edition, (Pearson), Chapter 8.
[71] See, William H. Greene (2012), *Econometric Analysis*, 7th edition, (Pearson), Example 8.4, p 269.

- energy cost index in Alberta;
- AESO electricity spot price;
- chemicals cost index;
- machinery cost index (valves and pipe);
- machinery cost index (material handling).

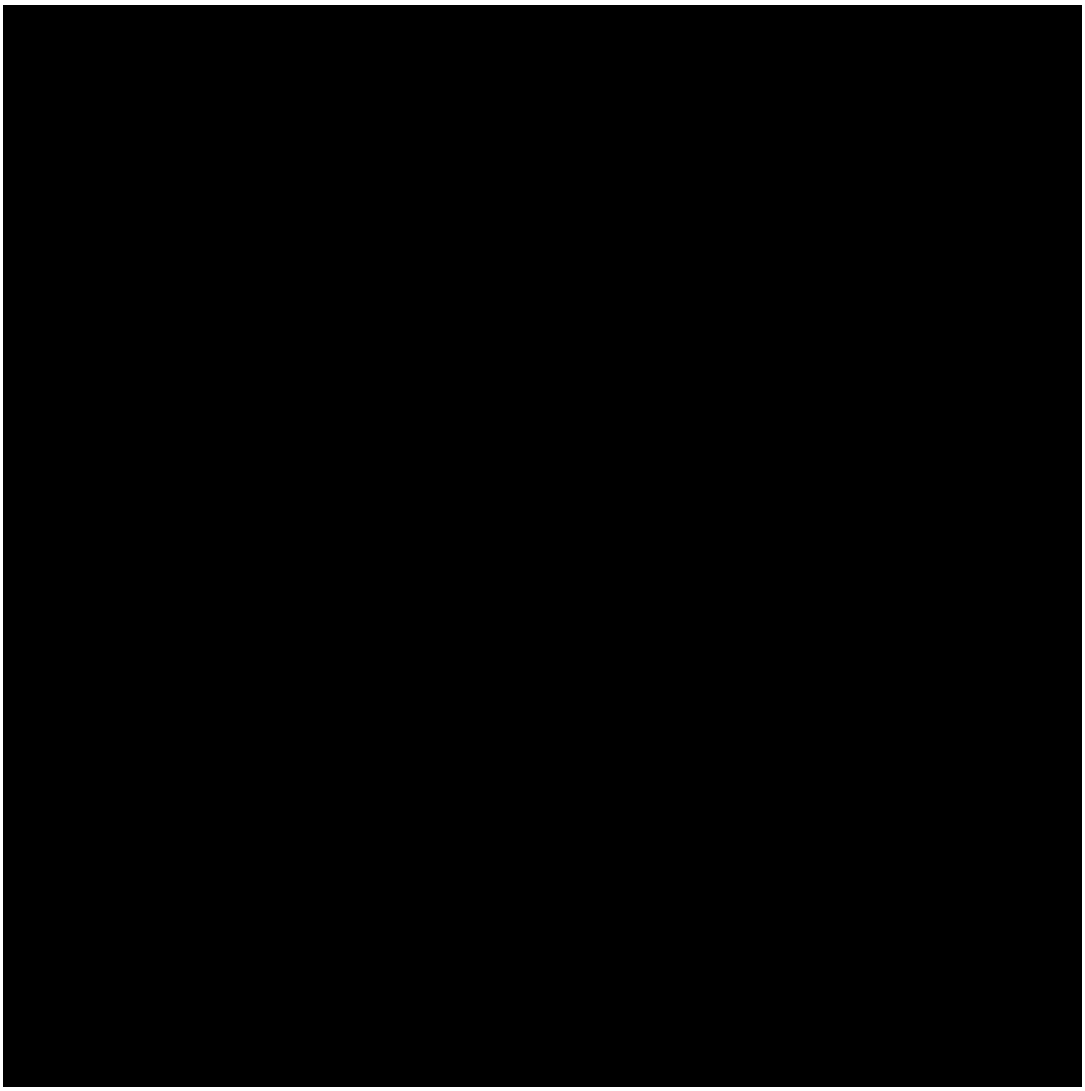
14. [redacted].



15. In the second stage, the fitted values of this first regression ($\hat{P}_t$) are used to replace P_t in equation (4) and the following model is estimated using OLS:

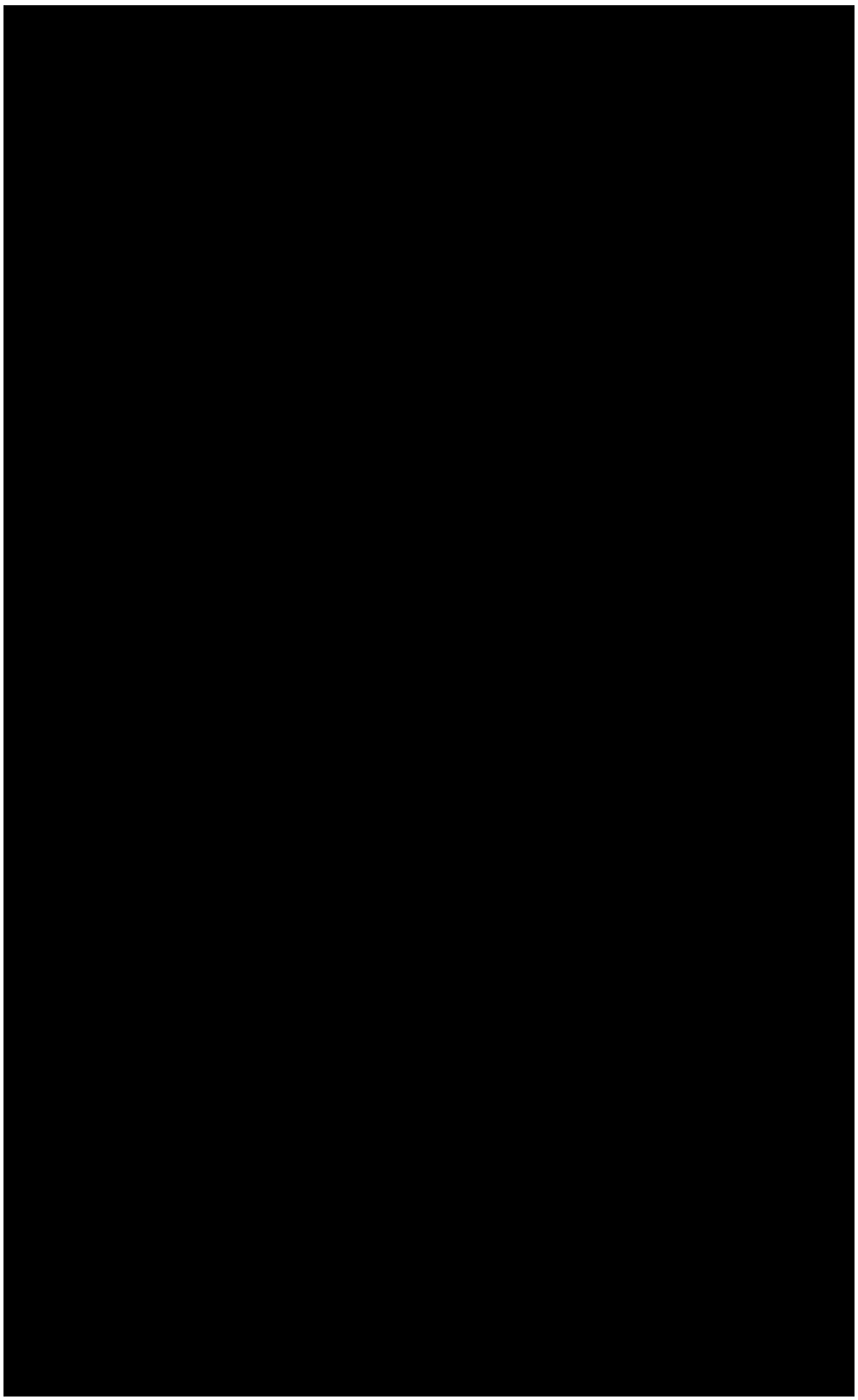
$$Q_t = \beta_0 + \beta_1 \hat{P}_t + \beta X_t' + \epsilon_t.$$

16. [redacted]



17. [redacted]

18. [redacted]



19. [redacted]

Exhibit E: Models and Empirical Results of Price and Quantity Data by Service Group

1. To assess the robustness of my previous results, I performed similar analyses by service group. (See Exhibit C for a description.)

Landfill Services

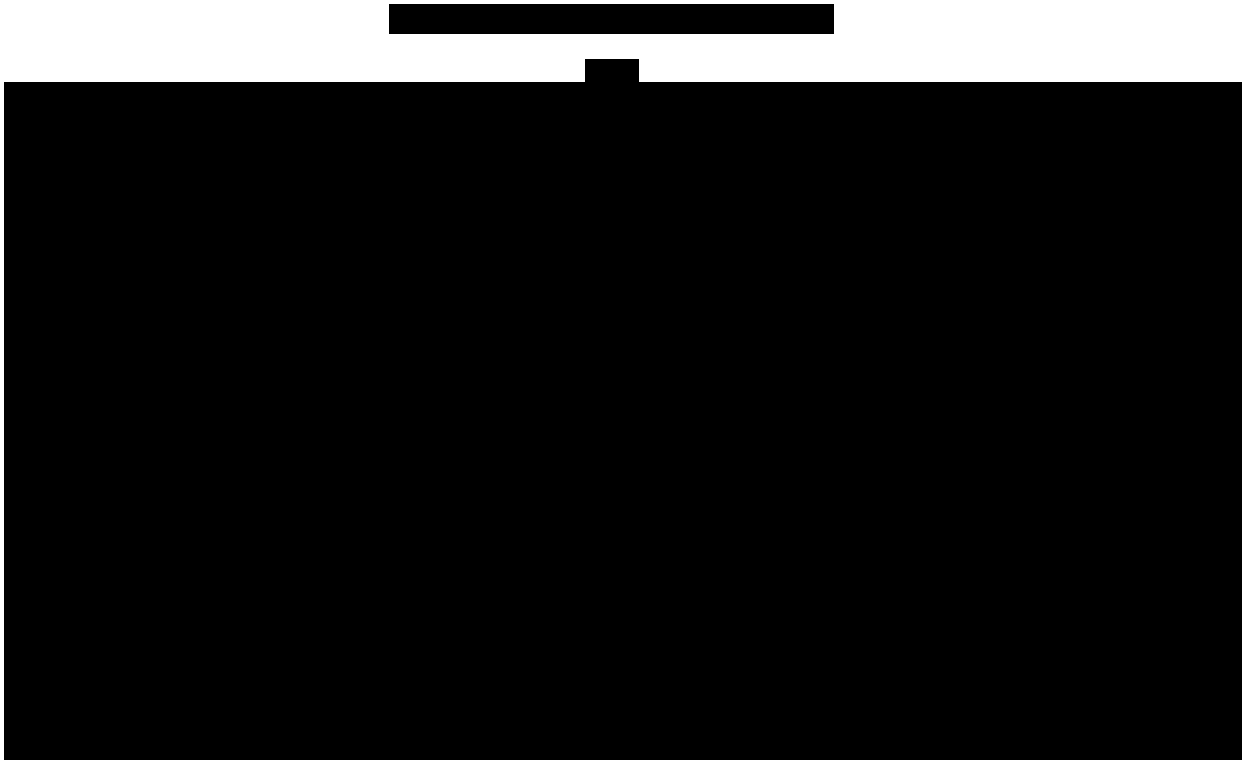
2. [redacted]

3. [redacted]

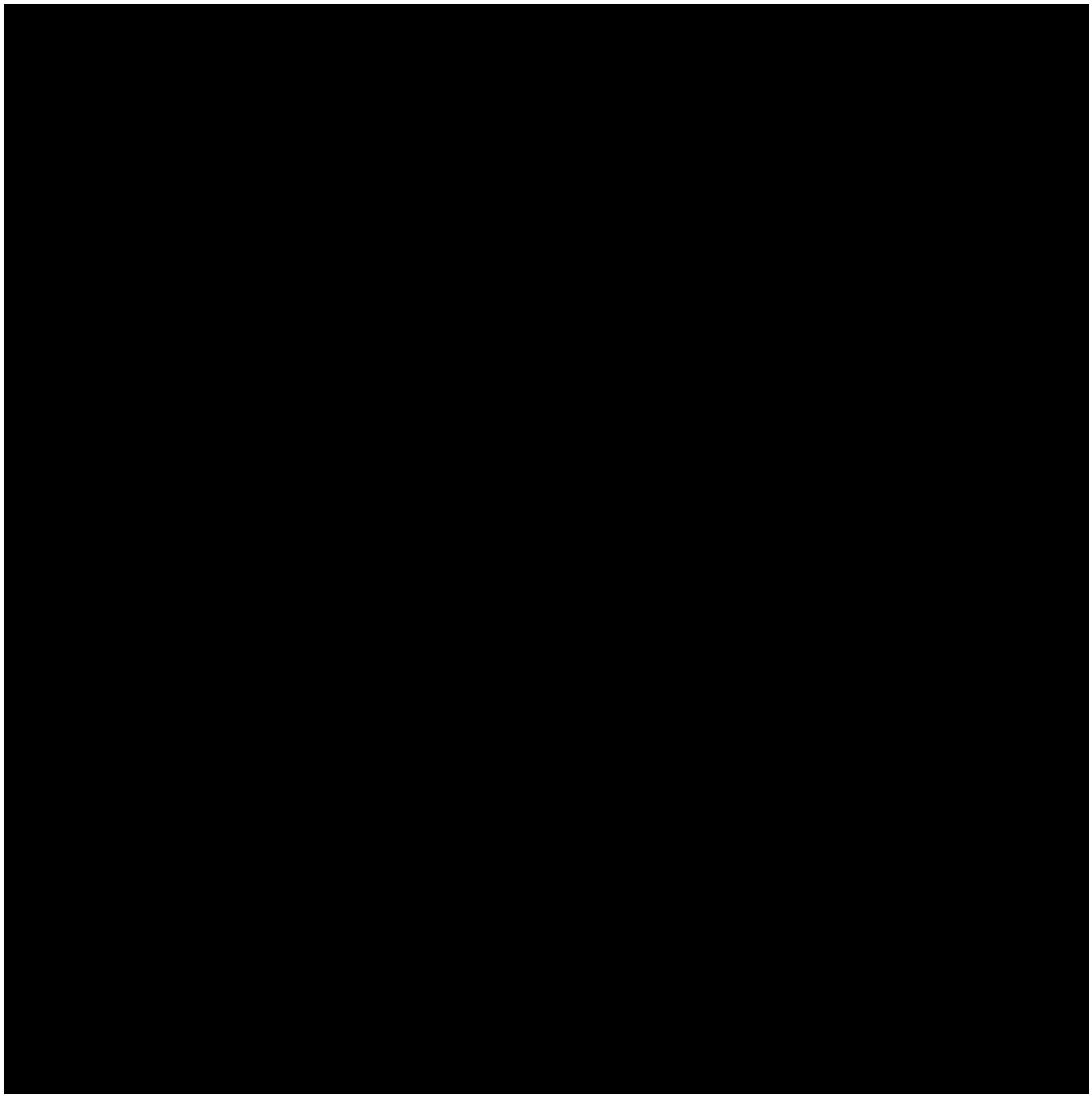
4. [redacted]

FST Services

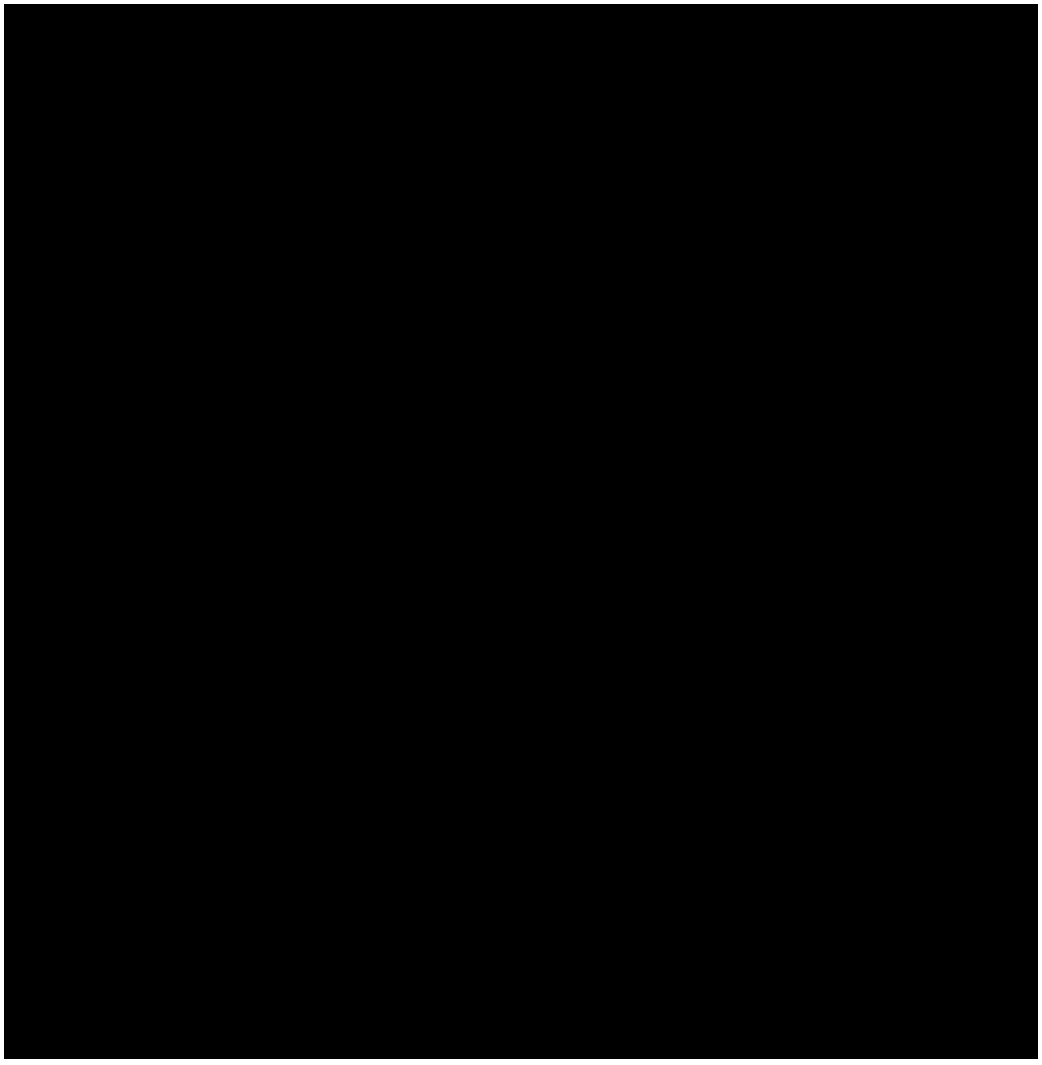
5. [redacted]



6. [redacted]

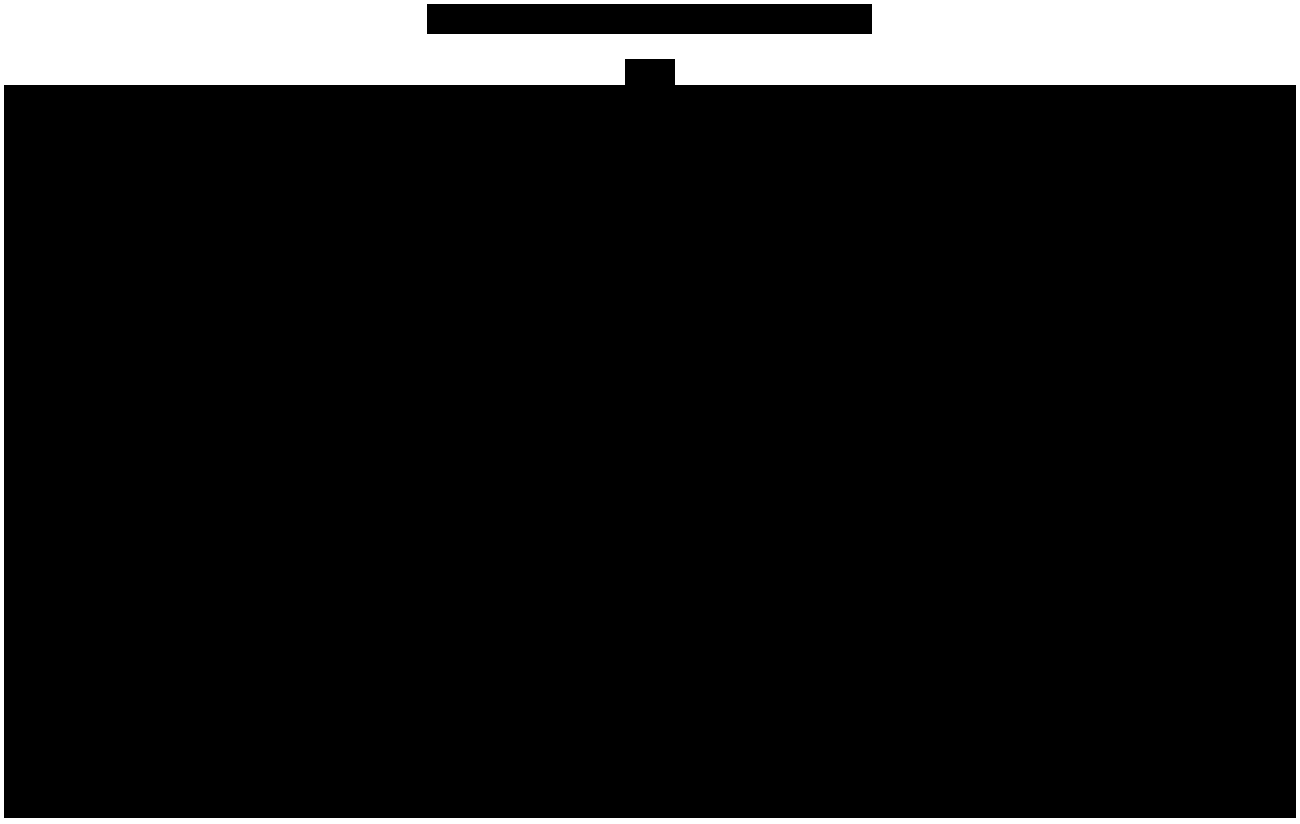


7. [redacted]



WD Services

8. [redacted]



9. [redacted]

10. [redacted]

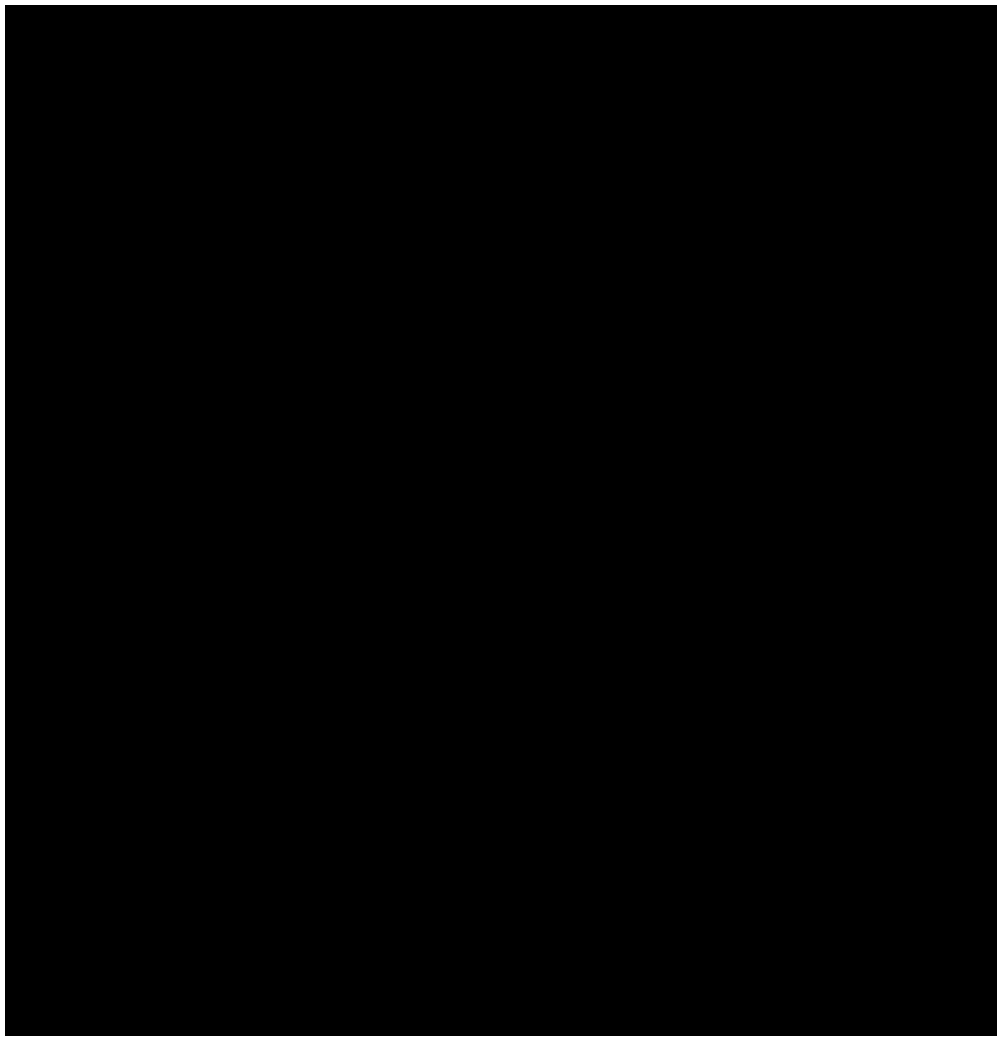


Exhibit F: Documents Relied Upon

Expert Reports

Expert Report of Nathan H. Miller, Ph.D., Exhibit A to the Affidavit of Nathan H. Miller, affirmed/sworn February 25, 2022

Tervita Transaction Data

[redacted]

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Exhibit G: Acknowledgement of Expert Witness

I, **Adonis Yatchew** acknowledge that I will comply with the Competition Tribunal's code of conduct for expert witnesses which is described below:

1. An expert witness who provides a report for use as evidence has a duty to assist the Tribunal impartially on matters relevant to his or her area of expertise.
2. This duty overrides any duty to a party to the proceeding, including the person retaining the expert witness. An expert is to be independent and objective. An expert is not an advocate for a party.

March 25, 2022

(Date) (Signature of expert witness)