Natural Resource and Environmental Issues

Related to

Hog Expansion in Alberta

Prepared for:

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Animal Industry Division

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Executive Summary

Water, feed or crop land will not limit the potential for the Alberta pork industry to expand significantly. Sufficient groundwater supplies and surface water sources are available in specific locations throughout the province. Alberta's livestock industry consumes only 50% of the feed barley produced in the province. Alberta's rural areas are still predominately agricultural except close to the urban areas of Edmonton, Calgary, Red Deer, Lethbridge and Medicine Hat. Low population densities mean that new facilities can be introduced into many rural areas without expensive land consolidations to meet area requirements for odour control and manure spreading.

However, water supplies and water quality are variable across Alberta. Likewise, rural population densities also vary significantly. Consequently, there are areas of Alberta where producers establishing new intensive livestock facilities will find more natural resources, which will support their livestock needs, in combination with lower population densities, which will facilitate the development process.

Site selection for new facilities should be based on well planned investigations. Security of water supply must be a key criterion. Producers should locate facilities where significant groundwater sources or permanently flowing minor or major rivers provide a reliable supply. Alberta Environmental Protection supports a well defined process that establishes the rights of the livestock operation to the water source it develops while answering local residents' concerns about potential impacts of the livestock operation on the quantity and quality of the local area's water supply. However, the livestock producer must develop credible information in support of his application for a water rights licence before applying if he wants the water rights development process to work efficiently.

The environmental impact of intensive livestock operations is an issue but there is no evidence to date that they are a significant environmental problem in Alberta. Manure odours and nutrient management issues are growing in importance as both livestock and population numbers increase. Locating new operations where population densities are low can minimize conflicts over odour. Alberta has large areas of crop land where manure can be used as a natural organic fertilizer. Sizing livestock operations so that manure output, transport and spreading match the capabilities of the land and crops to use the manure's nutrients is the base for a responsible manure management plan. Alberta's pristine environment is a strong marketing advantage for Alberta products. Most producers recognize this and, with the right information, can plan manure management systems that do not pollute surface water or groundwater or deteriorate soil quality. Research in Alberta shows that poor manure management can cause problems. Producers must address this issue thoroughly in their development plans in order to answer effectively the environmental questions that will arise during the development process.

The Alberta livestock industry has assisted in developing guidelines for intensive livestock operations. The guidelines should serve as a pro-active standard for responsible stewardship by the agricultural sector. These guidelines in combination with a well-defined planning approval procedure should assist rural municipalities in developing a clear, non-onerous permitting process, crucial to the orderly expansion of the hog industry in Alberta.

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1.0 Background And Assumptions

The opportunity for the Alberta hog industry to expand significantly to take advantage of new markets led Alberta Agriculture, Food and Rural Development (AAFRD) to investigate whether water, feed and environmental issues might limit new facilities being built in Alberta. Conservation and Development Branch (AAFRD) and Snowy Owl Software had demonstrated that large scale soil, water and agricultural production data bases could be integrated to identify where more intense agricultural production areas coincided with landscapes with key soil and water resources (Snowy Owl Software 1993). The analysis was presented by maps, appropriate for identifying areas of concentration or higher environmental risk (Cross 1994 and MacAlpine 1994).

The Animal Industry Division and the Rural Development Division both saw the opportunities of this process to answer natural resource and environmental questions for the pork industry. A combined team in AAFRD assisted Snowy Owl Software in accessing federal and provincial data bases and building queries to different pieces of information in the data bases. Work began on October 15 with the financial support of the Animal Industry Division. On November 8, at the Hog Expansion Symposium, Edmonton, Alberta, fundamental conclusions on environmental and natural resource limits were presented. This report completes this task by identifying areas in Alberta where natural resources and lower population densities coincide to offer opportunities for building new facilities to produce pigs.

The team guiding this analysis assumed:

a. The information in the data bases would support a provincial scale scoping exercise. While information could be built at a township scale, the maps do not point to selected townships but rather to key areas in the province.

b. Water, feed (in particular barley) and land area to meet spacing requirements for odour and recommended manure spreading rates were the key potential natural resource constraints to locating new hog facilities. Other issues related to expansion of the pork industry, trained labour, financing, herd health and genetics for example, were beyond the scope of the data bases immediately available for analysis. These issues also require producers' and the pork industry's attention in deciding the merits of expansion.

c. Simple queries provided the most reliable information on key parameters.

The limits of the first assumption guides the proper use of this report. For example, a series of queries and its map could be misinterpreted as identifying locations with a higher environmental risk. What they more often represent is not higher risks at a certain location but trends in certain landscapes. More complicated queries actually produced misinformation.

Consequently, there is a strong caution not to use the maps in this report to identify a specific location for water, feed, low population density or high manure spreading rates. The comments for each map qualify the data that led to the map and the specific interpretations that can applied to that map. Most queries were kept simple to avoid complicating the map interpretation.

2.0 Methods for Data Base Analysis

Six data bases were used to support the analysis in this project. The agencies holding the data bases were Alberta Agriculture, Food & Rural Development (AAFRD), Alberta Environmental Protection (AEP), Agriculture and Agri-Food Canada (AAFC) and Prairie Farm Rehabilitation Administration (PFRA):

a. Crow Benefit Offset Program (AAFRD) - annual livestock trends
b. Soil Landscapes of Canada, Census 1991 (AAFC) - soil landscapes and agricultural production
c. Water Rights Licences (AEP) - surface water and groundwater licences
d. Groundwater Information Centre (AEP) - water well information
e. Farm Fertilizer Price Protection Program (AAFRD) - farm fertilizer purchases
f. PFRA's Surface Water and Groundwater Development Programs
g. Base Maps (AAFRD) - Municipal boundaries, transportation, rivers and townships.

The Crow Benefit Offset Program has been terminated this year. However, it records livestock production trends between census years and key areas of livestock production from 1988 to 1994.

The Soil Landscape/Census (SLC) data base has integrated general landscape and Census 1991 information for areas smaller than municipalities (Shields et al. 1991). The province is subdivided into soil landscape polygons that aggregate similar soils, landscapes and climates. Alberta is divided into approximately 900 polygons, with approximately 450 having some agricultural activity.

The Water Rights Licence data base records volumes of diversions from surface water sources and pumping rates and depths from groundwater. While it is a record of where and how much water is licensed in Alberta, it also shows where there are major, reliable sources of supply and the current demands on those resources.

The Groundwater Information Centre's data base is a more complete record of well locations in Alberta. However, it includes minor uses like rural residential wells. It also includes water chemistry of wells, useful in assessing whether the groundwater is suitable for livestock watering.

The Farm Fertilizer Price Protection Program has a record of farm fertilizer purchases and the mix of nitrogen, phosphorus and potassium (N, P and K) purchased by each farm. A gross assessment of the amount of land receiving the fertilizer (irrigated or rain-fed) permits calculation of general farm averaged application rates. Combined with calculated nutrient loads from manure spreading, this data base helped with preliminary estimates of nutrients by landscape polygons.

Prairie Farm Rehabilitation Administration's (PFRA) data base records information on farm wells constructed with the technical and cost-share assistance of PFRA. The PFRA data base includes details on well construction not contained in other data bases. However, that information was not a focus of this data search. The Water Rights data base and the Groundwater Information Centre's data base provided the primary information on water sources.

Statistical Analysis System (SAS, Version 6.08) (1988) was chosen as the development software for this project. It can be used on a PC, thereby avoiding the expense of mainframe processing. SAS is capable of handling very large data bases, can easily integrate and restructure data, and can produce maps with overlays of information from data bases.

The methods used in qualifying, integrating and querying data bases were:

1. Data bases were forwarded from various agencies holding the data. Data were received in a variety of formats. SAS has the ability to import a wide variety of formats. Data were converted to a common data base format (SAS Version 6.08).
2. Data conversions to standardize time and geographic positions were used to integrate data sets.
3. Initially, simple queries at the Soil Landscape/Census (SLC) polygon level were used to roll-up point data and classify an activity (e.g. hog production) into five levels for comparison.
4. The results of each query were displayed on a provincial map with municipal boundaries. Where information was directly related to landscapes, the SLC polygons were used to display information with the municipal boundaries as an overlay. However, if the query produced information that could be displayed at the township level, maps were produced with this finer detail. Managers of the original data bases reviewed the maps and tables to ensure the information was consistent with their knowledge of the data.
5. Once key trends had been identified and the information in the data bases was better understood, queries were refined and maps, regenerated. An integrated series of queries were built to identify manure production trends and areas with optimum resources for new livestock operations.

A key step was to check data to be sure they were valid. Preparing data dictionaries was essential to get an accurate understanding of what information the data base actually contained, what data were missing and what were reasonable interpretations that could be drawn from the data. Consulting the managers of the original data bases was essential at this stage. It also was the most time-consuming aspect of the process.

Once the data were reliable and properly described, queries and maps could be produced readily.

3.0 Natural Resources to Support Expansion

3.1 Current Distribution of Primary Production

Figure 1, Sow Numbers by Township, presents a three-year average, from 1991 to 1993, of sow numbers. Data are mapped at the township level from Crow Benefit Offset Program data base. Four areas have the highest sow numbers in Alberta, County of Lacombe, County of Lethbridge, Neerlandia, north of Barrhead and Acme, west of Drumheller. St. Vincent, north of St. Paul, is a smaller but significant hog producing area. Most of the hog production is concentrated in the Black soil zone of Alberta, where moisture optimizes barley production. All agricultural areas have some level of hog production. Grande Prairie and the east side of the province, Medicine Hat, Oyen and Lloydminster are other areas of production outside of the primary concentration along the Edmonton to Lethbridge corridor. Areas of concentration indicate where supporting services for hog production (feed mills, equipment suppliers) are likely available. Increasing Alberta's pork production by 2 million hogs would require adding 91,000 sows to Alberta's current sow herd, assuming that the new operations will be efficient, high-end operations.

Definitions:
Sow Unit for Feed Consumption: Because most hog operations are farrow to finish, annual feed consumption for an operation is calculated on the basis of a sow and the 2.2 litters or 22 pigs she farrows per year. This represents 10 marketed hogs per litter. On average, a sow unit consumes 7.72 tonnes of feed annually. Eighty-five percent of the ration is grain. Thirty percent of the grain is feed wheat; 70% is barley. Consequently, barley, as the principal component of feed, makes up 60% or 4.63 tonnes of a sow unit's ration. The percentage of barley for individual pig rations will vary (Schuld 1994).

Sow Unit for Water Consumption: While feed consumption is based on the annual needs of a sow and the 22 pigs per year she produces, water needs are calculated on a daily basis. Water is needed on a continuous basis by the animals actually present in an operation on any day. These include the breeding herd replacements, dry and gestating sows, weanling pigs, nursing sows and the feeder hogs. A sow unit for water consumption consists of the total consumption for the operation, expressed on a per sow basis. Daily water consumption for this sow unit is 90 litres (20 imperial gallons) (West 1994b).

3.2 Water Supplies

Water can be the primary constraint for locating new hog facilities in Alberta. Figures 2 to 4 illustrate the water resources available for livestock. Clearly there are areas where surface and groundwater supplies are limited (particularly in areas where snowmelt is limited). The maps also show areas where water is ample, available and under-utilized. Careful planning is necessary to guarantee a reliable water source. However, with the variety of sources available, expansion of the hog industry is not limited by water supplies in Alberta.

A lactating sow typically drinks 20 litres (4.4 imperial gallons) per day while a finishing pig drinks 7.0 litres (1.6 imperial gallons). On the basis of a sow unit for water consumption, the daily consumption averages 90 litres (20 imperial gallons). Midwest Plan Services (1977) recommends a well pumping rate for peak demand related to peak daily consumption of:

$$PR = 0.3445\ DD^{0.53} \qquad \text{Equation 3.2.1}$$

where: PR, Well Pumping Rate (U.S. gallons per minute, (US gpm))
DD, Peak Daily Demand (US gpm), where DD is greater than 3000 US gpm and less than 12,000 US gpm.

Equation 3.2.1 is derived from Figure 441.1, Flow Rates for Livestock Production, Midwest Plan Services (1977), p. 380. Assuming that this equation can be extrapolated for larger daily demands, Table 1 summarizes the peak daily demands and well pumping rates for typical sow unit expansions. Two well pumping rate situations are summarized: the optimal situation where the well's safe pumping rate (Q_{20}) equals the instantaneous peak demand estimated from Equation 3.2.1 and the worst-case scenario where significant storage must be provided to meet peak demands. In this case, the well pumping rate just meets the average daily demand. Pumps and their flow rates must be planned on what the well can deliver, not on peak demands. The difference between what the well can deliver instantaneously and the peak demand must be met from water storage.

Table 1. Daily Water Demands and Well Pumping Rates for Different Sow Units

No. of Sows in Unit	Daily Requirement (imperial gallons)	Well Pumping Rate No Storage (imperial gpm)	Well Pumping Rate Storage = Daily Demand* (imperial gpm)
100	2,000	20	1.5
500	10,000	42	7
1000	20,000	60	14
1500	30,000	75	21

* This pumping rate is based on continuous 24 hour pumping of the well and is the lowest rate that a well could supply and meet the water needs of the unit. Significant water storage must be planned to meet peak demands.

Figure 2, Median Pump Rates, presents reliable, long-term pumping rates (in imperial gallons per minute) for licensed wells in Alberta. Data are mapped at the township level from Alberta Environmental Protection's (AEP) Water Rights Licence data base. To meet licensing requirements of AEP, the well driller must test the well to establish the rate at which the well can be pumped continuously for the long term. These pumping rates include safety factors to protect the well's production zone from over-use. Consequently, these pump rates are more reliable indicators of groundwater potential than estimated rates from domestic use wells.

Figure 2 represents where water users, urban, industry and livestock operations, have found enough groundwater to have it licensed for their needs. Consequently, *Figure 2* presents proven groundwater potential. It also presents groundwater quality because licensed users need well water that meets domestic, livestock or industrial water quality standards. The exception is the oil and gas industry that uses saline groundwater for oil well recovery. Some high yielding, deep wells identified in *Figure 2* are saline wells used by the oil and gas industry.

Figure 2 identifies Alberta's major aquifers: the Milk River Ridge aquifer south of Lethbridge, the Cold Lake aquifer north of Lloydminster, and the Paskapoo Formation, west of Calgary and Red Deer to the foothills and north west to Edson. The Paskapoo Formation is one of the most widespread and important bedrock aquifers in Alberta. Water quality and pumping rates improve through this formation westward towards the foothills. Well yields as high as 40 litres per second (500 imperial gallons per minute) with total dissolved solids (TDS) as low as 800 to 900 mg/litre to depths of 250 to 350 metres have been reported in western parts of the Paskapoo Formation (Pupp et al. 1989). The oil and gas industry tends to predominate well production on the western edge of this formation. Agricultural use of the Paskapoo is significant in the Counties of Red Deer and Lacombe but agriculture does not significantly use the western portion of this formation.

Groundwater supplies are more abundant in the western half of the province, a reflection of more snowmelt for recharge. The gaps on *Figure 2* identify where groundwater is not available or is poor quality. The entrenched river valleys in the Peace River region limit groundwater sources but there are also good wells near Grande Prairie. Preparation of an aquifer management plan has been recommended for the Grimshaw Gravels west of Peace River. The gravels come close to the surface, making contamination from surface water a concern. The aquifer also is an important local water source. A detailed test drilling program over the last three years on the east side of the province has located buried river valleys with reasonable yield and quality.

Figure 3, Total Dissolved Solids, maps recent groundwater chemistry data from wells logged in the Groundwater Information Centre's data base. Total Dissolved Solids (TDS) is an indicator of the salinity and mineral content of groundwater. TDS greater than 3000 mg/litre is unpalatable for pigs. TDS greater than 5000 mg/litre may cause diarrhoea. Since much of Alberta is underlain by marine bedrock, groundwater may be unpalatable for human consumption (TDS greater than 1000 mg/litre). However, this limited data base illustrates that livestock use of groundwater is restricted only in some locations of southern Alberta. Since livestock pass high salt loads from their drinking water on through to their manure, high TDS water also has implications for manure spreading. The combination of manure with high TDS and saline soils can increase soil salinity levels.

Figure 4, Surface Water Supplies for Feedlots, maps the locations and volumes of surface water licensed for intensive livestock operations, not just feedlots, with water needs greater than 5 acre-feet (6100 cubic metres or 1.3 million imperial gallons). *Figure 4* illustrates that livestock operations are located next to permanently flowing minor and major rivers or irrigation canals if their surface water needs are significant. Those operations off river systems are located in areas where groundwater supplies are inadequate leaving snowmelt-fed watercourses as the only water source. PFRA and AAFRD recommend two years' supply be stored in pasture dugouts throughout Alberta because snowmelt is not a reliable water source. Intensive livestock operations should not rely on snowmelt for their water supply. If the surface water source is not permanently flowing, it will not supply water during extended runoff droughts.

In the South Saskatchewan River basin, new surface water licences for irrigation are not being released because of concerns that irrigation water is fully allocated. New livestock operations using surface water will be considered on an individual case basis by AEP. Groundwater licences are not under the same constraint. *Figure 4* also illustrates that agriculture has not used the western reaches of Alberta's surface water sources in the same way it has not used the western portion of the Paskapoo Formation (*Figure 2*). Table 2 lists the annual water supplies needed by different sized sow units for comparison with licensed surface water withdrawals for livestock watering (*Figure 4*).

Table 2. Annual Water Needs of Different Sow Units

No. of Sows in Unit	Annual Volume (acre-feet)	Annual Volume (cubic metres)	Annual Volume (imperial gallons)
100	2.7	3,300	730,000
500	14	17,000	3,650,000
1000	27	33,000	7,300,000
1500	41	50,000	11,000,000

3.3 Feed Supplies

Barley is the largest component of hog feed rations (approximately 60% of a farrow to finish operation's overall ration). It also is a major component of cattle feedlot rations as well. Is there enough barley grown for both groups of livestock? In 1993, barley acreage in Alberta declined to a low of 4.4 to 4.6 million acres. In 1994, it rebounded to 4.8 to 4.9 million acres. Adding another 2 million hogs in Alberta would require 422,000 tonnes of barley, about 240,000 to 390,000 additional acres of barley. The increase in production from 1993 to 1994 met those requirements. Also, barley acreage in the recent past has averaged 5 million acres. When a major increase in hog production requires an increase in feed production that is within the range of error for measuring provincial barley production, it makes the case that Alberta is in a very strong position relative to livestock feed supplies (McLelland 1994).

Figure 5, Percent of Soil Landscape Unit in Barley, 1991, shows the areas dominated by barley production. Every hog production concentration in *Figure 1* matches with a landscape polygon in *Figure 5* that had 20 to 40% of its area in barley in 1991. Equally distinctive is the north-south corridor of barley production through west central Alberta. West of that line, barley production rapidly falls off, a reflection of fewer heat units as elevations rise towards the foothills. Significantly, the high production water wells of the Paskapoo Formation lie to the west of the intense barley production areas. Two secondary pockets of intensity are around Lloydminster and Grande Prairie. While transportation of barley may not be a significant limitation to siting new hog production facilities, most areas with 500 sows or more per township also have 20% or more of the area's land base in barley. Is hog production located where barley production is intense or has barley acreage increased in response to increased livestock feeding? Table 3 summarizes barley tonnage and acreage required to support different sizes of sow units.

Table 3. Annual Barley Consumption and Acreage For Different Sow Units

No. of Sows in Unit	Annual Barley Consumption (metric tonnes)	Acres of Barley Required Assuming Av. Yields *	Acres of Barley Required Assuming Typical Yields *
100	470	400	260
500	2,350	2,000	1,300
1000	4,700	4,000	2,600
1500	7,000	6,000	4,000

* Average yields are calculated using provincial averages for bushel weight (48 pounds/bushel) and yields (53 bushels/acre). Typical yields are calculated using bushel weights and yields typical of hog production areas in Alberta (51 pounds/bushel and 77 bushels/acre, respectively). In high producing areas, yields over 100 bushels/acre are regular at 48 to 50 pounds/bushel. With the advent of hull-less barley, bushel weights increase to 58 pounds/bushel at yields of 70 to 80 bushels/acre and digestibility increases 10 to 15% over regular barley (McLelland 1994).

To relate Table 3 to *Figure 5*, local barley production in the township will meet the feed supply needs of an operation if:

a. For a 500 sow unit, between 5.6% (using typical barley yields and bushel weights) to 8.6% (using average weights and yields) of the land area of the township is in barley production.

b. For a 1000 sow unit, between 11.3% (again using typical barley yields and weights) to 17.3% (using average yields and weights) of the land area of the township is in barley production.

Since hog production is not the only livestock industry using local barley production, *Figure 5* should not be interpreted as identifying areas of extra feed. Intense areas of production may be saturated with livestock operations to use the feed source. However, since areas of higher hog production coincide with areas of more intense barley production, in general, *Figure 5* is an indicator of feed supply.

4.0 Environmental Issues

Environmental issues for intensive livestock operations focus primarily on manure management. In particular, separating new intensive livestock operations from neighbours is necessary to limit complaints about odour. In addition, treating manure spreading as waste disposal rather than application of crop nutrients to farmland can lead to nutrient applications in excess of crop requirements. Research in Alberta has shown that spreading cattle feedlot manure at excessive rates has resulted in nitrates leaching below the root zone (Riddell and Rodvang 1992). Consequently, Alberta's livestock associations have taken the lead in developing voluntary guidelines to assist municipalities and producers in siting, design and management of new and expanding livestock facilities. While the "Code of Practice: for the Safe and Economic Handling of Animal Manure" (West 1994a) is awaiting official publication, similar criteria are used by Alberta Agriculture, Food and Rural Development's staff to assist municipalities in assessing the environmental sensitivity of proposed operations.

4.1 Population Densities

With odour the principal issue for siting intensive livestock operations, the population density of the rural area is a key indicator of how close neighbours will be to the operation. Rural areas with small farms and rural acreages generally have residents who are not familiar with the smells and operation of intensive livestock operations. Statistically, high population densities have more neighbours to question the establishment of a new operation. *Figure 6, Number of Farms by Township,* shows the density of farms in Alberta. However, it does not show the density of rural acreages since the data bases used to build this map were agricultural production data bases. Consequently, rural population densities immediately next to Edmonton, Calgary and Red Deer have been underestimated. Currently, even in predominately agricultural areas, proposers of new operations are finding that neighbouring farmers can be as vigorous in questioning new operations as non-agricultural rural residents. Odour nuisance is often only the launching point for other attacks on the industry including such issues as runoff, nutrient leaching to groundwater and nutrient management. Consequently, population densities are an important factor to consider in the development permit process.

4.2 Distance Requirements

Population densities are complementary to the minimum distance separation (MDS) criteria used by AAFRD staff assessing the environmental sensitivity of siting new developments, either livestock or non-agricultural, in a rural area. The MDS method provides recommended minimum separation distances between livestock operations and other uses (residential, commercial or recreational). It accounts for the differences in odour related to livestock type, manure production and manure handling system. Potential nuisance conflicts can be reduced by recognizing that normal odour production can be compensated by meeting minimum separation distances. Table 4 summarizes the minimum separation distances recommended for farrow to finish operations.

Table 4. Recommended Minimum Distance Separation (MDS) for Farrow to Finish Piggeries

No. of Sows in Unit	100	500	1000	1500
Minimum Distance Separation * (miles)	0.25	0.5	0.6	0.75

* MDS are derived from Appendix D-4, Recommended MDS (ft) for Farrow-Finish Piggeries, Code of Practice: For the Safe and Economic Handling of Animal Manures (Draft). Separation distances summarized here are more conservative than recommended by the Code of Practice.

To relate Table 4 to *Figure 6, Number of Farms by Township*, minimum separation distances for 500 and 1000 sow units, respectively, convert to a farm density of:

a. One farm per section, or 36 farms per township, for a separation distance of 0.5 miles.

b. One farm per 2.25 sections, or 17 farms per township, for a separation distance of 0.6 to 0.75 miles.

Based on these criteria, *Figure 6* indicates that a 500 sow unit farrow to finish operation can be located in all areas of the province except immediately adjacent to major urban centres and recreational lakes. However, a 1000 sow unit will likely have to locate outside of existing areas where hog production is concentrated (except for the Acme area).

4.3 Manure Spreading

4.3.1 Land Base Requirements

The Code of Practice (Draft) also recommends the land base required for spreading manure to meet crop requirements. Table 5 summarizes these land requirements.

Table 5. Land Requirements for Manure Spreading: Farrow to Finish Piggeries

No. of Sows in Unit	Dark Brown & Brown Soils No. of sections	Grey Wooded Soils No. of sections	Black Soils No. of sections	Irrigated Soils No. of sections
100	0.22	0.15	0.12	0.11
500	1.10	0.75	0.60	0.55
1000	2.20	1.50	1.20	1.10

Adapted from Appendix E-1: Land Base Requirements (acres) for Farrow-Finish Piggeries, Code of Practice: for the Safe and Economic Handling of Animal Manures (Draft).

Comparing Table 4 to Table 5, controlling nuisance odour through minimum distance separation requires a lower population density than does the land base required for manure spreading. The Dark Brown and the Brown Soil zone does have nearly equivalent land requirements for both criteria. While in principle, separation distances for odour do not translate into land requirements for intensive livestock operations, this analysis shows odour control will require intensive livestock operations to locate in lower population areas than does the land base requirement for manure spreading. Odour management is the key manure management issue and can translate directly into the capital costs of land acquisition for new operations.

To relate land base requirements for manure spreading to *Figure 6, Number of Farms by Township*, a new operation of 500 sow units and 1000 sow units respectively would locate where a township's average farm density is below:

a. 32 to 60 farms per township, for the Dark Brown and Brown Soil zone to the Black Soil zone
b. 16 to 30 farms per township, for the Dark Brown and Brown Soil zone to the Black Soil zone

to acquire a typical farm with enough land to meet manure spreading requirements.

As *Figure 6* shows, this criterion flags only the most densely populated areas of rural Alberta.

4.3.2 Manure Spreading to Supply Crop Nutrients

The primary environmental question related to manure spreading is whether intensive livestock operations are concentrated in certain areas of Alberta to the point that the manure output exceeds the cropped land base available to manage manure as a crop nutrient. *Figure 7, Theoretical Application Rates for Nitrogen from Manure*, illustrates the nitrogen spreading rates for all intensive livestock operations (including cattle, poultry and dairy) if the manure from these operations is spread on cultivated land immediately available within a soil landscape/census unit (SLC). Nitrogen application rates were calculated from the number of livestock in a soil landscape unit multiplied by the typical manure weights and nutrient content by species. Total nitrogen was divided by the total cultivated acres reported in the 1991 census for that SLC unit. As *Figure 7* shows, no area in Alberta has more nutrients from manure than could be used by the crops locally.

However, in southern Alberta, Riddell and Rodvang (1992) found nitrates at levels above drinking water guidelines in groundwater, 10 feet below fields where manure spreading from cattle feedlots was above recommended rates. This could be due to the transportation costs associated with hauling manure to land further away from the livestock operation, resulting in over-application of nutrients to land close to the source of the manure.

Figure 7 confirms that nitrate leaching from manure spreading is not a land base problem. It is a manure management problem. Managers of intensive livestock operations have the responsibility of ensuring that they have enough land or secure agreements with neighbours to spread their operation's manure output at rates consistent with the nutrient uptake on the fields receiving the manure.

4.4 Municipal Planning and Development Processes

Development of new livestock operations is controlled at the municipal level. Procedures to obtain development permits for intensive livestock operations range from well defined to none. Municipalities that are familiar with intensive livestock developments generally have some procedures developed. New operations will have some form of public review, either in the development permit process or in the process to obtain a water rights licence for the operation's surface or groundwater source. Consequently, the absence of a well defined development permit process may not be positive. Neighbours who have concerns about a new operation may have no assurances that they can ask questions or their concerns will be addressed in a simplistic development process. Their reaction may be to raise objections and force delays that would be unwarranted under a better defined process.

A well defined planning approval process should not be onerous but rather should clearly set out responsibilities of the involved agencies as well as the livestock developer. In the few rural municipalities where this has occurred, risk and uncertainty faced by livestock developers as well as neighbouring residents have been greatly reduced. Processing time has also been shortened.

Figure 8, Municipal Planning and Approval Process for Intensive Livestock Operations, identifies the detail of development permit processes by municipality throughout Alberta, as assessed by AAFRD staff involved in reviewing development permit applications.

5.0 Opportunities for Expansion

The process of examining resources critical to an expanding hog industry and the environmental issues that surround them defines a series of queries to illustrate where resources offer the best opportunities for the industry to expand.

Water, the land base (defined by population densities) and feed supplies (intensity of barley production) were identified as the key resources at the local level that would define the best locations to site new operations. Groundwater, as defined by Alberta Environmental Protection's Water Rights data base, was assumed to be the preferred water source.

Because SAS, the software used to query the data bases, can integrate large data bases, the data bases could be treated as a seamless block of information that allowed sequential queries to screen down to areas that have an overlay of key resources. Two scenarios were investigated, the requirements to site a new 500 sow unit and a new 1000 sow unit, farrow to finish. The queries began with population density. The key criteria were the minimum distance separation (MDS) to reduce nuisance odour. As the discussion in Section 4.3.1 illustrated, the land base requirement for odour control is larger than for manure spreading. The areas whose population density was low enough to meet MDS criteria were retained and checked against a second query for local self-sufficiency in feed production. The amount of local land area in barley required to meet a 500 or a 1000 sow unit's feed requirements formed the basis for this second query. Townships with low population densities and high barley production were retained and displayed with the water well pumping rates for licensed water wells in that township.

Figure 9a, 500 Sow Unit Odour Spacing Criterion (less than 36 Farms per Township), displays townships that meet the MDS criterion summarized in Section 4.2 for a 500 sow unit. Specifically, townships with 36 farms or less per township were selected. *Figure 9b, 1000 Sow Unit Odour Spacing Criterion (less than 17 Farms per Township)*, displays townships that meet the MDS criterion for a 1000 sow unit, townships with 17 farms or less per township. The central corridor of the province drops out when farm density limits for a 1000 sow unit are applied.

Figure 10a, Pumping Rates for Wells in Townships that Meet 500 Sow Unit Spacing Criterion and *Figure 10b, Pumping Rates for Wells in Townships that Meet 1000 Sow Unit Spacing Criterion* present the townships meeting the population density criteria for a 500 and 1000 sow unit, respectively, overlaid with the median pumping rates for licensed water wells in each selected township, if available. For a 500 sow unit, the well pumping rate should exceed 42 imperial gpm if no water storage is planned. The cutoff below which a well will not meet water needs of a 500 sow unit is 7 imperial gpm. For a 1000 sow unit, the well pumping rate should exceed 60 imperial gpm with no storage. Below 14 imperial gpm, even with significant storage, a well will not meet the needs of a 1000 sow unit.

Figure 11a, Pumping Rates for Wells in Townships that Meet 500 Sow Unit Barley and Spacing Criteria, adds the feed supply criterion to the population density criterion for a 500 sow unit. Townships displayed on this map have a low enough population density to meet the MDS criterion and enough local barley production to make the 500 sow unit self-sufficient on barley grown in the township. Selection was based on the criterion that 7.5% of the land area in the township be in barley. This value is a conservative average based on the land requirements using typical barley yields (5.6%) and average barley yields (8.5%). This selection is overlaid with the median pumping rates for licensed wells in each selected township. The identification of townships with adequate groundwater supplies follows the criterion described for *Figure 10a*.

Figure 11b, Pumping Rates for Wells in Townships that Meet 1000 Sow Unit Barley and Spacing Criteria, represents the same process for a 1000 sow unit. In this case, townships were selected on the basis that 15% of the township's land area was in barley production. Again, this is a conservative average based on the land requirements using typical barley yields (11.3%) and average barley yields (17.3%). Again, the selection is overlaid with the median pumping rates for licensed wells in the township. Well pumping rates that meet the needs of a 1000 sow unit follow the criterion described for *Figure 10b*.

Figures 11a and *11b* identify general areas of the province that are worthwhile investigating for hog expansion. They do not identify specific townships. In particular, since feed supply suitability is judged on barley acreages, not actual yields by township, this selection process does not account for areas where barley area intensity is below the selection criterion's standard but yields are significantly above provincial averages. Nor does this selection criterion account for townships that are adjacent to high production areas, where transport costs to bring in feed may not be significant. This is particularly true west of the intense barley production corridor down the centre of Alberta. While population densities are low and groundwater supplies are significant in this area, the sharp decline in barley acreage west of the province's central corridor is not accounted for in this selection process. Consequently, *Figure 11b* may overestimate the importance of local self-sufficiency in barley for a 1000 sow unit. If that is the case, *Figure 10b* may better represent opportunities for siting a 1000 sow unit operation.

Figures 11a and *11b* both misrepresent opportunities immediately next to Calgary, Edmonton and Red Deer. Rural acreages are not accounted for in the selection process and consequently population densities next to these major centres are underestimated.

In summary, *Figures 10b*, *11a* and *11b* indicate that the following areas are worthwhile investigating in terms of hog expansion opportunities: the Grande Prairie area, north east Alberta, the Lloydminster area, west of Edmonton, west of the central corridor between Calgary to Edmonton, west of Drumheller and west of Lethbridge. This is highly qualified in that the groundwater information does not incorporate water quality or the reliability of consistent well yields through a township. Likewise, the barley acreages are from 1991 Census data and do not reflect local trends since that time. Other factors outside feed, water and population densities are not incorporated and in a local context may be just as significant as the provincial scoping factors used in this screening process. Since the process was directed as the provincial scale, these maps should be interpreted at that scale.

6.0 Conclusions

The analysis highlights these conclusions:

1. Water supplies are not limiting if new or existing operations expand where groundwater sources have been identified or adjacent to permanently flowing minor and major river systems. Areas that rely on snowmelt for water supply are high risk and not recommended for major water-consuming operations. Both groundwater and surface water sources are well defined from existing data and, with the proper technical help, developing reliable, good quality water sources is not a constraint.

2. Feed supply is a major Alberta advantage. While local supplies should be investigated to check on competition from other livestock operations, the opportunities to market Alberta's barley production through livestock are significant. Even with expansion in other livestock sectors, the internal use of barley in Alberta can grow substantially.

3. Manure management is a management issue not a land base issue. Enough crop land is in the vicinity of livestock operations that application of manure above crop needs is not warranted. Increased manure production is not a waste since it can substitute for chemical fertilizers. Odour management is an issue. Alberta has a low rural population density so odour management does not need to be a capital cost as it is in other jurisdictions. However, minimum distance separation for odour is the most important factor in land base needs. Alberta's hog producers need to pay attention to this issue because of its potential affect on land base costs.

4. While not all areas of Alberta are suitable for expansion, there are numerous areas where water, feed supplies and low population densities coincide to make expansion desirable. Producers must be flexible enough to recognize that areas where hog production currently is the highest are not necessarily the best areas for expansion. Non-traditional areas may have significant advantages if labour, feed processing and transportation to slaughter facilities are not limiting.

5. Municipalities that want to encourage value-added production can make the development process straightforward with clear, well defined permit processes. No process does not mean "no red tape".

6. The industry should consider initiatives that would create awareness of the importance of good public relations and responsible stewardship of the natural resources used in hog production.

This could be achieved by a self-assessment environmental audit, a quality assurance program including manure management aspects of production, and increased leadership in developing best management practices.

7. Integrating large data bases and displaying simple queries to the data graphically is an effective tool to convey trends and interrelationships between resources and production. The human ability to see trends in a series of maps and interpret those trends from individual expertise extracts more information from the data than conventional analysis. The data base and statistical strengths of the software used in this analysis are just as important as the GIS (Geographic Information System) aspects of the maps. The process outlined here is logic driven and out runs any biases inherent in the interpreter's perspectives.

7.0 References

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