Rural Municipality of Hanover
Agricultural Mapping Project

Agriculture and Agri-Food Canada
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Administration du rétablissement agricole des Prairies
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This report provides the RM of Hanover with valuable tools and knowledge that will assist them in making informed decisions regarding sustainable agricultural and rural development, protecting the water and soil resource.

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The report was prepared by:
Jarrett Powers
Assistant District Soil Conservationist
PFRA, Beausejour

Assistance and review of the report was provided by:

Doug Cavers	RM Hanover, Steinbach
John Ewanek	Manitoba Agriculture & Food, Selkirk
John Fitzmaurice	PFRA, Winnipeg
John Gehrer	PFRA, Beausejour (term)
John McGregor	Manitoba Agriculture & Food, Steinbach
Nicole Mischuk	PFRA, Winnipeg
Steve Sager	PFRA, Beausejour
Bill Sawka	Manitoba Intergovernmental Affairs, Steinbach
Dennis Schindler	Manitoba Agriculture & Food, Morris

PFRA ARAP
Prairie Farm Rehabilitation Administration
Administration du rétablissement agricole des Prairies

Western Economic Diversification Canada
Canada

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Rural Municipality of Hanover Manitoba 1881

Abstract

Growth in Manitoba's livestock industry has been dramatic over the last decade. Expansion has been most notable in the hog industry, where production has more than doubled in the last 10 years. The Rural Municipality of Hanover was, and continues to be, a leader in the livestock industry in the province. Livestock production has traditionally played a significant role in Hanover's agricultural industry.

To ensure livestock operations operate and develop in a sustainable fashion, the RM of Hanover has used a Geographic Information System (GIS) to digitally map and record data on all farm and rural residences in the municipality. The dataset has been combined with other data to provide information on any land use activity or proposed development.

This report details the development of the data and analysis of the agricultural land base to support existing livestock operations within the municipality. More specifically, the analysis compares the amount of nitrogen that is produced from livestock manure to the nitrogen utilization potential of the agricultural land base that is used for manure application. This produced an overall nitrogen balance for each township in the RM of Hanover.

Overall, the results indicate that over half of the agricultural crops' nitrogen requirement can be met by manure that is produced from the current livestock operations in the RM of Hanover. When broken down by township, the analysis has revealed areas of the municipality that have a higher nitrogen balance and may be considered at or near their limit for further expansion of livestock. These tended to be on lands that are predominantly used for forage production. Other areas, primarily used for production of annual crops, had lower nitrogen balances. In terms of land availability for application of manure, these areas may offer further room for expansion.

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1.0 INTRODUCTION

Growth of Manitoba's livestock industry has presented several challenges to local governments and the decisions regarding land use planning. Environmental, economic, agronomic and social information must be considered when developing planning statements, enacting bylaws and evaluating new livestock operations. Often this information is of a complex nature and is not readily available to local decision makers.

The RM of Hanover Agriculture Mapping Project was an initiative proposed by the RM of Hanover to help address these issues. The project's goal was to use a Geographic Information System (GIS) to collect information on agricultural operations within the RM. This dataset would then be used with existing resource-based datasets to analyze the current status of the municipality's livestock industry and agricultural land base. The ability of a GIS to create, manage, analyze and output spatial data makes it well suited for projects of this nature. The following report details the development and source of the data, analysis and results for this project.

2.0 BACKGROUND

The Manitoba agricultural industry is in a period of dynamic change. The removal of the Western Grains Transportation subsidy, increased foreign grain subsidies and rising input costs have all had a major effect on the grains and oilseed sector. As a result, many Western Canadian farming operations have diversified into livestock to add value to grains and increase profitability. In particular, the hog industry in Manitoba has seen extensive growth. Fuelled by increased world demand for meat and investment in processing facilities, provincial hog numbers have steadily increased from 2.3 million hogs in 1992 to 3.2 million hogs in 1996. The most recent production numbers have Manitoba production at 4.8 million hogs in 1999 (Manitoba Agriculture and Food, 1999).

The Rural Municipality of Hanover has historically been at the forefront of livestock production in Manitoba. Established in 1881, the Hanover municipality covers 8 townships and is located southeast of Winnipeg. According to the 1996 Census, Hanover has:

- 25.4% of the provincial poultry production
- 13.2% of the provincial hog production
- 10.8% of the provincial dairy production
- A population of 9,833 people

Additionally, the Town of Niverville and the City of Steinbach, with a combined population of 10,093 (1996 Census), are located within the RM. In recent years there has been extensive growth in businesses and residences in these communities as well as the RM of Hanover.

As a result of development, decisions regarding land use planning in the municipality have become increasingly complex. This is notably true as it pertains to the continued growth of livestock operations. Council must evaluate economic, environmental, agronomic and social information to ensure the development of the livestock industry proceeds in a sustainable fashion. To do this in an effective and efficient manner, municipalities and the Regional Technical Review Committees must have access to relevant resource based data. In many cases the location of existing livestock operations, number of animals and manure management information does not exist. Additional datasets such as topographic data, land use, soils, cadastral, municipal conditional and variation information does exist but is often in hard copy form. The data may also be scattered amongst federal and provincial agencies and municipal governments. This makes it difficult to access the most relevant and current data that is required for evaluating new or expanding livestock operations.

To address this issue, the RM of Hanover, Prairie Farm Rehabilitation Administration (PFRA) and Manitoba Intergovernmental Affairs undertook an initiative to collect data on agricultural operations within the municipality. Intergovernmental Affairs began data collection during July and August, 2000. Data collection was completed by PFRA during February and March, 2001. The project was one of several projects that was sponsored by Keystone Agricultural Producers (KAP) and participating municipalities. Western Economic Diversification (WED) provided funding for these projects.

3.0 METHODOLOGY

3.1 Needs Assessment

Discussions with the RM of Hanover and Manitoba Intergovernmental Affairs were conducted to establish what data would be required and what analysis would be performed for the project. Specifically, the RM wished to have data on agricultural operations within the municipality that would be used to help evaluate proposals for new and expanding livestock operations. Once the project was completed, this dataset would be incorporated into the municipality's existing GIS. The RM would retain ownership of the data and be responsible for all updates thereafter.

3.2 Data Description

Parcel Map

The RM of Hanover had previously invested in a complete land parcel spatial dataset for their municipal GIS. The data contains information on the land parcel, landowner(s) and tax roll number. This dataset was used to help identify agricultural and residential locations in the municipality, as well as a contact name. Once the collection of agricultural information had been complete, the data was linked to the land parcel data by using the tax roll number. All agricultural information can now be viewed spatially in a GIS.

Agricultural Operation Database

All agricultural data was collected in a relational database. Each record was defined by using the tax roll number as the identifier. The tax roll number is then used to link the data to the municipal parcel map and used in a GIS. Additionally, the data can be linked to the most current assessment data to provide assessed land values, ownership and mailing address.

Based on the needs assessment, a number of fields were created for the agricultural database tables. Each record contains information on:

- Tax roll number
- Habitation (rural residence, farm residence, farm)
- Structure type
- Farm operation (grain, mixed, livestock, hobby)
- Livestock type (hog, beef, poultry, etc)
- Livestock subtypes (hog – farrow to finish, feeder, weanling, etc)
- Number livestock
- Animal units
- Type of manure storage (earthen lagoon, concrete lagoon, dry, etc)
- Identification of manure application fields
- Acreage of manure application fields
- Crop type of manure application fields (forage, pasture, annual cropland)
- Conditional use and variation file number

Both primary and secondary livestock types were recorded (if applicable) and animal units were calculated for each operation. The animal unit (AU) is equivalent to the production of 73 kg of nitrogen annually. Animal units were used for manure management purposes to equate the amount of nitrogen that is produced from livestock operations and to determine the land base required for manure application. The calculations that were used in the database are from the Farm Practices Guidelines for Poultry Producers in Manitoba (Manitoba Agriculture and Food, 2000).

Data was collected during July and August, 2000 and February and March, 2001. Landowners were contacted either by phone or in person and asked to provide the information regarding their operation(s). This information was entered into the database along with the date it was collected. Upon completion of the project, there were 2,077 entries made in the database.

Soils Data

Soil resource information is an important consideration when evaluating any land use activity in a municipality. The soils database contains important information on soil characteristics such as stoniness, slope, internal drainage and surface texture. Interpretive data such as soil suitability for agriculture, irrigation and erosion risk were also provided in the data.

Soils information for the RM of Hanover was mapped at a 1:50,000 scale. The spatial data used in this report is from the Soils of the Rural Municipality of Hanover: Report D82. Data was produced by the Land Resource Unit of Agriculture and Agri-Food Canada and the Soil Resource Section of Manitoba Agriculture and Food.

Land Use

Availability of agricultural land is another key consideration when evaluating new or expanding livestock operations. Nitrogen utilization, and therefore rate of manure application, is based on agricultural production (annual cropland, alfalfa, grasses and alfalfa-grass mixtures). The Farm Practices Guidelines for Livestock Producers outline general nitrogen requirements based on crop requirements and soil surface texture.

Land use data is derived from Landsat 7 satellite imagery. Sensors on the satellite measure spectral signatures that are reflected from the land. Using these signature values, the image is then classified into 16 land use classes. These classes were further aggregated into 7 classes. Resolution of the image is 30 metres.

The date of the image that was used for the RM of Hanover was September 23, 1999. The image was acquired by RadarSat International and classification was completed by the Manitoba Centre for Remote Sensing.

Topographic Data

Topographic datasets are used to show several important geographic features on a map. These include lakes, rivers, wetlands, roads, railways, etc. Maps that were produced for the project used the Province of Manitoba 1:20,000 scale Topographic Series data to show the location of roads in the RM.

4.0 ANALYSIS

4.1 Assessment of Livestock Information

Knowing the location, size and other information of existing livestock operations is important when any new agricultural, business or residential developments is considered. Information of this nature is also important when comparing the existing resource base (land and water) and its ability to support current and/or expanding livestock operations. The information can also be used to assess infrastructure needs (roads, water, drainage).

Figures 1 – 8 are maps detailing the livestock industry in the RM of Hanover. The maps show type of livestock operations, animal unit size and primary livestock manure storage system. Using the municipal land parcel dataset, the points used to represent the livestock operation are the centroid of the land parcel on which the operation is located. The agricultural operation database is then linked to these points. Information pertaining to the livestock operations can be extracted.

Tables 1 gives a further breakdown of livestock operations in the municipality. There were 550 livestock operations of varying size and type located in the RM. In some instances, more than one operation was located on the same site. Manure production for all livestock operations in the RM of Hanover was calculated at 82,631 animal unit

TABLE 1: RM HANOVER - SUMMARY OF LIVESTOCK OPERATIONS								
LIVESTOCK TYPE	OPERATIONS BY ANIMAL UNITS						NO OF OPERATIONS	ANIMAL UNITS
	1-100	101-200	201-400	401-800	801-1600	1600-3200		
Beef								
Backgrounder	5						5	170
Cow/Calf	124	9					133	5870
Feeder Cattle	13	3	3	3			22	3354
Summer Pasture	10						10	290
Total Beef	**152**	**12**	**3**	**3**			**170**	**9684**
Chickens								
Broiler Breeder Hens	8	1	1				10	930
Broiler Breeder Pullets	3						3	69
Broilers	17	24	6	1			48	6600
Layers	12	4	1				17	2580
Pullets	4	3		1			8	1178
Total Chickens	**44**	**32**	**8**	**2**			**86**	**11357**
Dairy								
Milking Cows	25	35	14		1		75	11234
Hogs								
Feeders	31	28	18	13	6		96	24654
Sows: Farrow to Finish	5	4	4	8		1	22	8296
Sows: Farrow to Nursery	6	6	11	2	2		27	8285
Sows: Farrow to Weanling	4	3	5	3	1		16	4321
Weanlings	6	2	2	2			12	2538
Total Hogs	**52**	**43**	**40**	**28**	**9**	**1**	**173**	**48095**
Turkeys								
Broiler Breeder Hens		1					1	100
Broilers	1	2					3	335
Heavy Hens	2						2	118
Heavy Toms		1	1	1			3	860
Roasters	1	1					2	180
Total Turkeys	**4**	**5**	**1**	**1**			**11**	**1593**
Other Livestock								
Buffalo	3	1					4	205
Elk	3						3	101
Horses	22						22	123
Sheep	5	1					6	238
TOTAL	**310**	**129**	**66**	**34**	**10**	**1**	**550**	**82631**

4.2 Agricultural Land: Assessment of Nitrogen Utilization

Livestock manure can be an important nutrient source for annual crop and forage production. Manure can take the place of commercial fertilizer, supplying the necessary nutrients for the crop or forage and helps to reduce input costs. In addition, organic matter contained in the manure helps to improve soil physical properties such as aeration, structure and water holding capacity. Under a sustainable fertility management system, the rate of manure that is applied is based upon crop requirements and the nutrient content of the manure.

In order to assess the amount of land that is available for manure application, soils and land use data must be analyzed jointly. The types of crops grown and the surface texture of the soils will provide a general estimate of the amount of manure that can be applied based on nitrogen content. As shown in Table 2, the Farm Practices Guidelines for Poultry Producers provides a general outline of annual nitrogen utilization based on the following crop and soil conditions.

TABLE 2: SOIL AND CROP NITROGEN UTILIZATION

TYPE OF CROP	NITROGEN UTILIZATION (kg/ha)	NITROGEN UTILIZATION (lb/ac)
Forages (established)		
Alfalfa	250	225
Grasses	165	150
Grass-Alfalfa Mixture	195	175
Annual Crops		
Medium to Fine Texture	90	80
Coarse Texture	65	60

The 1999 classified Landsat imagery shows the 8 land use classes. Table 3 and Figure 9 provide information on land use in the RM of Hanover. For the assessment of land availability for manure application and nitrogen utilization, only annual crop, forage and grasslands/pasture were considered. For the calculation of nitrogen utilization, all grasslands/pasture were given a grass nitrogen utilization rating. Landsat imagery is not able to distinguish between an alfalfa and grass-alfalfa stand, so all forage land is given a grass-alfalfa nitrogen utilization rating. Annual croplands needed to be intersected with the soils dataset to define the nitrogen utilization based on soil texture. An intersection is essentially a geometric combination of two spatial datasets to create a third spatial dataset. The features that fall within the common area of both datasets were preserved in the third dataset.

The soils dataset contains information on surface soil texture for each soil series that is listed. For the purposes of this study, only the dominant soil series is used. Table 4 and Figure 10 provide a breakdown of the soil textures and soil texture groupings and distribution in the municipality. For the assessment of soil texture on annual cropland, all clayey, fine loamy and coarse loamy soils were rated as medium to fine texture. Sand soils were rated as coarse textured. Coarse sands and organic soils were excluded.

Following the intersection of the soils and land use dataset, the area for each new polygon is calculated and the appropriate nitrogen utilization rating is coded into the database. The total nitrogen utilization for each polygon is calculated (area x nitrogen utilization) and recorded in the database. Table 5 and Figure 11 provide a breakdown and distribution of the total nitrogen utilization for agricultural lands in the RM of Hanover.

TABLE 3: RM HANOVER - 1999 LAND USE SUMMARY			
LAND USE	AREA (ha)	AREA (ac)	PERCENTAGE
Annual Crops	31554	77973	40.90
Forages	10051	24837	13.03
Grasslands/Pasture	15883	39249	20.59
Trees	15152	37443	19.64
Water	80	197	0.10
Wetlands	68	169	0.09
Urban/Transport	3886	9603	5.04
Bare Rock/Sand/Gravel	448	1106	0.58

TABLE 4: RM HANOVER - SOIL SURFACE TEXTURE			
SOIL SURFACE TEXTURE	AREA (ha)	AREA (ac)	PERCENTAGE
Clayey			
C - Clay	26789	66197	35.22
Fine Loamy			
CL - Clay Loam	4004	9894	5.26
SiCL - Silty Clay Loam	451	1115	0.59
L - Loam	9701	23972	12.75
Coarse Loamy			
VFSL - Very Fine Sandy Loam	1750	4325	2.30
SL-L - Sand Loam-Loam	153	378	0.20
FSL - Fine Sandy Loam	5844	14442	7.68
VFS - Very Fine Sand	478	1180	0.63
SL - Sand Loam	367	907	0.48
Sand			
LFS - Loamy Fine Sand	16782	41469	22.06
LS - Loamy Sand	4488	11091	5.90
FS - Fine Sand	2702	6676	3.55
Organic			
M - Mesic Peat	2260	5584	2.97
O - Organic	299	738	0.39

TABLE 5: RM HANOVER - ANNUAL NITROGEN UTILIZATION		
TYPE OF CROP	TOTAL NITROGEN UTILIZATION (kg)	TOTAL NITROGEN UTILIZATION (lbs)
Forages (established)		
Grasses	2668033	5882037
Grass-Alfalfa Mixture	1969156	4341269
Annual Crops		
Medium to Fine Texture	2355372	5192733
Coarse Texture	331991	731919
TOTAL	**7324552**	**16147958**

4.3 Comparison of Livestock and Land Base for Manure Application

The agricultural land base can now be assessed to determine its ability to support existing agricultural operations based on the amount of land required for manure application. The analysis is made on the basis of nitrogen by comparing the nitrogen utilization data to the amount of nitrogen that is produced on an annual basis from livestock operations in the municipality. This is referred to as the *nitrogen balance*.

The annual nitrogen utilization of all agricultural lands in the RM of Hanover is 7.325 million kg (16.148 million lb). The annual production of nitrogen produced by manure from all livestock operations (82,631 animal units) in the municipality is 6.032 million kg (13.298 million lb). However, 100% of the nitrogen that is contained in livestock manure is not available for crop and forage production. Volatilization, the loss of nitrogen to the atmosphere as NH_3 gas, from manure storage and application will occur. This results in an overall reduction of nitrogen in the manure. De-nitrification, the conversion of NO_2 and NO_3 to NO and N_2 in the soil following the application of manure, can also result in minor losses of nitrogen. To account for these losses, a 65% efficiency factor is used to more accurately reflect the amount of nitrogen that would be available for crop and forage production. When this is taken into consideration, the annual amount of nitrogen that is available for crops and forages from livestock manure is 3.921 million kg (8.645 million lbs). Table 6 gives a breakdown of the comparison and nitrogen balance for the 8 townships in the municipality.

TABLE 6: RM HANOVER - LIVESTOCK NITROGEN BALANCE

TOWNSHIP	TOTAL LIVESTOCK N PRODUCTION (kg)[1]	TOTAL LIVESTOCK N PRODUCTION (lb)[1]	TOTAL N UTILIZATION (kg)	TOTAL N UTILIZATION (lb)	N BALANCE (PERCENT)[2]
Tp 4 R 6E	590691	1302256	883830	1948522	66.83
Tp 5 R 5E	564517	1244552	865153	1907346	65.25
Tp 5 R 6E	378299	834010	787194	1735475	48.06
Tp 6 R 5E	569176	1254823	952257	2099379	59.77
Tp 6 R 6E	334862	738248	945817	2085181	35.40
Tp 7 R 4E	484149	1067369	881641	1943696	54.91
Tp 7 R 5E	566812	1249612	1042241	2297759	54.38
Tp 7 R 6E	432608	953741	966418	2130599	44.76
TOTAL	**3921116**	**8644610**	**7324552**	**16147957**	**53.53**

[1] Amounts are 65% of nitrogen that are produced from all livestock

[2] Percentage of nitrogen produced by all livestock to nitrogen utilization of the agricultural land base

5.0 DISCUSSION

From a manure management perspective, the comparison of the agricultural land base and manure that is generated from current livestock operations provides a good understanding of the current status of the livestock industry in the municipality. The analysis shows the livestock nitrogen balance figure to be 53.5%. However, there are a number of factors that influence the overall nitrogen balance that should be noted when conducting analysis of this nature or when evaluating individual operations on a site-specific basis. These are as follows:

1) Application Fields Located Outside the Municipality
For those operations that are located on the periphery of the RM of Hanover, manure is applied on lands in neighboring municipalities. Only land located within the RM of Hanover was used in the analysis. Conversely, operations in neighboring RMs will apply on lands located within the RM of Hanover. It is assumed that this would neither significantly increase nor decrease the overall nitrogen balance figure.

2) Alfalfa Fields not Included
Landsat imagery is unable to distinguish between alfalfa and alfalfa-grass stands. As a result, all forage lands were listed as alfalfa-grass and rated lower than an alfalfa stand in terms of nitrogen utilization. The representation of alfalfa stands with higher nitrogen utilization capability would result in a decrease in the overall nitrogen balance figure.

3) Availability of the Agricultural Land Base for Manure Application
The analysis included all lands that were forage, grasslands/pasture and annual cropland. In reality, not all of this land would be available for application due to setbacks that would need to be observed from watercourses and property lines. Other setbacks, or buffers, may also be considered from designated residential areas. Additionally, many grass pasturelands (both native and tame) tend to be under fertilized or not fertilized at all. If these factors were taken into account, there would be an increase in the overall nitrogen balance figure.

4) Specific Storage and Application Information
To account for volatilization loss of nitrogen during storage and application, a 65% efficiency factor was used. This was based on the average losses that would occur with storage and application of manure in the municipality. For individual farms, these losses may be higher or lower, dependent on their manure management system.

5) Crop Nitrogen Utilization
The amount of nitrogen that was specified for forages and crops is an approximate value. Actual plant nitrogen demands can vary within crop types. For annual crops, corn and potatoes have higher nitrogen demands than canola and wheat. Crops such as oats and buckwheat would have lower nitrogen demands. Again, for individual operations, this can change the nitrogen requirements and amount of land required for application.

6) Commercial Fertilizer

The annual application of commercial fertilizer was not considered in the overall nitrogen balance of agricultural lands in the municipality. Current information regarding commercial fertilizer use is unable to approximate the amount of nitrogen that is applied from these sources. Analysis of Manitoba Crop Insurance data does indicate the amounts of nutrients that were applied on different crops within the municipality. However, there is no distinction between nutrients from commercial fertilizer and livestock manure. The 1996 Census data shows that 34,681 ha (85,699 ac) of land in the RM of Hanover received commercial fertilizer, but does not indicate the amounts.

Although data analysis is unable to determine the amount of commercial fertilizer that is applied annually, we can make the assumption that there is application on annual croplands, with limited amounts being applied on forages. This would increase the overall nitrogen balance figure.

While it is difficult to quantify the impact the previously noted factors would have on the nitrogen balance of land in the RM of Hanover, we can assume that the overall effect would be to increase the nitrogen balance of agricultural lands across the municipality. This assumption is based primarily on the fact that nitrogen from commercial fertilizer is not included in the calculations and the tendency of forages to be underfertilized.

A breakdown of the nitrogen balance figures by township shows that in Tp4-R6E, Tp5-R5E and Tp6-R5E approximately 60% to 70% of the nitrogen utilization of the agricultural land base can be met by current livestock operations located within the townships. Approximately 75% of the land in Tp4-R6E, 63% of land Tp5-R5E and 61% of the land in Tp6-R5E is forage-pastureland. As previously noted, forage-pastureland tend to be underfertilized which would further increase the nitrogen balance. In addition, the use of commercial fertilizer on cropland in these areas would further increase the nitrogen balance figure. In terms of nitrogen utilization of the agricultural land base, livestock numbers in these areas may be very close or at their maximum.

Tp5-R6E and Tp6-R6E also have relatively similar ratios of cropland to forage-pastureland, however the nitrogen balance amounts were lower (48.1% and 35.4%, respectively). In terms of land availability for manure application, there may be more room for growth of livestock in these townships. However, for Tp6-R6E, there may be social considerations pertaining to manure application on agricultural lands in the immediate areas of Steinbach and Mitchell.

Tp7-4E, Tp7-5E and Tp7-6E have very high ratios of cropland to forage-pasture. Nitrogen balances were approximately 45% to 55% on these townships. Again, the use of commercial fertilizer on cropland would increase the overall nitrogen balance. As well, there may be social considerations for application in the immediate vicinity of Steinbach, Mitchell, Niverville and other communities that are located in these townships.

The lack of information regarding the annual amounts of commercial fertilizer application restricts the ability to approximate the overall nitrogen balance in each township. The effect of commercial fertilizer is more notable on those areas with a higher percentage of cropland and less on forage-pastureland. It is recommended that more information needs to be collected to determine the amounts of commercial fertilizer that is applied on an annual basis. Possible sources that could be investigated would include local fertilizer outlets, Manitoba Conservation manure management plans and the 2001 Statistics Canada Census.

6.0 CONCLUSIONS

The RM of Hanover Agricultural Mapping Project has demonstrated the application of GIS and spatial data at the local government level. Agricultural data that has been collected from the project will provide local decision makers with the information to help answer complex land use issues. The analysis of livestock and the land base for manure application is one example of how the data can be integrated and analyzed to provide this type of information. The comparison has highlighted important differences in the nitrogen balance of agricultural lands in different areas of the municipality. In terms of availability of land for manure application, the analysis indicates that further development in Tp4-6E, Tp5-5E and Tp6-5E will be more limiting than in other areas of the municipality

The RM of Hanover is continuing to develop their GIS resources. Data that was collected from this project will be maintained and managed by the municipality. Additional funding has been secured to purchase additional spatial data, hardware, software and training. The municipality is working closely with the private sector to develop applications that will allow for easy access, retrieval and analysis of the datasets. The continued growth of GIS at the local government level will assist council and staff in their overall management of municipal affairs.

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