Bioeconomy Development Opportunity Zone Rating: The City of Estevan, SK

Biomass Category: Wheat Straw

Date of Issue: March 2, 2023

Rating Score: 'A'

BDO Zone Rating

'A'

The City of Estevan, SK BDO Zone for wheat straw is rated 'A'. Long-term outlook on price and quantity is deemed stable. Key scale-up risks are likely addressable with reasonable mitigation measures.

Rating Parameters

Feedstock Quantity	Feedstock Form	Price Range ($/ADMT)	BDO Zone Radius
0.76-1.74 million ADMT/yr	**large square bales**	**$74–$109 delivered**	**150 km**

BDO Zone Assets

- **Stable long-term outlook on feedstock price and quantity with strong inventory management in place.**
- **Ability to access larger supply basin at marginal increase in transport costs.**
- **BDO Zone estimates include feedstock in both Canada and the US sides of the supply basin.**
- **Relatively large average farm size requires the engagement of fewer growers.**
- **No large-scale competition for wheat straw.**
- **Positively rated infrastructure asset profile.**

BDO Zone Liabilities

- **Grower interest in supplying wheat straw will require further direct validation.**
- **High probability of need to engage a third-party company to carry out harvest with square balers.**
- **Wheat straw in this area may be more suspectible to natural event risks and climate change impacts.**

BDO Zone Risk Rating

The City of Estevan, SK Bioeconomy Development Opportunity Zone is rated 'A', or *low risk*.

Risk Rating Grades are defined as follows: Aa (*very low*), A (*low*), Baa (*low-moderate*), Ba (*moderate*), B (*moderate-high*), or C (*high*).

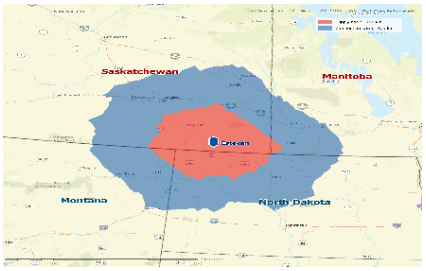
In assessing the biomass supply chain risk for the City of Estevan, SK Bio-economy Development Opportunity (BDO) Zone, 49 Risk Indicators from the *Canadian National Standards for Biomass Supply* were applied. These BDO Zone Risk Indicators are the subset of BSCR Risk Indicators applicable to gauging feedstock risk within a BDO Zone.

Feedstock quantity is expressed in Air-Dried Metric Tons (ADMT). Feedstock Price is expressed in Canadian dollars and delivered to the plant yard, assuming the plant is located centrally in the BDO Zone. Maximum transport distance is calculated assuming the maximum quantity in this BDO Zone Rating. Delivered feedstock costs for projects with lower volume requirements can be expected to be at the lower end of the BDO Zone's price range.

Scoring and Rating Methodology

The BDO Zone rating is based on an aggregation of the scores assigned to each BDO Zone Risk Indicator (RI) assessed in this report. First, each BDO Zone Risk Indicator is given a **Raw RI Score** based on the current, undeveloped state of the supply chain and the uncertainty drivers within it. Raw RI Scores are scaled between 1 (*low risk*) and 10 (*high risk*).

Next, each Risk Indicator is discounted, or "notched", based on the degree to which the uncertainty drivers are deemed to be addressable and whether there is a reasonable expectation that mitigation measures could be put into place within the price parameters for this rating. The **Notched Salience Score** corresponds to the likelihood of each Risk Indicator's described risk materializing given the implementation of reasonable mitigation measures. To arrive at the Notched Salience Score, Raw RI Scores are reduced based on the efficacy of the proposed mitigation measures. If applicable, notching occurs at one of four levels: *moderate* (25%), *significant* (50%), *broad* (75%), or *comprehensive* (100%).



The potential impact of each Risk Indicator on the supply chain is assessed and scored on a 10-point **Impact Level** scale, as either *low (3.33)*, *moderate (6.66)*, or *high (9.99)*.

Impact Level scores are based on the assumption that key measures were implemented to mitigate uncertainty drivers in the BDO Zone but failed to do so.

The **Loaded RI Score** for each Risk Indicator is then calculated as the product of Notched Salience and Impact Level scores. For example, *Risk Indicator 3.2.2: Low Historical Demand for Feedstock in the Supply Basin* has a Notched Salience scored of 4.5 and its Impact Level is deemed *low* (3.33 out of 10). The final Loaded RI score for RI 3.2.2 is therefore 4.5 × 3.33 = 14.99 (out of 100).

Loaded RI scores of 33.33 or less are deemed *low risk*; scores greater than 33.33 and less than 66.66 are deemed a *moderate risk*, and scores of 66.66 to 100 are deemed *high risk*.

The total risk rating for the BDO Zone is the average of all Loaded RI scores. **The BDO Zone score for the City of Estevan is 18.43 out of 100, resulting in an 'A' designation.** All scoring and rationale for each Risk Indicator are provided in Appendix A.

Analyst Notes

The Estevan BDO Zone presents several strong assets. These include a lack of competition for wheat straw and an expected stable long-term outlook on feedstock price and quantity with strong inventory management practices. There are substantial large growers and access to a larger supply basin at marginal increases in transport costs. Overall infrastructure is good.

Key Low and Moderate Risk Indicators

Most Loaded RI Scores are below 33.33 and are thus deemed *low* risk.

Risks related to competition are all scored as *low*. This is primarily because no large-scale facilities consuming wheat straw within the 300 km competition zone surrounding Estevan, SK are currently in operation. Cattle feedlots are the only consumers of wheat straw in the region, intaking approximtely 5% of generated wheat straw in the BDO Zone.

Risks related to potential feedstock availability are also scored *low*. Three participation rates are modeled at 75%, 50%, and 33% and the rating is based on 50%. When considering wheat production variation, the 1-in-10-year low wheat yield case and grower participation rates, we estimate 720,000 ADMT/yr of potentially available feedstock within 150 km in the 50% participation scenario.

Most farms in the Estevan BDO Zone tend to be large. Sizeable bio-based projects may still require aggregations of individual growers. The degree of management complexity for this is significant; however, it is likely manageable. A large pool of suppliers will also bring with it positive supply chain attributes, as the presence of many suppliers can increase supply chain resilience.

We assess the Loaded RI Score of *Risk Indicator 1.9.1: Feedstock Production Priority* as 52.45, or *moderate*. While the initial farmer outreach did not generate clear interest from growers, based on experience in adjacent areas it is reasonable to assume that larger suppliers would become interested once a project is announced and/or commissioned.

Key High-Risk Indicators

The most significant risks in the Estevan BDO Zone wheat straw supply chain are: 1) risks related to harvesting and collection equipment; and 2) risks related to natural events.

Harvesting, Collection, and Equipment Risk Indicators

Due to a current lack of markets for wheat straw in the region, suppliers in the Estevan BDO Zone are generally inexperienced in the harvesting and baling of wheat straw. In addition, few growers own the square baling equipment ideal for the storage and delivery of wheat straw. Round balers are far more commonly used. Differences in baling equipment and harvest practices among growers may result in variations in delivered feedstock quality.

We assume that bio-based projects that locate in the Estevan BDO Zone will take measures to mitigate key risks. This expectation is indicated by the difference between Raw RI Scores and Notched Salience Scores for multiple Risk Indicators detailed in Appendix A.

The risks around harvesting/collection equipment can be substantially mitigated by the vertical integration of a bio-project with wheat straw harvest/baling processes or by engaging a credible third-party to carry out harvest/baling activities. Scoring and this rating assume that such measures will be implemented.

We assess a high scale-up risk for *Risk Indicator 5.1.2: Capacity of Supply Chain Components and Equipment to Scale* with a Loaded RI score of 59.94. This indicator presents a salient risk even with mitigation measures and a high impact if mitigation measures were to fail.

Natural Event Risk Indicators

Natural events can have a significant impact on wheat straw supply in the Estevan BDO Zone, and this category of risk presents the highest risk scores for this BDO Zone rating. The Loaded RI Score of *Risk Indicator 3.7.1: Seasonal Weather Impacts on Feedstock Supply* is 34.97. Specific projects may be able to effectively mitigate RI 3.7.1 through strong inventory management practices.

Other *moderate* Risk Indicators (scoring between 33.33 and 66.66) include *3.7.2: Long-Term Weather and Climate Trends; 3.7.4: Risk of Infestation;* and *3.7.5–9: Risk of Hail, Flood, Drought, Hurricanes, Tornadoes, Strong Winds, and Low Temperatures*. Mitigation measures are somewhat limited by natural risk factors.

BDO Rating Parameters

In the interest of avoiding undue market influence and prejudicing a project's ability to negotiate with suppliers, BDO Zone rating reports do not provide information on total feedstock cost breakdowns obtained during the assessment. This includes all costs associated with the engagement of a third party, as well as the development of a vertically integrated supply chain.

For this rating, we used proxy prices for grower ask and baling costs from adjacent growing areas. Transportation costs were calculated using average distances based on the supply curves and trucking costs typical for the region.

The rating of the Estevan BDO Zone is based on total delivered costs of the feedstock in a price range of $74–$109/ADMT and at an average distance range of 90–110 km and a supply radius of 150 km.

Infrastructure Asset Profile

Overall, the City of Estevan presents a profile of positively rated infrastructure assets. These assets were scored on a scale of 0–10, with scores defined as follows: 0 (*insufficient*); 2 (*poor*); 4 (*fair*); 6 (*reasonable*); 8 (*good*); 10 (*very good*). An average of 7.58 of 10 of all assets scored as either *good* or *very good*, and 0 scored as *poor* or *insufficient*. Among the top-rated assets are the ease of local rail and highway access and the safe local community.

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Figure 1 - Risk Indicators (sorted by risk level)

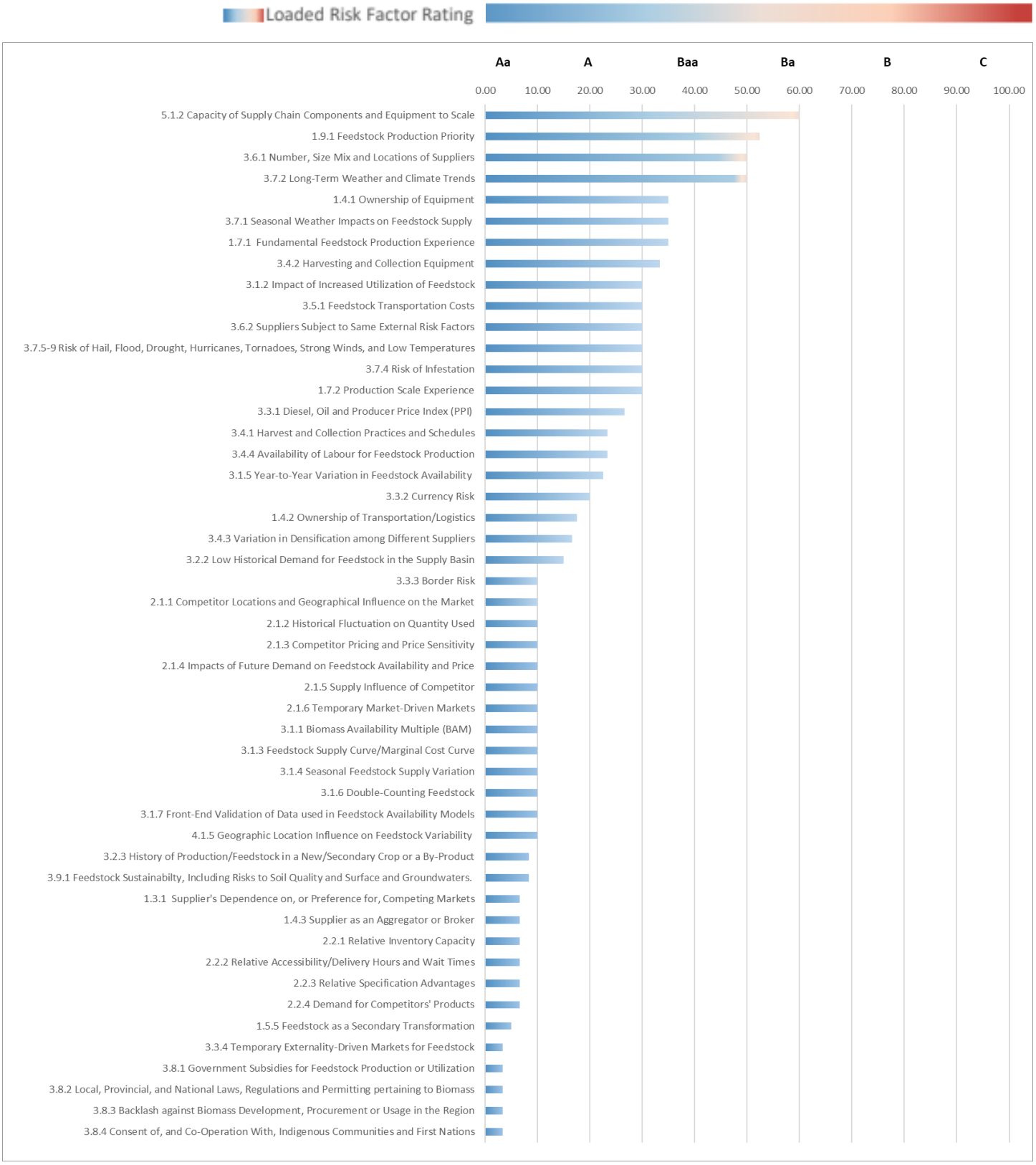


Table 1 - Risk Indicators

Feedstock Supply Chain Risk Indicators	Raw RI Score	Notched Salience	Impact Level	Loaded RI Score
Category 1: Supplier Risk				
1.3.1 Supplier's Dependence on, or Preference for, Competing Markets	2	1.0	3.33	6.66
1.4.1 Ownership of Equipment	7	5.25	6.66	34.97
1.4.2 Ownership of Transportation/Logistics	6	1.75	9.99	17.48
1.4.3 Supplier as an Aggregator or Broker	1	1.0	6.66	6.66
1.5.5 Feedstock as a Secondary Transformation	3	0.75	6.66	5.00
1.7.1 Fundamental Feedstock Production Experience	7	3.5	9.99	34.97
1.7.2 Production Scale Experience	9	4.5	6.66	29.97
1.9.1 Feedstock Production Priority	7	5.25	9.99	52.45
Category 2: Competitor Risk				
2.1.1 Competitor Locations and Geographical Influence on the Market	1	1.0	9.99	9.99
2.1.2 Historical Fluctuation on Quantity Used	1	1.0	9.99	9.99
2.1.3 Competitor Pricing and Price Sensitivity	1	1.0	9.99	9.99
2.1.4 Impacts of Future Demand on Feedstock Availability and Price	1	1.0	9.99	9.99
2.1.5 Supply Influence of Competitor	1	1.0	9.99	9.99
2.1.6 Temporary Market-Driven Markets	1	1.0	9.99	9.99
2.2.1 Relative Inventory Capacity	1	1.0	6.66	6.66
2.2.2 Relative Accessibility/Delivery Hours and Wait Times	1	1.0	6.66	6.66
2.2.3 Relative Specification Advantages	1	1.0	6.66	6.66
2.2.4 Demand for Competitors' Products	1	1.0	6.66	6.66
Category 3: Supply Chain Risk				
3.1.1 Biomass Availability Multiple (BAM)	1	1.0	9.99	9.99
3.1.2 Impact of Increased Utilization of Feedstock	3	3.0	9.99	29.97
3.1.3 Feedstock Supply Curve/Marginal Cost Curve	1	1.0	9.99	9.99
3.1.4 Seasonal Feedstock Supply Variation	1	1.0	9.99	9.99
3.1.5 Year-to-Year Variation in Feedstock Availability	9	2.25	9.99	22.48
3.1.6 Double-Counting Feedstock	1	1.0	9.99	9.99
3.1.7 Front-End Validation of Data used in Feedstock Availability Models	1	1.0	9.99	9.99
3.2.2 Feedstock Production Priority	9	4.5	3.33	14.99
3.2.3 History of Production/Feedstock in a New/Secondary Crop or a By-Product	10	2.5	3.33	8.33
3.3.1 Diesel, Oil, and Producer Price Index (PPI)	4	4.0	6.66	26.64
3.3.2 Currency Risk	6	3.0	6.66	19.98
3.3.3 Border Risk	6	3.0	3.33	9.99
3.3.4 Temporary Externality-Driven Markets for Feedstock	1	1.0	3.33	3.33
3.4.1 Harvest and Collection Practices and Schedules	7	3.5	6.66	23.31
3.4.2 Harvesting and Collection Equipment	10	5.0	6.66	33.30
3.4.3 Variation in Densification among Different Suppliers	5	2.5	6.66	16.65
3.4.4 Availability of Labour for Feedstock Production	7	3.5	6.66	23.31
3.5.1 Feedstock Transportation Costs	3	3.0	9.99	29.97
3.6.1 Number, Size Mix, and Locations of Suppliers	5	7.5	6.66	49.95
3.6.2 Suppliers Subject to Same External Risk Factors	9	4.5	6.66	29.97
3.7.1 Seasonal Weather Impacts on Feedstock Supply	7	3.5	9.99	34.97
3.7.2 Long-Term Weather and Climate Trends	5	5.0	9.99	49.95
3.7.4 Risk of Infestation	4	3	9.99	29.97
3.7.5-9 Risk of hail, flood, drought, hurricanes, tornadoes, strong winds, and low temperatures	3	3	9.99	29.97
3.8.1 Government Subsidies for Feedstock Production or Utilization	1	1.0	3.33	3.33
3.8.2 Local, Provincial, and National Laws, Regulations, and Permitting pertaining to Biomass	1	1.0	3.33	3.33
3.8.3 Backlash against Biomass Development, Procurement or Usage in the Region	1	1.0	3.33	3.33
3.8.4 Consent of, and Co-Operation With, Indigenous Communities and First Nations	1	1.0	3.33	3.33
3.9.1 Feedstock Sustainability, including risks to soil quality and surface and groundwaters.	5	2.5	3.33	8.33
Category 4: Feedstock Quality				
4.1.5 Geographic Location Influence on Feedstock Variability	1	1.0	9.99	9.99
Category 5: Feedstock Scale-up Risk				
5.1.2 Capacity of Supply Chain Components and Equipment to Scale	8	6	9.99	59.94
Average				**18.43**

Table 2: Infrastructure Asset Indicators

Infrastructure Assets	Overview	Score
Category 1: Physical Infrastructure		
1.1 Land Parcel	Subdivision procedures and processes are used by the City of Estevan to regulate splitting up land into smaller parcels to accommodate development.	8
1.2 City Ownership	City owns and/or intends to acquire all lands for industrial purposes.	8
1.3 Industrial Land Use Zone	The 45-acre park within the city limits of Estevan has a total of 13 lots of varying sizes available for industrial use and is located next to key transport routes.	9
1.4 Natural Gas Line	SaskEnergy is Saskatchewan's natural gas distribution company and provides lines to the city.	8
1.5 Electrical	Electrical power comes from Sask power.	8
1.6 Fresh Water Supply Line	Fresh water is from Boundary Dam. Saskatchewan Watershed Authority regulates drinking water quality.	8.5
1.7 Sewage Disposal	Estevan's sanitary sewer system includes many kilometers of sewer pipes and 4,000 service connections to individual residences, businesses, and industrial sites.	9
1.8 Drainage	Drainage department supports City requirements by maintaining existing roads and drainage systems.	8
1.9 Stormwater Management	Storm Drainage design specifications for all contractors involved in projects in the City of Estevan.	7
1.10 Natural Gas Power Generation Site	No natural gas power generation site.	3
1.11 Available ICT (Information & Communication Technology) Services	SaskTel and its wholly-owned subsidiaries offer a wide range of ICT products and services.	7
1.12 Available Land	City-owned land is available and ready for use.	8
1.13 Cost of Land - Initial Cost	$2,200 per acre	8
1.14 Cost of Land - Property Tax, Utilities	Offered by City at cost with other incentives to be negotiated.	7
1.15 Infrastructure - Pre-existing Infrastructure	No pre-existing plant infrastructure. "Greenfield" situation will enable custom-designed site.	8
1.16 Infrastructure - Landfill/waste disposal	The City of Estevan and GFL Environmental Inc. have partnered to create the Garbage and Recycling program.	9
Category 2: Logistics		
2.1 Rail	CP Rail at Estevan provides direct rail connections to east and west mainlines at Brandon, Manitoba and Moose Jaw, Saskatchewan.	8
2.2 Highway Access and Intersection	Adjacent to highways 18, 39 and 47 with Saskatchewan's only 24-hour port of entry from the United States.	8
2.3 Proximity to Major Markets	Major markets are within a range of 200 kilometers.	9
2.4 Inbound/Outbound Shipping Costs	Unsure	7
2.5 Accessibility to Airport	The airport is located 5 km north of Estevan on Highway #47 and 2 km east on R.M. road #704. Land location is Southwest 13-3-8—W2.	8
2.6 Railway Service	CP rail line with access to the port of Vancouver as well as Minneapolis, Chicago, and Kansas City.	8
2.7 Logistics - Construction Logistics	Good	7
2.8 Logistics – Proximity	Proximity to the United States adds another layer of business.	7
Category 3: Social Infrastructure		
3.1 Quality of Life	Home to a population of 11,000. Residents of Estevan enjoy big city offerings combined with the spirit of a small town.	9
3.2 Education - Elementary & High School	Schools in Estevan fall under the South East Corner Stone Public School Division #209.	8
3.3 Education - Post Secondary	For over 40 years, Southeast College has adapted and consistently delivered on the academic needs of the people and communities in which it operates.	8
3.4 Local Retail	Estevan offers a range of big box stores as well as small, family-owned businesses.	7
3.5 Culture and Recreation	Estevan offers a wide range of recreational activities, including sports and an abundance of cultural opportunities for all ages.	7
3.6 Hospital and Doctors	St Josephs Hospital; 20 doctors or more.	7
3.7 Housing Availability	Estevan has planned major housing developments for its new residents.	7
3.8 Crime Rate	Estevan is a safe, neighbourly community with a low crime rate.	8
Category 4: Workforce		
4.1 Labour Costs	The Saskatchewan government has announced that it will be increasing the minimum wage from $11.81/hour to $13/hour.	6
4.2 Available Skilled Labour	Highly skilled labour force.	8
4.3 Available Unskilled Labour	Agricultural producers will be a good, reliable source of unskilled labour.	8
4.4 Training Programs / Community College	Southeast College offers dedicated training courses.	8
4.5 Workforce - Population Support/Size of Workforce	7,000	7
4.6 Workforce - Community Impact	Mostly mine workers	7
4.7 Workforce - EA Impact - Public Opinion	Good. City and residents interested in new industrial growth.	8
4.8 Workforce - Labour Cost	Good	7
Category: 5 Financial		
5.1 Corporate tax rate	Good. 12% with reductions possible for Saskatchewan-based investments.	8
5.2 Construction Costs	High for now with supply and demand.	6
5.3 Provincial Incentives	Ongoing and changing.	7
5.4 Municipal Incentives	Tax discounts. Any new business establishing and locating operations in the City of Estevan is entitled to a five-year property tax levy exemption.	9
5.5 Energy Availability and Costs	Power and natural gas, unsure of specific unit costs.	7
5.6 Environmental Regulations	Stringent	6
5.7 Expedited Permit Process	Moves fairly quicky.	8
	Total	***7.58***



Bioeconomy Development Opportunity Zone Rating Independent Review Committee – Estevan, SK

Roy Ludwig, City of Estevan

Jeff Ward, City of Estevan

Josh Gustufson, Farmer

Jordon Mantei, Farmer

Chad Ross, Farmer

Russell Mante, Farmer

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APPENDIX A: Scoring Protocols, Rationale, and Ratings

Bioeconomy Development Opportunity (BDO) Zone Assessment for Estevan, SK

The objective of this Bioeconomy Development Opportunity (BDO) Zone assessment is to assess wheat straw biomass supply chain risk for the City of Estevan, SK. **The BDO Zone rating for wheat straw in Estevan, SK is 'A'**.

Category 1: Supplier Risk

1.3.1. Supplier's Dependence On, or Preference For, Competing Markets

Rationale: Supplier may have a vested interest or preference to supply to specific competitors for biomass feedstock. Preferences may be due to historical, long-term, or personal relationships, less stringent feedstock quality requirements, more flexible operating hours by competing markets, or supplier's dependence on competing markets to accept or purchase other products/by-products. During periods of feedstock shortage such suppliers may be more likely to allocate the scarce supply to a competitor, resulting in supply disruptions for the Proponent.	**Score**
Raw RI Score: There are no large-scale consumers of wheat straw in the region. The cattle bedding market is estimated to consume approximately 5 % of all generated wheat straw, which is too small to pose a significant risk. Raw RI Score is deemed *low*.	**2**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 2**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score 6.66**

1.4.1. Ownership of Equipment

Rationale: In most cases, suppliers that own or lease equipment for harvest, collection, and processing of feedstock are lower risk than those who do not. For example, third-party harvesting equipment may not be available when required. Short harvest windows may be missed if a farmer and contractor cannot schedule convenient harvest times, resulting in quantity shortages. In some circumstances, however, relying on third-party equipment to harvest or produce feedstock can decrease supply chain risk. For example, when harvesting agricultural residues such as corn stover, the use of a third-party company with standard equipment specializing in harvesting, collection, and transportation may decrease quality variations (e.g., ash content) of final feedstock.	**Score**
Raw RI Score: There are commonly two types of balers: round and square. Round balers are generally used for wheat harvest. Square bales are preferred for wheat straw as they are easier to stack and store than round bales, increasing the number of bales per trailer. Square balers are not in use in Estevan as there is currently no market for baled wheat straw. As few producers own this equipment, engaging a third-party company with suitable baling equipment is likely required. Several third-party baling companies in the region, which could provide a pool of service providers to mitigate risk.	**7**

We see two major risks associated with engaging third-parties to harvest wheat straw in the BDO Zone: First, use of a third-party baler will increase feedstock costs, and costs may be higher than estimated in this report. The additional cost associated with engaging a third-party (or by vertically integrating a similar service within a project) is estimated at $10–20/bale. This addition to feedstock cost has been incorporated into the feedstock cost range on which this rating is based. Second, not all growers will accept wheat straw harvesting by third parties, so grower participation rates could be lower than expected. Raw RI Score is deemed high.

Notched Salience: RI 1.5.2 could be significantly mitigated by the involvement of an experienced third-party baling company or vertical integration within the project. The risks posed by inexperience with square balers and potential farmer reluctance to use third-party balers is incorporated into the assumptions for the low-end participation rate (33 %). As a result, Raw RI Score is notched by 25%: Notched Salience is 5.25.	**Score Notched 5.25**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 34.97 out of 100.	**Score 34.97**

1.4.2. Ownership of Transportation/Logistics

Rationale: In most cases, suppliers that own or lease equipment necessary to transport biomass from forest or field are lower risk than those who do not. However, in some circumstances, reliance on third-parties to transport biomass is common practice and does not contribute to risk.	**Score**
Raw RI Score: The wheat straw currently being sold is transported by growers, but the total number of trucks and trailers owned by growers is insufficient to support a large consumer of straw. Although growers may invest in equipment once demand increases and confidence in wheat straw market stability grows, the lack of widespread ownership of transportation equipment and the likely need to hire third-party transportation companies poses a distinct risk to the supply chain. This risk is heightened by the fact that the harvesting season is only a few weeks long and sufficient transport equipment must be moved into the region in a short period of time. Raw RI score is deemed *moderate*.	**6**
Notched Salience: Sufficient transportation equipment can most likely be obtained from other custom haulers. A few companies also offer custom baling and hauling services. Several well-known trucking companies currently transport other products using flatbed and super B flatbed trailers that can transport bales. Secondary research indicates that the existing trucking infrastructure should be able to support a large-scale project, since trucks could be brought into the region from other parts of Saskatchewan. As a result, Raw RI Score is notched by 75%: Notched Salience is 1.75.	**Score Notched 1.75**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 17.48 out of 100.	**Score 17.48**

1.4.3 Supplier as an Aggregator or Broker

Rationale: Aggregators may effectively provide supply chain redundancy and eliminate the risk and complexity of dealing with multiple sources of supply by combining supplies into a single master contact. Aggregators can add much needed stability into biomass supply basins by increasing offtake stability for both suppliers and markets. An aggregator can be a more reliable long-term offtake for suppliers by having multiple markets and can be a more reliable long-term supplier for markets by having multiple suppliers. Further, when a single supplier breaches, the aggregator can source from another.

Score

Both aggregators and brokers are intermediaries. Aggregators consolidate and manage feedstock procurement from a number of smaller suppliers. Brokers tend to act as intermediaries between a single source of supply, but brokers of multiple sources of feedstock are common. Aggregators act as principles in the supply of feedstock and assume the contractual obligations of a direct supplier; brokers do not.

Definitional confusion between aggregators and brokers is common. If an aggregator does not assume the supply risk of sub-contractors, then they are more accurately deemed either a "procurement manager" or "broker". Aggregators add more value in terms of risk mitigation than other intermediaries. An aggregator premium should relate to the degree to which they are able to mitigate feedstock supply risks.

Raw RI Score: There are no aggregators in the area. However, the presence of a large number of growers allows for the spread of supply sources and reduces the risk of supply shortages. Some balers have collaborated on a business to business(B2B) basis and aggregators may not be necessary. Raw RI Score is deemed *low*.

1

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score** **Unnotched** **1**
Impact Level: RI Impact Level is deemed *moderate*.	**Score** **6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score** **6.66**

1.5.5. Feedstock as a Secondary Transformation

Rationale: A secondary transformation **is** dependent upon the production of primary products, e.g. wheat straw resulting from the production of wheat.

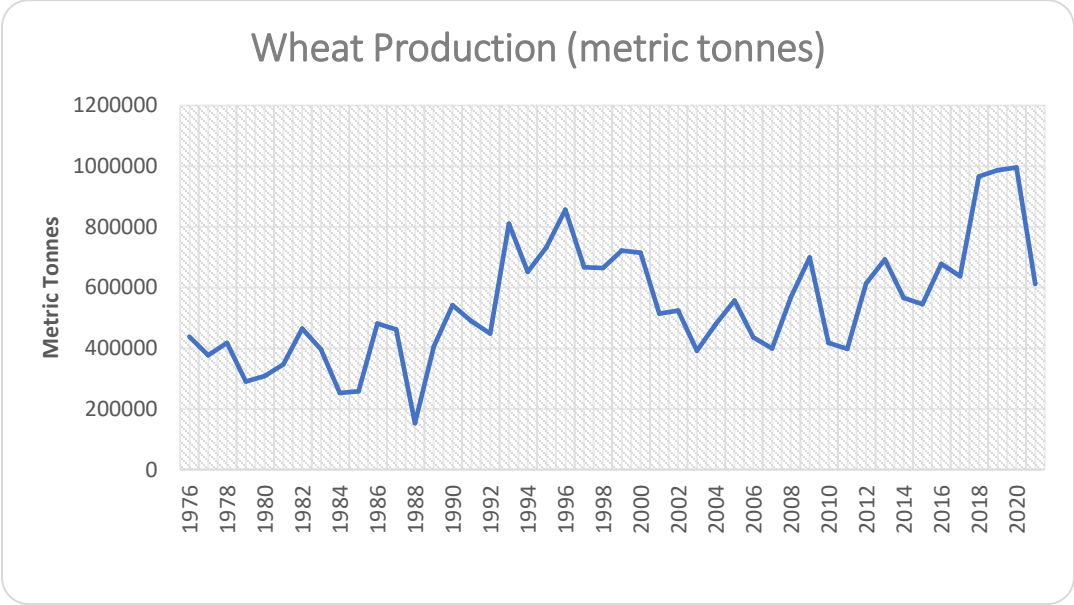
Score

Risks are higher if feedstock is a secondary transformation of a primary, more valuable product. It may not be economical for suppliers to produce biomass on their own in the absence of markets for the primary product.

In the case of agricultural feedstocks such as wheat straw, the feedstock is a by-product of a primary crop. Since the primary crop is significantly more lucrative than the residue, it will be a priority for the producer. If production of the primary crop requires that resources be taken away from the production of a secondary crop (e.g., in case of shorter harvesting windows due to weather), the secondary feedstock supply will suffer. In times of stretched resources, suppliers may also perceive harvesting and collection of the feedstock as a nuisance, potentially decreasing production levels.

Raw RI Score: Wheat straw is a byproduct of wheat, a primary crop. As a result, producers will always prioritize producing wheat grain, with straw as a potential secondary /by-product. However, since 2002, wheat production has been steadily increasing, as has the production of wheat straw. Many farmers use wheat straw as fertilizer, but this could be overcome if wheat straw prices are higher than the additional costs of using fertilizer. Raw RI Score is deemed *low*. **3**

Wheat Production - Estevan BDO Zone



Notched Salience: RI 1.5.5 could be greatly reduced by broadening the supply basin. In the event of a feedstock shortage due to low wheat production, more feedstock can be obtained from areas outside the core supply basin. When compared to the total cost of feedstock, the cost of additional transportation is relatively low (e.g., at 50 km from Estevan the transportation cost makes up 15 percent of the total cost). While the estimated BDO Zone volumes in the preferred range of 90–110 km are solely from Canadian wheat straw, given Estevan's proximity to the border, the BDO Zone can expand easily into the United States. Potential volumes from the US are estimated at 680,400 ODMT with 50% participation rate within a 150-km supply basin.

To further mitigate wheat harvest shortfalls, an on-site inventory of 18 months or more of feedstock could be kept under cover.

As a result, Raw RI Score is notched by 75%; Notched Salience is .75**.** **Score Notched 0.75**

Impact Level: RI Impact Level is deemed *moderate*. **Score 6.66**

Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 5.00 out of 100. **Score 5.00**

1.7.1. Fundamental Feedstock Production Experience

Rationale: Risk is higher when a supplier has limited experience with planting, growing, harvesting, processing, and/or collecting biomass. Limited experience may be common for agricultural residue supply chains where farmers may have no previous experience. In cases where experience is lacking, Proponent should show that steps have been taken to ensure proper training, knowledge dissemination, and monitoring.	**Score**
Raw RI Score: The supply chain has little experience producing wheat straw as the only consumers are the cattle bedding and feed markets. Many individual growers have never baled wheat straw, though some have baled straw from other crops. Raw RI Score is deemed *high*.	**7**
Notched Salience: RI 1.7.1 could be significantly reduced by enlisting the services of an experienced third-party baling company (or companies) or by providing similar services by establishing a vertically integrated bio-project. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score Notched 3.5**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 34.97 out of 100.	**Score 34.97**

1.7.2. Production Scale Experience

Rationale: Scale-up entails risk. Risk is higher when a supplier has limited experience with production at the quantity of feedstock required.	**Score**
Raw RI Score: Production-scale experience with wheat straw is lacking in the region. The transition from current wheat straw production levels to those required for a large-scale facility would be significant. Raw RI Score is deemed *high*.	**9**
Notched Salience: RI 1.7.2 could be reduced by outsourcing harvest and collection to a credible third-party baling company or by providing similar services through a vertically integrated bio-project. As a result, Raw RI Score is notched by 50%: Notched Salience is 4.5.	**Score Notched 4.5**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97 out of 100.	**Score 29.97**

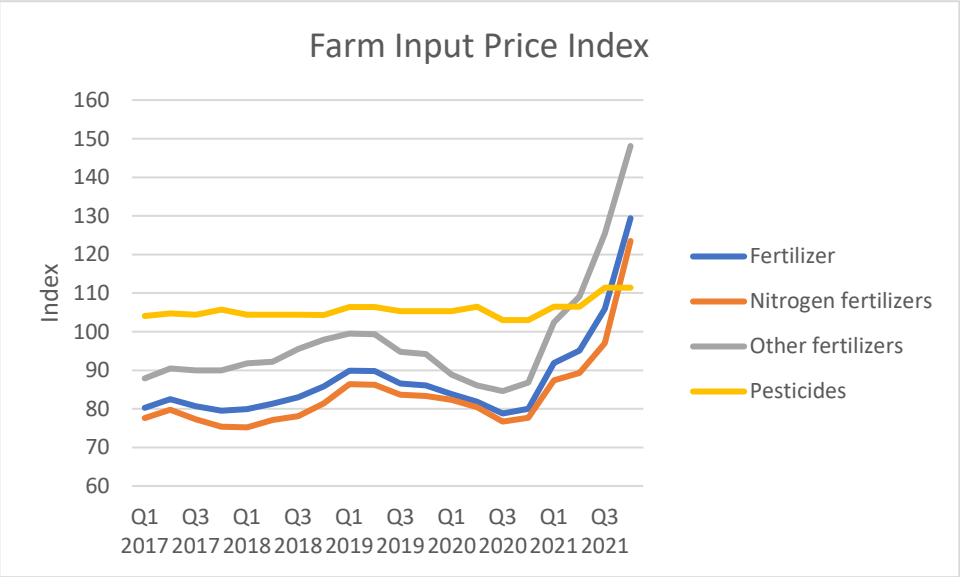
1.9.1. Feedstock Production Priority

Rationale: When biomass feedstock is a secondary or non-core line of business, or when it is a by-product or a residual from a more valuable primary product, suppliers may not put sufficient effort into consistently producing it. Risk of breach increases when production and/or delivery of feedstock compromises supplier's ability to make a primary product.	**Score**

When biomass feedstock is a by-product of another main higher margin or main product (e.g. wheat straw), supply may not be a top priority for a supplier.

Raw RI Score: We were not able to confirm interest in supplying wheat straw from local growers. However, when taking surrounding area feedback into account, we anticipate that wheat straw could become a significant source of on-farm income. **7**

Growers in adjacent areas who expressed reservations noted two conditions that must be addressed for them to consider supplying wheat straw: First, costs associated with potential need for fertilizer when wheat straw is removed from the field; second, wheat straw prices would need to be attractive enough for them to consider becoming a supplier. Wheat straw production is not a top priority for growers in either case.



This risk is exacerbated because the harvesting window is relatively short: 4 to 6 weeks. As a result, suppliers will prioritize grain production and will only supply wheat straw if it does not interfere with their ability to harvest grain efficiently. Raw RI Score is deemed *high*.

Notched Salience: Based on experience from adjacent regions, face-to-face meetings with potential suppliers would likely yield positive interest. Outsourcing harvest and collection to a reputable third-party baling company or providing similar services through a vertically integrated bio-project could help to mitigate this risk. As a result, Raw RI Score is notched by 25%: Notched Salience is 5.25.	**Score Notched 5.25**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 52.45 out of 100.	**Score 52.45**

Category 2: Competitor Risk

2.1.1. Competitor Locations and Geographical Influence on the Market

Rationale: Competitors' locations relative to a Proponent can affect the viability of procuring feedstock and feedstock cost. Accurate and detailed competitor mapping provides an understanding of the geographical influence a competitor may have, including competitive advantages such as short hauling.	**Score**
Raw RI Score: There are no large-scale competitors for wheat straw in the region. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.1.2. Historical Fluctuation of Quantity Used

Rationale: Clear understanding of key competitors' consumption of each type of feedstock is essential to quantifying the risks associated with each competitor. Understanding historical trends of feedstock utilization can provide valuable information about feedstock price elasticity during shortages and insight into events that may impact future supply conditions. It allows more accurate estimates of the sensitivity of feedstock availability to potential future consumption levels or to the impact of external events (e.g., weather events, structural economic changes, seasonality, or policy change).	**Score**
Raw RI Score: There are no major historical competitors for wheat straw. The cattle bedding and feed markets are the only current local consumers of wheat straw, consuming only 5% of all wheat straw generated. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.1.3. Competitor Pricing and Price Sensitivity

Rationale: Understanding how much competitors pay for different feedstock types is an essential to determining competitiveness of Proponent. Historical prices paid by competitors provide insight into their procurement behaviours and ability/willingness to pay premiums for feedstock and exert pressure on Proponent's suppliers during times	**Score**

of feedstock shortage. Competitors that can offer higher prices for feedstock during shortages can pose significant risks to Proponent.
Knowledge of competitor pricing and price sensitivity is also an essential prerequisite to formulating a feedstock cost curve which can enable predictions of feedstock redundancy; i.e., how much feedstock could become available at different pricing levels (see Category 3–Supply Chain Risk 3.1.3).

Raw RI Score: There are no significant competitors for wheat straw in the region. Raw RI Score is deemed *low*. **1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.1.4. Impacts of Future Demand on Feedstock Availability and Price

Rationale: Future competitors for feedstock or expansion of feedstock demand by current competitors can cause feedstock market disruption. **Score**

Even before new competitors become operational, high interest in a supply basin can make suppliers overconfident, leading to a supplier-controlled market where short-term contracting becomes the norm and supply chain reliability is compromised for the Proponent. Once operational, new competitors increase demand on feedstock, potentially lowering availability and increasing cost.

Existing competitors may seek to expand operations, increasing consumption of feedstock.

Raw RI Score: There are no large-scale potential competitors for wheat straw proposed. Wheat straw can be found all over the province. The risk that, once a project is located in the BDO Zone, another project will be located in the same BDO Zone is likely low. **1**

Wheat straw's cattle bedding and feed market is unlikely to grow significantly in the future due to its low quality in comparison to other types of straw (e.g., flax, oat, etc.). The raw RI Score is deemed low.

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.1.5. Supply Influence of Competitor

Rationale: In some cases, competitors may be able to exert high degrees of pressure over local suppliers, effectively enabling them to control feedstock, especially during times of shortage. This control can derive **Score**

from long previous relationships between suppliers and competitor, from verbal or "understood" agreements, or from a competitor being able to assist suppliers in times of surplus by maintaining large inventories which enable suppliers to continue supplying when other markets impose quotas. Understanding and planning around such soft risk factors is important. If such relationships exist in the Proponent's procurement area, they may indicate increased risk of feedstock shortage or pricing changes.

Raw RI Score: Wheat straw has no large-scale competitors. Wheat straw is widely available throughout the province, so competitors for wheat straw are unlikely to locate in the same BDO Zone. Raw RI Score is deemed low.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.1.6. Temporary Market-Driven Markets

Rationale: Alternative, non-traditional, market-driven competitors for feedstock can drive feedstock demand in unusual circumstances. A Proponent using corn stover as a feedstock, for example, would not typically compete with higher-end animal feed markets due to quality issues. However, in times of significant hay shortage (e.g., during drought), farmers use corn stover in place of hay, driving up the price of feedstock and decreasing availability for bio-projects (Bergtold 2018).	**Score**
Raw RI Score: There are no non-traditional or market-driven markets for feedstock. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.2.1. Relative Inventory Capacity

Rationale: Storing inventory will enhance competitiveness. Ability to store large inventories allows biomass Proponents to purchase inventory when prices are low, giving it an economic advantage. Additionally, the ability to store inventory during feedstock supply surpluses enables competitor to continue to intake feedstock when the Proponent (with lesser inventory capacity) may be forced to put suppliers on quota. Larger investor capacity thereby creates supplier loyalty, and this can increase reliability and decrease risk.	**Score**

Raw RI Score: Wheat straw has no large-scale suppliers at present and there is relatively little demand for the feedstock so no current need for large-scale inventory. Cattle feedlots typically stockpile up to a year's worth of feedstock but are a relatively small market for wheat straw, consuming only 5% of all locally generated feedstock. The raw RI Score is deemed *low*.	**1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score 6.66**

2.2.2 Relative Accessibility/Delivery Hours and Wait Times

Rationale: The value attributed by suppliers to local markets is often directly related to the degree of flexibility the market provides in terms of delivery hours and the efficiency of discharge.	**Score**
Raw RI Score: There are no large-scale competitors for feedstock in the region. Raw RI Score is deemed *low*.	**1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score 6.66**

2.2.3 Relative Specification Advantages

Rationale: When choosing a market, suppliers look at price as well as relative quality requirements or specifications. It is important to understand a competitor's feedstock quality specifications to accurately quantify the risk that a competitor can exert on the Proponent's supply chain.	**Score**
Raw RI Score: There are no large-scale competitors for feedstock in the region. The cattle bedding and feed market is tolerant of poor feedstock quality and accounts for only 5% of total wheat straw generated in the region. The raw RI Score is deemed low.	**1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score 6.66**

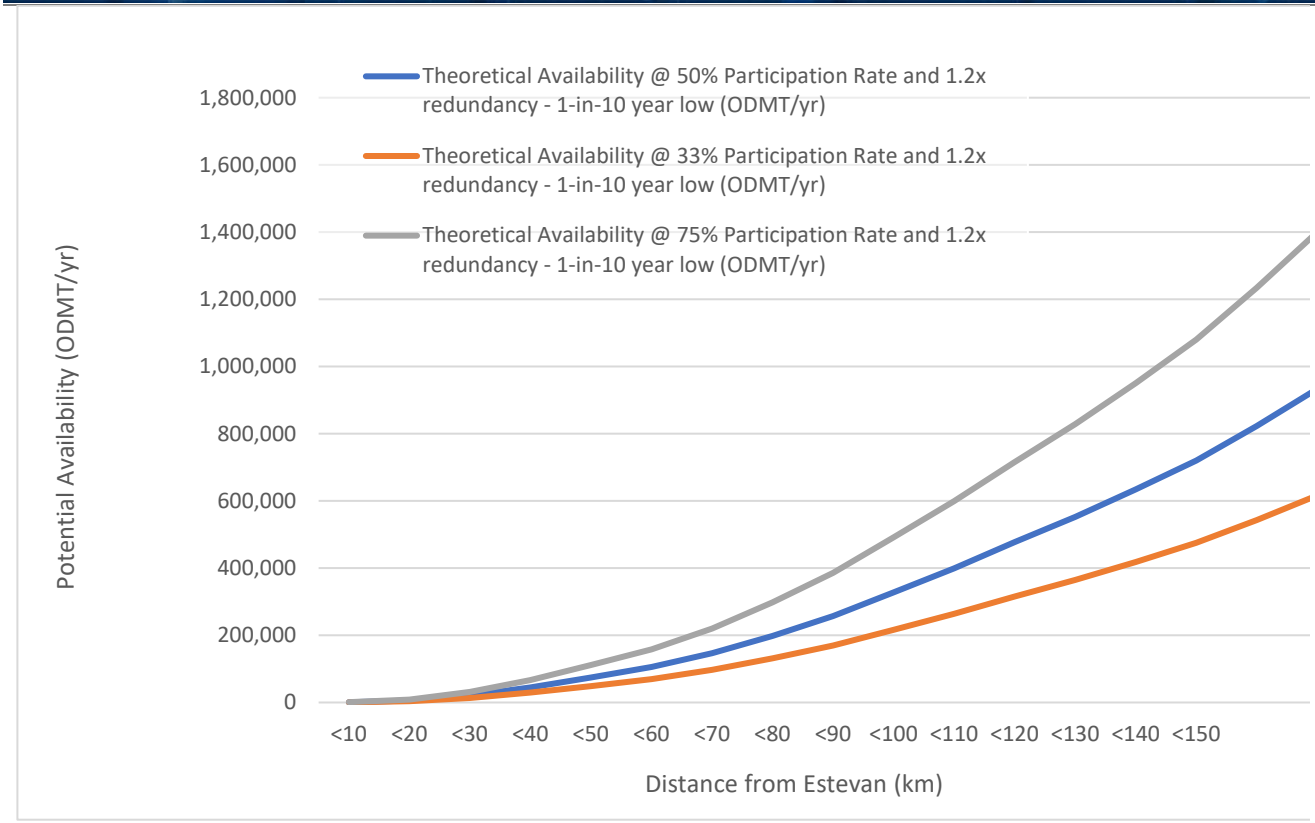
2.2.4 Demand for Competitors' Products

Rationale: Increased demand for competitor's product can cause an increased demand for feedstock by the competitor, given the competitor can increase its production capacity easily. For example, an increased demand for biofuels due to a clean fuels policy can cause increased biofuel production by the competitor, thereby increasing demand for feedstock.	**Score**
Raw RI Score: There are no large-scale competitors for wheat straw in the region. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score** **Unnotched** **1**
Impact Level: RI Impact Level is deemed *moderate*.	**Score** **6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 6.66 out of 100.	**Score** **6.66**

Category 3: Supply Chain Risk

3.1.1 Biomass Availability Multiple (BAM)

Rationale: Biomass Availability Multiple (BAM) indicates the degree of redundancy in a Proponent's supply chain. BAM is the ratio of biomass feedstock available to a project, at costs, timing, and in quality feasible for the Proponent, divided by the project's feedstock requirements. BAM is a strong indicator of supply chain resilience when stressed by supply shortage and/or supplier breach.	**Score**
Raw RI Score: BAM is represented by availability and cost curves projected in the future. Appendix B of this rating contains detailed information on the potentially available feedstock participation rates, costs, and distance curves. The raw RI Score is deemed *low*.	**1**



Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.1.2 Impact of Increased Utilization of Feedstock

Rationale: Feedstock utilization in a supply basin can change over time. Existing consumers of feedstock can expand operations or new facilities can enter the market. Increased utilization puts additional pressure on feedstock and can lead to higher prices, feedstock disruptions, shortages, or supplier breach.	**Score**
	3

Raw RI Score: Currently, there is no existing substantive wheat straw market and considerable supply is available. Increased feedstock utilization is represented by projected availability and cost curves, which are included in this rating. Raw RI Score is deemed *low*.

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 3**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97 out of 100.	**Score 29.97**

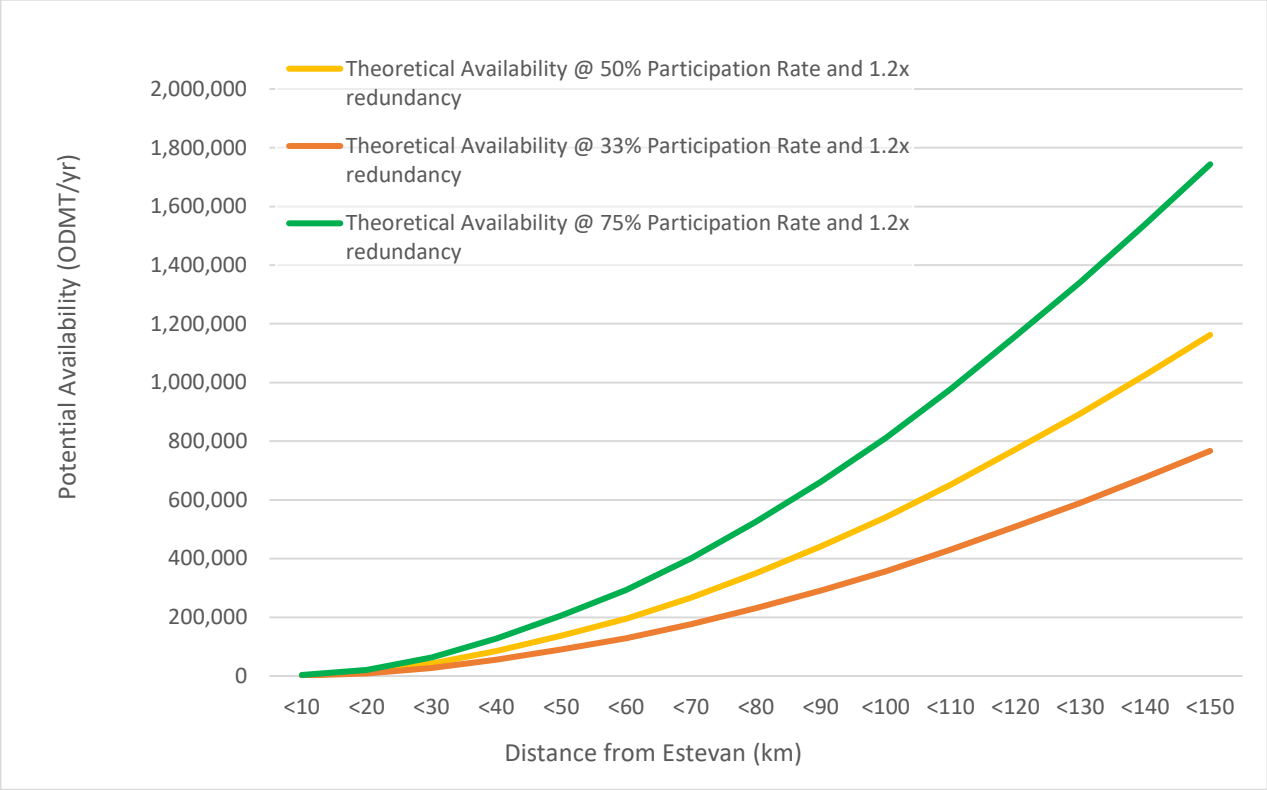
3.1.3 Feedstock Supply Curve / Marginal Cost Curve

Rationale: The greater the feasible transport distance, the more feedstock is accessible to the Proponent, but at a higher delivered cost. The feedstock supply curve, sometimes referred to as the marginal cost curve, is a function of feedstock availability over its cost, which is primarily, but not exclusively, a function of distance. The feedstock supply curve is used to determine the availability of redundant feedstock at various price points and the cost of replacing feedstock with substitutes located at different distances. **Score**

Feedstock cost curves are useful in determining supply chain resilience; they provide information about the cost of feedstock availability in times of supply disturbance. Biomass supply chains are prone to supply disturbances over time; suppliers can become insolvent, or weather events can temporarily disrupt feedstock availability. When a disturbance occurs, the Proponent may need to source replacement feedstock from different suppliers at different locations and costs. A biomass supply curve indicates quantities of feedstock available at various price levels from suppliers generally located farther away than core suppliers.

Raw RI Score: Appendix C of this rating contains supply curves representing feedstock availability based on price and distance of potentially available feedstock. As a result, the supply curves represent high-level estimates of feedstock availability based on assumptions derived from a sample of potential suppliers. **1**

Appendix C's supply curves assess the economic burden on a project procuring redundant feedstock from greater distances and under various stress scenarios (i.e., participation rates). The raw RI Score is deemed *low*.



Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.1.4 Seasonal Feedstock Supply Variation

Rationale: Biomass supply can present significant seasonal supply variations, which, combined with limitations associated with longer-distance transportation and storage, can lead to regional biomass supply imbalances (Golecha & Gan 2016) and can manifest in shortages and higher costs for Proponents.	**Score**
Raw RI Score: Wheat straw is only available during wheat harvesting, which takes place exclusively between late August and early October. There is no seasonal variation in feedstock supply. The risk of a short harvest window has been factored into the RI 1.9.1 score above. As a result, this risk indicator's Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched**

	1
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

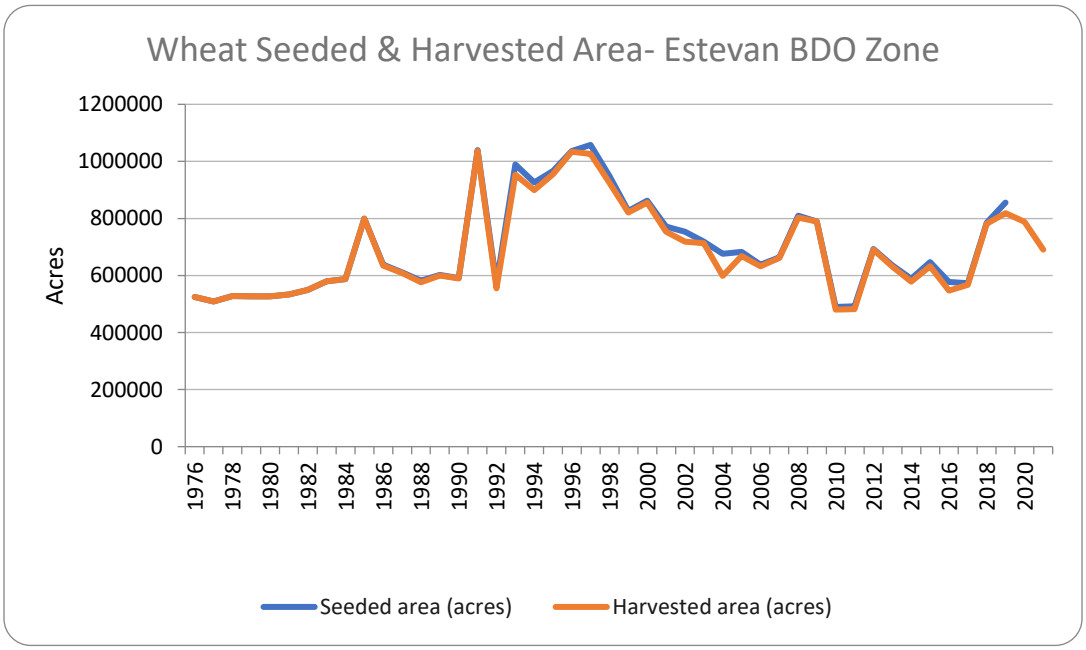
3.1.5 Year-to-Year Variation in Feedstock Availability

Rationale: Biomass can have significant year-to-year supply variations due to variability in yield from biomass harvesting operations, particularly with agricultural biomass. **Score**

Raw RI Score: Wheat straw is only available between late August and early October. Harvesting typically begins four weeks earlier in Estevan's northern regions than in the southern regions, with a four-week gap between them. The harvesting window varies from season to season due to weather. **9**

The variation in feedstock supply from year to year is determined by the number of wheat acres planted, the proportion of generated wheat left in the field, and the harvesting window.

The figure below shows annual variation of wheat seeded since 1976. Annual variations can be significant: between 2018 and 2019 there was an increase in seeded wheat by 8%, while between 2019 and 2021 there was a drop of 18%. These variations pose a significant risk to wheat straw supply.



The risk is heightened by the fact that many growers regularly leave wheat straw in the field for fertilization (likely every 3 years). This trend has the potential to increase the annual variability of potential wheat straw availability.

Dry weather can reduce the availability of wheat straw because it reduces wheat yields and because drier straw is more difficult to bale, especially when rotary combines are used (as they currently are in the majority of cases here). Raw RI Score is deemed *high*.

Notched Salience: The large BAM in the BDO Zone, which provides significant feedstock redundancy, as well as the planned inclusion of >18 months' worth of on-site inventory capacity, could significantly mitigate RI 3.1.5. The cost of additional transportation is relatively low in comparison to the total feedstock costs (see supply curves in Appendix B). This relatively minor additional cost due to year-to-year supply variation is shown in Table 12 of Appendix B, in the 1-in-10- and 1-in-20-year low columns. As a result, Raw RI Score is notched by 75%: Notched Salience is 2.25.	**Score notched 2.25**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 22.48 out of 100.	**Score 22.48**

3.1.6 Double-Counting Feedstock

Rationale: Aggregators, intermediaries, or brokers organize and distribute feedstock produced by suppliers. If such sources of supply are used in assessing feedstock availability for BAMs or supply curves, Proponent should be sure not to double count feedstock produced by one supplier and traded/supplied by an intermediary.	**Score**
Raw RI Score: Feedstock availability estimates are based on estimates of what is directly available from growers and results from adjacent regions. There is no risk of double-counting in our method. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.1.7 Front-End Validation of Data Used in Feedstock Availability Models

Rationale: Feedstock supply models can be complex. Lack of clarity about model assumptions and baseline data can result in confusion on the part of the capital markets and drive financing costs for biomass projects. The adequacy and credibility of assumptions and baseline data is paramount to credible model outputs.	**Score**
Raw RI Score: Appendix B of this rating contains a list of all assumptions used in the development of feedstock supply curves. The assumptions are based on verbal feedback from a number of local growers in the BDO Zone. Other theoretical approaches, such as the BIMAT (Biomass Inventory Mapping and Analysis Tool) model, were used to validate these assumptions. Raw RI Score is deemed *low.*	**1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.2.2 Feedstock Production Priority

Rationale: If Proponent's supply basin does not have a history of developed, large-scale feedstock procurement, suppliers may not have sufficient expertise in feedstock production to ensure reliable supply, especially early on. This can be particularity true for forest residues, where typically the infrastructure for collection, processing, and delivery is immature. Where supply chains are not well-established, risk can be mitigated if Proponent controls a higher degree of feedstock processing. For example, if Proponent requires clean wood chips and the historical demand in the woodshed is exclusively for pulpwood, then supply chain risk will be decreased by Proponent's intake of pulpwood and internal log debarking and chipping, rather than requiring inexperienced suppliers to deliver debarked wood chips.	**Score**
Raw RI Score: There is no history of developed, large-scale wheat straw consumers in the supply basin. Suppliers' lack of expertise in feedstock production poses a significant risk of unreliable supply. Raw RI Score is deemed *high*.	**9**
Notched Salience: Outsourcing harvest and collection to a credible third-party baling company or providing similar services through a vertically integrated bio-project could significantly reduce RI 3.2.2. As a result, Raw RI Score is notched by 50%: Notched Salience is 4.5.	**Score Notched 4.5**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 14.99 out of 100.	**Score 14.99**

3.2.3 History of Production / Feedstock Is a Secondary Crop or a By-Product

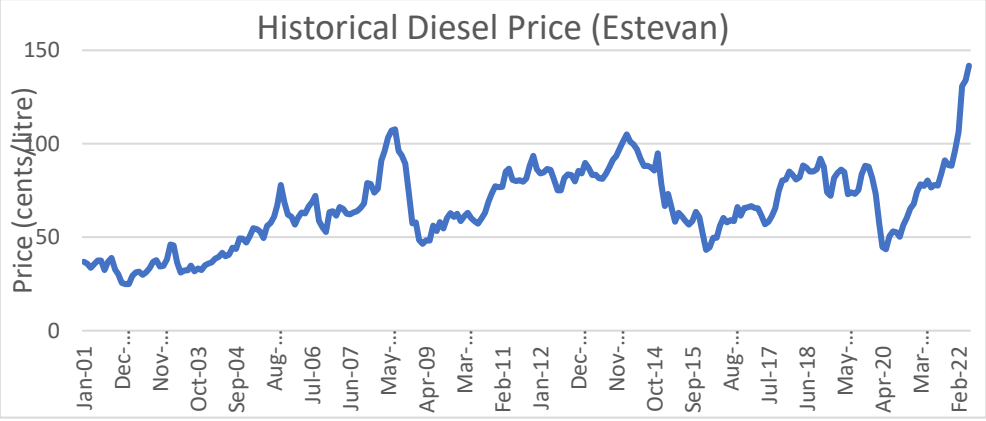
Rationale: If feedstock is a new/secondary crop or a by-product, suppliers may either lack sufficient experience to mitigate risk or be unable to react to such risk. Secondary crop or by-product producers may be less likely to prioritize production. For new crop types, inexperience in planting, harvest, collection, and yield data may pose higher levels of risk. If feedstock is a secondary crop, then production can be subject to variables beyond suppliers' control (e.g., changing primary crop prices).	**Score**
Raw RI Score: There is no history of producing wheat straw on a large scale in the BDO Zone. Feedstock is a by-product of wheat production.	**10**

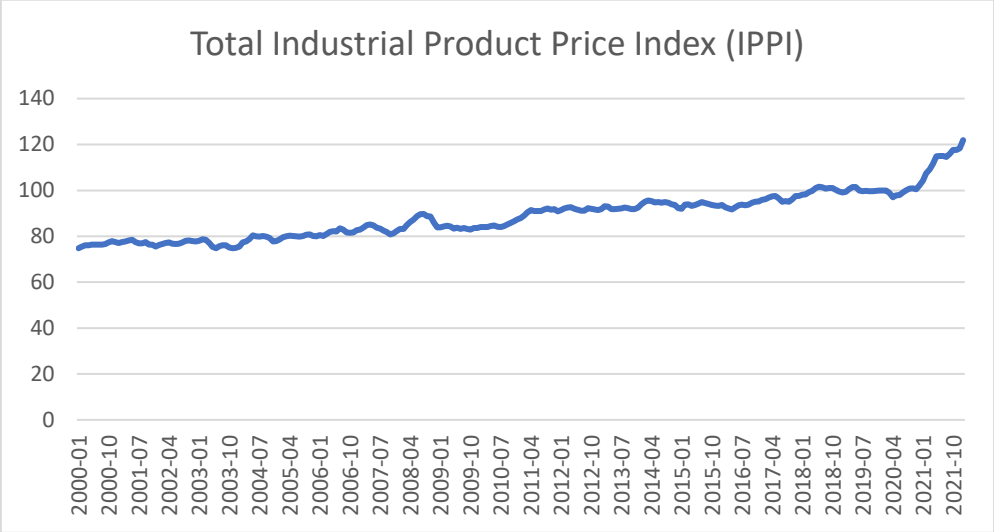
Wheat straw production is proportional to wheat production. The potential availability of wheat straw is determined by the number of wheat acres planted, the weather, and the type of wheat. The number of wheat acres planted each year is influenced in part by crop prices. Growers will plant less wheat and more of other crops if they believe wheat prices will be low and other crop prices will be high (growers often make planting decisions a few months before seeding).
Raw RI Score is deemed *high*.

Notched Salience: RI 3.2.3 could be broadly mitigated by the large BAM and relatively flat supply curve. The cost of additional transportation is relatively small compared to the total cost of feedstock. As a result, Raw RI Score is notched by 75%: Notched Salience is 2.5.	**Score Notched 2.5**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 8.33 out of 100.	**Score 8.33**

3.3.1 Diesel, Oil and Producer Price Index (PPI)

Rationale: Diesel, oil, and Producer Price Index (PPI) can impact feedstock cost of harvest and collection over time. Sensitivities to worst case scenarios should be run.	**Score**
Raw RI Score: The delivered cost of wheat straw is affected by the price of diesel/oil and the PPI. The cost of baling and transportation is directly affected by the price of diesel. The PPI has an indirect impact on baling and transportation costs via labour costs. The graph below depicts historical diesel prices in Estevan, SK over the last ten years. The price of diesel is volatile. The industrial product price index (IPPI), on the other hand, shows little year-to-year volatility and continues to rise. Raw RI Score is deemed low.	**4**





Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 4**
Impact Level: RI Impact Level is deemed *low*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 26.64 out of 100.	**Score 26.64**

3.3.2 Currency Risk

Rationale: If Proponent's supply basin does not have a history of developed, large-scale feedstock procurement, suppliers may not have sufficient expertise in feedstock production to ensure reliable supply, especially early on. This can be particularity true for forest residues where typically the infrastructure for collection, processing and delivery is immature. **Score**

Where supply chains are not well-established, risk can be mitigated when Proponent controls a higher degree of feedstock processing. For example, if a Proponent requires clean wood chips and the historical demand in the woodshed is exclusively for pulpwood, then supply chain risk will be decreased by Proponent's intake of pulpwood and internal log debarking and chipping, rather than requiring inexperienced suppliers to deliver debarked wood chips.

Raw RI Score: While we have not included US feedstock in the summary feedstock quantity numbers, it is a large available source that could be tapped if local Canadian growers did not participate as expected. In this situation there would be currency risk. Raw RI Score is deemed *moderate*. **6**

Notched Salience: The risk can be mitigated by a robust hedging policy. As a result, Raw RI is notched by notched by 50%; Notched Salience is 3.	**Score Notched 3**
Impact Level: RI Impact Level is deemed *moderate*.	**Score**

	6.66
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 19.98 out of 100.	**Score 19.98**

3.3.3 Border Risk

Rationale: Where feedstock is transported to another country, there is risk exposure to border closures and crossing delays. The availability of trucks willing to do cross-border runs is limited, which can decrease supply chain flexibility and resilience. Plants near the US-Canada border which intake feedstock from both countries are exposed to these risks.	**Score**
Raw RI Score: While we have not included US feedstock in the summary feedstock quantity numbers, it is a large available source that could be tapped if local Canadian growers did not participate as expected. In this scenario there could be exposure to border risk. Raw RI Score is deemed *moderate*.	**6**
Notched Salience: The risk of border delays and closures can be mitigated to a certain extent by inventory management for the amount that is sourced across the border. Raw RI score is notched by 50%; Notched Salience is 3.	**Score Notched 3**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.3.4 Temporary Externality-Driven Markets for Feedstock

Rationale: Alternative, non-traditional, externality-driven competitors for feedstock can drive feedstock demand (and cost) in unusual circumstances. For example, a Proponent using corn stover as a feedstock would not typically compete with the higher-end animal feed market. However, in times of significant hay shortage (e.g., during drought), farmers may use corn stover as hay replacement, driving the price of stover feedstock and decreasing its availability for bio-projects (Bergtold 2018).	**Score**
Raw RI Score: No non-traditional and externality-driven markets for feedstock were identified. Raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.4.1 Harvest and Collection Practices and Schedules

Rationale: Differences in harvest timing and practices can create risk to both the quantity and quality of feedstock. For example, feedstock harvested by different suppliers in different windows can undergo different levels of exposure to sun, wind, and moisture, leading to variations in delivered feedstock quality. For example, agricultural feedstocks and energy crops have optimal harvesting windows to ensure minimal moisture content. In certain regions these harvesting windows may coincide with heightened weather risk, such as frost or rain.	**Score**
Raw RI Score: Wheat harvesting season lasts from late August to early October. Harvesting time varies by four weeks between the supply basin's southern and northern regions. Because of the weather, the harvesting window may be reduced. Wheat straw must be baled and transported as soon as it is harvested. Growers said they would not tolerate wheat straw laying in bales in their fields. Dry weather can have a negative impact on the quality and quantity of feedstock. For example, it can reduce wheat yields, resulting in the production of less wheat straw. It can also cause wheat straw to dry out to the point where it is difficult to bale. This is especially true when rotary combines are used, which exacerbates the impact of dry weather. There will be no public backlash against feedstock production, collection, or delivery. Raw RI Score is deemed *high*.	**7**
Notched Salience: The involvement of an experienced third-party baling company who uses square balers or vertical integration within the bio project could significantly reduce RI 3.4.1. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score Notched 3.5**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 23.31 out of 100.	**Score 23.31**

3.4.2 Harvesting and Collection Equipment

Rationale: Different types of harvesting and collection equipment used by suppliers can have a significant impact on the quality and availability of feedstock. Use of different types and combinations of harvesting, collection, and processing equipment among suppliers can lead to non-homogeneous feedstock. Equipment that is not designed specifically for biomass cultivation, harvesting, and collection can increase feedstock quality risks. Relevant equipment should be specified for the sake of product consistency and risk reduction.	**Score**
Raw RI Score: The conventional combine is the best type for harvesting wheat straw in terms of yield. Wheat straw produced by conventional combines is relatively long, making it easier for balers to collect. Rotary combines, which produce more wheat than conventional combines but cut the straw into shorter lengths that are more difficult to bale, are a popular alternative. The vast majority of wheat growers in	**10**

the BDO Zone use rotary combines for this reason; conventional combines are typically used only by wheat growers who also raise cattle and collect straw for bedding and feed. Square balers can handle short straw lengths with ease, but they are uncommon in the BDO Zone.

Because the harvesting and collection equipment most commonly used in the supply basin is not designed for collecting/baling wheat straw, the raw RI Score is deemed *high*.

Notched Salience: Given the high capital investment and loss of primary crop yield, growers are unlikely to purchase conventional balers. For the same reasons, there is a low likelihood of large-scale investment in square balers by local growers to supply a bio-plant in the BDO Zone. RI 3.4.2 could be significantly reduced by outsourcing harvest and collection to a reputable third-party baling company capable of supplying square balers or by vertical integration within the bio-project. As a result, Raw RI Score is notched by 50%: Notched Salience is 5.	**Score Notched 5**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 33.30 out of 100.	**Score 33.30**

3.4.3 Variation in Densification Methods among Different Suppliers

Rationale: The shape and density of the unit in which feedstock is supplied can impact feedstock cost and quality. Standard feedstock densification modes for biomass consist of round or square bales, pellets, cubes, chips, or grindings. The size of wood fibre processed in a grinder is less homogenous than wood fibre processed in a chipper. Bales of different densities can absorb moisture at different rates. In certain cases, round bales have been viewed as problematic due to their uneven moisture content distribution (Huhnke 2018).	**Score**
Raw RI Score: The vast majority of balers available in the supply basin are round balers. If growers invest in square balers (which is unlikely due to capital costs), the resulting mix of round and square bales can result in a less homogeneous feedstock supply for a bio-project, including high variations in moisture content and problems with handling and processing equipment. Furthermore, round bales cost more to transport per tonne than square bales, though the difference is not that significant. Raw RI Score is deemed *moderate*.	**5**
Notched Salience: Outsourcing harvest and collection to a credible third-party baling company that can supply square balers and ensure homogeneous bale density and size or through a vertically integrated bio-project could significantly mitigate RI 3.4.3. As a result, Raw RI Score is notched by 50%: Notched Salience is 2.5.	**Score Notched 2.5**

Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 16.65 out of 100.	**Score 16.65**

3.4.4 Availability of Labour for Feedstock Production

Rationale: Skilled labour shortages can be difficult to remedy in the short term. Availability of suitable labour in an area can impact the ability to procure sufficient feedstock quantities on required schedules. Labour risks are higher for greenfield facilities where supply chains are not yet active; or for Proponents for whom large feedstock requirements or development of new (or expanded) supply chains demand significant additions to the local labour force.	**Score**
Raw RI Score: Labour for wheat straw collection and transportation is only required for the 4–6 week harvest period. We believe that transport companies will be able to handle the temporary increase in demand because this is a common dynamic in agricultural markets: trucks could be brought in from other provinces and states if necessary. We are concerned about the existing labour force's ability to meet the increased demand for baling. A more immediate risk is a shortage of trained baler operators. Due to a current lack of markets for wheat straw and an underdeveloped supply chain, the number of trained baler operators is low. As a result, willing participants would need to be trained. The relatively short harvesting season means there is less time to train new baler operators. Raw RI Score is deemed *high*.	**7**
Notched Salience: RI 3.4.4 can be significantly mitigated by importing temporary labour and trucking equipment from other regions. In addition, all sub-risks in RI 3.4.4 could be significantly mitigated by outsourcing harvest and collection to a credible third-party baling company or by provision of similar services through a vertically integrated bio-project. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score notched 3.5**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 23.31 out of 100.	**Score 23.31**

3.5.1 Feedstock Transportation Costs

Rationale: Transportation can be one of the most significant cost components of biomass supply chains. The average transport cost and percentage of total feedstock cost attributable to transport should be known.	**Score**
Raw RI Score: We estimate that transportation costs account for about 10% to 15% of total feedstock delivered costs. Given that a minor increase in average transport distance results in a significant expansion of the feedstock supply basin (see supply curves), we consider the risk of rising transportation costs significantly impacting the delivered price of feedstock to be low.	**3**

To avoid jeopardizing future negotiations between markets and growers, detailed transportation calculations are not included in this rating. The raw RI Score is deemed *low/moderate*.

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 3**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.6.1 Number, Size, Mix and Locations of Suppliers

Rationale: In general, a supply portfolio involving multiple suppliers of various sizes (and from multiple regions) is important for ensuring steady and uninterrupted feedstock supply with minimal price fluctuations. If a small number of large suppliers provides a high proportion of total feedstock, a disruption or supplier breach will have a greater impact on the supply chain. In such cases the risk of disruption is lower, but the impact of those disruptions is higher. Conversely, a large number of small suppliers are less likely to have the capacity to withstand internal disruptions and thus may be more likely to breach. Here, risk of disruption is higher, but its likely impact is lower. The number of suppliers as well as the ratio of small to large suppliers should be optimized. There is no pre-determined number or optimal ratio of suppliers, although having too many or too few can both pose higher degrees of risk.	**Score**
Raw RI Score: There are numerous viable potential feedstock suppliers in the area. Based on our previous studies, a large-scale project would require between 150 and 250 growers. A large number of suppliers can reduce feedstock risk because isolated failures would not have a significant impact on the entire supply chain. Feedstock supply chains of this size, on the other hand, can be more difficult to coordinate. The raw RI Score is deemed *moderate*.	**5**
Notched Salience: The large number of potential suppliers can make coordinating the supply chain potentially more complicated and costly. Because the number of suppliers could impact the interest and effectiveness of a third-party baling company as a mitigant to other RIs, Raw RI Score notched by 125%: Notched Salience is 7.5.	**Score Notched 7.5**
Impact Level: RI Impact Level is deemed *high*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 49.95 out of 100.	**Score 49.95**

3.6.2 Suppliers Subject to Same External Risk Factors (Non-Weather and Equipment Based)

Rationale: When a single risk event can impact the feedstock production ability of all (or most) suppliers, then feedstock risk is higher and supply chain resiliency is lower. Resilience is maximized when biomass supply chains exhibit diversity in spatial location (i.e., geography), production practices, and other	**Score**

elements of supply chain structure such that the impact of single high-risk events has varying impacts on suppliers.

9

Raw RI Score: Wheat straw suppliers face risks related to falling wheat prices, which may force growers to switch to other crops. The raw RI Score is deemed *high*.

Notched Salience: The radius of the supply basin could be expanded to significantly reduce RI 3.6.2, including into the United States. Supply curves show widespread availability at a marginally higher cost. On-site bale inventories of more than 18 months can help to smooth out typical moderate fluctuations in straw supply. Farmers who enter into supply contracts with a bio-project would consider their profit from straw in addition to primary wheat generation. This additional income may keep wheat planting competitive (in terms of farmer profit), even if other crops become marginally more valuable in certain years. As a result, Raw RI Score is notched by 50%: Notched Salience is 4.5.	**Score Notched 4.5**
Impact Level: RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.7.1 Seasonal Weather Impacts on Feedstock Supply

Rationale: Seasonal weather impacts are defined deriving from natural weather variations (i.e., spring thaws, rainy seasons or dry seasons) as opposed to singular weather events (like fires, droughts or hurricanes). Seasonal weather changes can be a significant risk factor affecting feedstock availability, quality, and price. **Score**

Given the major influence that weather has on multiple aspects of growing, harvesting, and transporting biomass, it is difficult to predict the availability of biomass at a given location with a high degree of certainty. However, it is still possible, using past data and statistical models, to generate reasonable upper/lower bound estimates of biomass production in any given year in a wider supply basin. Such estimates are important in assessing feedstock risk and enable accurate assessment of the efficacy of Proponent's mitigation methods.

Raw RI Score: Weather can have a big impact on feedstock supply. Wheat production, and thus wheat straw availability, varies from year to year. Weather events (among other factors) may cause significant variations in yield, but the range of variance has been well tracked: 1-in-10-year low statistics and 1-in-20-year low statistics are published (BIMAT). Potential wheat straw availability is 59 percent of an average year's availability within 10 kilometers of Estevan in a 1-in-10-year low wheat yield year, and 51 percent in a 1-in-20-year low wheat yield year. **7**

Wheat straw can be too dry for baling when the weather is dry (especially with rotary combines, which are common in the BDO Zone), resulting in lower wheat straw yields. Early winters can shorten the harvesting season, leaving less time for wheat straw collection (growers prioritize grain over collection of wheat straw). Dry weather reduces the potential availability of wheat straw because it reduces wheat yields and

because drier straw is more difficult to bale, especially when rotary combines are used (which they are in the majority of cases in the BDO Zone). Raw RI Score is deemed *high*.

Notched Salience: The region's large BAM; marginal cost increases due to longer transport distances; on-site bale inventories of more than 18 months; option agreements with redundant growers; and engagement of a credible third-party (or equivalent vertical integration of such service within a bio-project) to harvest/bale wheat straw from redundant growers could all help to mitigate RI 3.7.1. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score Notched 3.5**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 34.97 out of 100.	**Score 34.97**

3.7.2 Long-Term Weather and Climate Trends

Rationale: In certain regions, climatic trends and significant potential changes to future weather patterns can create feedstock risk.	**Score**
Raw RI Score: Although precise forecasting is impossible, regional temperatures are expected to rise as a result of climate change. The same risks would exist in drier weather as in 3.7.1. Raw RI Score is deemed *moderate*.	**5**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 5**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 49.95 out of 100.	**Score 49.95**

3.7.4 Risk of Infestation

Rationale: Risk of future infestation, including its estimated consequences on feedstock supply, should be calculated into the overall risk profile. Since insect populations are influenced by environmental conditions, future changes in climate can be expected to significantly alter the outbreak dynamics of certain insect species. In some cases, larger and more frequent insect outbreaks may occur, but in other cases recurring outbreaks may be disrupted or diminished.	**Score**
Raw RI Score: The use of a third-party baler could amplify RI 3.7.4. However historic data has shown that there have been only a few instances of crop disease around the supply basin. Importantly, no confirmed cases of club root disease have been reported in the Estevan BDO Zone. With proper management, most diseases can be controlled. Raw RI Score is deemed *moderate*.	**4**
Notched Salience: Proper management, such as ensuring equipment sanitization between fields, can help reduce the spread of infestations.	**Score Notched**

As a result, Raw RI Score is notched by 25%: Notched Salience is 3.0.	**3**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97out of 100.	**Score 29.97**

3.7.5–9 Risk of Extreme Weather Events—Hail, Flood, Drought, Hurricanes, Tornadoes, Strong Winds, and Extreme Low Temperature

Rationale: See BSCRS Standards RI 3.7.5 Risk of Hail; 3.7.6 Risk of Flood; 3.7.7 Risk of Drought; 3.7.8 Risk of Hurricanes, Tornadoes, Strong Winds; 3.9.7 Risk of Low Temperatures.	**Score**
Raw RI Score: Extreme weather events such has hail, flooding, and strong winds pose a limited risk to wheat straw availability in the Estevan BDO Zone. Raw RI Score is deemed *low*.	**3**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 3**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.8.1 Government Subsidies for Feedstock Production or Utilization

Rationale: Feedstock that is directly subsidized though government programs can pose greater long-term risk than feedstock that is not. Subsidies may be subject to amendment or repeal, sometimes with minimal notice. NOTE: This risk indicator refers to direct feedstock subsides only; it does not apply to government subsidies that pertain indirectly to the operations of the Proponent, such as Loan Guarantees, or to the markets for products produced by the Proponent.	**Score**
Raw RI Score: No government subsidies for feedstock exist at this time, including wheat. The raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *low*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.8.2 Local, Provincial, and National Laws, Regulations and Permitting Pertaining to Biomass

Rationale: Feedstock whose production is directly dependent on local, provincial/state, or national laws or government regulations can pose greater long-term risk than feedstock that is not, since laws and regulations may be subject to amendment or repeal. If utilization of biomass requires specific permits (i.e., percentage removal of forest residues or corn stover, allowable cut limits, air emission, storage permits, rights-of-way, overweight permits for trucks, cross-border permitting for shipment of biomass, chain of custody, or certification of sustainability) then likelihood of obtaining such permits and/or complying with permitting requirements should be examined.	**Score**
Raw RI Score: Wheat straw supply is not governed by any laws, regulations, or permits issued by the government. The raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.8.3 Backlash Against Biomass Development, Procurement or Usage in the Region

Rationale: Public backlash against biomass development in the Proponent region can directly impact Proponent's ability to procure, transport, trans-load, store, or utilize feedstock by affecting local policies, regulations, and Proponent's ability to obtain necessary permitting.	**Score**
Raw RI Score: No backlash against biomass development is expected. The raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *low*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.8.4 Consent of, and Co-Operation With, Indigenous Communities and First Nations

Rationale: Where new project development is on or near Indigenous or First Nation land, or when? Indigenous or First Nations exert influence over feedstock producing areas, consent of, and co-operation with, Indigenous communities and First Nations decreases Proponent risk.	**Score**
Raw RI Score: No Indigenous communities that would be impacted by wheat straw production or procurement were identified in the supply basin. The raw RI Score is deemed *low*.	**1**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched**

	1
Impact Level: RI Impact Level is deemed *low*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.9.1 Feedstock Sustainability, Including Risks to Soil Quality and Surface and Ground Waters

Rationale: Understanding a project's overall emissions and carbon intensity throughout the feedstock supply chain is essential to reducing risks related to carbon pricing mechanisms and related regulations. GHG emissions from production, harvest, and transportation can be a significant challenge to Proponent claims of carbon neutrality for biomass projects. Carbon emissions from harvested soils, as well as emissions from harvesting machinery or delivery trucks, can make the achievement of net-zero GHG emissions difficult. If a Proponent's financial model relies on carbon neutrality/GHG regulatory pricing frameworks, then an investigation into the feedstock's carbon emission status is essential.	**Score**
Raw RI Score: The vast majority of wheat straw is currently used as a fertilizer in the field. If significant quantities were diverted to the Project/removed for use as bio-project feedstock, replacement fertilizer would be necessary. The perceived impact of wheat straw removal on soil quality may influence participation: not all suppliers will agree to wheat straw removal. Even growers who agree to supply must leave wheat straw in the field every three years. The raw RI Score is deemed *moderate*.	**5**
Notched Salience: RI 3.9.1 could be significantly mitigated by using fertilizer as a replacement for wheat straw that would otherwise have remained in the fields. Prices for wheat straw must be higher than the cost and perceived inconvenience of using fertilizer. As a result, Raw RI Score is notched by 50%: Notched Salience is 2.5.	**Score Notched 2.5**
Impact Level: RI Impact Level is deemed *low*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 8.33 out of 100.	**Score 8.33**

Category 4: Feedstock Quality

4.1.5 Geographic Location Influence on Feedstock Variability

Rationale Feedstock from different regions may differ in quality due to variations in soil quality, topography, harvest practices, weather, fertilizer applied, etc.	**Score**
Raw RI Score: There should be no significant variation in feedstock quality from feedstock harvested within the BDO Zone. Raw RI Score is deemed *low*.	**1**

Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 1, as they are already the lowest risk.	**Score Unnotched 1**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 9.99 out of 100.	**Score 9.99**

Category 5: Feedstock Scale-up Risk

5.1.2 Capacity of Supply Chain Components and Equipment to Scale

Rationale: Scale-up risk increases if supply chain components or underlying feedstock infrastructure necessary for these components cannot scale to handle Proponent feedstock requirements and throughput capacity. Capacity to scale should be demonstrated**.**	**Score**
Raw RI Score: Estimates of wheat straw quantities in the BDO Zone indicate the ability to support a large-scale project (see feedstock supply curves). However, the supply basin's baling equipment is insufficient to support a large-scale project at present. The current use of round balers in conjunction with rotary combines presents a high risk as round balers are ineffective for baling straw processed by rotary combines. Individual growers are unlikely to invest in more efficient baling equipment. There is a high risk that baling equipment would not scale, especially in the short term. Labour availability may be an issue as well, as discussed above. Raw RI Score is deemed *high*.	**8**
Notched Salience: RI 5.1.2 could be moderately mitigated by outsourcing harvest and collection to a credible third-party baling company or by vertically integrating in the bio-project. As a result, Raw RI Score is notched by 25%: Notched Salience is 6.	**Score Notched 6.0**
Impact Level: RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Score × Impact Level) is 59.94 out of 100.	**Score 59.94**

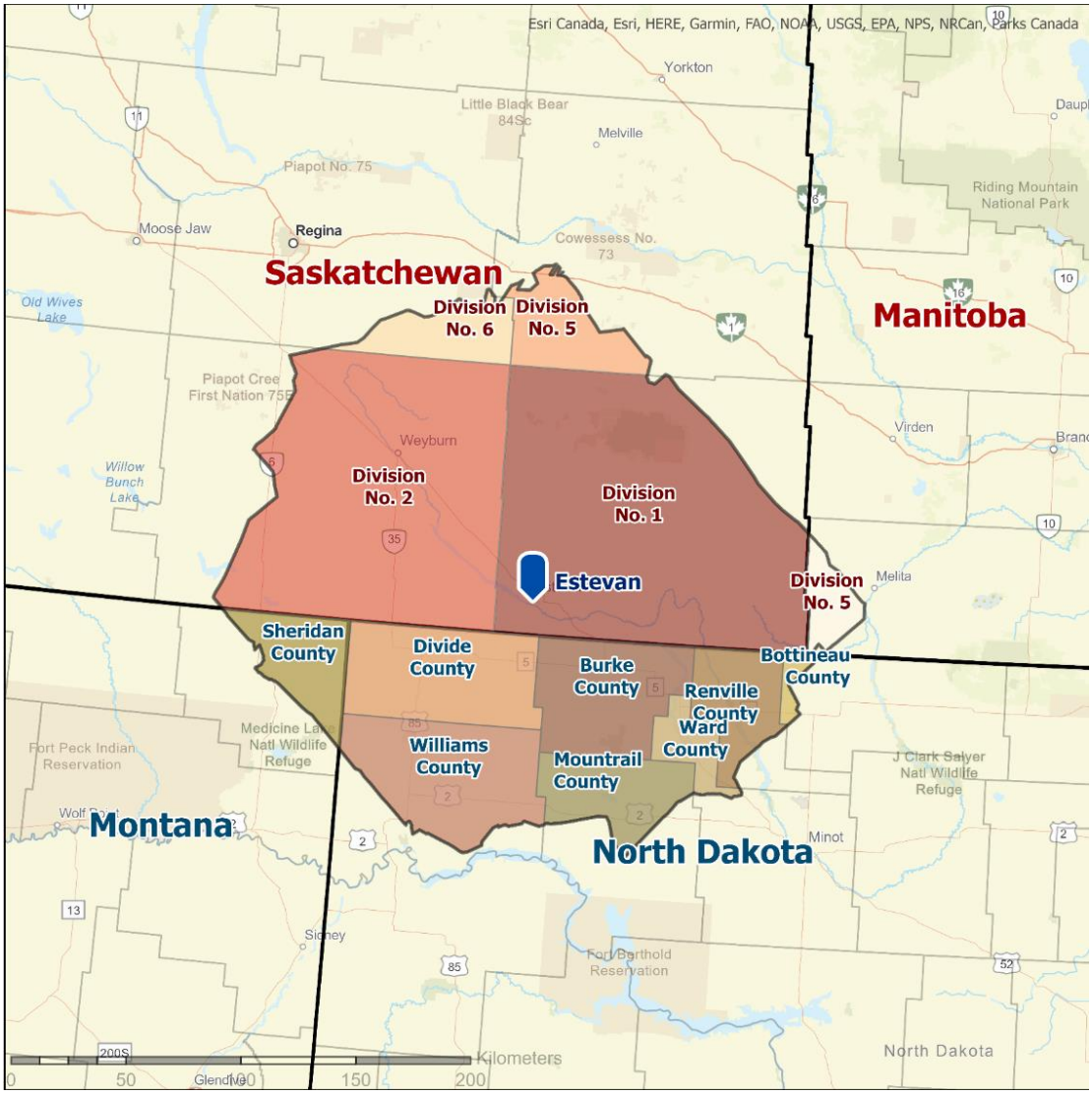
APPENDIX B : BDO Zone Designation

This appendix serves as a wheat straw availability background study to the BDO Zone Risk Rating for the City of Estevan, SK.

Background Research and Assumptions

The City of Estevan is close to the US border and when we extend the supply basin to 150 km, much of the southern portion falls into the United States. Currently there are a phytosanitary and an inspection requirement for wheat straw sourced and transported to Canada from the United States. These do not appear to be significant barriers at present, but there is always some uncertainty about future border and regulatory changes. Considering the US supply, 680,400 ODMT is available at a 50% participation rate for a supply radius of 150 km.

Map 1: Feedstock supply basin



Current Demand

Presently, there are no large-scale facilities consuming wheat straw in a 300 km zone around Estevan, SK. Cattle feedlots are the only significant consumers of wheat straw in the region, accounting for an estimated 5% of generated wheat straw. The remainder is left in the fields after the grain is harvested.

Outreach and Assumptions

Based on our previous studies and information from adjacent areas, we have assumed three levels of famer participation rates: 33%, 50%, and 75%. Since the current demand for wheat straw is limited in the supply area, we assumed up to 75% of farmers would be willing to supply their wheat straw as feedstock for future bioconversion projects. On the other hand, it is assumed the farm participation rate could be as low as 33% as many farmers may prefer to leave wheat straw in the field as a fertilizer replacement. A farm participation rate of 50% has been considered as the most likely scenario to estimate the average wheat straw availability in the supply basin.

Overview of Results

The graph below depicts a summary of all feedstock availability projections both on the Canadian and US sides of the supply basin. Within 150 km of Estevan from the Canadian side, the Project would likely acquire a feedstock of 318,000 ODMT (oven dried metric tonnes)/yr under the 33% participation rate; 482,000 ODMT/yr under the 50% participation rate; and 723,000 ODMT/yr under the 75% participation rate.

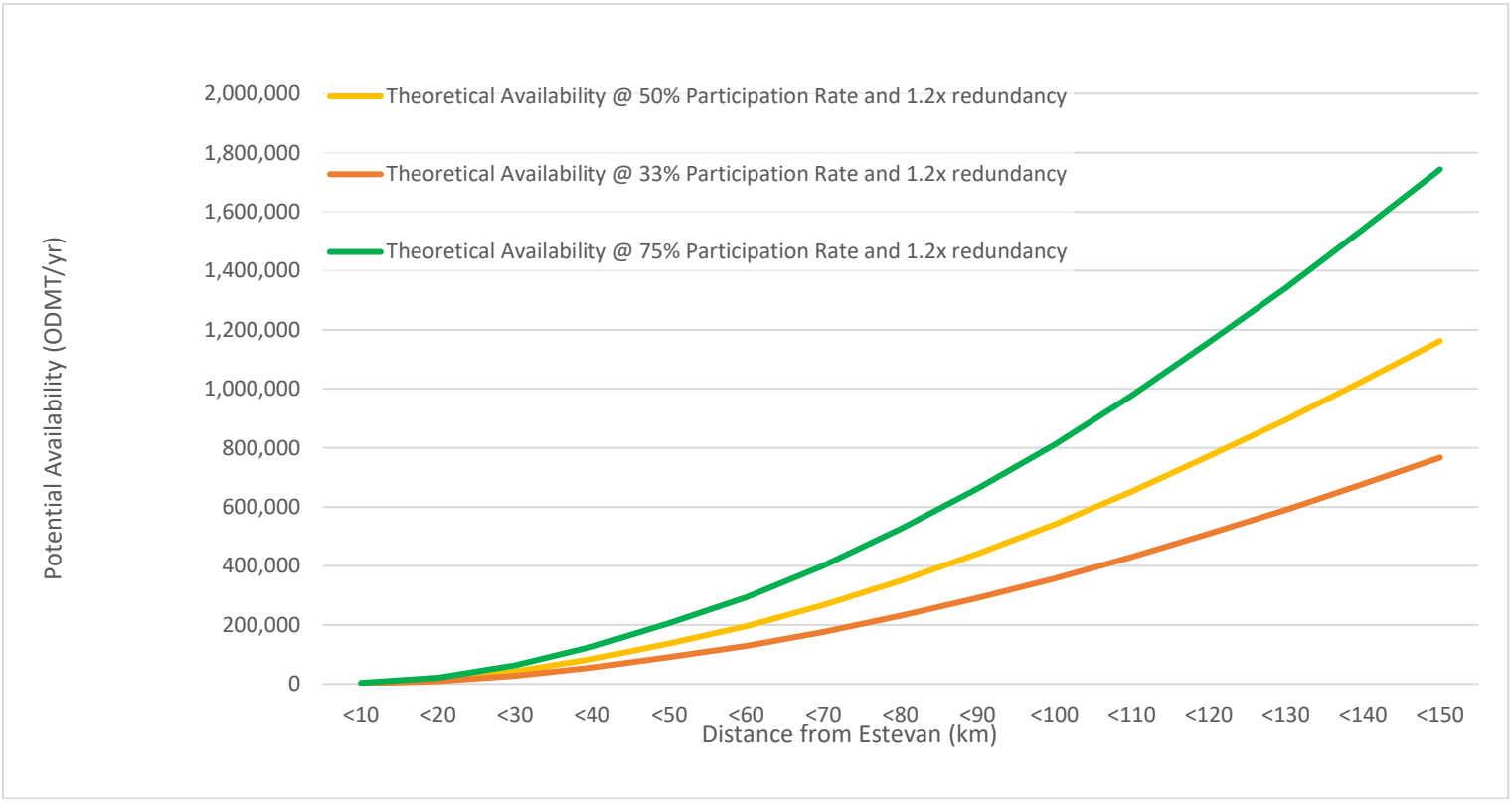


Table 1 indicates the average projected feedstock cost assuming a facility feedstock intake of 300,000 ODMT/yr. There is a small difference in the average delivered feedstock cost between participation rates because incremental transportation cost is a relatively small portion of the total cost.

Table 1: Average feedstock price in $/ODMT

	75% participation rate	50% participation rate	33% participation rate
Average	76.66	82.06	87.46

Overview of Risks

We identified five high-level areas of risk:

- **Underestimating wheat straw price**. This risk can likely be mitigated through fixed-price contracts.
- **Lack of interest from large growers during study outreach**. This risk can likely be mitigated through in-person visits and credibility building.
- **Lack of baling infrastructure and a third-party baler**. The lack of baling infrastructure can be mitigated by engaging one or more third-party baling companies.
- **Widespread use of rotary combines and round balers**. This risk can likely be mitigated by the use of a square baler (for example, by a third-party baler).
- **Dry weather negatively affecting the availability of wheat straw**. This risk can be mitigated by expanding the procurement radius.

1.0 About the Study

The purpose of the Study is to:

1. Provide the City of Estevan with a high-level analysis of wheat straw projected availability and cost and an understanding of feedstock supply risk.
2. Determine the City of Estevan's viability as a low-feedstock-risk site location and designate the City of Estevan as a Bioeconomy Development Opportunity Zone ("BDO Zone"), which includes a Feedstock Risk Rating based on the Standards for Biomass Supply Chain Risk.

Project Description

A proposed project for the construction of a biomass facility in the City of Estevan (herein referred to as "the Project").

2.0 Background Research and Assumptions

2.1 Supply Basin

The supply basin is an area around Estevan in which wheat straw can be economically sourced. In the agricultural residue supply chains, the supply basin is not constant. It is affected by changing availability of feedstock in the region; for example, if dry weather causes lower yields, the supply basin expands. That said, the supply basin is limited by the maximum cost of feedstock the Project can pay because transportation cost is a minor component of the final feedstock cost. For analysis purposes we looked at a region up to 150 km from Estevan at 10 km intervals (Map 2, p. 45).

The competition zone is defined as an area double that of the supply basin, or 300 km (Map 3, p. 46).

2.2 Current Demand

Presently there are no large-scale facilities consuming wheat straw within the 300 km competition zone.

Cattle feedlots are the only consumers of wheat straw in the region. Wheat straw is mostly used for bedding and sometimes for feed. Sokhansanj et al. (2006)[1] estimate that in the Prairies, 2.5% of generated wheat straw goes to cattle feedlots *and we estimate up to 5% in all following calculations*.

Due to the lack of significant markets for wheat straw, an estimated 95% of the total annual generation is left in the fields.

2.3 Supply Research and Assumptions

Potential Wheat Straw Availability

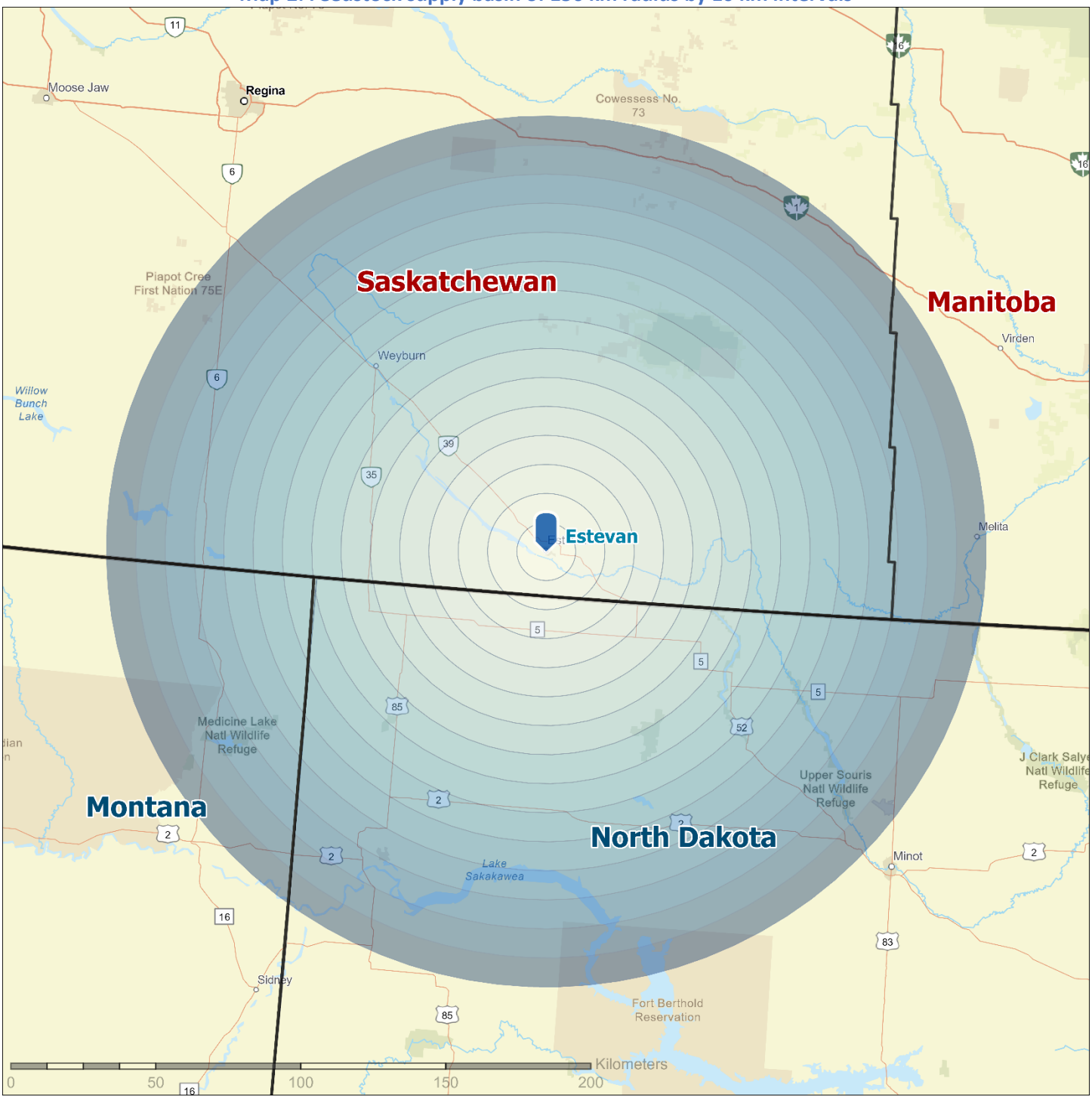
We utilized two approaches to determine the potential availability of wheat straw in the region. Potential (as opposed to actual) wheat straw availability is the amount of wheat straw that could be acquired from the supply basin. It does not consider the availability of equipment or other variables related to infrastructure that could affect actual availability. These variables are discussed later.

Approach 1: Theoretical Model

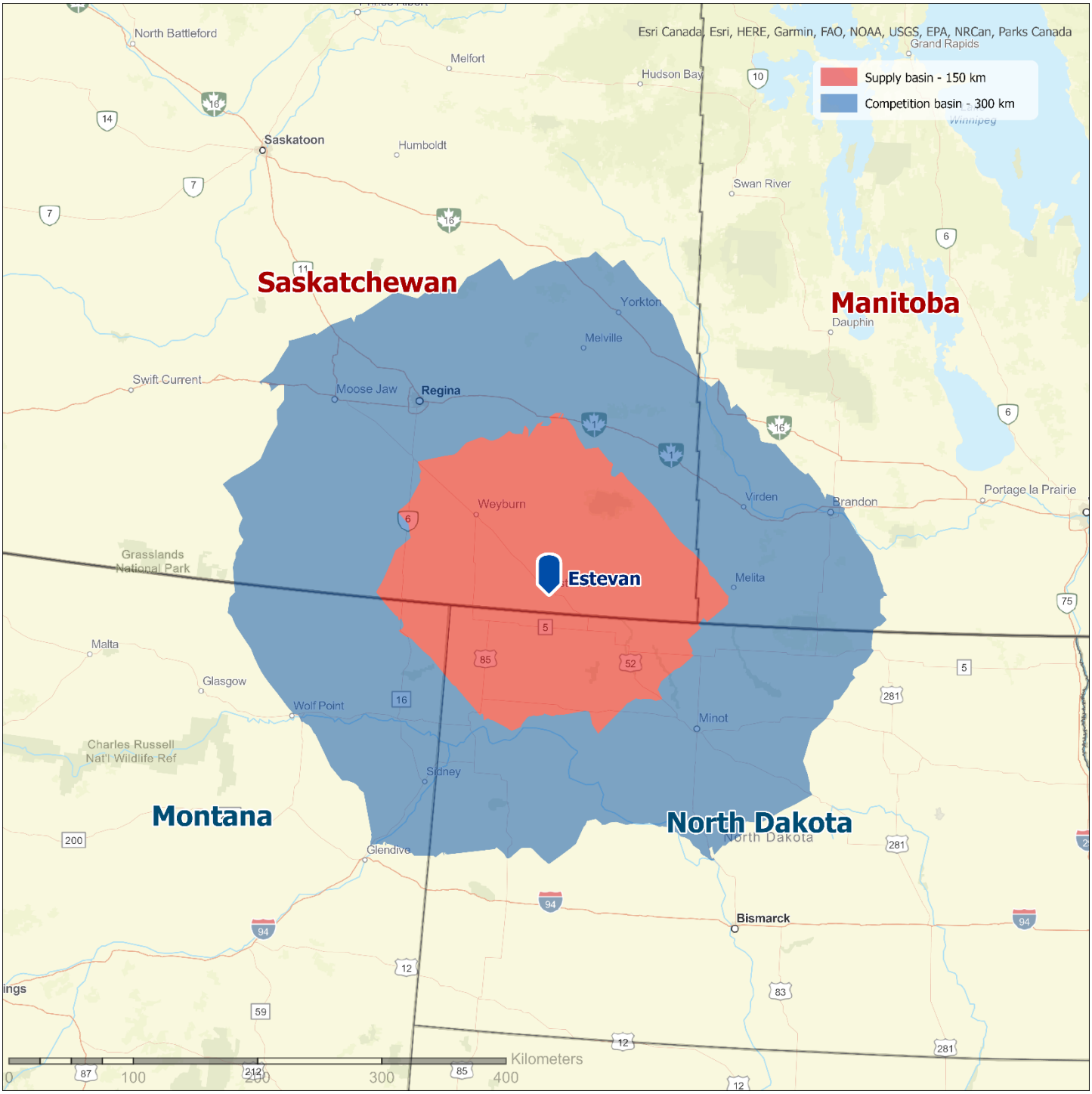
To estimate theoretical potential availability of wheat straw, we first used Agriculture and Agri-Food Canada's Biomass Inventory Mapping and Analysis Tool (BIMAT)[2] to determine potential wheat straw availability at each 10 km distance interval from Estevan. Since BIMAT provides data up to 2016 (based on data collected between 1985 and 2016), we acquired additional data from Statistics Canada and extrapolated BIMAT assumptions onto data for 2017 through 2021.

[1] Sokhansanj, S., Mani, S., Stumborg, M., Samson, R., and Fenton, J. (2006). Production and distribution of cereal straw on the Canadian prairies. Canadian Biosystems Engineering, Vol. 48.
https://www.researchgate.net/publication/236999871_Production_and_distribution_of_cereal_straw_on_the_Canadian_prairies
[2] Accessible through: http://www.agr.gc.ca/atlas/bimat

Map 2: Feedstock supply basin of 150 km radius by 10 km intervals



Map 3: Feedstock supply basin and competition zone



We developed a separate model to verify BIMAT's assumptions. The following are assumptions in our model:

- Total wheat straw that could be potentially acquired makes up between 60 and 80% of grain yield (in pounds). This estimate already includes losses due to chaff and stubbles[3].

- Tillage has not been considered for modeling purposes as this is the convention in the region.[4]

As previously stated, Prairie-wide estimates indicate that 2.5% of generated wheat straw is utilized as cattle bedding and feed, and we estimate 5% in our calculations.

Approach 2: Outreach to Farmers and Transport Companies in Adjacent Area

To determine farmers' willingness to supply wheat straw to the Project and to confirm wheat straw potential availability, assumptions based on previous studies in adjacent areas have been considered.

Farmers tend to provide estimates based on the bale and acre unit. For example, the price of wheat straw paid for by cattle feedlots is calculated per bale.

To determine the quantity of wheat straw per acre we assume a rough estimate of 2 bales per acre with approximately 0.5 MT per bale. We recognize the number of bales per acre varies between wheat straw farmers and cattle farmers.

Supply Curve Scenarios

Based on the above assumptions, we developed three potential wheat straw availability scenarios:

Expected scenario assumes 2 bales/acre with 0.5 MT/bale. This is the 'rule-of-thumb' assumption quoted by the majority of farmers interviewed in adjacent regions.

Upside scenario assumes 2 bales/acre with 0.6125 MT/bale. The 0.6125 MT/bale estimate is an average of estimates provided by farmers in adjacent region who did not agree with 0.5 MT/bale estimate.

Downside scenario assumes 1 bale/acre with 0.5 MT/bale. The 1 bale/acre estimate was provided by a custom baler in an adjacent area that used to bale for a processing facility. Although this estimate was the most conservative of those we gathered, we applied it because this baler is the only one we spoke with that had previously worked for a large-scale wheat straw processing facility.

Participation rates are based on the proportion of farmers that might be willing to supply feedstock and are estimated at 1/3, 1/2 and 3/4, which is 33%, 50%, and 75%.

Limitations to our methodology:

There are two main assumptions in the methodology:

1) Given fair wheat straw prices, farmers will be willing to supply;
2) Once the biomass facility is commissioned and the price of the straw becomes attractive and the supply chain develops, participation levels will increase.

[3] Chaff refers to small particles created through the harvesting process. Stubble refers to the part of the wheat plant that is left in the ground following harvesting.

Since a large-scale market for wheat straw does not exist, farmers may be underestimating the effort it takes to collect and bale wheat straw or underestimating potential problems (such as fertilizer replacement or twine left in the fields). Faced with the realities of actual wheat straw supply, some growers may decline to participate.

On the other hand, farmers who indicated that they are currently not interested in supplying may change their minds and supply once the Project demonstrates that it is a serious buyer and that wheat straw can be a significant source of income for them. Many farmers may be skeptical about the Project given the history of the failed Dow project in Manitoba. Additionally, farmers with negative experience in supplying straw for the cattle bedding market (for example, uneven demand or problems with twine left in the fields) might be initially reluctant to supply. This may change once the Project demonstrates it is a reliable and profitable wheat straw buyer.

Risks associated with assumption 1 are likely to be balanced out by assumption 2. Therefore, we keep the participation rates at 50%, 33%, and 25%, recognizing that more research needs to be done to understand the actual availability of wheat straw.

1-in-10- and 1-in-20-Year Lows

Wheat production, and therefore wheat straw potential availability, varies from year to year. 1-in-10- and 1-in-20-year low wheat yield statistics are available from BIMAT. By determining the percentage of annual potential availability that makes up the 1-in-10- and 1-in-20-year lows, we estimated the expected lows for each scenario. For example, BIMAT estimates indicate that during a 1-in-10-year low year, wheat straw potential availability is 59% of an average year (within 10 km of Estevan), and during a 1-in-20-year low, it is 51%. We then apply the 59% and 51% factors to the Expected, Upside, and Downside scenarios.

Wheat Straw Cost

With the exception of a relatively small cattle bedding market (estimated 5% of all potential wheat straw production), there is no other market for wheat straw. Therefore, an understanding of the market price is limited. The bedding market is scattered and unreliable and often operates based on a "special deal" basis (for example, when neighbours sell to neighbours at a discounted price).

There is no index that tracks the price of wheat straw in the region. For these reasons, we estimate price based on farmers' verbal indications from adjacent regions and the available prices of wheat straw in other parts of the Canadian Prairies.

Limitations: When interpreting prices verbally indicated by farmers, two limitations should be considered:

- Farmers provide 'ask' prices. In regular markets, ask prices tend to be higher than the market price as sellers attempt to raise prices. Therefore, reported 'ask' prices tend to overestimate the actual price.

- With high demand for feedstock, price can increase significantly. Farmers base their price indications on variables such as the cost of replacing fertilizer, the cost of baling, and the current market price for bedding straw. Once a large-scale facility significantly increases demand for straw, farmers may increase prices[4]. However, the large-scale facility should be able to provide a long-term fixed price which is favorable for many farmers to have a predictable fixed income from their crop residues.

[4] One way to mitigate price increases due to increased demand is through fixed-price contracts. At this point, however, we do not know whether farmers would be open to such agreements.

Tables 3 and 4 show the estimated price range for wheat straw in the BDO Zone at the farm gate, ready to be picked up by a truck to be delivered to a bioconversion facility. The price of wheat straw at the farm-gate includes the material cost, baling loose straw in a windrow, bale collection and stacking at the roadside of the crop field.

Material cost: Material cost refers to the price of wheat straw paid to the farmers, dictated by its nutrition value. Straw offers nutrients and minerals to crop land. Therefore, a producer may want to estimate the nutrient value of straw before they decide whether to sell it. If chemical fertilizer prices are high, a producer may be more reluctant to sell straw. When evaluating the nutrient value of wheat straw based on the price of fertilizers in 2018-2019, Farmers in adjacent areas indicated material cost, which ranged from $9 to $17.25 per bale, with an average of $11/bale. Assuming wheat straw moisture content of 14%[5] and 0.5MT of wheat straw per bale, material cost ranged from $21 to $46 per ODMT, with an average of $25/ODMT.

Baling and collection cost: This cost item includes straw baling, bale collection, and stacking at the roadside of the crop field. In an interview with a few local farmers and a custom harvest group, the farm-gate cost ranges $13.5-23/bale with the average value of $17/bale. The baling and collection cost varies as it depends on factors such as the type of baling and bale collection equipment, operator experience, the straw yield, bale density, and size of the field.

Total cost: Based on material, baling and bale collection costs indicated by farmers in adjacent regions and other parts of the Canadian Prairies, total wheat straw costs (delivered price supplier or farm-gate price) range between $20and $35.25 per bale, with an average of $26/bale. Assuming wheat straw moisture content of 14% and 0.5MT of wheat straw per bale, the total indicated cost for wheat straw delivered price supplier ranges between $46.51 and $81.97 per ODMT, with an average of $60.46/ODMT.

Note on cost ranges: Tables 3 and 4 indicate large ranges between the low and high costs. These ranges should be taken with caution as they are skewed by singular indications.

Table 3: Verbal price indications provided by farmers. Prices per bale

	Low	High	Average
Material Cost ($/bale)	$9.00	$17.25	$11.00
Baling and bale collection Cost ($/bale)	$11.00	$18.00	$15.50
Total Cost- Farm-Gate($/bale)	$20.00	$35.25	$26.00

Table 4: Verbal price indications provided by farmers. Prices per ODMT

$/ODMT assuming 0.5 MT per bale

	Low	High	Average
Material Cost ($/ODMT)	$20.93	$40.11	$25.58

[5] Reported wheat straw moisture content ranged between 10% and 18%, with an average of 14%.

Baling and bale collection Cost ($/ODMT)	$25.58	$41.86	$36.04
Total Cost- Farm Gate ($/ODMT)	$46.51	$81.97	$60.46

Transportation Cost

We acquired five verbal transportation cost indications, which were provided in $/km (Table 5). These rates include 1 hour of loading and 1 hour of unloading rates. Any additional time ranged from $100 to $120 per hour. The average indicated cost of transporting wheat straw is $0.35 per loaded km and per ODMT.

Note on minimum hours: Many trucking companies in the region are located at a distance to Estevan, and if engaged, they would need to bring trucks to the area. For this reason, a minimum number of hours is sometimes required; a company would not bring trucks in just for one haul.

Table 5: Transportation cost indications

Rates based on km travel		
Km	**Rate ($)**	**$/km**
25	450	18
50	500	10
75	550	7.33
100	600	6.00
125	650	5.20
150	700	4.67
175	750	4.29
200	800	4.00
225	850	3.78
250	900	3.6
Average		6.69

Indicated transportation rates provided above are expressed in $/loaded km for an entire load. For modelling purposes, we estimated cost per ODMT. First, we estimated the number of bales that can be fit on a trailer based on indications provided by companies (Table 6). Then we converted these estimates to MT per trailer (Table 7), arriving at a cost per km per ODMT (Table 8).

There are two types of trailers that are fit to transport round bales: 53" flatbed and super-B flatbed trailers. Between 30 and 34 (average 32) round bales fit on a 53" flatbed trailer and between 34 and 42 bales fit on a super-B flatbed (average 38)[6]. These estimates convert to between 18.38 and 20.83 MT/trailer (average 19.60 MT/trailer) for a 53" flatbed trailer and between 20.83 and 25.73 MT/trailer (average 23.28 MT/trailer) for a super-B flatbed. These estimates result in

[6] These verbal indications can be easily verified with more trucking and equipment companies.

transportation costs of $0.26/ODMT/loaded km and $0.22/ODMT/loaded km for a 53" flatbed and super-B flatbed trailers, respectively. We use the average $0.24/ODMT/loaded km cost estimate in modelling (Table 8).

Note that all estimates are based on round bales because the vast majority of balers currently available in the region are round. Round bales tend to be less efficient to transport than square bales. Therefore, to be conservative, we assumed bales are round.

Table 6: Number of bales per trailer indications

Source	Round bales/53" flatbed	Round bale/Super-B flatbed	Square bales/ flatbed	Square bales/trailer
1	34	42	48	60
2	30	34	50	64
Average	**32**	**38**	49	62

Table 7: Estimated number of MT per trailer

Source	Round bales/53" flatbed	Round bale/Super-B flatbed	Square bales/ flatbed	Square bales/trailer
1	20.83	25.73	19.68	27
2	18.38	20.83	25.00	28.80
Average	**19.60**	**23.28**	**22.34**	**28**

Table 8: Estimated transport cost $/ODMT/loaded km

Round bales/53" flatbed	Round bale/Super-B flatbed	Square bales/trailer	Square bales/53-ft triaxle
$0.40	**$0.33**	**$0.35**	**$0.27**

Appendix C: Supply Cost Curve Charts and Tables

The following are charts and tables with results from research conducted for the purposes of this BDO Zone development.

Figure 2. Theoretical availability of Wheat Straw at 33%, 50% and 75% participation rate and 1.2x redundancy including both Canadian and US sides of the supply radius

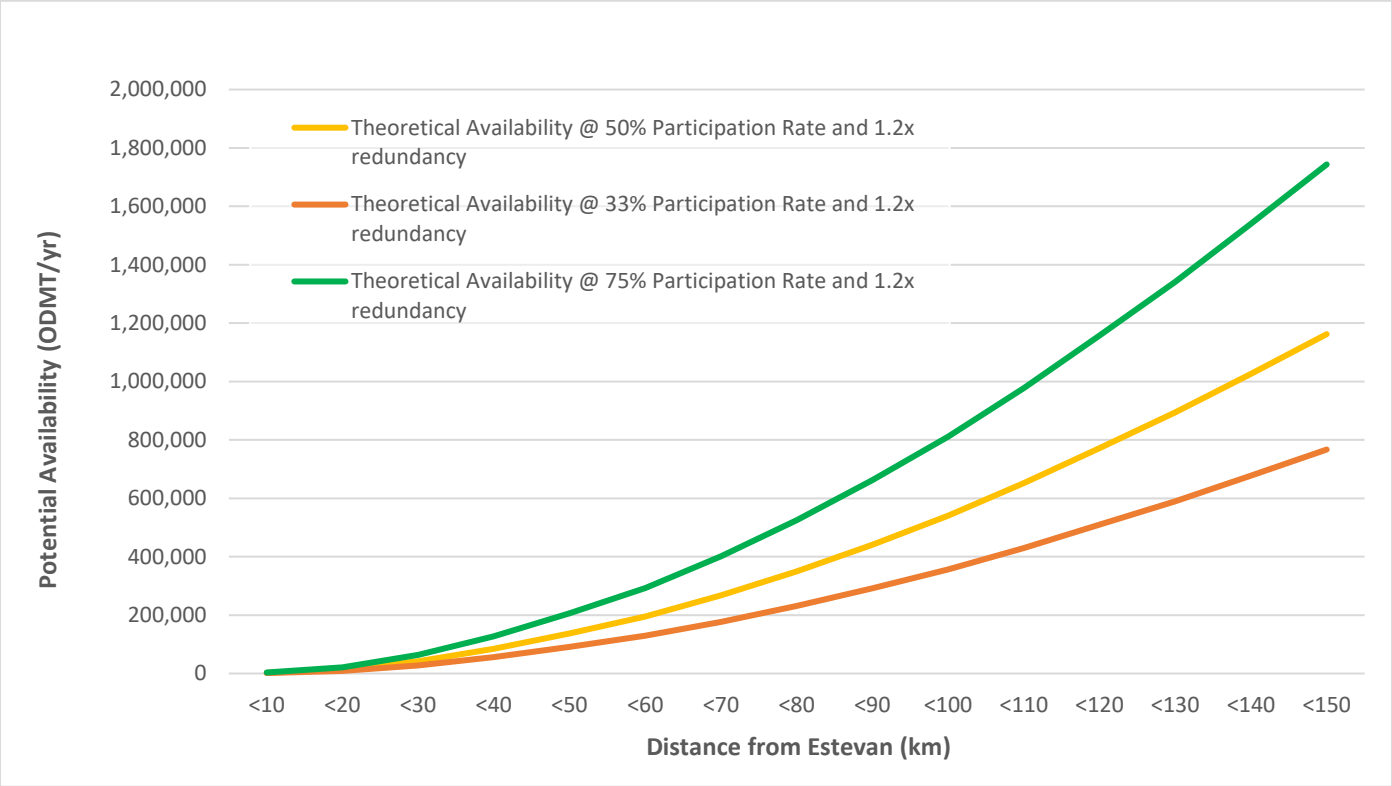
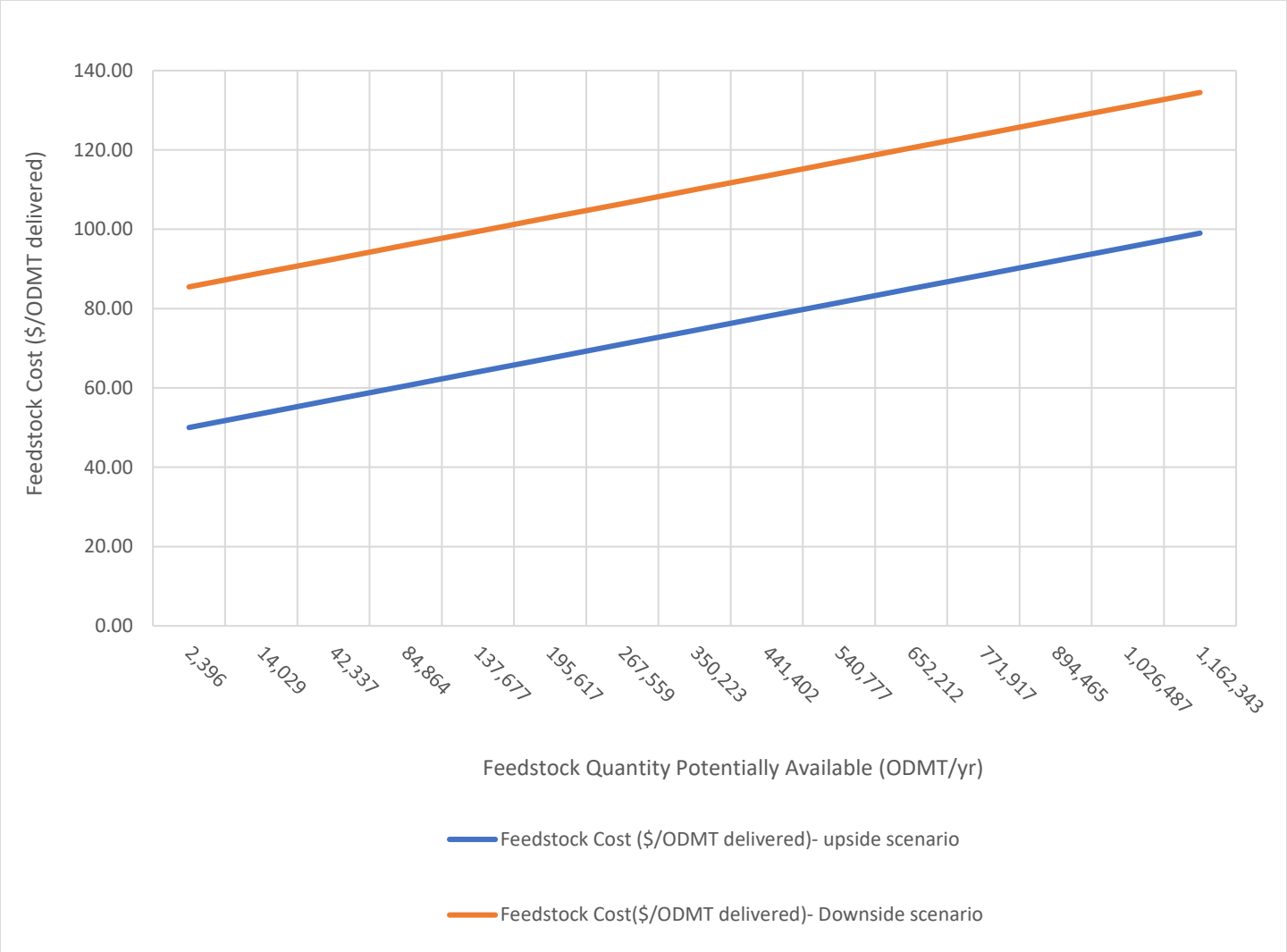


Figure 3. Marginal Flax Straw cost as a function of quantity potentially available



APPENDIX D: Legal Disclaimer

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