Appendix K
Biosolids Management Plan

APPENDIX K
BIOSOLIDS MANAGEMENT PLAN

1.0 BACKGROUND

The Town of Neepawa and Springhill Farms LP, in partnership, are developing a new industrial wastewater treatment facility (IWWTF) to replace the existing facility constructed in 1986. In doing so, the additional processes have created additional waste biosolids streams that require a specific management procedure. These waste streams include the sludge removed from the treatment process at 2 separate locations, initial treatment via a two-stage dissolved air flotation (DAF) system and thickened waste activated sludge (WAS). Once this sludge is stabilized in the two proposed lagoon cells, it will be considered biosolids and will be applied to agricultural land at agronomic rates. Selection of suitable agricultural land within a 30 km radius and estimation of application rates is provided below.

2.0 BIOSOLIDS CHARACTERIZATION

It is important to characterize the biosolids in order to understand the nutrient application rate and to determine which are the limiting parameters. The anticipated sludge characteristics for residual biosolids following a one year aerated fill period and close to 1 year of isolation are provided in **Table 1**. Parameter values are based on pilot testing done at the Springhill Farms plant in February and March of 2008 as well as anticipated biosolids values provided by Pharmer Engineering. As the facility is not currently operating in the upgraded mode, the characteristics are only estimated, but they will be updated as part of the yearly land application procedure.

Table 1: Estimated IWWTF Biosolids Characterization

Parameter	Stabilized Biosolids After 1 Year Aerated Fill and 1 Year of Isolation		
	mg/kg	kg/day	kg/year
TSS		1760	643,000
VSS	541,000	953	348,000
Total Nitrogen	80,100	141	51,500
Organic Nitrogen	67,900	120	43,800
Ammonia	12,000	21.1	7,700
Total Phosphorus	25,500	45	16,400
Arsenic	72	0.126	46
Cadmium	6.8	0.012	4.38
Total Chromium	2530	4.45	1,630
Copper	6040	10.6	3,880
Lead	86	0.152	55
Molybdenum	337	0.593	216
Nickel	793	1.400	510
Selenium	69	0.122	45
Zinc	14,000	24.7	9,000

Notes:
1. Values used based on pilot testing at Springhill Farms and background data for WAS provided by Pharmer Engineering
2. mg/kg value can be changed to kg/kg values by dividing by 1000, as used in Section 7.

Values utilized from the DAF pilot project for initial treatment were the highest concentrations recorded through 13 sample replications. The WAS biosolids component of the combined biosolid mixture was based on estimates and past experiences of Pharmer Engineering. Total nitrogen in the biosolids was estimated as 8% of TSS and ammonia was estimated as 15% of TN, with negligible nitrates. Ongoing sampling throughout the IWWTF operation and sampling of the biosolids prior to and during land application activities will provide a more accurate characterization of constituents to properly adjust the land application program as necessary.

3.0 REGULATORY DOCUMENTS IMPACTING LAND APPLICATION OF BIOSOLIDS

3.1 Nutrient Management Regulations

On June 16th, 2005, the Province of Manitoba passed the *Water Protection Act* as a means to further protect Manitoba surface and groundwater supplies. The Nutrient Management Regulation under *The Water Protection Act* came into effect on March 18, 2008. The purpose of the regulation is to protect water quality by encouraging responsible nutrient planning, regulating the application of materials containing nutrients and restricting the development of certain types of facilities in environmentally sensitive areas. This regulation has in it provisions for the management of nutrients from all sources, including municipal and industrial biosolids. Land application activities from the Town of Neepawa IWWTF will be governed under this regulation.

The Nutrient Management Regulation takes into account nitrogen and phosphorus as the regulatory constituents for land application with other elements contained within biosolids having no specific guidelines. In order to appropriately manage these micronutrients, heavy metals and other constituents within the biosolids, rigorous additional soil and biosolids testing will be required to ensure soil values remain within acceptable levels.

The Nutrient Management Regulation 62/2008 (Registered on March 18, 2008) bases nutrient and biosolids application on the basis of soil Agricultural Capability (Ag capability). These Ag capability classes are then utilized to delineate four distinctive zones as they relate to nutrient application, each with their own set of allowable residual nutrient thresholds as well as maximum allowable nutrient levels. Further discussion with regards to Ag capability is discussed in the land base characterization section of this document. The four nutrient management zones are defined as follows:

"**Zone N1**" for nutrient management includes land belonging to, or having characteristics of, Ag capability soil classes 1, 2, and 3, other than 3M, 3ME, 3MI, 3MN, 3MP, 3MT, 3MW and any other subclass of soil class 3 having a "M" subclass designation.

"**Zone N2**" for nutrient management includes land belonging to, or having characteristics of, Ag capability soil classes 3M, 3ME, 3MI, 3MN, 3MP, 3MT, 3MW or any other subclass of soil class 3 having a "M" subclass designation, soil class 4, and soil classes 5M, 5ME, 5MP, 5MT or 5RM or any other subclass of soil class 5 having a "M" subclass designation if it is being irrigated.

"**Zone N3**" for nutrient management includes land belonging to, or having characteristics of, Ag capability soil class 5 that is not included in nutrient management Zone N2.

"**Zone N4**" for nutrient management includes land belonging to, or having characteristics of, Ag capability soil classes 6 or 7 and land comprised of unimproved organic soils.

For the purpose of biosolids application to land, the Nutrient Management Regulation will be utilized and annual nutrient management plans will be required and filed with Manitoba Water Stewardship. Further details on the plan itself and Manitoba Water Stewardships requirements are not yet defined, but are expected to available by fall of 2008.

The zones provided in this regulation will be utilized in the assessment of the potential land base and in the estimation of land application rates in subsequent sections.

3.2 Canadian Council of Minsters of the Environment Canadian Environmental Quality Guidelines

The Canadian Council of the Ministers of the Environment (CCME) have environmental quality guidelines for contaminated soils for agricultural soil types. These guidelines have historically been followed by Manitoba Conservation to guide the application of metals to farm land. These guideline concentrations will be used in determining the biosolids application rate for such constituents as copper, cadmium, arsenic, etc., and will be stipulated in Section 7 in this document.

4.0 LANDBASE ASSESSMENT

4.1 Introduction

The land in a 30 km radius surrounding the IWWTF has been identified and assessed to determine the land characteristics and the potential area of land that may be used for biosolids application. This is a general assessment that only identifies the potential availability, as specific soil testing, identification of specific site characteristics and discussion with the land owner is a significant secondary step.

4.2 Municipal Land Ownership

The Town of Neepawa IWWTF is located in the southwestern portion of agricultural Manitoba. The Municipal land ownership and estimated available land is provided in Figure B-1 for a 30 km radius around the IWWTF. This general area is considered to be relatively close to the IWWTF, with a total land area of approximately 282,743 hectares. This radius encompasses land within the Rural Municipalities of; Minto, Rosedale, Lansdowne, Westbourne, Odanah, Langford, Elton, North Norfolk, Clan William and North Cypress. The relative amount of land base within the 30 km radius from each Municipality is further described in Figure B-1. Land application of biosolids is not limited to this region and proceeding outside of this region is operationally feasible, but will come at a greater cost for application.

4.3 Soil Description Within the 30 km Radius

Soils within this 30 km radius are dominated by three fairly distinct soil characteristics, but do experience some variability throughout the region. In general, the eastern portions are composed mainly of sandy lacustrine soil with sandy surface textures over a clay lacustrine substrate. The central portion is composed mainly of loamy lacustrine soils with pockets of sandy lacustrine and sandy eolian soils with loamy and sandy surface textures. The western portion is dominated with loamy tills with fine loamy to loamy surface textures.

4.4 Agricultural Landuse

The total land available within the 30 km radius is approximately 282,743 hectares comprising various land/soil types and land uses ranging from agriculture and recreation to deciduous and mixed wood forests as shown in the attached Figure B-2. Of the 282,743 hectares, 143,861 hectares are considered to be in agricultural production (2001 Landsat 7 data). Grassland and forage crops are not included in the estimated total area for agriculture and would increase this value considerably. This land use has not been utilized for this assessment as it is difficult to determine from the available coarse level data which forage/grasslands are being used for agricultural purposes with any level of certainty.

Further landbase calculations will be based only on land that is considered to be in agricultural production and the remaining land will be disregarded. It is important to note that all landbase calculations have been based on reconnaissance level data which is the best information available. In delivery of the nutrient management plan, all landuse related information will be verified with field inspections on a site by site basis.

4.5 Agricultural Capability

Agricultural capability is the Canada Land Inventory (CLI) standard methodology for determining the agriculture (Ag) capability for dryland agriculture. Soils are classified based on various limitations to agricultural productivity and grouping soils into seven classes. Limitations to agriculture increase as the classes get greater, with 1 having no limitation to agricultural production and 7 being unsuitable for agricultural production. Utilizing the CLI Ag capability is a general method of determining overall potential soil productivity within a given area, but is only a generalization. Figure B-3 displays the general soil Ag capabilities within the 30 km radius.

The soil Ag capability generalization is further used to determine the general areas of differing nutrient management zones within the 30 km radius as defined by Manitoba Water Stewardship’s Nutrient Management regulation. Also, in order to determine the relevance of the Ag capability rating within the area, Manitoba Agricultural Services Corporation (MASC) average regional crop yield data was used for comparison. Since soil survey information for this area is only at a reconnaissance scale and MASC average yields are compiled as regional averages, the soil and yield data are reasonable for use for planning purposes only. Field inspections by a certified agrologist will be required prior to land application to confirm the lands Ag capability.

Within the IWWTF 30 km radius, of the 143,861 hectares in agricultural production, over 124,000 hectares are class 3 or better with moderate to no limitations for agricultural production. The remaining land can be identified as having characteristics of class 4 or worse Ag capability and therefore less productive capacity for dryland agriculture. Class 4 & 5 soil do have some agricultural capacity, though limited, and in most circumstances is comprised of land under permanent forage cover. Figure B-4 shows the agricultural capability classifications within the 30 km radius associated with land considered to be under agricultural production. Further delineation of the soil Ag capability classes is provided below taking into account the soil Ag capability class and its subclasses as they pertain to the nutrient management zones.

4.6 Nutrient Management Zones

Within the available agricultural landbase, the associated nutrient management zone as defined in the Nutrient Management Regulation was determined based on soil Ag capability ratings. Of the 143,861 hectares of available land, the following breakdown was determined and is shown in the attached Figure B-5:

- Zone N1 – 107 050 hectares
- Zone N2 – 27 881 hectares
- Zone N3 – 7 127 hectares
- Zone N4 – 1 803 hectares

Each of these zones, as previously indicated, have their own distinctive set of residual nutrient thresholds and maximum soil nutrient values and will be discussed further in the land application section but for general purposes, zones N1, N2 and N3 are all considered capable of receiving biosolids for land application with Zone N4 not being permitted for land application. Once Zone N4 is removed from the database, 142,058 hectares remain as potentially available.

4.7 Groundwater Pollution Hazard Area

The Neepawa area is located within a Groundwater Pollution Hazard Area. This area was determined by the Province of Manitoba, Department of Mines, Resources and Environmental Management and was completed in 1978. This area has been determined to have potential for groundwater pollution from at or near surface pollutant sources regardless of how local or extensive the aquifer may be. This area encompasses approximately 160,000 hectares of the eastern portion of the defined 30 km radius. Due to the sensitivity of the groundwater hazard area, it will not be considered for biosolids application due to the potential risk to groundwater contamination. Figure B-6 displays the overall area encompassed in the Groundwater Pollution Hazard Area. Once this land is removed from the inventory, approximately 74,386 hectares are available for land application Zones N1, N2 and N3.

4.8 Summary – Available Land Base Assessment

In assessing total available land suitable for land application of IWWTF biosolids, all the above listed parameters have been taken into account. First, available land base has been defined by proximity to the proposed IWWTF as the region within 30 km of the proposed facility (a total area of 282,743 hectares). Secondly, an assessment of the area's land use determined that within the 30 km region, 143,861 hectares are utilized for agriculture and would be theoretically capable of utilizing the IWWTF biosolids for agricultural production. A third assessment of the available agricultural landbase is a determination of the Ag capability of the soils and determination of the nutrient management zones. Of the remaining land base, 142,058 hectares are Zoned N3 or better and can be considered for biosolids application. Next, the area within the Groundwater Pollution Hazard Area was removed.

The remaining landbase available is depicted in Figure B-7 that shows approximately 4,300 hectares of Zone N3 land, 3,559 hectares of Zone N2 land and 66,527 hectares of Zone N1 land available for biosolids application. This provides a total of 74,386 hectares of land available for biosolids land application activities.

Once the program is underway, the specific sites will need to be examined further for their potential to receive biosolids.

5.0 LAND APPLICATION PROCESS

Land application of biosolids from the Springhill Farms IWWTF will be conducted by utilizing tankers or an umbilical cord fed applicator, depending on the season, distance to fields, and availability of the applicator. Biosolids will be removed annually in the fall (post crop removal) and applied on agricultural land at agronomic rates. Fall is utilized as the application period as it provides greater flexibility for biosolids application and a larger window of application opportunity as opposed to pre crop seeding in spring. Biosolids will be shallow injected below the soil surface to reduce the potential for odor related issues associated with the activity and minimize the potential for surface runoff of biosolids.

6.0 CROP NUTRIENT REQUIREMENTS

A summary of the typical agronomic uptake of nitrogen and phosphorus for the three main crops grown in the area is given in **Table 2.**

<u>Table 2</u>: Typical Crop Removal Rates

Crop	Estimated Acres Planted	Average Yields bushels/hectare	Anticipated Uptake		Nutrient Removal	
Barley	2007 total acres (%) 15.90%	148 bu/ha	Nitrogen 124.3 kg/ha	Phosphorus 50.4 kg/ha	Nitrogen 87.4 kg/ha	Phosphorus 36.9 kg/ha
Wheat	2007 total acres (%) 35.50%	98.7 bu/ha	Nitrogen 95.2 kg/ha	Phosphorus 35.8 kg/ha	Nitrogen 67.2 kg/ha	Phosphorus 26.9 kg/ha
Canola	2007 total acres (%) 32.80%	73.3 bu/ha	Nitrogen 125.4 kg/ha	Phosphorus 57.1 kg/ha	Nitrogen 76.1 kg/ha	Phosphorus 41.4 kg/ha

Averaging nutrient requirements based on these three main crops, the average nutrient requirements are 112.4 kg/ha nitrogen and 46.9 kg/ha phosphorus. It can be assumed that residual soil test nitrogen values will be minimal, though residual nitrogen will be present due to past growing season carryover and organic nitrogen conversion. It was assumed that residual nitrogen values will be in the range of 20 to 56 kg/ha although 25 kg/ha was used in calculating biosolids application rates in Section 7.

7.0 ASSESSMENT OF BIOSOLIDS APPLICATION RATES

Nutrient management plans will be compiled for the IWWTF biosolids application on an annual basis, utilizing the *Manitoba Nutrient Management Regulation* as the basis for residual nutrient values and allowable land application rates. Use of the Nutrient Management Regulation requires annual soil testing to take place on proposed fields and ensures that nutrient application activities are done on a site specific basis. The annual soil sampling of spread, measuring available nitrogen and phosphorus in the soil, will provide the basis for nutrient application recommendations while ensuring that biosolids application rates are based on agronomic requirements specific to individual fields and crops. These recommendations will also be compared back to the particular nutrient management zone in which the specific field occurs to determine whether or not the residual nutrient values are within the threshold limits and to assist in determining the allowable land application rate.

Appendix A provides an overview of each nutrient management zone along with its residual nutrient thresholds and maximum allowable nutrient limits. With the majority of available land being composed of Zone N1, the limitations to land application are anticipated to be minor and nutrient application recommendations will typically be governed by agronomic nitrogen requirements.

Nitrogen and phosphorus are the two main nutrients required for crop growth and are the basis for manure and biosolids application on agricultural land. As shown in **Table 2**, average crop removal rates based on a dominant wheat, barley, and canola crop rotation and average yields in the region will have an average nitrogen removal of 112.4 kg/ha (100.35 lbs/acre) and 46.9kg/ha (41.85 lbs/acre) for phosphorus.

The nutrients contained in the biosolids product will be somewhat variable, but it is assumed that, following a stabilization period of approximately 365 days, the majority of nitrogen will be in the organic form with approximately 15% as ammonia nitrogen. Exact percentages of nitrogen in each form will be variable and will be established through biosolids sampling prior to setting application rates. The various forms of nitrogen have differing plant availabilities with ammonia being completely plant available the first year following application and the organic form of nitrogen being approximately 20% available the first year following land application. The remaining portion of organic nitrogen requires further degradation through soil processes and portions will become plant available each year over a period of time. The general calculation for plant available nitrogen year 1 is as follows:

Total Available Nitrogen = (100% ammonia nitrogen) + (20% organic nitrogen) + (100% Nitrate Nitrogen {Assumed to be Zero})

Calculation of the year 1 available nitrogen is the basis point for establishing nitrogen based biosolids application activities.

Phosphorus in the organic form, for crop production purposes is converted to its P_2O_5 equivalent (approximately 2.3 times the total P value) and is typically considered to be 50%

plant available in year 1, but will not be the case in regards to the IWWTF biosolids. Use of ferric chloride as a precipitant in the IWWTF treatment train will reduce the plant available phosphorus in the biosolids. In acidic environments such as the DAF sludge, phosphorus will bind with the ferric chloride not allowing it to be easily taken up by plants without further soil degradation. By injecting the biosolids below surface in a slightly basic soil environment, the ferric chloride bound phosphorus will be slow to release and thus be less plant available in relative comparison to animal manures. This being said, the phosphorus component will become plant available over a period of time and act in a similar fashion to a slow release fertilizer.

In order to limit phosphorus addition to fields through repeated biosolids application, sufficient landbase should be accessible to accommodate at least a 1 in 5 year application program to ensure that the ferric chloride-bound phosphorus has had appropriate time to breakdown and be utilized for crop growth. Current land availability would allow significantly more than the 1 in 5 year rotation as discussed below.

Table 3 displays the basic agronomic equivalents of the expected biosolids product produced at the IWWTF. Unlike most other organic nutrient amendments such as livestock manure, no over application of biosolids phosphorus should occur when applying biosolids based on crop nitrogen requirements as the total nitrogen to total phosphorus ratio is similar to that of actual crop requirements. It is important to note however, as previously discussed, the availability of phosphorus for plant growth following biosolids application will be limited and agronomic recommendations for agricultural producers receiving biosolids from the IWWTF will likely include the addition of inorganic phosphorus to achieve crop uptake requirements.

Application of organic nutrient sources are typically based on the crop nitrogen or phosphorus requirements. In the case of the Springhill IWWTF biosolids, application rates will likely be determined based on crop nitrogen requirements. As previously mentioned, application rates meeting nitrogen requirements will have a net deficiency in plant available phosphorus and inorganic phosphorus application will be required in order to satisfy crop needs.

Biosolids application rate will be calculated by:

Crop N uptake (kg/ha) – residual soil N (kg/ha)(as determined by soil test) = N requirement (kg/ha)

112.4 kg/ha – 25 kg/ha (estimated) = 87.4 kg/ha

N requirement (kg/ha) X 120% of N Requirement = N application rate (kg/ha) {Including 20% winter losses}

87.4 x 1.20 = 104.9 kg/ha

100% Ammonia N (kg/kg)+ 20% Organic Nitrogen (kg/kg) = Plant Available N per kg dry biosolids

0.012kg/kg + 0.2 x 0.067 kg/kg = 0.0256 kg Plant Available N per kg dry biosolids

N application rate (kg/ha) / Plant Available N per kg/dry biosolids = Dry Mass biosolids applied to land/ha

104.9 kg/ha/ 0.0256 = 4098 kg/ha

Mass of biosolids applied to land)/ (Percent Solids (estimated at 7%) x 1000kg/m^3) = Volume of biosolids applied to land (m^3)

4098 / (0.07 x 1000) = 59.5m^3 biosolids at 7% applied per hectare

Total dry mass TSS biosolids per year / dry mass biosolids applied to land/ha = Area required per year (ha)

643,000kg/yr / 4098 kg/ha = 157 hectares

Using the current anticipated sludge characteristics it is anticipated that 157 hectares would be required on a yearly basis. Assuming a 5 year rotation, based on nitrogen application, approximately 785 hectares would be required.

In addition to crop nutrient residual values, the presence of heavy metals in the soil and biosolids must be taken into account when selecting fields for biosolids application. **Table 3** shows the heavy metals present in the biosolids as well as the maximum background levels that would be acceptable for continued biosolids applications. The Table provides CCME guidelines, the mass loading associated with sludge addition and then provides the number of repeat applications that would result in matching the CCME guideline. It should be noted that there will be background values for the soil, however they have not been obtained.

As it is believed that the area is a relatively uncontaminated area, it is anticipated that background metal numbers would be only a fraction of that provided by CCME. Even if the background levels were 50% of the CCME guideline, the allowable repetitions would be reduced by 50%. Based on Nickel, the biosolids could likely be applied up to 7 times, even if background soil levels were half of the CCME concentrations.

Table 3: Biosolids Application Rates and CCME Guidelines for Residual Heavy Metals

Parameter	CCME Guidelines for agricultural soil (mg/kg)	CCME Guidelines for agricultural soil (kg/ha)*	Sludge Addition Based on 104.9 kg/ha Nitrogen requirement	Allowable repeated applications to meet or exceed CCME Guidelines in Top 15 cm Layer	Repeat Applications Assuming Background Soil is Half of CCME Guideline
Arsenic	12	21.6	0.096	73	37
Cadmium	1.4	2.5	0.0090	90	45
Total Chromium	64	115.2	3.36	11	5.5
Copper	63	113.4	8.01	4.6	2.3
Lead	70	126	0.114	358	179
Mercury	6.6	11.88	Not Tested		
Nickel	50	90.0	1.05	28	14
Zinc	200	360	18.6	6.3	3.1

*Calculated values are based on a soil bulk density of 1200 kilograms per cubic meter and a soil depth of 15 centimetres.

Currently, there is approximately 74,386 hectares of land available for biosolids application with 157 hectares required for application on an annual basis. This would allow for a 473 year land application rotation if all available land would be utilized prior to additional applications. Practically, biosolids would likely applied twice to about 4000 hectares over a 50 year period. Additional land could be obtained in the large inventory if background soil levels are higher than expected.

Heavy metals would be monitored in both the soils and the biosolids yearly to make sure the biosolids are applied agronomically and to make sure the agricultural soil does not accumulate excessive metals.

A full description of the sampling program is detailed below.

8.0 SOIL AND BIOSOLIDS SAMPLING PROGRAM

The envisaged biosolids program will include sampling for additional parameters outside of normal agronomic testing such as copper, lead, nickel, and other relevant, potentially hazardous elements occurring in the biosolids that are not normally present in animal manures at significant concentrations. Full determination of actual elements to be considered will be determined through sludge sampling after approximately 10 months of storage. The aim of sampling for these additional parameters is to ensure that levels of heavy metals and deleterious substances within the biosolids product are monitored and levels are kept within acceptable concentrations within the soil. Soil parameters to be sampled for and their respective sample depths are described in **Table 4**.

Table 4: Soil sampling parameters & sample depths

Sample Parameter	Sample Depth
Total Nitrogen	0 – 60 cm
Nitrate Nitrogen	0 – 60 cm
Ammonia – N	0 – 60 cm
Sodium Bicarb – P (Olsen P)	0 – 15 cm
pH	0 – 15 cm
Potassium	0 – 15 cm
Nickel	0 – 15 cm
Mercury	0 – 15 cm
Zinc	0 – 15 cm
Cadmium	0 – 15 cm
Copper	0 – 15 cm
Lead	0 – 15 cm
Arsenic	0 – 15 cm

Annual soil sampling will be conducted by composite sampling (as described in the *Farm Practices Guidelines*) from each field to which biosolids are to be applied prior to application. Each composite sample will consist of a minimum of twelve representative samples or one sample location per four hectares, whichever is greater. Each sample depth (0 – 15 cm & 15 – 60 cm) will be collected separately and thoroughly mixed and a subsample of compiled soil shall be made and submitted to a laboratory acceptable to the director for analysis. A total of two samples per field will be submitted with a field being no greater than 69 hectares with individual fields of greater area than this to be divided and sampled as two individual fields. Attempting to sample fields greater than 69 hectares is difficult to ensure that a representative sample is taken as field conditions vary significantly over areas this large and the accuracy of a composite soil sample could be questionable.

Using an annual soil sampling regime will allow the calculation of the appropriate crop nutrient requirements based the planned crop type, expected yield and typical crop nutrient removal rates. This allows for setting field and crop specific biosolids application rates limiting the potential for nutrient and heavy metals accumulation on particular fields.

Biosolids to be applied will be sampled to confirm the overall characteristics and establish application rates. The results of all sample analyses will be recorded in a database and utilized for future determinations of sludge characteristics to assist in long term biosolids handling plans. Parameters to be analyzed are:

a. conductivity
b. pH
c. total solids
d. volatile solids
e. nitrate nitrogen
f. total Kjeldahl nitrogen
g. ammonia nitrogen
h. organic nitrogen
i. total phosphorus
j. lead
k. mercury
l. nickel
m. potassium
n. cadmium
o. copper
p. zinc
q. chromium
r. arsenic

A representative sample will be taken of the biosolids prior to annual biosolids land application activities. The representative sample will be drawn from the biosolids storage basin from at least 8 well distributed points throughout the basin and mixed thoroughly. A grab sample will be taken from the composite and submitted to an accredited laboratory. Sample analysis shall be received prior to land application commencing as it will be utilized for establishing specific application rates.

All biosolids land applied will be done so in accordance with the Nutrient Management Regulation as well as any additional requirements as set out in the environment act license. All setbacks from water courses shall be taken into account for all biosolids applied and subsurface injection shall be utilized to reduce potential for nutrient loss and odour production from application activities.

All nutrient management plans will be completed by a professional agrologist and filed in accordance with the Nutrient Management Regulation and requirements as set out in the forthcoming Environment Act License.

Appendix A - Residual Soil Nitrate-Nitrogen Limits and Soil Test Phosphorus Thresholds in Water Quality Management Zones for Nutrient Management

Water Quality Management Zone for Nutrient Management		Residual[†] soil nitrate-nitrogen limits within the top 60 cm (24 inches) of soil	Water Quality Management Zone for Nutrient Management	Soil P thresholds within the top 15 cm (6 inches) of soil (Olsen P)	Allowable application rate of P expressed as P_2O_5
Zone	**Soil Class**	**kg/ha (lb/ac)**	**Zone**	**Parts per million**	**kg/ha (lb/ac)**
N1	class 1, 2, and 3 except any 3M* subclass	157.1 (140)	N1 N2 and N3	<60	no restriction
				between 60 and <120	two times the crop removal rate**
N2	any 3M* subclass, class 4 and any 5M[§] subclass if it is being irrigated	101 (90)		between 120 and <180	one times the crop removal rate**
N3	class 5 except 5M[§] under irrigation	33.6 (30)		180 or more	no more application without approval by the director
N4	class 6, 7, and unimproved organics	no nitrogen applications	N4	no phosphorus applications	
NBZ	Not applicable	no nitrogen applications	NBZ	no phosphorus applications	

* A "3M" subclass includes soil classes 3M, 3ME, 3MI, 3MN, 3MP, 3MT 3MW and any other subclass of soil class 3 having an "M" subclass designation.

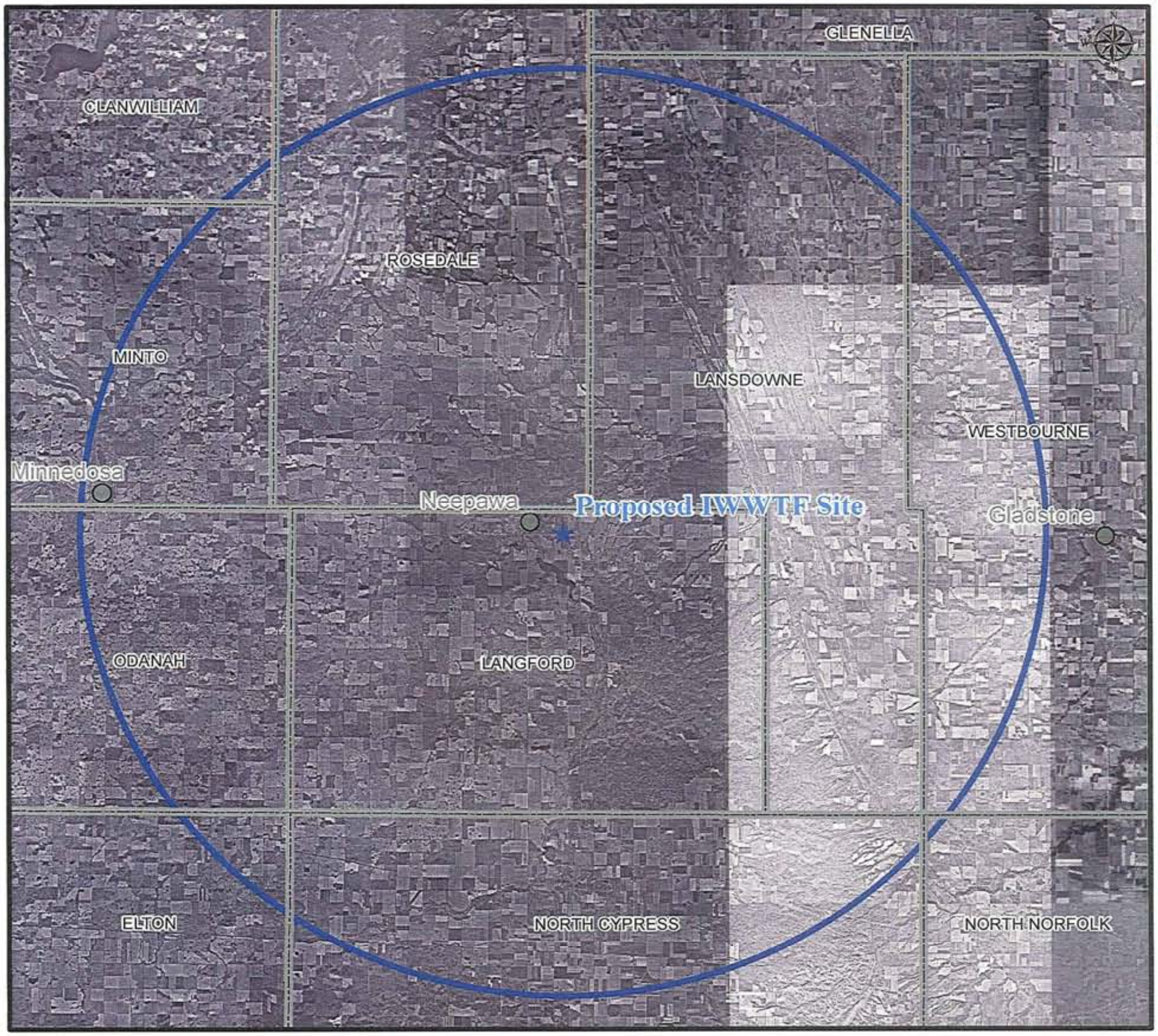
§ A "5M" subclass includes soil classes 5M, 5ME, 5MP, 5MT or 5RM and any other subclass of soil class 5 having an "M" subclass designation.

NBZ Nutrient Buffer Zone

** May apply manure with up to five times the annual crop removal rate provided the next application does not occur until the equivalent number of application years have passed or soil test phosphorus levels at any place in the field do not exceed the soil test values prior to the manure application. However, the annual nitrate nitrogen limits must not be exceeded.

† at the end of the growing season after the production of a crop.

Figure B-1: Municipal Land Ownership within 30 km Radius



Key Features

- Springhill 30 km buffer
- RuralMunicipality
- Towns

Total land in 30 km range - 282 743 hectares

Rural Municipalities	Land Area (hectares)
Lansdowne	69 652 HA
Langford	58 025 HA
Rosedale	52 619 HA
North Cypress	36 590 HA
Westbourne	22 645 HA
Odanah	22 210 HA
Minto	17 828 HA
Elton	2 538 HA
Clan William	507 HA
North Norfolk	129 HA

1:371,832

0 4 8 16 24 32 Kilometers

SPRINGHILL FARMS

Hytek

Prepared by:
Sheldon Stott
Director of Environmental Affairs
Hytek Ltd.

Figure B-2: Land Use within 30 km Radius of the IWWTF

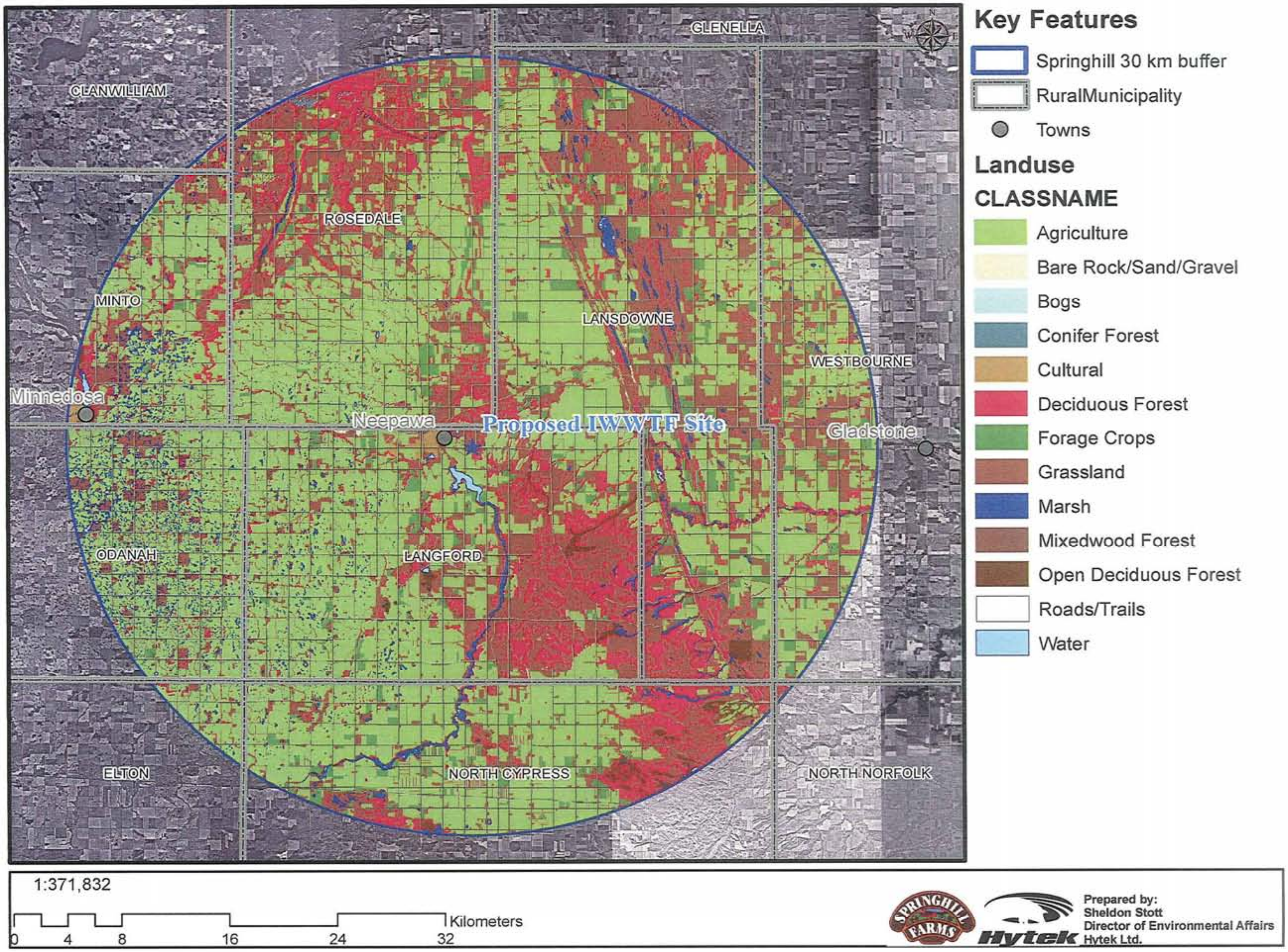


Figure B-3: Soil Agriculture Capability within 30 km Radius

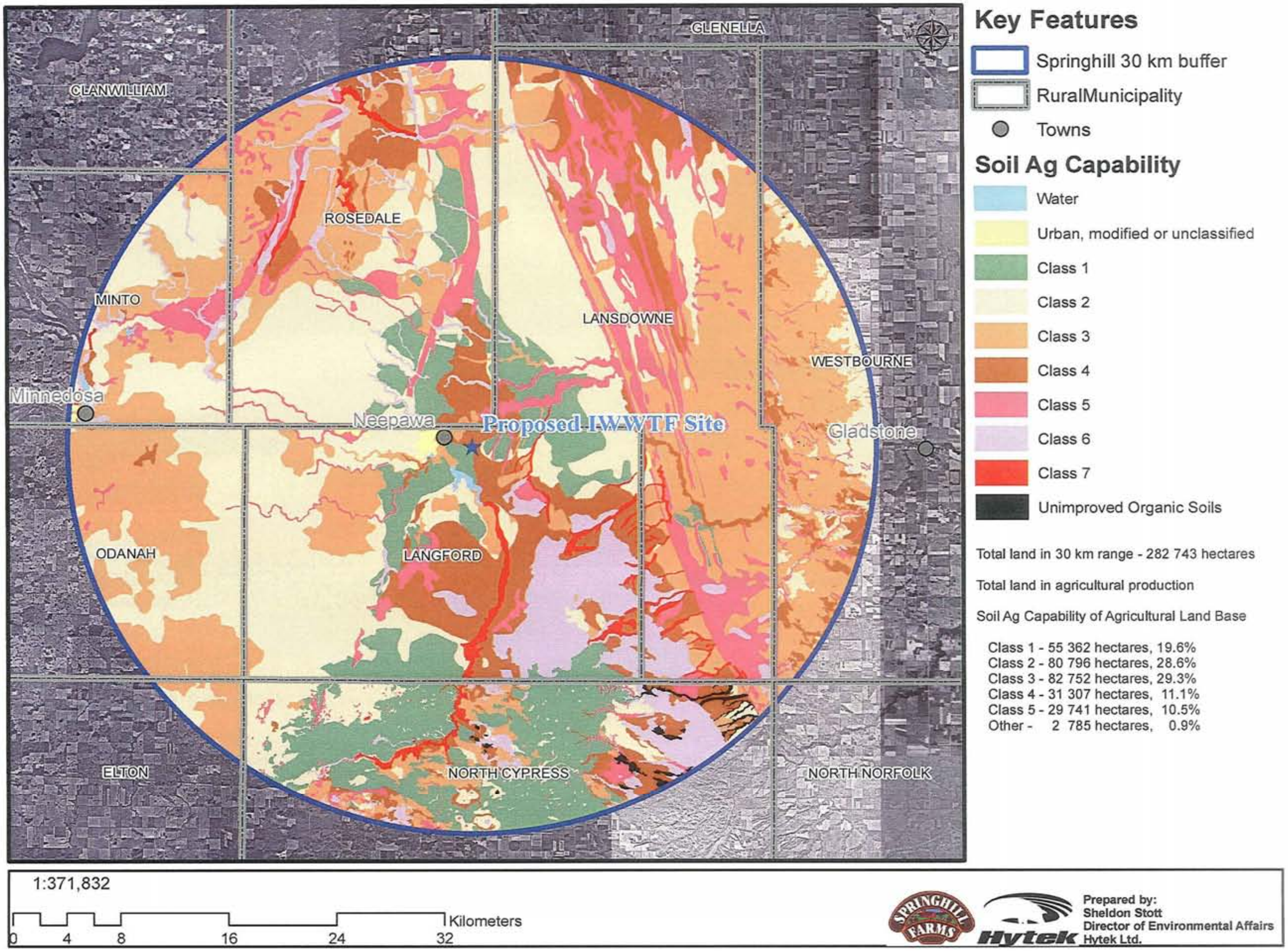


Figure B-4: Soil Agriculture Capability Applied to Agricultural Land within 30 km Radius

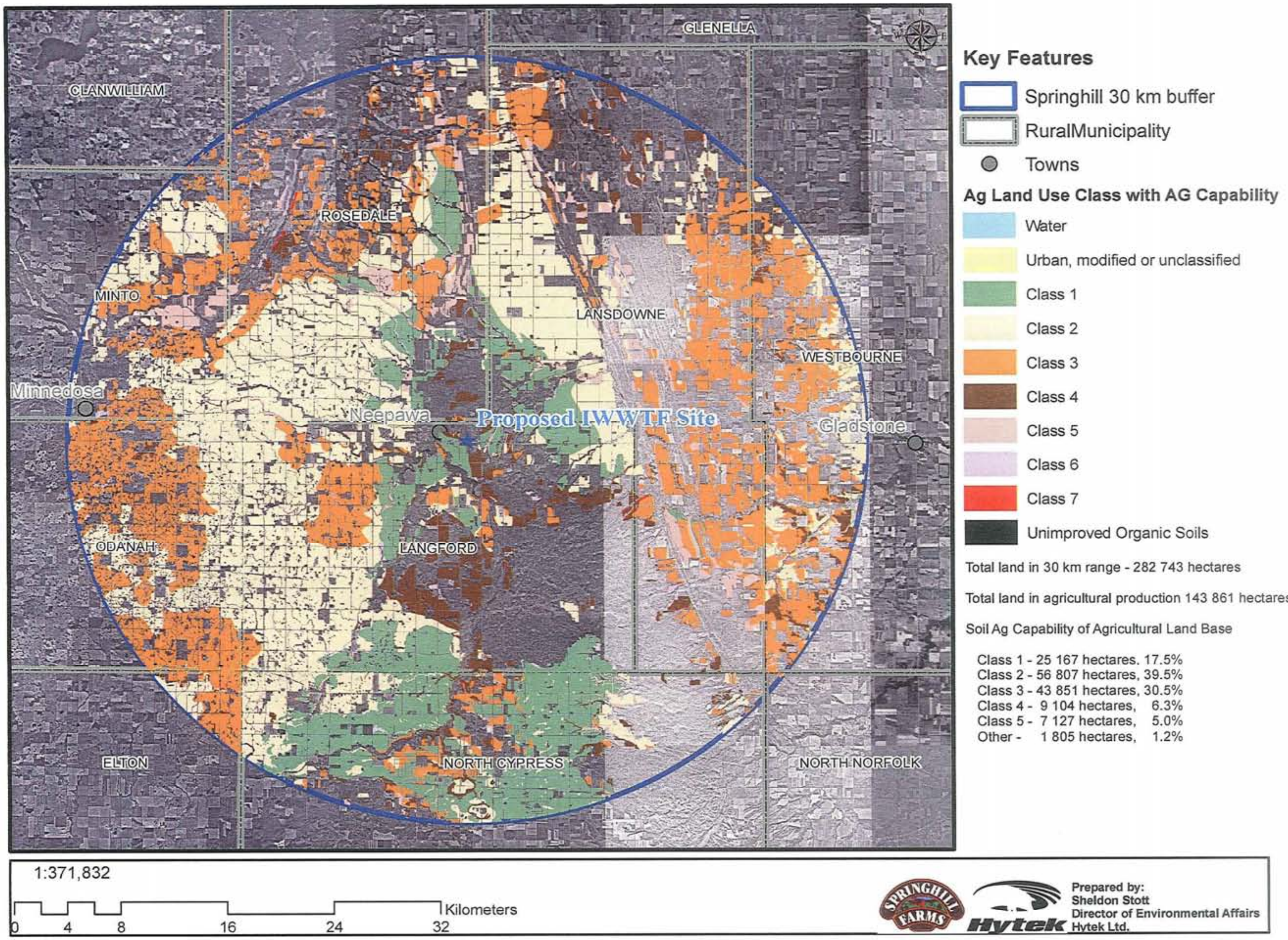


Figure B-5: Nutrient Management Zones of Agricultural Land within 30 km Radius

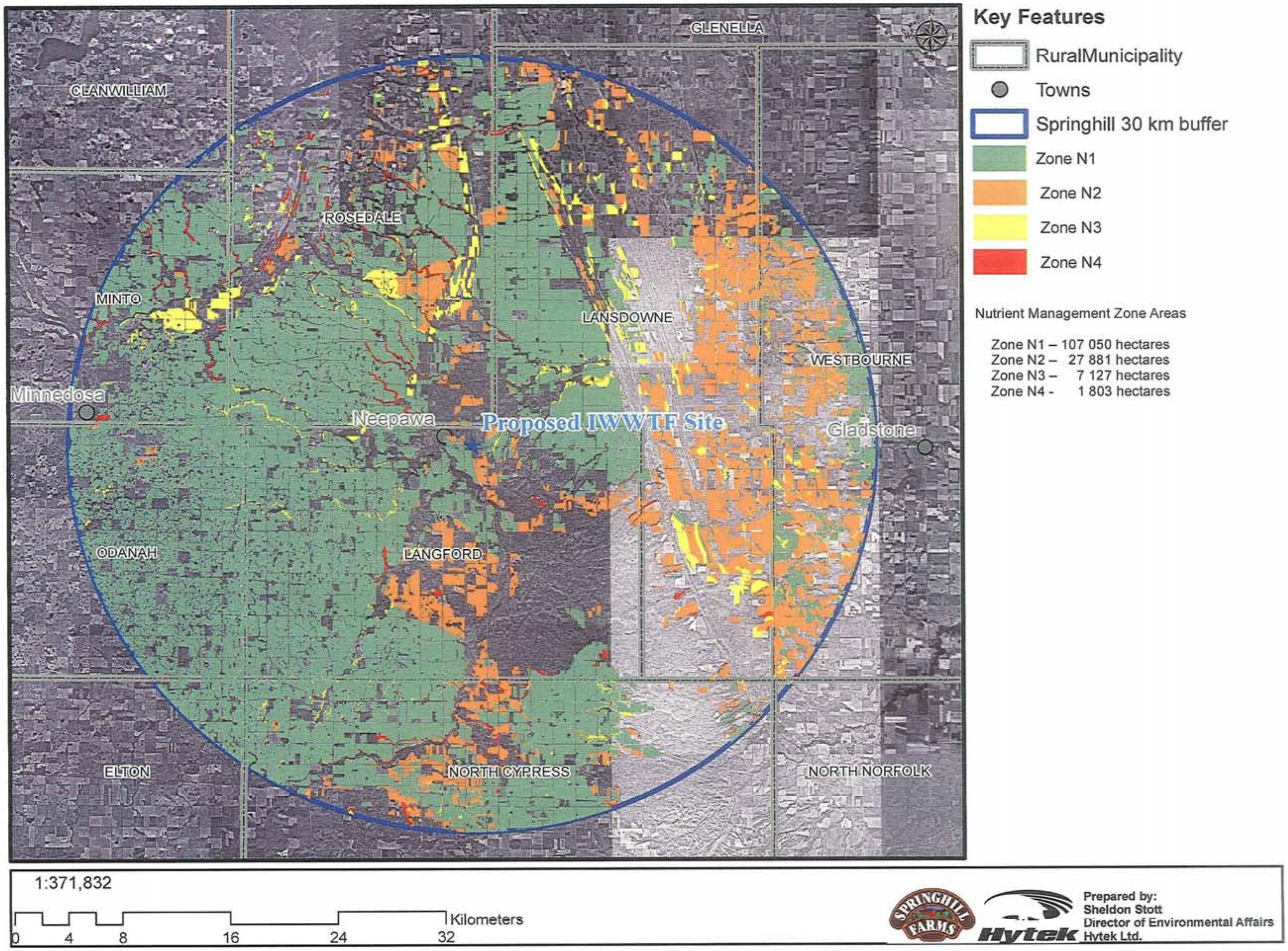


Figure B-6: Neepawa Area Groundwater Pollution Hazard Map

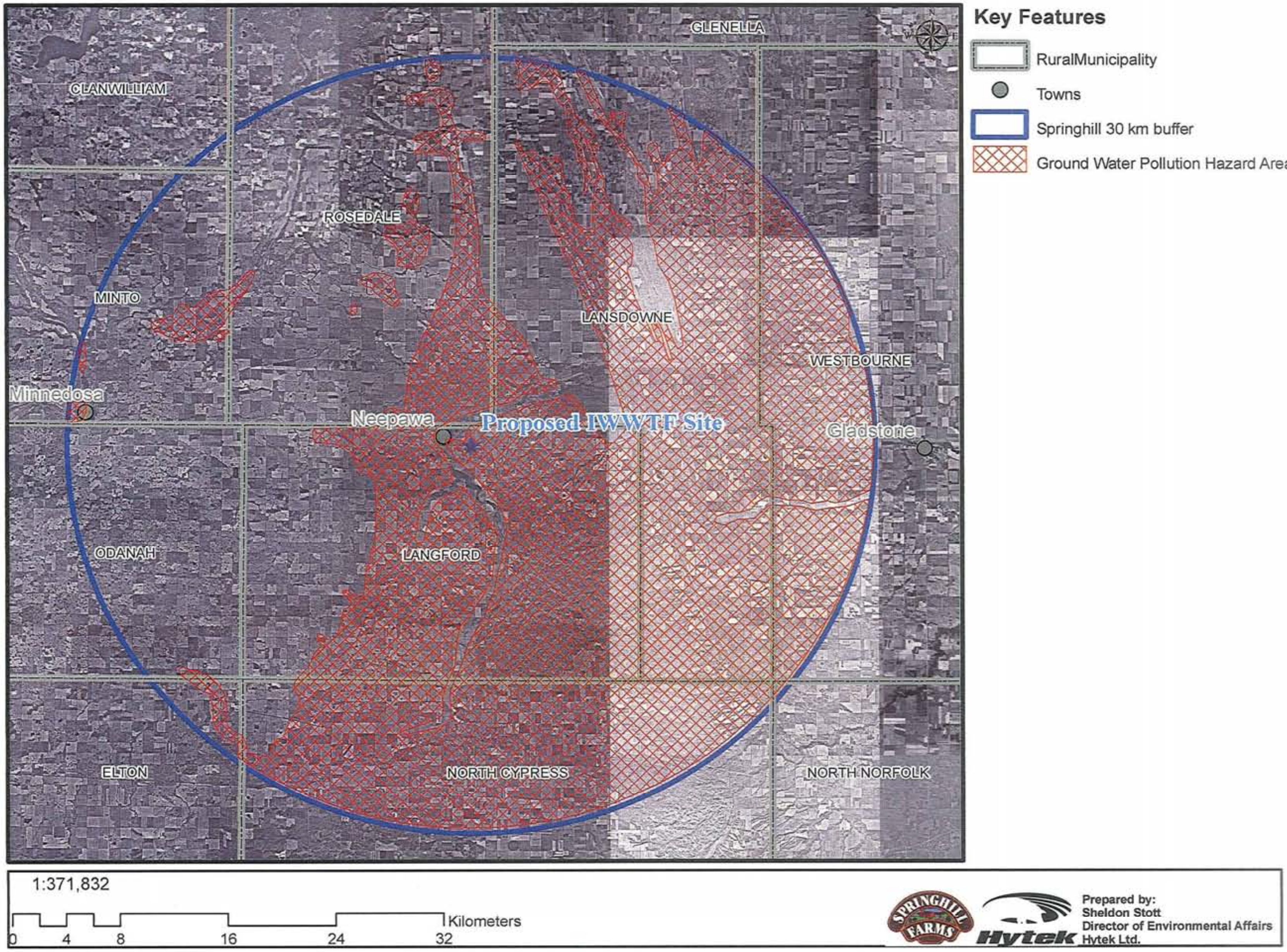


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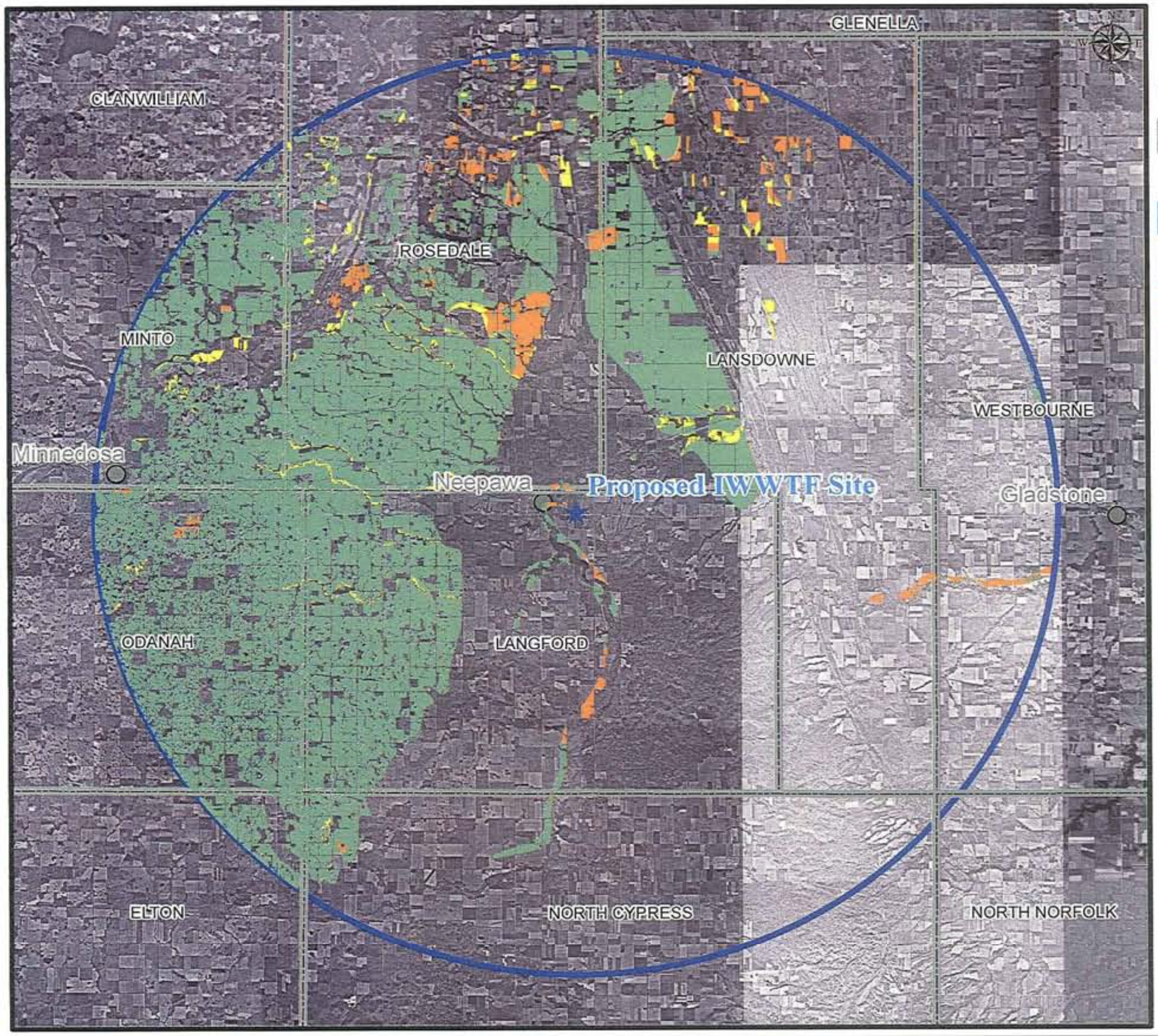
Figure B-7: Available Landbase for Biosolids Application with Nutrient Management Zones



Key Features

- RuralMunicipality
- Towns
- Springhill 30 km buffer
- Zone N1
- Zone N2
- Zone N3

Nutrient Management Zone Areas

Zone N1 – 66 527 hectares
Zone N2 – 3 559 hectares
Zone N3 – 4 300 hectares

1:371,832

0 5 10 20 30 40 Kilometers

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