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11.0 COUNTY OF OXFORD

11.1 Oxford County Water Quality Risk Assessment

Three municipal groundwater systems are located within the portion of the County of Oxford that falls within the Grand River Source Protection Area: Bright, Drumbo-Princeton, and Plattsville (**Table 11-1**). The areas serviced by these systems are shown on **Map 11-1**.

Table 11-1: Municipal Residential Drinking Water Systems Information for Oxford County in the Grand River Source Protection Area (Bright, Drumbo-Princeton and Plattsville Water Systems)

DWS Number	DWS Name	Operating Authority	GW or SW	System Classification[1]	Number of Users served[2]
220009050	Bright Water System	Oxford County	GW	Large municipal residential	436
220007515	Drumbo-PrincetonWater System	Oxford County	GW	Large municipal residential	1,540
210001291	Plattsville Water System	Oxford County	GW	Large municipal residential	1,506

[1] as defined by O. Reg. 170/03 (Drinking Water Systems) made under the *Safe Drinking Water Act, 2002.*
[2] Based on County of Oxford 2017 Water System Reports

Table 11-2: Annual and Monthly Average Pumping Rates for Oxford County Municipal Residential Drinking Water Systems in the Grand River Source Protection Area

Well or Intake	Annual Avg. Taking[1] (m^3/d)	Monthly Average Taking[1] (m^3/d)											
	2017	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bright Water System	72	71	74	72	72	73	78	73	67	73	78	74	70
Drumbo-Priceton Water System	266	238	238	283	325	257	297	285	252	265	269	241	247
Plattsville Water System	442	480	500	400	443	422	416	440	430	418	486	435	433

[1] source: Oxford County annual summary reports, based on 2017 monitoring data

11.1.1 Bright Water System

The Bright water system is supplied by two wells, Well 5 and Well 4A, located in the west part of the village.

Well 5, constructed in 2003, was refurbished in 2008 through the installation of a new well screen and completed to a depth of 25.9 m below ground surface (bgs) in the Waterloo Moraine sand and gravel aquifer. Well 4A, constructed in 2009, replaced Well 4 which was taken offline in 2010. Well 4A is completed to a depth of 26.7 m bgs and is screened across the Waterloo Moraine sand and gravel aquifer.

None of the wells are considered to be grounderwater under the direct influence of surface water (GUDI) according to the County of Oxford Water Systems Drinking Water Quality Management System Operational Plan.

Wells 5 and 4A are permitted to operate at a maximum pumping rate of 3.78 L/s under Permit to Take Water (PTTW) 7467-84BQEE. Well 4A supplies the majority of the water demand.

11.1.2 Drumbo-Princeton Water System

The Drumbo-Princeton water system is supplied by three production wells: Well 1, Well 2A, and Well 3.

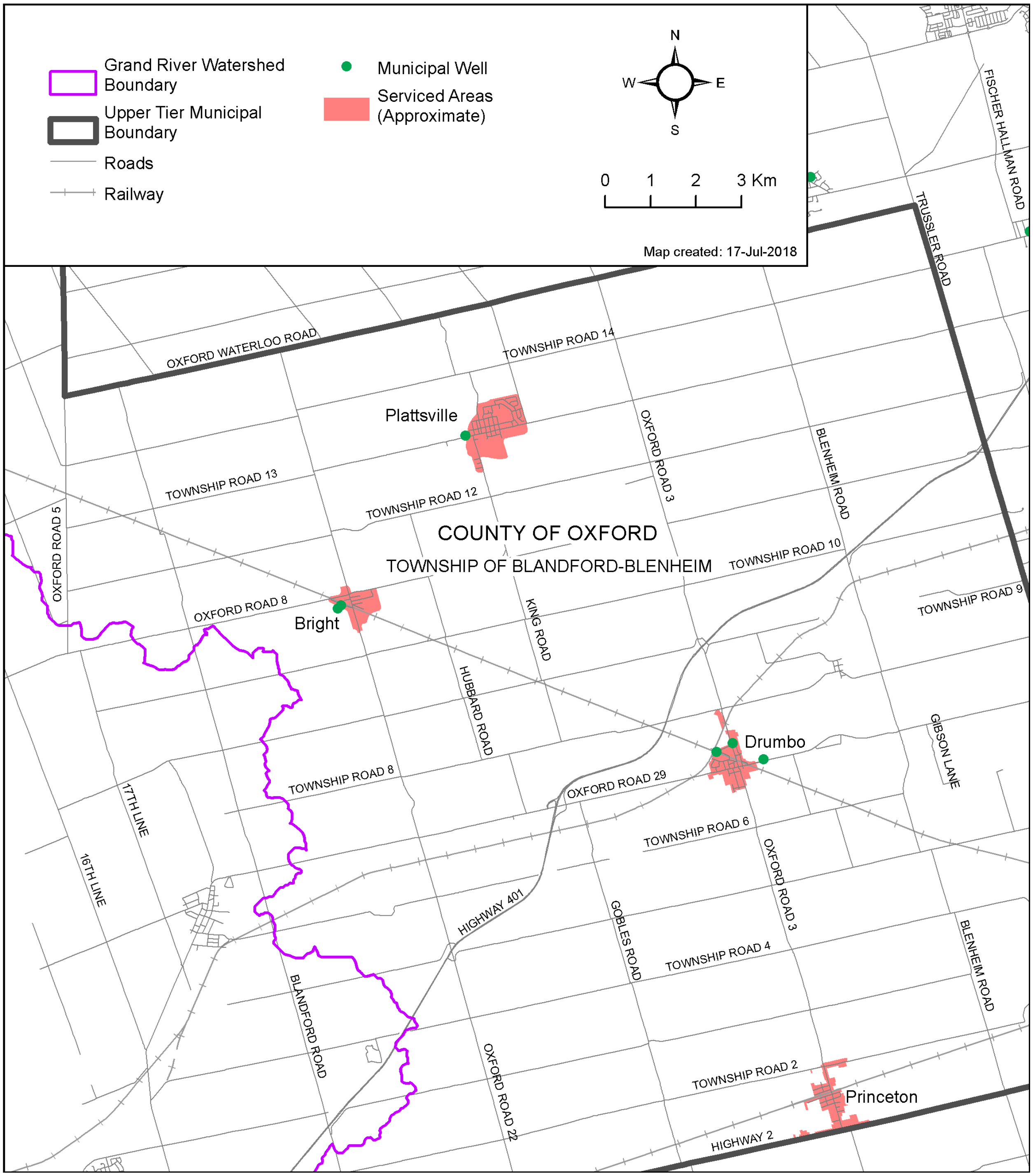
Well 1, brought online in 2013, is located on the east side of County Road 3 in the north part of Drumbo. Well 2A is located on the east side of the village of Drumbo on the north side of County Road 29 (Drumbo Road). Well 3 is located in the northwest part of the village.

Well 1 is screened over a depth interval of 33 to 37 m bgs. Water well records indicate that the approximate screen depth intervals are 40 to 44 m bgs at Well 2A and 26 to 32 m bgs at Well 3. The well completion zones were considered to be part of the deep overburden sand silty aquifer (Golder, 2001).

11.1.3 Plattsville Water System

The Plattsville water system is supplied by two overburden wells located on the western edge of the community (north side of County Road 42), approximately 60 m from the Nith River. The well completions are reported to be in a sand and gravel aquifer with screen settings from about 12 to 15 m bgs (Golder, 2001). Neither of the supply wells are considered GUDI.

Map 11-1: County of Oxford Supply Serviced Areas (within the Grand River Watershed)



11.1.4 Vulnerability Analysis

Delineation of Wellhead Protection Areas for the Bright Water System

The Bright WHPAs were delineated using the Whitemans Creek Tier 3 groundwater flow model (EarthFX, 2017a). The Whitemans Creek Tier 3 groundwater flow model was built using the U.S. Geological Survey (USGS) MODFLOW code (Harbaugh, 2005). The MODFLOW-NWT (Niswonger *et al.*, 2011) version of the code was used in this study because it is especially well suited for representing thin aquifers and sharp changes in model layer stratigraphy such as that occurring along the incised valleys of Whitemans Creek and the Grand River. The conceptual geologic model comprises of 17 layers, which were used to generate a 12- layer groundwater flow model for the Whitemans Creek area. Refer to Chapter 21 of this report for additional information on the Whitemans Creek Tier 3 groundwater flow model.

Groundwater recharge rates for the Wellhead Protection Area (WHPA) delineation was calculated using the PRMS hydrologic submodel delveloped for the Whitemans Creek Tier 3 study (Earthfx, 2017a). The groundwater recharge rates reflect the effects of spatial variation in climate, topography, land cover, and soil properties. Overall, the model was not overly sensitive to changes in recharge.

The Bright municipal supply wells are screened in Waterloo Moraine equivalent sediments and are referred as the Waterloo Moraine Aquifer. The aquifer is composed of sand and gravel and is between 5 and 30 m thick in the wellfield vicinity. The aquifer is confined within the wellfield vicinity; however it becomes less confined to the northeast and to the south where the Port Stanley Till thins. The Waterloo Moraine aquifer pinches out to the west and northwest and is generally continuous in all other directions. Below the Waterloo Moraine Aquifer, the Maryhill Till aquitard, and the older Catfish Creek Till aquitard provide vertical confinement for the deeper overburden aquifers, however, are generally thin and discontinuous in the study area.

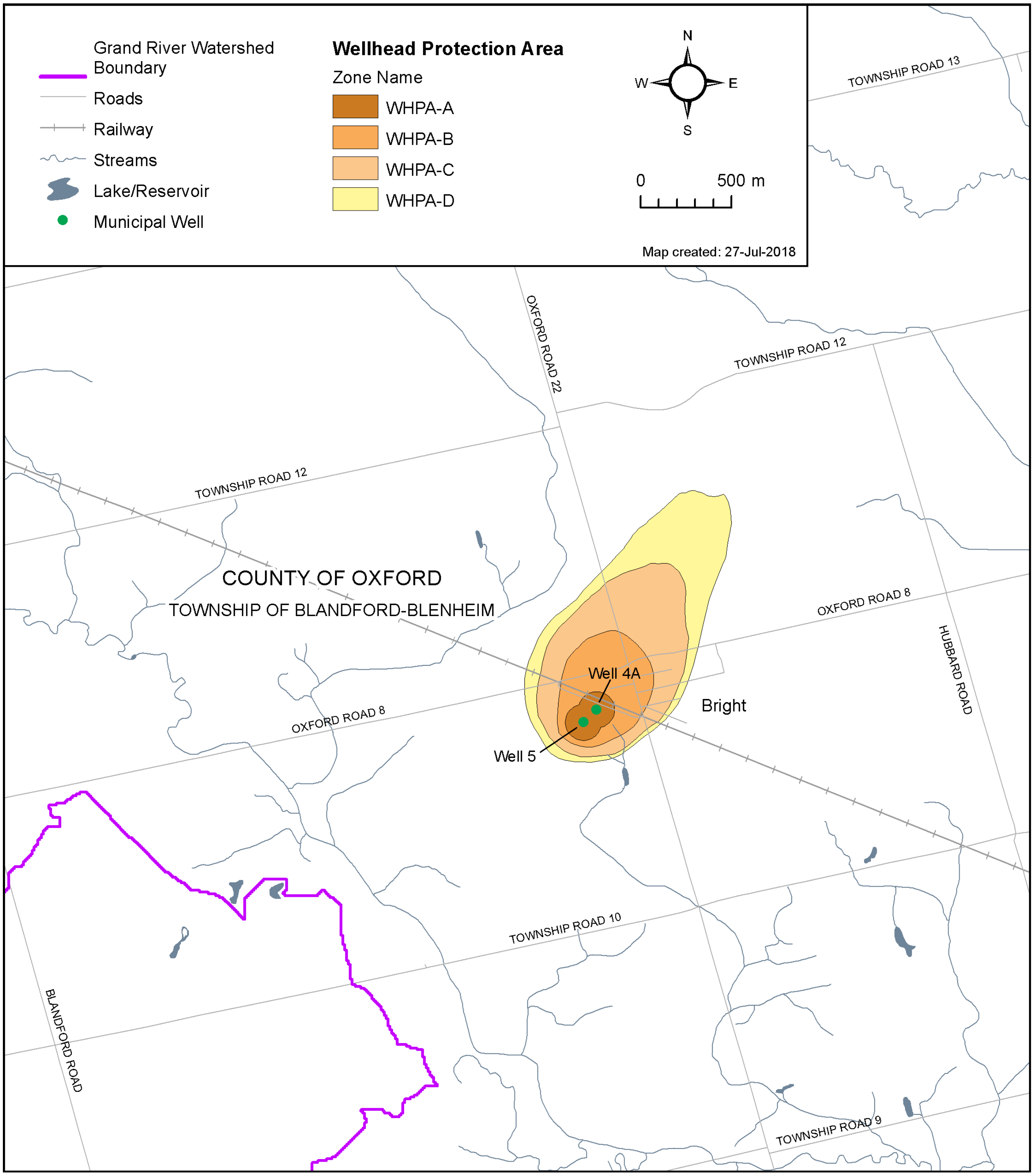
The water levels in both the overburden and bedrock aquifers indicate that regional groundwater flow is from northwest to southeast. Locally high groundwater levels are observed in the overburden to the east of the municipal wellfield, where high recharge is believed to occur. Here, groundwater flow in the overburden fans out in multiple directions and causes groundwater flow through the municipal wellfield to be from the northeast to the southwest.

The pumping rates used to model WHPAs for Well 4A and Well 5 were 3.0 L/s and 0.78 L/s, respectively. The modelled rates were selected to represent a realistic distribution of the maximum permitted rates for the two wells. The 25-year capture zone extends approximately 1.4 km to the northeast following the general direction of local groundwater flow patterns in the area, as determined through interpolation of MECP water levels.

Well 4A and Well 5 are both classified as non-GUDI, therefore a WHPA-E and WHPA-F were not delineated.

Map 11-2 illustrates the time-related capture zones for the Bright Water System.

Map 11-2: Bright Water Supply Wellhead Protection Areas



Delineation of Wellhead Protection Areas for the Drumbo-Princeton Water System

A local-scale numerical groundwater flow model was used to generate WHPAs for the Drumbo-Princeton municipal wells (Golder, 2001). The model covers an area of approximately 13 km², and is oriented in a northwest to southeast direction, parallel to the direction of regional groundwater flow in the deep overburden aquifer. The following provides a summary of the Drumbo Groundwater Model based on the available hydrogeological information at the time of the Golder (2001) study.

The bedrock is overlain in the Drumbo area by about 50 to 70 m of glacial drift which includes predominantly fine grained materials in the upper 40 m which are typically underlain by more permeable sands and gravels at depth. Permeable lenses of aquifer material are also found at shallow and intermediate depths. The Drumbo-Princeton wells are considered to lie within the Deep Aquifer, with an assumed aquifer thickness of about 4 m. This aquifer is considered to be semi-confined. Based on the above, the Drumbo Groundwater Model was constructed as a single layer model with vertical leakage into the aquifer from above. The base of the model was assumed to be defined by the base of the Deep Aquifer pumped by the Drumbo-Princeton water supply wells. Groundwater flow in the Deep Aquifer at Drumbo is inferred to occur in a southeasterly direction.

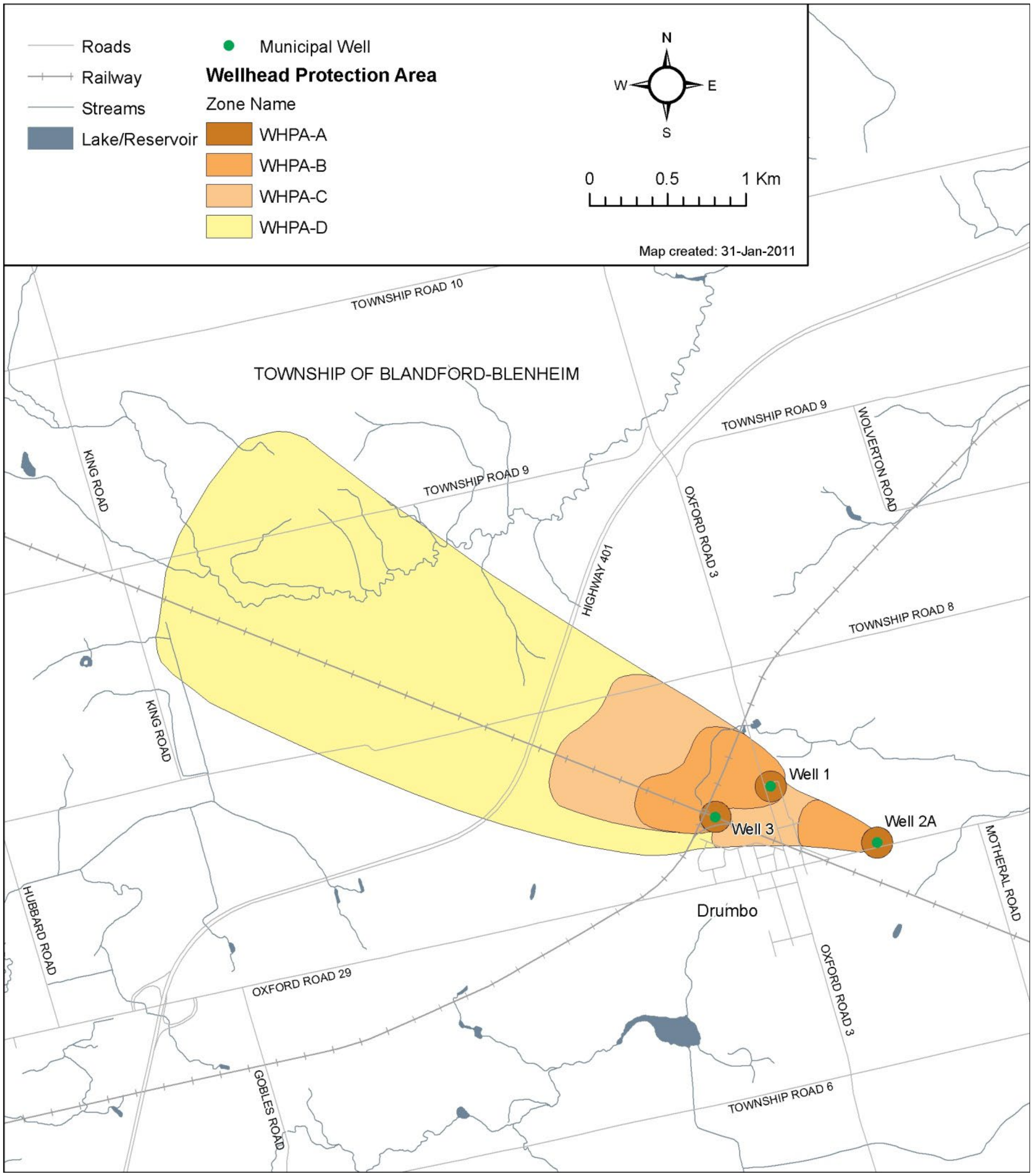
Groundwater flow directions in the overburden aquifers are influenced by the presence of the Nith River. The Nith River is expected to be a groundwater discharge location for the shallow, and perhaps deeper aquifers. The Nith River was not directly included in the Drumbo Groundwater Model although its effect is indirectly included by the assignment of a constant head boundary along the eastern/southeastern model limit. This boundary allows groundwater flow to occur from the Deep Aquifer in the direction of the Nith River.

Groundwater recharge was applied uniformly across the model area to the Deep Aquifer at a rate of 20 mm/yr.

WHPAs are presented on **Map 11-3** for the Drumbo-Princeton municipal wells. Uncertainty was addressed in both the aquifer data and groundwater flow direction through adjustments (shape factors) to the capture zones (Golder, 2001). The projected population growth and increase in water use demand for the Drumbo area is 30 percent relative to water usein 1999. Therefore, the pumping rate used to forecast the time-related capture zones for the Drumbo-Princeton wells was increased by 30 percent compared to rates estimated for 1999 (197 m³/day).

Historical testing data from the Deep Aquifer at Drumbo-Princeton Well 3 estimates the transmissivity of this location to be approximately 44 to 51 m^3 per day. Assuming an aquifer thickness of about 4.3 m at this location, this corresponds to an aquifer hydraulic conductivity on the order of $1.3x10^{-4}$ m/s. Historical testing at Well 2 indicated a wider range in transmissivity; from 8.6 to 86 m²/day. Assuming an aquifer thickness of 3.7 m at this location, this corresponds to a range in hydraulic conductivity from $2.7x10^{-5}$ m/s to $2.7x10^{-4}$ m/s.

Map 11-3: Drumbo-Princeton Water Supply Wellhead Protection Areas



Delineation of Wellhead Protection Areas for the Plattsville Water System

A local-scale numerical groundwater flow model covering area of approximately 7 km² was developed to delineate WHPAs for the Plattsville municipal wells (Golder, 2001). The following provides a summary of the Plattsville Groundwater Flow Model based on the available hydrogeological information:

The Plattsville area is underlain by an extensive glaciofluvial outwash sand and gravel deposit that generally follows the floodplain of the Nith River. These deposits comprise the Shallow Aquifer that provides groundwater to the Plattsville Water System. In the Plattsville town area the Shallow Aquifer is underlain by about 20 to 30 m of silt and clay sediments which in turn are underlain by bedrock. To the east, the topography rises from about 300 masl at the Nith River to about 325 masl at the contact between the outwash deposits and the silty clay to sandy silt till plain (Port Stanley Till). The Plattsville Groundwater Model was constructed using two overburden layers. Along the Nith River valley both layers are represented by the high permeability outwash sands and gravels. To the east, the upper model layer is comprised of a Shallow Aquifer while the lower model layer is defined by finer grained, lower permeability silts and clays.

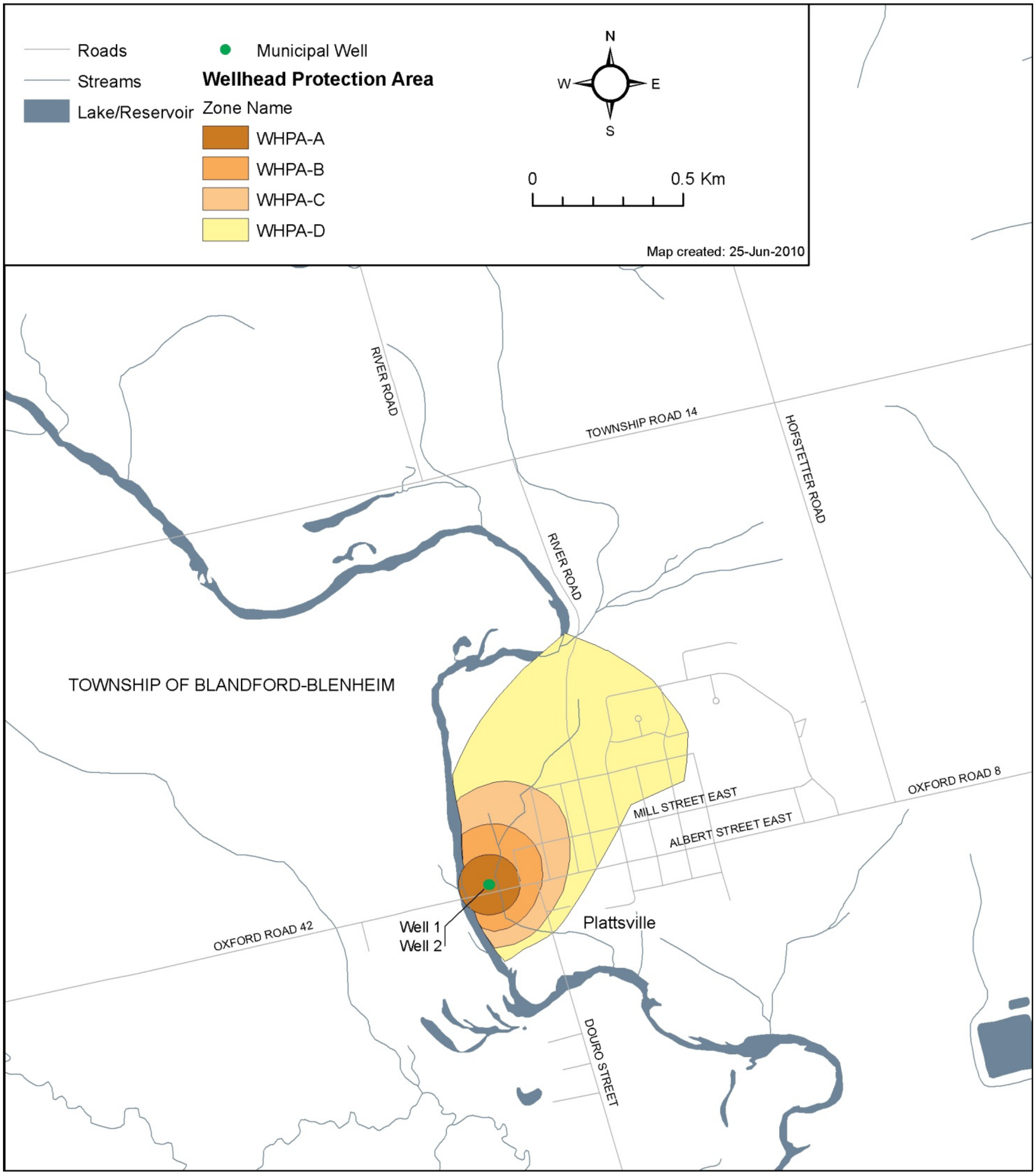
The Shallow Aquifer in the Plattsville area is unconfined and assumed to be directly connected to the Nith River. The western boundary of the model follows the Nith River and the surface water elevation in the creek (from the DEM) was assumed to be similar to the Shallow Aquifer groundwater elevation beneath the creek. Groundwater flow in the Shallow Aquifer at Plattsville is inferred to occur in a west to southwesterly direction towards the Nith River.

The hydraulic conductivity of the aquifer in the Nith River valley was estimated to be $1x10^{-4}$ m/s, with recharge rates ranging from 350 mm/yr into the outwash sands to 150 mm/yr into the surficial materials along the till plain. The average annual pumping rate in 1999 was used in the calibration process.

Map 11-4 illustrates the WHPAs for the Plattsville water system. The WHPAs incorporate uncertainty in both the aquifer data and groundwater flow direction through adjustments (shape factors) to the length and width of the WHPAs. The projected population growth in the Plattsville area is 20 percent relative to 1999 pumping rates.. Therefore, the pumping rate for the Plattsville water supply wells used to forecast the WHPAs was increased by 20 percent compared to 1999 (619 m³/day).

The Plattsville WHPAs extend to the north/northeast of the municipal wells over a fairly broad area. The WHPAs include the river floodplain and the western and central parts of the community and the west edge underlies the Nith River. This suggests that surface water from the Nith River is recharging the Shallow Aquifer and is part of the overall capture of the Plattsville water supply wells.

Map 11-4: Plattsville Water Supply Wellhead Protection Area



Uncertainty in the Delineation of Wellhead Protections Areas

An uncertainty factor of "high" or "low" was assigned to each WHPA delineated based on the results of the uncertainty analysis.

Bright

Results of the uncertainty analysis are discussed below and final uncertainty factors for the WHPA delineation is provided in **Table 11-3**.

There is inherent variation in the level of confidence with numerical modelling studies, which includes the quality of the input data and the model output due to computational assumptions within the model. Overall the model produced good matches to the observed water levels; however, the ability of the model to exactly reproduce local flow patterns is not certain. There is a high level of uncertainty surrounding the aggregate pit, north of the WHPA, where future expansion may alter recharge and local groundwater flow patterns. For this reason the ability of the model to reflect the processes of the hydrogeologic system has been given a high level of uncertainty.

Table 11-3: Summary of Uncertainty Analysis for WHPA Delineation

Uncertainty Element	**Uncertainty**
Distribution, variability, quality and relevance of data	Low
Ability of the methods and models used to accurately reflect the flow processes in the hydrogeological system	High
Quality assurance and quality control procedures applied	Low
Extent and level of calibration and validation achieved for models used or calculations or general assessments completed	Low
Overall	**High**

Drumbo-Princeton and Plattsville

The WHPAs for the Drumbo-Princeton and Plattsville drinking water systems were delineated using numerical modelling procedures (MODFLOW and MODPATH) as part of the Phase II Groundwater Protection Study (Golder, 2001). The models developed for the municipal well systems were calibrated to existing conditions at the time (1999). Pumping rates required to service the projected population growth were then input to the models and used to delineate the predicted capture zones by way of particle tracking within the groundwater saturated zone. The capture zones were then projected to ground surface to create a capture area at ground surface. It was recognized at the time that a level of conservatism was built into the process by neglecting to account for the travel time from surface to the water table.

Sources of uncertainty associated with the capture areas were recognized and addressed as part of the Phase II Groundwater Protection Study (Golder, 2001). One example was the effect of uncertainty in the hydraulic conductivity (K). It was noted that a lower K can result in a wider, but shorter capture zone, whereas a higher K can result in a narrower, but longer capture zone. A second example was the effect of uncertainty in the direction of regional groundwater flow, which was based on interpretation of MOE water well record data. It was noted that a difference of 5 degrees in the direction of groundwater flow may be insignificant near the production wells but would be much more significant further upgradient of the wells (Golder, 2001). To address these uncertainties, the shape of the capture zone was adjusted using two shape factors. The first shape factor was a 20% increase in the overall shape of the capture zone (20% increase in width at the centreline, and a 20% increase in length upgradient and downgradient of the production well). The second shape factor was the addition of a 5 degree angle added to the centreline of the capture zone, in effect increasing the width at increasing distances from the pumping well. The objective of applying the second shape factor was to compensate for uncertainty in the regional groundwater flow direction. For capture zones intersecting groundwater flow divides and recharge boundaries (i.e. river boundaries), those boundaries were still used to limit the extent of the capture zone, notwithstanding the adjustments made in applying the shape factors.

As noted previously, a number of the WHPAs have been modified since 2001 to incorporate changes to the municipal well systems, well locations, and flow rates. All of the modifications were performed by Golder and some were undertaken in 2007 as part of the source protection program. The net result is that the WHPA delineation for the active municipal production wells at the Drumbo-Princeton and Plattsville drinking water systems has been undertaken using a consistent and well documented modelling procedure, based on hydrogeological interpretations, and incorporating practical measures to address uncertainty.

In general, the WHPAs for the Drumbo-Princeton and Plattsville production wells appear to be reasonable approximations and can be considered as having a relatively low level of uncertainty.

Vulnerability Scoring of Wellhead Protection Areas

The intrinsic vulnerability of the aquifer within each WHPA was assessed using one of the methods approved under the *Clean Water Act* Technical Rules. The resulting maps rank aquifer vulnerability as high, medium or low. The intrinsic vulnerability for the Bright, Drumbo-Princeton and Plattsville WHPAs are shown on **Map 11-5, Map 11-7**and **Map 11-9.**

In the County of Oxford, aquifer vulnerability mapping within the Drumbo-Princeton and Plattsville WHPAs was completed using the Aquifer Vulnerability Index (AVI) (Golder, 2001). Aquifer vulnerability mapping within the Bright WHPAs was completed using the surface to well advective time (SWAT) method (EarthFX, 2018).

The aquifer vulnerability mapping recognized three overburden units based on depth, with the classification of units as follows: Shallow aquifers occurring from surface to 15 m, intermediate aquifers occurring from 15 – 30 m, deep aquifers occurring at depths greater than 30 m. The bedrock aquifer was also recognized as a fourth unit. The capture zone delineation included the 2, 5, 10 and 25 year time of travel.

Identification of Transport Pathways and Vulnerability Adjustment

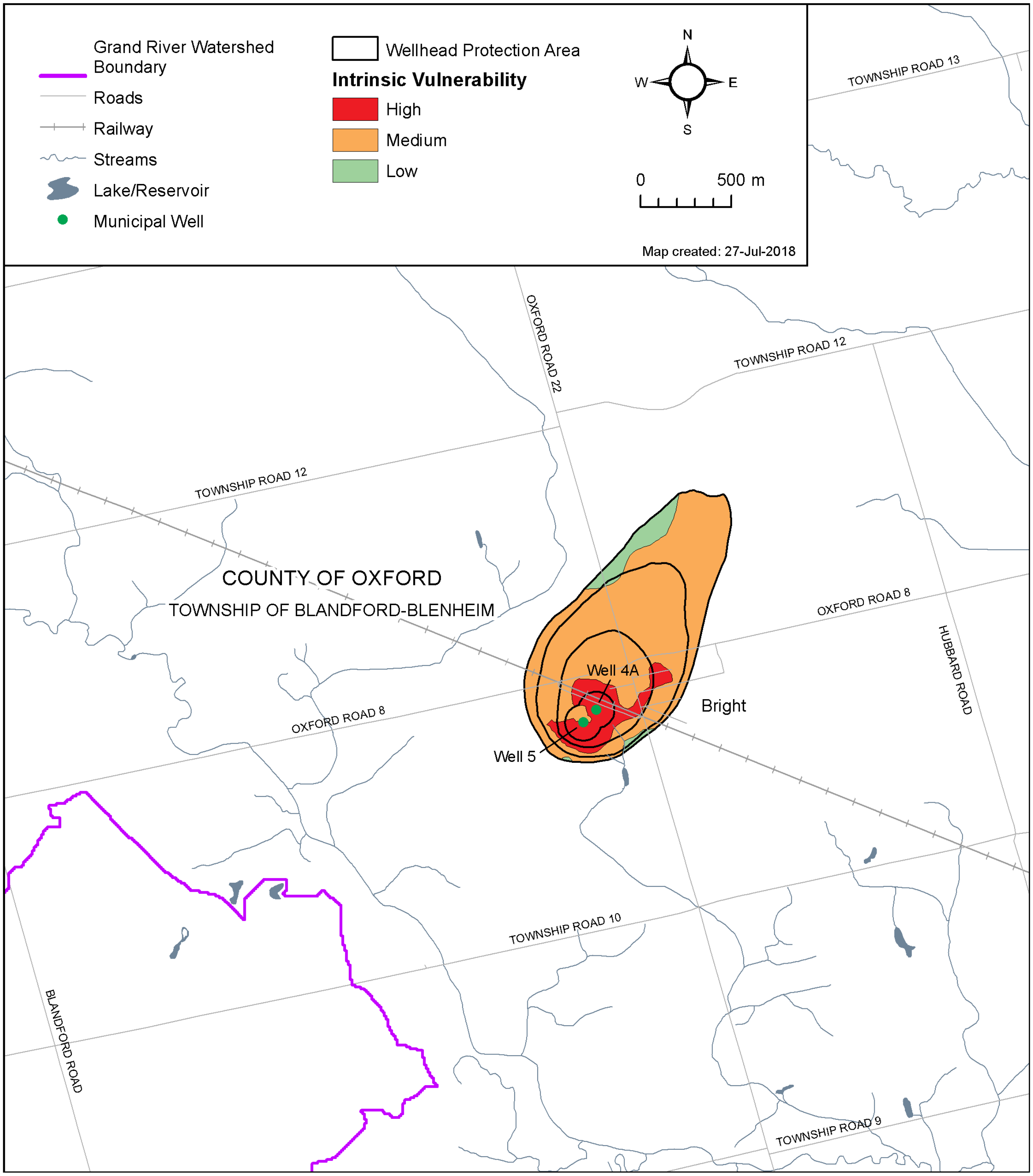
Following a review of the initial vulnerability scoring maps, an assessment of transport pathways was completed to determine whether adjustments to the vulnerability assessment were warranted. Transport pathways for groundwater based drinking water systems include: wells (existing and abandoned), pits and quarries, mines, construction activities, storm water infiltration, septic systems, sanitary sewer infrastructure.

Adjusted Vulnerability Scoring for the Bright Wellhead Protection Areas

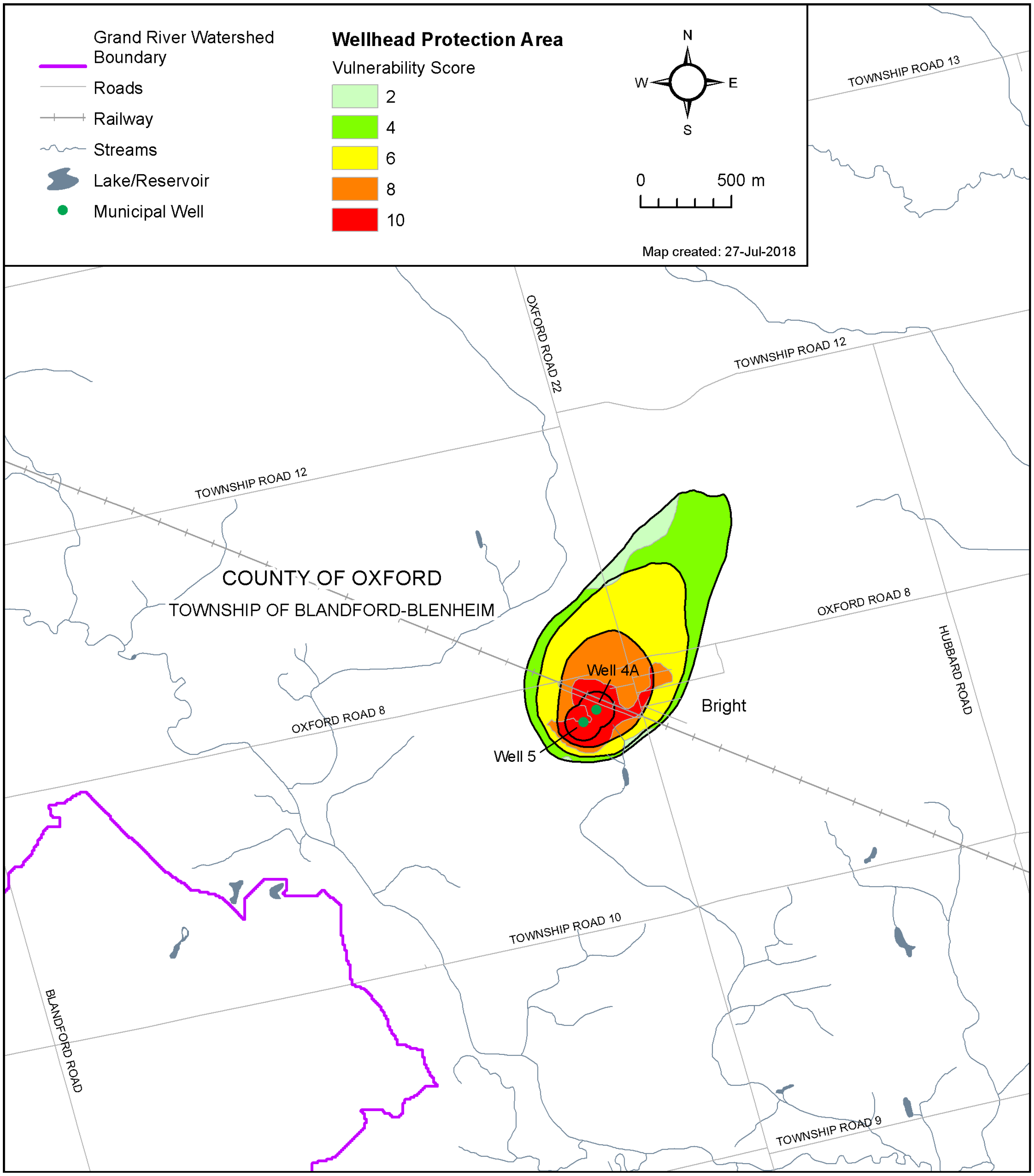
Due to the uncertainties related to the estimation of unsaturated travel times, the unsaturated zone travel times (UZAT) were not factored into the calculation of SWAT values, resulting in a more conservative vulnerability assessment. Potential pathways for shortened travel times to the wells were also evaluated. A total of 33 wells were identified within the WHPAs which were assessed based on likely construction quality and potential to be in communication with the aquifer pumped by the municipal supply wells. While some wells were identified as moderate to high risk, no adjustments were made to the vulnerability scores due to the uncertainty of well locations. Further investigation into the location and condition of the identified wells is recommended in order to properly assess their vulnerability. In addition, two aggregate extraction pit operations were identified as possible preferential pathways; however they were not considered a risk because they were outside the WHPA. No adjustments to the intrinsic vulnerability were made due to transport pathways.

The final vulnerability map is presented in **Map 11-6.** High local recharge to the northeast of the wellfield resulted in moderate vulnerability scores with some locally higher scores in the WHPA-B and WHPA-C. Low scores within the WHPA-C and WHPA-D corresponded to areas in which particles did not arrive at the wells during the forward particle tracking analysis.

Map 11-5 Bright Water Supply Intrinsic Vulnerability



Map 11-6: Bright Water Supply Wellhead Protection Area Vulnerability



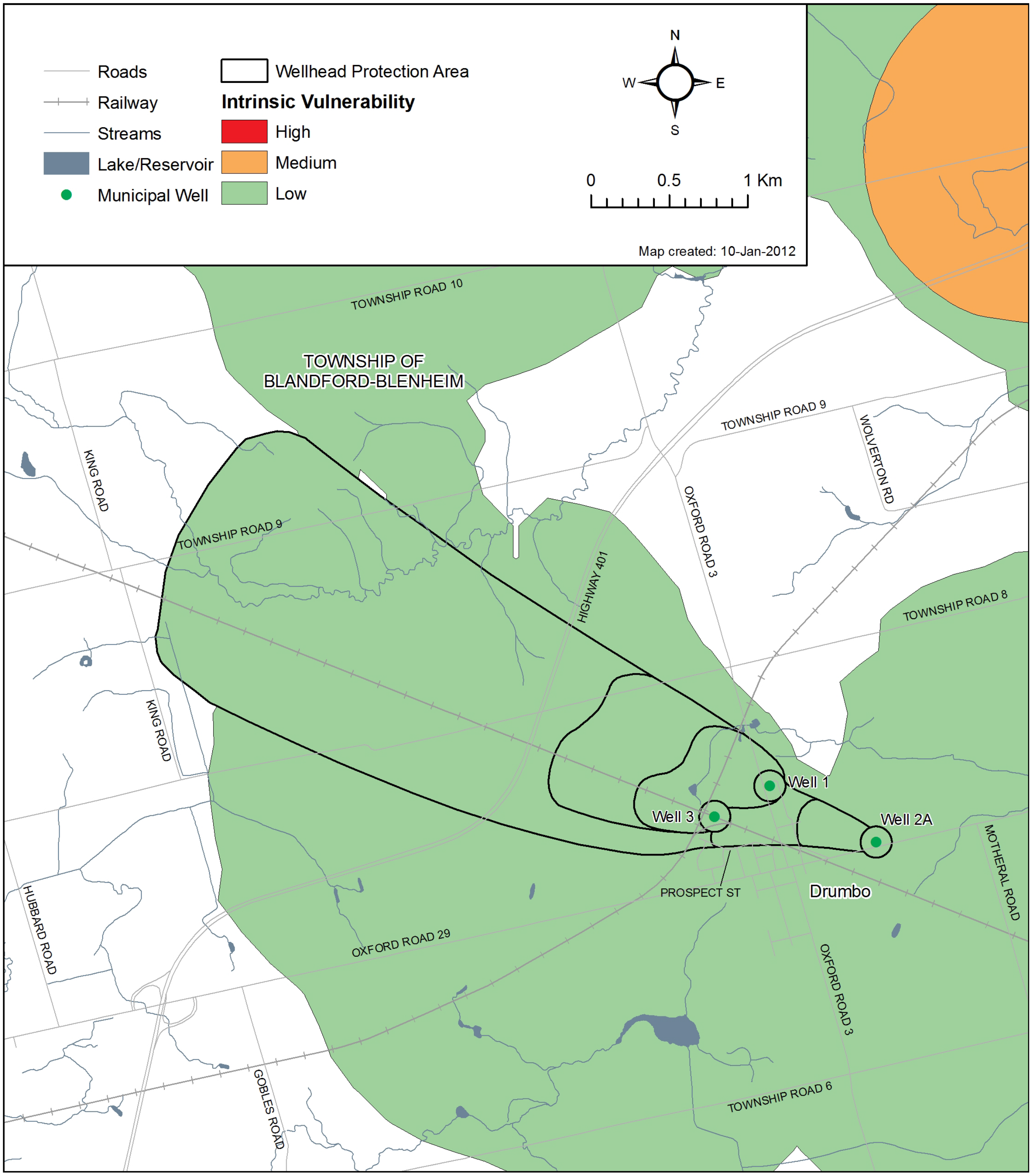
Adjusted Vulnerability Scoring for the Drumbo-Princeton Wellhead Protection Areas

The Wellhead Protection Areas for Well 1, Well 2A, and Well 3 extend approximately 4 km to the northwest, and are based on a forecast pumping rate of 197 m^3/day (2.3 L/s). There are no transport pathways warranting an adjustment to the intrinsic vulnerability within the WHPA. Gaps in the vulnerability mapping within Zone D were filled by extending the low vulnerability index that occurred over most of the remaining portion of Zone D. The resulting vulnerability scores are 6 in Zone B, 4 in Zone C and 2 in Zone D as shown on **Map 11-8.**

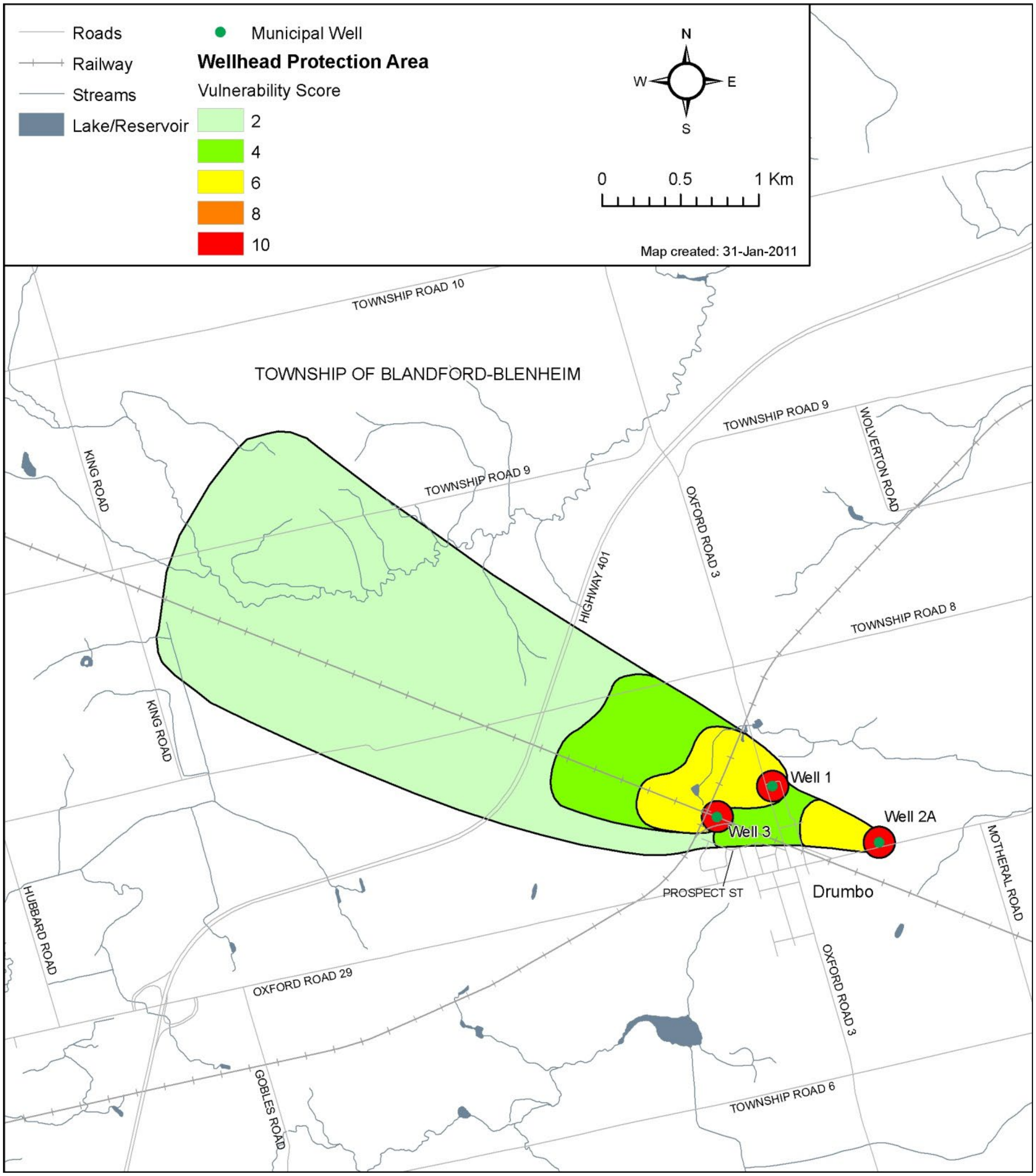
Adjusted Vulnerability Scoring for the Plattsville Wellhead Protection Areas

An adjustment was made to the vulnerability mapping to remove an anomalous area within a portion of Zones C and D, which resulted in a decrease in the vulnerability scores for the adjusted area. This adjustment was based on professional judgement. Sanitary sewer lines and a few private wells appear to occur within the WHPA. However, these potential transport pathways were not considered sufficient to warrant adjustments to the vulnerability mapping. The results indicate vulnerability scores of 10 in Zone B, 8 in Zone C and 6 in Zone D as shown on **Map 11-10.**

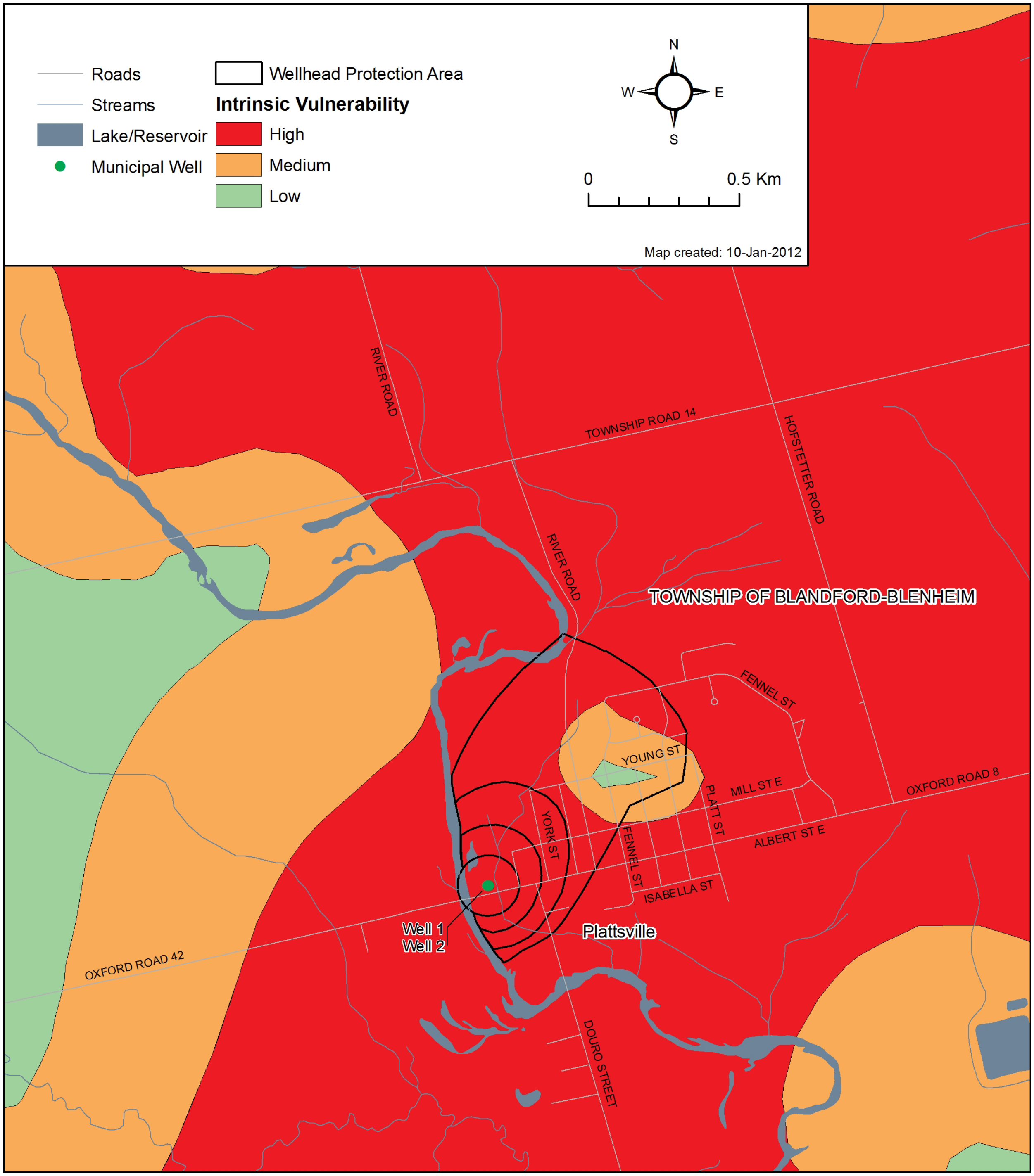
Map 11-7 Drumbo-Princeton Well Supply Intrinsic Vulnerability



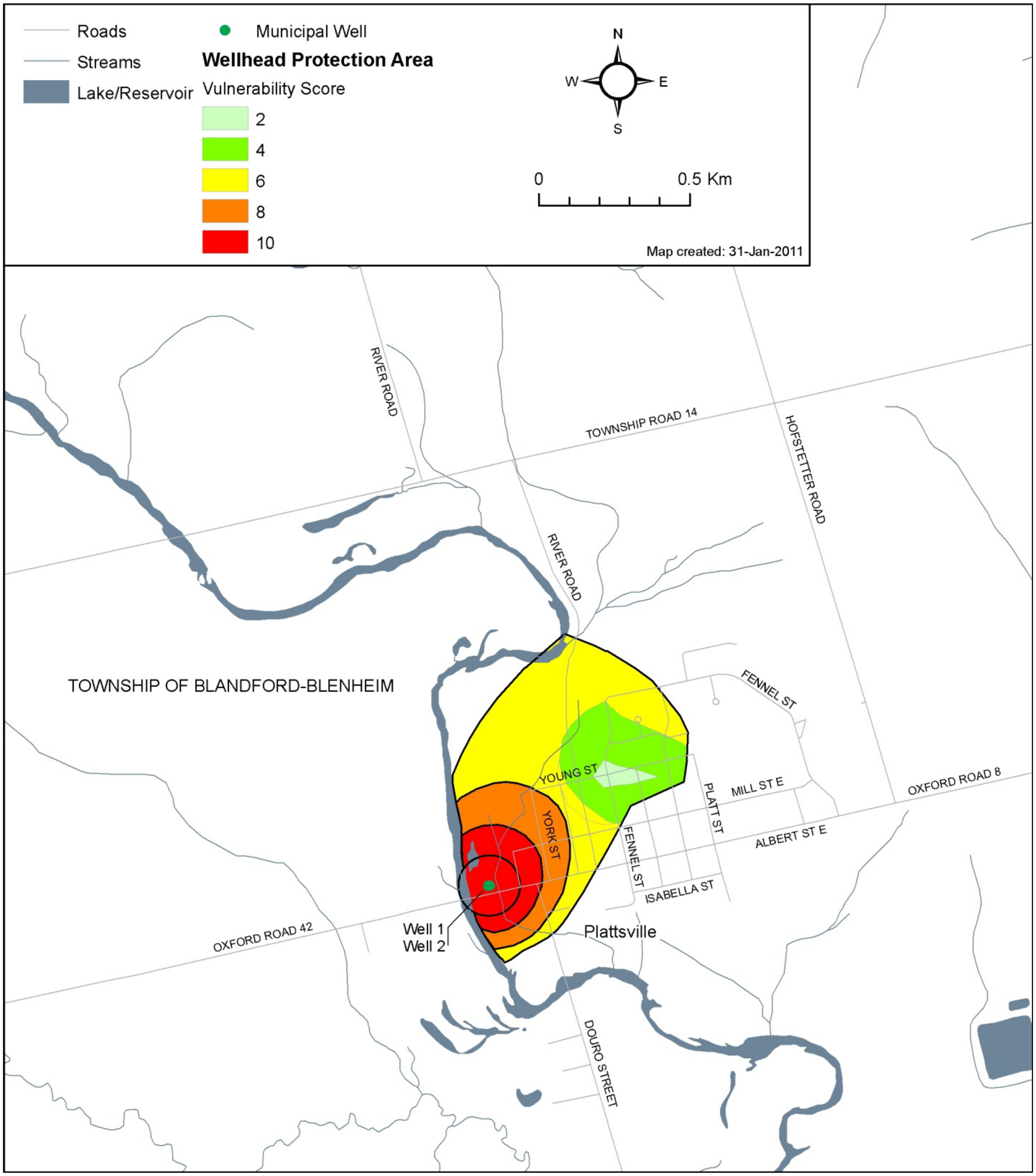
Map 11-8: Drumbo-Princeton Water Supply Wellhead Protection Area Vulnerability



Map 11-9 Plattsville Water Supply Intrinsic Vulnerability



Map 11-10: Plattsville Water Supply Wellhead Protection Area Vulnerability



Managed Lands within the County of Oxford Wellhead Protection Areas

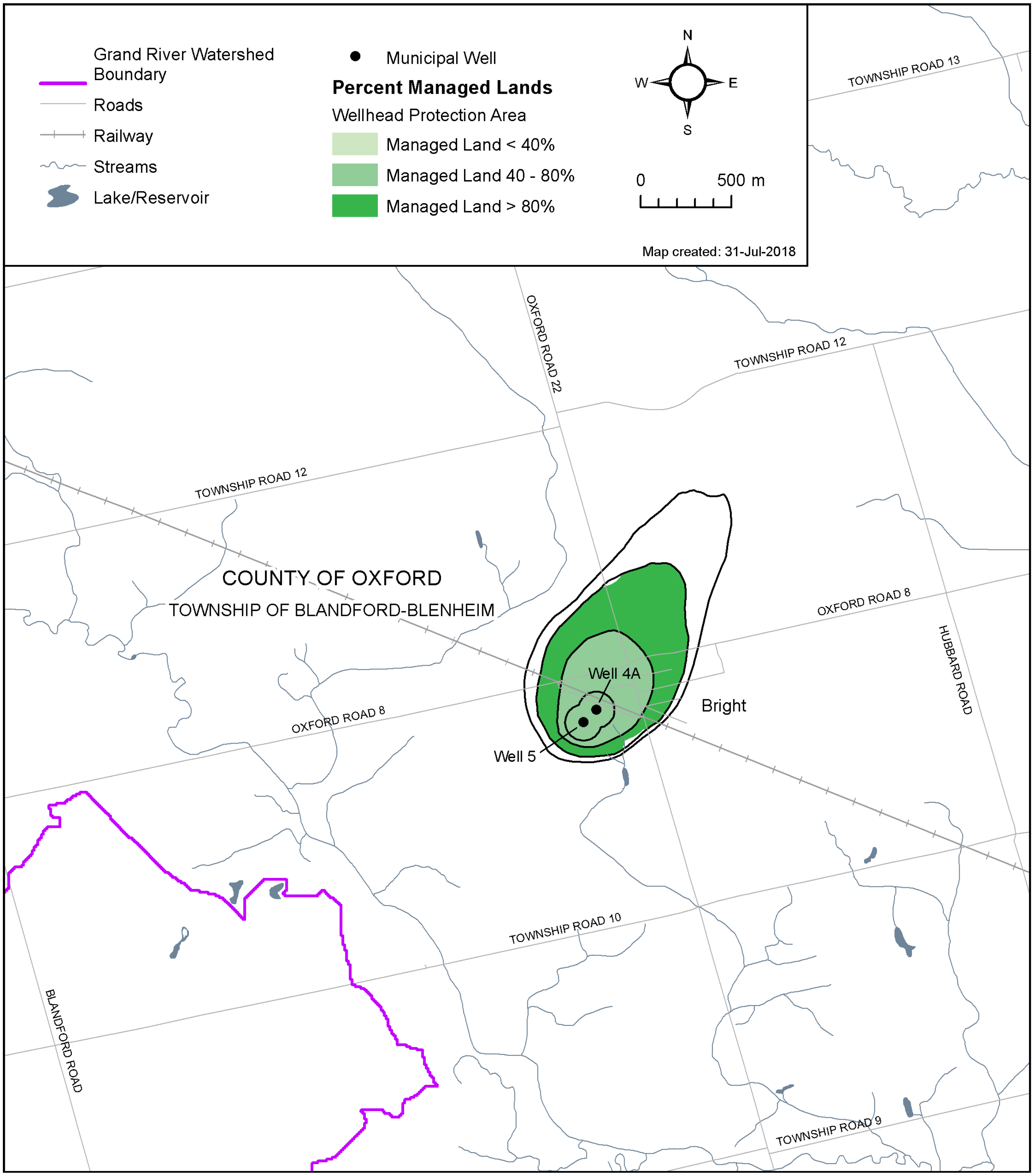
Managed lands, defined as lands to which nutrients are applied, are categorized into two groups: agricultural managed land and non-agricultural managed land. Agricultural managed land includes areas of cropland, fallow, and improved pasture that may receive nutrients. Non-agricultural managed land includes golf courses, sports fields, lawns and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer).

The managed land mapping was completed for the WHPAs where the vulnerability score was high enough for related activities to be considered low, moderate or significant threats (vulnerability score of 6 or higher). Managed lands were completed using the methodology outlined in Section 3 of this Assessment Report. The percent managed lands for the Bright, Drumbo-Princeton and Plattsville WHPAs are presented in **Table 11-4.** These are further illustrated on **Map 11-11, Map 11-12** and **Map 11-13.**

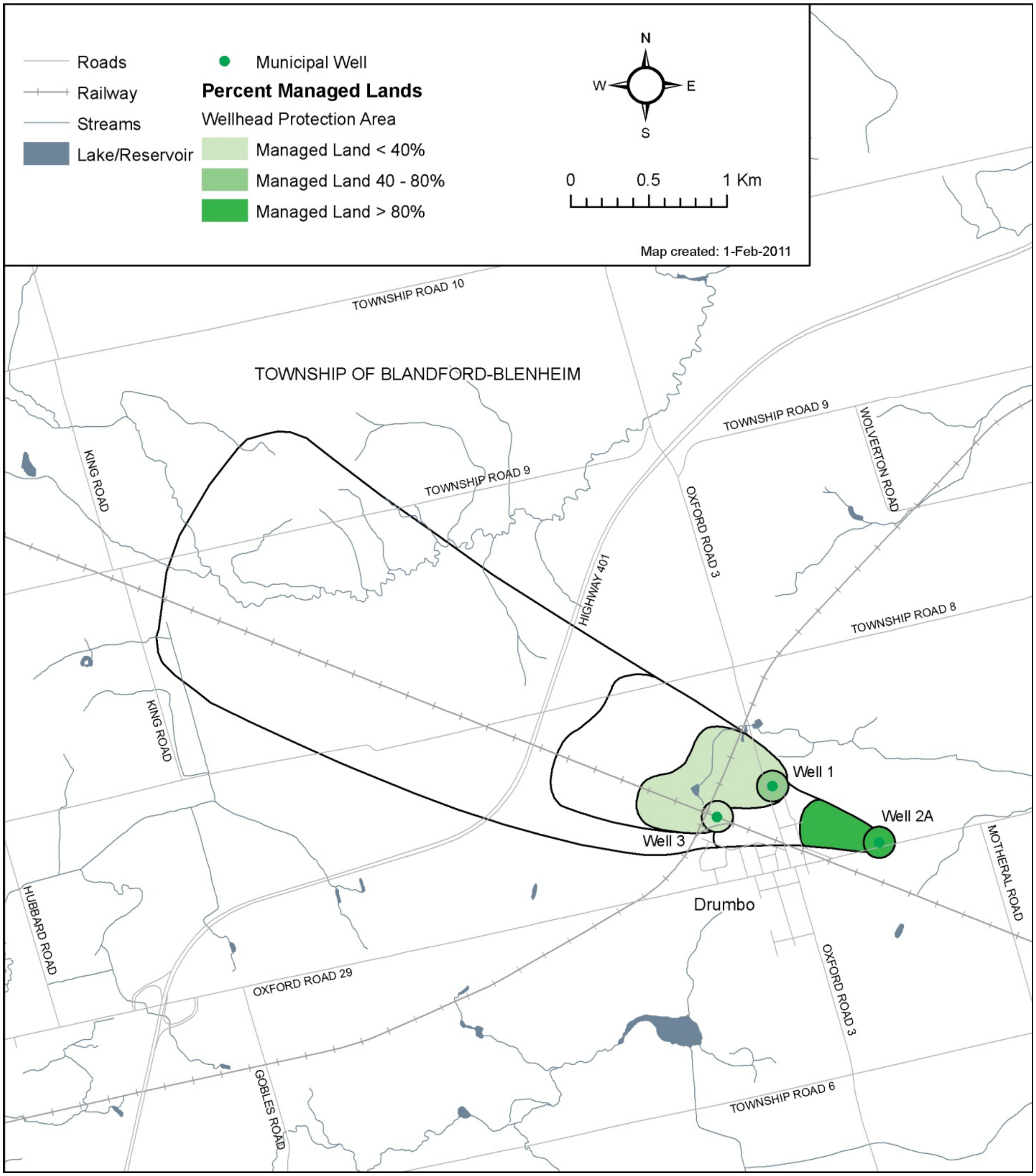
Table 11-4: Percent Managed Lands in the County of Oxford Wellhead Protection Areas

County	Location	Well	WHPA-A	WHPA-B	WHPA-C	WHPA-D
Oxford	Bright	Well 4A and Well 5	79.6%	62.3%	87.8%	No
	Drumbo-Princeton	Well 2A	89%	95%	No	No
		Well 1	44%	17%	No	No
		Well 3	11%	17%	No	No
	Plattsville	Well 1 and Well 2	21%	21%	47%	67%

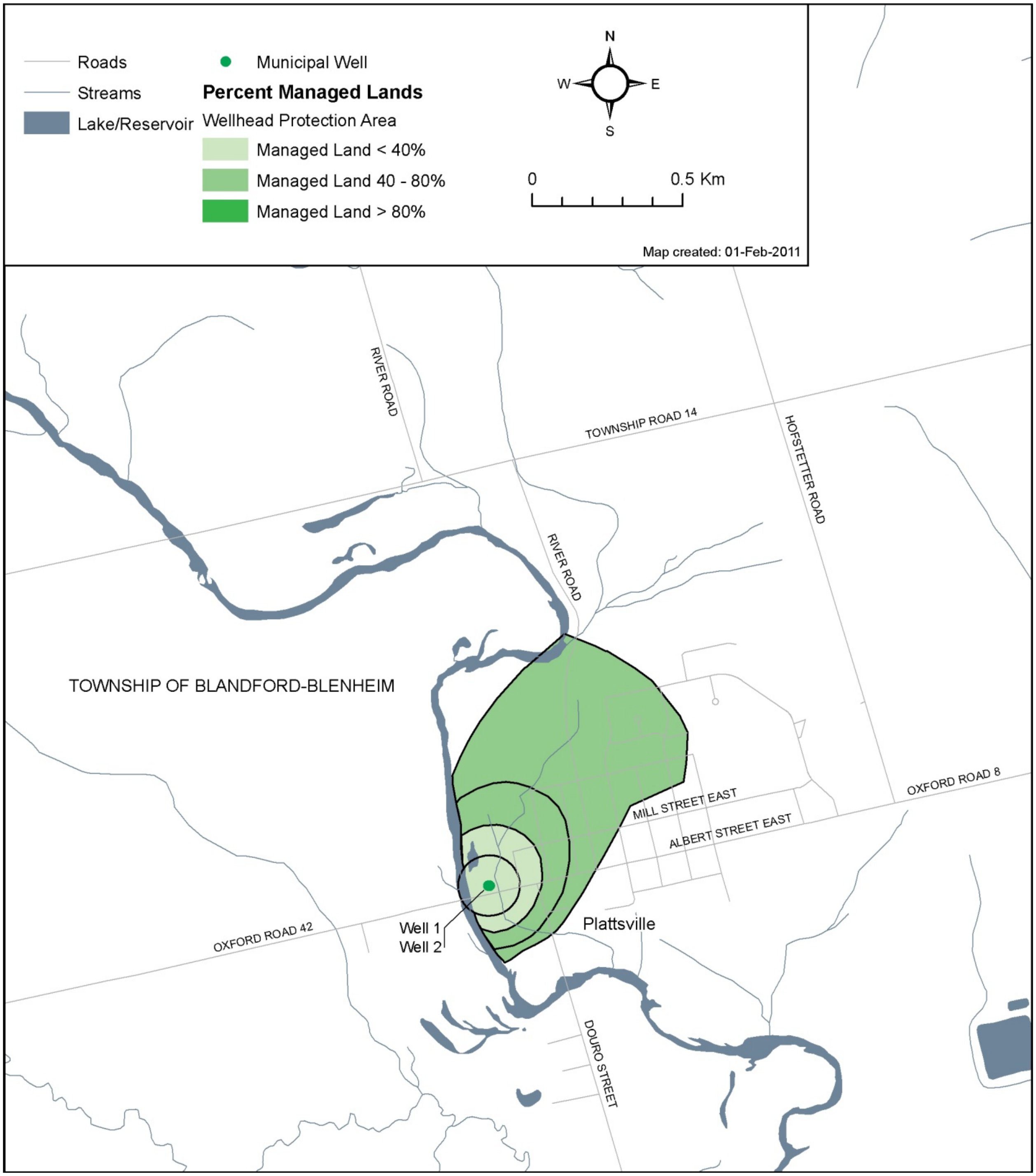
Map 11-11: Bright Water Supply Percent Managed Lands



Map 11-12: Drumbo-Princeton Water Supply Percent Managed Lands



Map 11-13: Plattsville Water Supply Percent Managed Lands



Livestock Density within the County of Oxford Wellhead Protection Areas

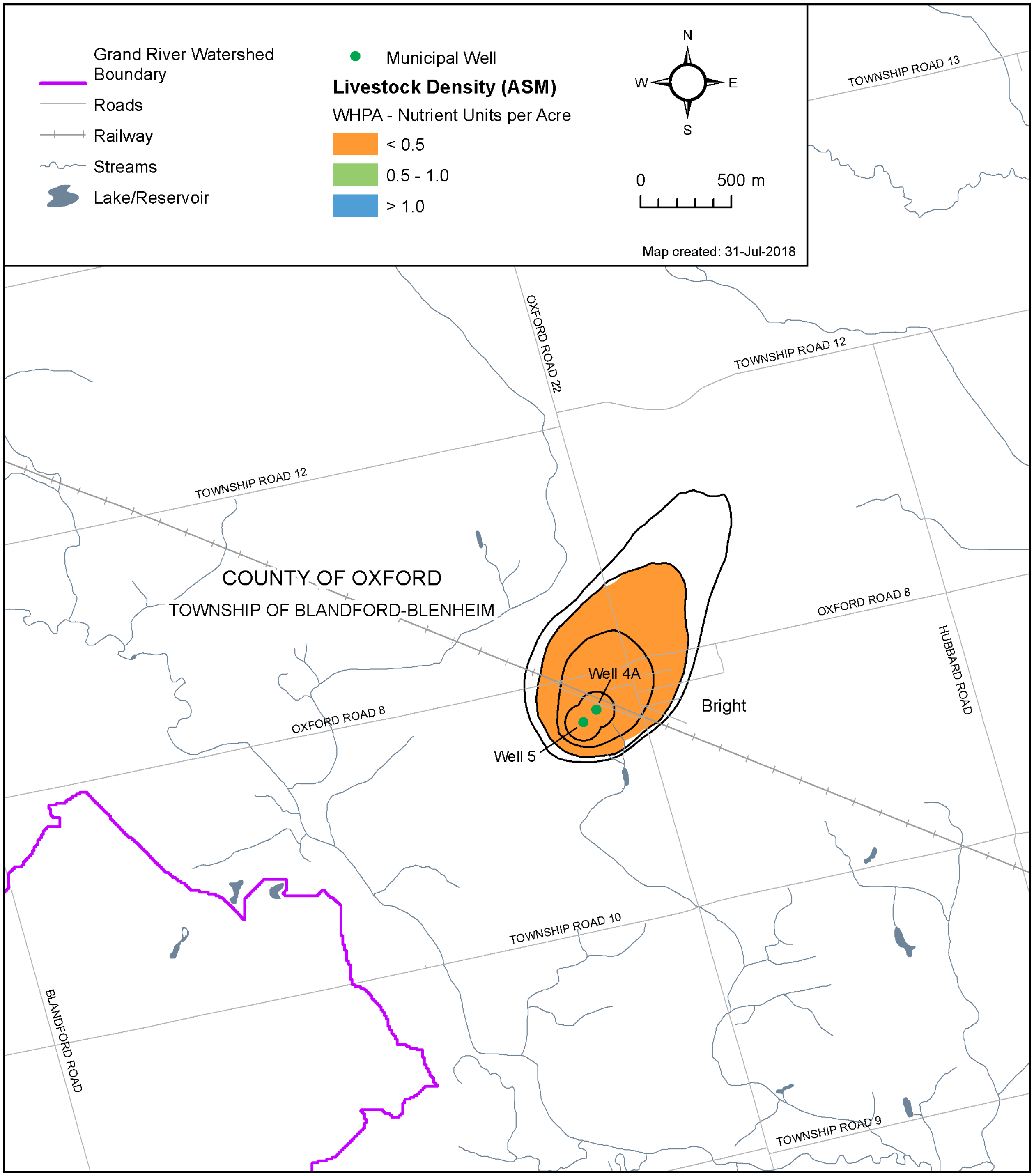
Livestock density is a measure to determine the intensity of livestock animals and as such, can be used as a surrogate measure for the generation, storage and land application of agricultural source material. Livestock density methodoly is detailed in Section 3 of this Assessment Report.

The livestock density for each WHPA is shown in **Table 11-5**. All areas fall into the "low" livestock density category.

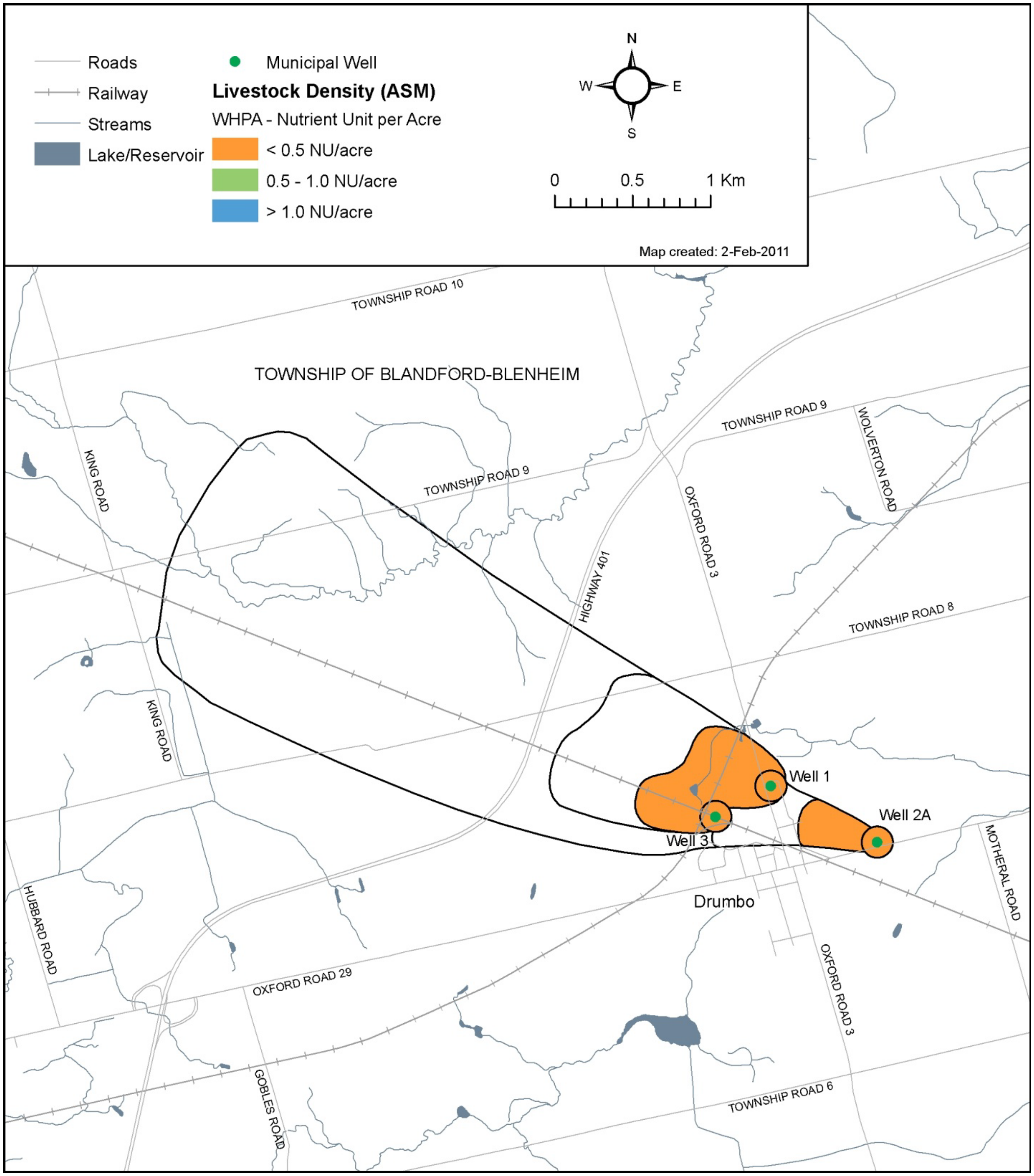
Table 11-5: Livestock Density (NU/acre) in the County of Oxford Wellhead Protection Areas

County	Location	Well	WHPA-A	WHPA-B	WHPA-C	WHPA-D
Oxford	Bright	Well 4A and Well 5	0.0	0.0	0.0	N/A
	Drumbo	Well 2A	0.1	0.0	N/A	N/A
		Well 1	0.0	0.0	N/A	N/A
		Well 3	0.0	0.0	N/A	N/A
	Plattsville	Well 1 and Well 2	0.0	0.0	0.0	0.0

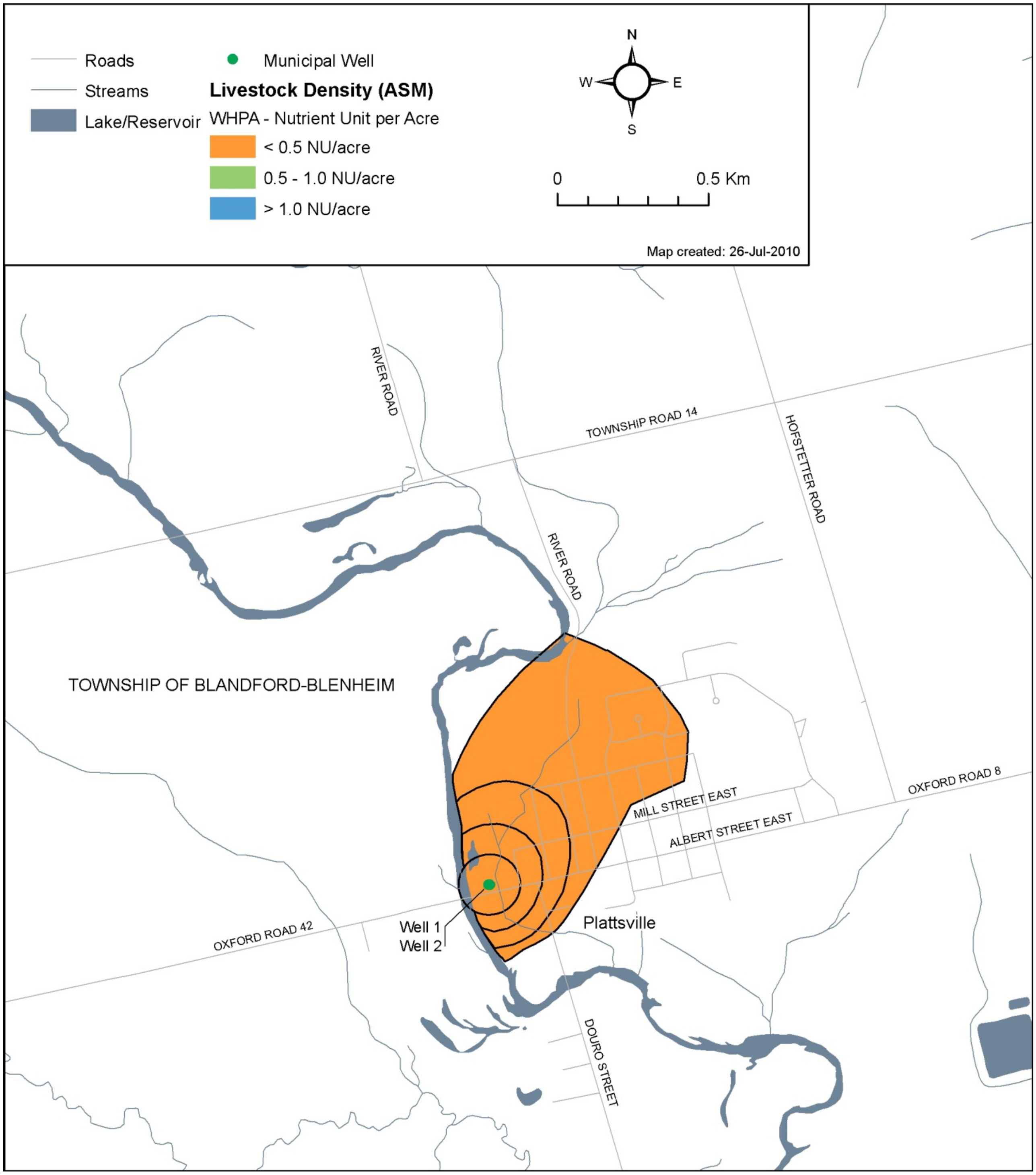
Map 11-14: Bright Water Supply Livestock Density



Map 11-15: Drumbo-Princeton Water Supply Livestock Density



Map 11-16: Plattsville Water Supply Livestock Density

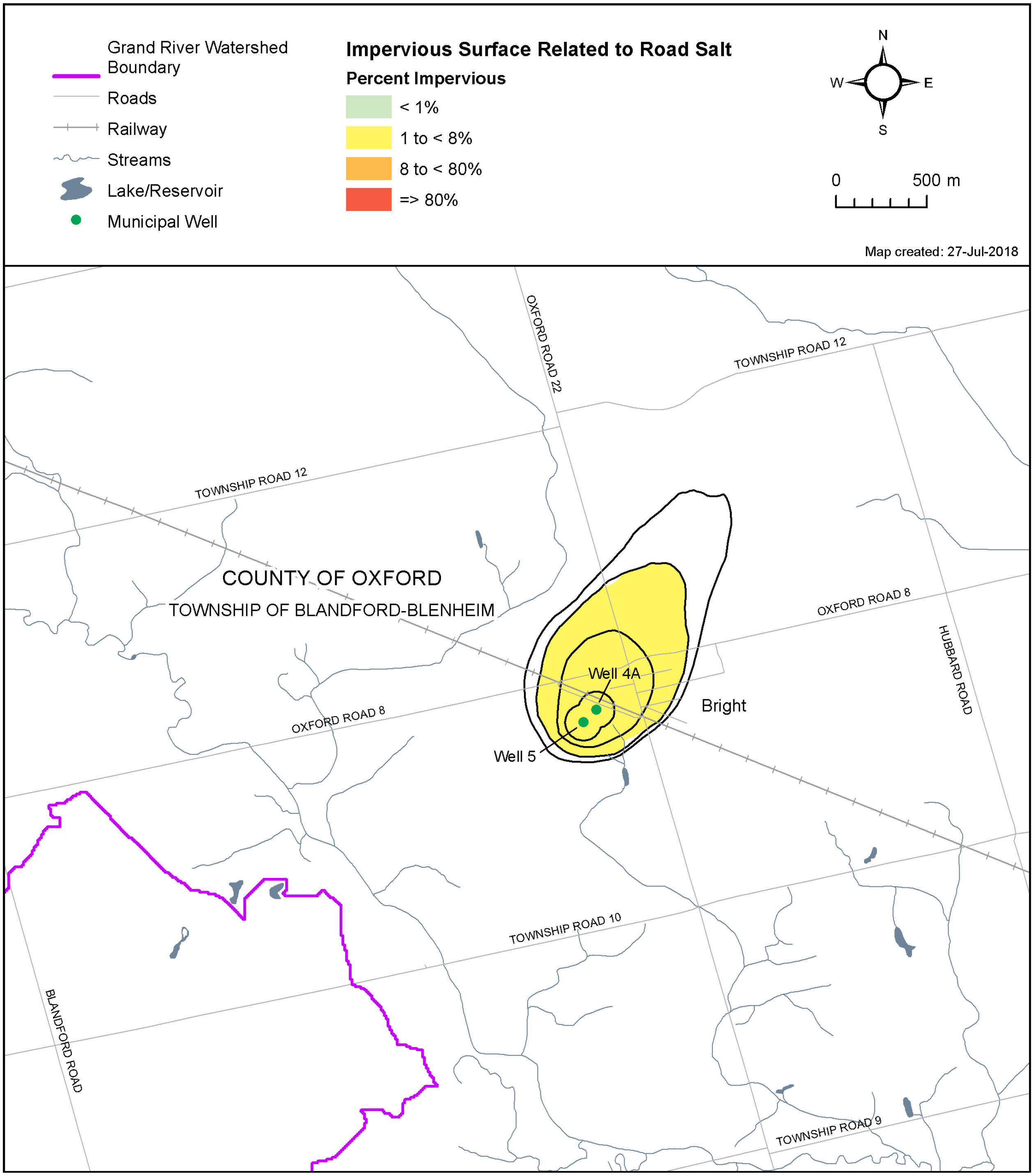


Percentage of Impervious Surface Area within the County of Oxford Wellhead Protection Areas

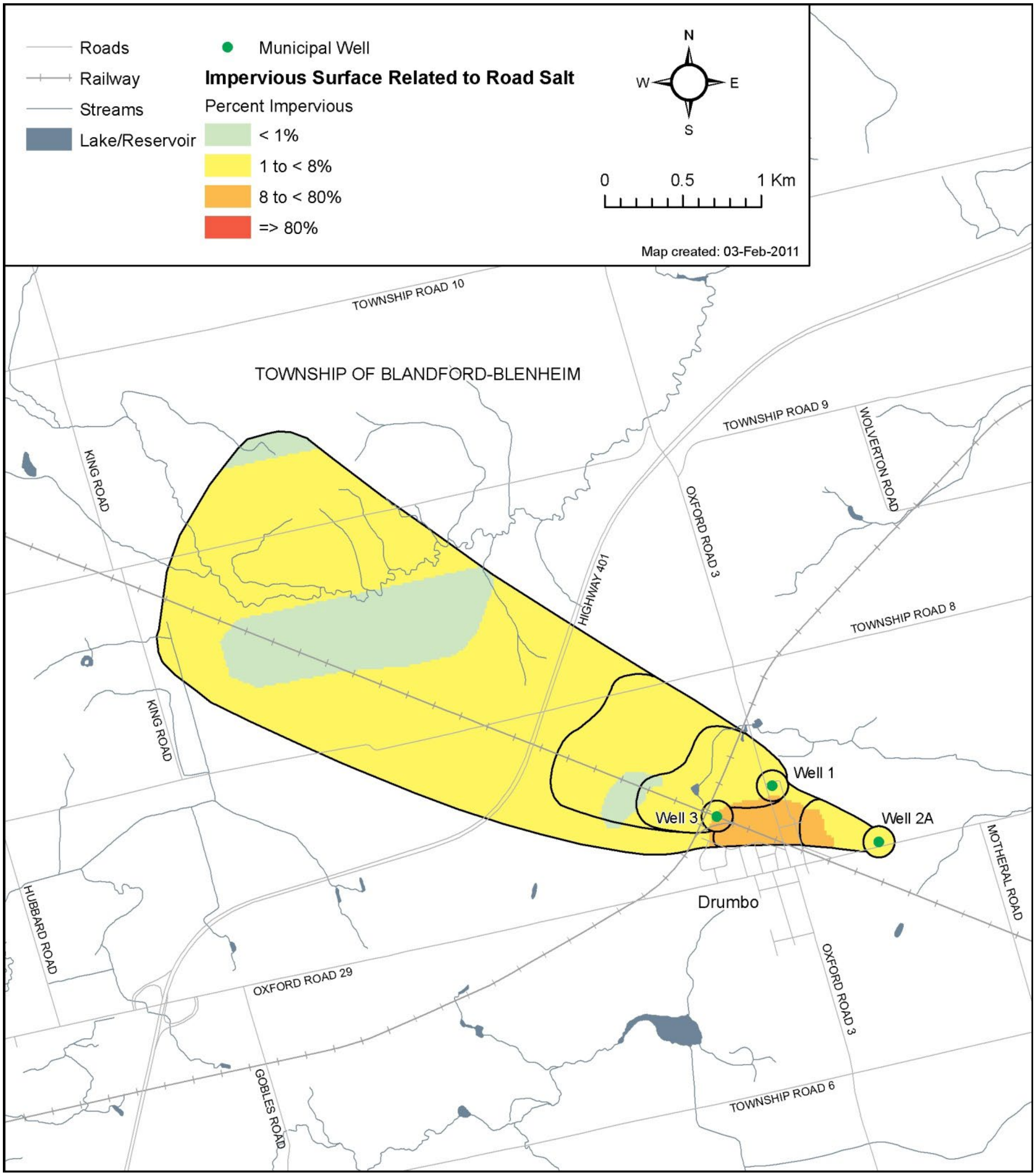
To determine whether the application of road salt poses a threat in the County of Oxford, the percentage of impervious surface was calculated using the window-moving average approach for the Bright and Drumbo-Princeton WHPAs, while impervious surface was calculated using the 1X1 kilometre grid approach for the Plattsville WHPAs. Furhter detail on the impervious surface calculation methodology is described in Section 3.

The results of the impervious surface calculations indicate that there are low percentages in Bright (**Map 11-17**), Drumbo-Princeton **(Map 11-18)** and Plattsville **(Map 11-19)** and that the application of road salt would not be a significant threat.

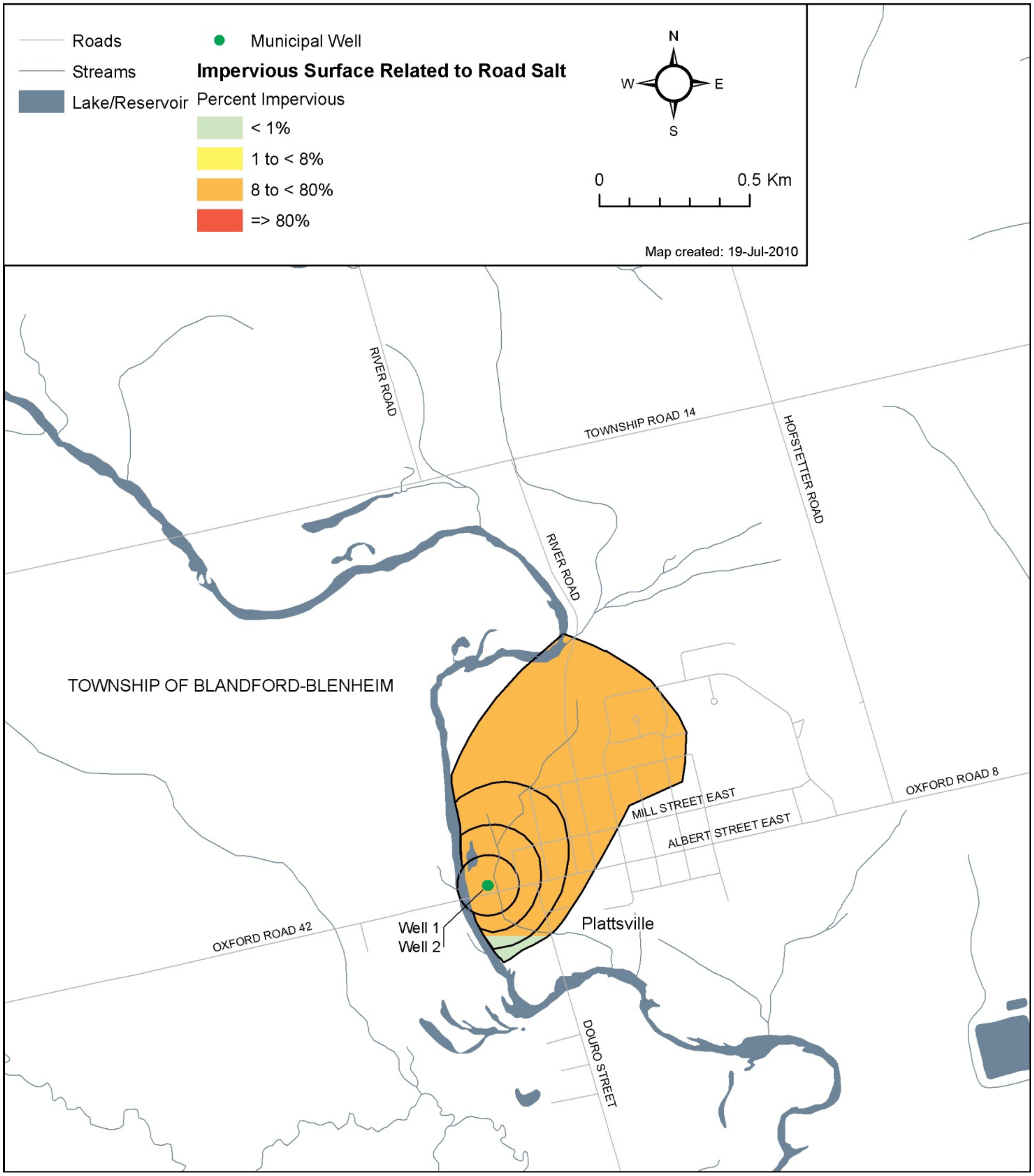
Map 11-17: Bright Water Supply Percent Impervious Surfaces



Map 11-18: Drumbo-Princeton Water Supply Percent Impervious Surfaces



Map 11-19: Plattsville Water Supply Percent Impervious Surfaces



11.1.5 Drinking Water Quality Threat Assessment

The *Ontario Clean Water Act, 2006* defines a Drinking Water Threat as "an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat." Further details on the drinking water quality threats assessment are detailed in Section 3 of this Assessment Report.

Identification of Significant, Moderate and Low Drinking Water Threats for the County of Oxford Drinking Water Systems in the Grand River Watershed

Table 11-6, Table 11-7 and Table 11-8 provide a summary of the threat levels possible in the County of Oxford Drinking Water Systems for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. A checkmark indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in the maps.

Table 11-6: Identification of Drinking Water Quality Threats in the Bright Water Supply Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A/B	10	✔	✔	✔
	WHPA-B/C	8	✔	✔	✔
	WHPA-C	6		✔	✔
	WHPA-C/D	2 & 4			
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	2 & 4			
Pathogens	WHPA-A/B	10	✔	✔	
	WHPA-B	8		✔	✔

Table 11-7: Identification of Drinking Water Quality Threats in the Drumbo-Princeton Water Supply Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A	10	✔	✔	✔
	WHPA-B	6		✔	✔
	WHPA-C/D	2 & 4			
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	2			
Pathogens	WHPA-A	10	✔	✔	
	WHPA-B	6			✔
	WHPA-C/D	Any Score			

Table 11-8: Identification of Drinking Water Quality Threats in the Plattsville Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A/B	10	✔	✔	✔
	WHPA-C	8	✔	✔	✔
	WHPA-D	6		✔	✔
	WHPA-D	2 & 4			
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	6		✔	✔
	WHPA-D	2 & 4			
Pathogens	WHPA-A/B	10	✔	✔	
	WHPA-C/D	Any Score			

11.1.6 Enumeration of Significant Drinking Water Quality Threats

Available desktop information, publicly available databases, air photo interpretation and local County staff knowledge was used to determine the types of land use activity information and potential threats associated with these land uses. To associate the prescribed drinking water threats listed **Error! Reference source not found.** with land use activities, the County of Oxford has compiled a land use inventory. The inventory was based on a review of multiple data sources which included previous groundwater-related work undertaken by the County, public records, local knowledge and windshield surveys.

Consultation with property owners will be undertaken to verify the existence of circumstances that constitute a significant threat.

Enumeration of Significant Drinking Water Quality Threats for the Bright Water System

For the Bright municipal wells, significant threats that were enumerated occured in WHPA-A and WHPA-B. A list of significant threat types identified in Bright is located in **Error! Reference source not found.**. These threats are current to March 2019.

Table 11-9: Significant Drinking Water Quality Threats for the Bright Water System (current to the March 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage System or Sewage Works- Onsite Sewage System	29	WHPA-A WHPA-B
3	Application of Agricultural Source Material to Land	1	WHPA-A
10	Application of Pesticides to Land	1	WHPA A
16	Handling and Storage of DNAPLs	1	WHPA B
Total Number of Properties		**31**	
Total Number of Activities		**32**	

Table 11-9: Significant Drinking Water Quality Threats for the Bright Water System (current to the March 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area

1: Prescribed Drinking Water Quality Threat Number refers to the prescribed drinking water threat listed in O.Reg 287/07 s.1.1.(1).
2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category

Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facility.

Enumeration of Significant Drinking Water Quality Threats for the Drumbo-Princeton Water System

In Drumbo, the significant threats that were enumerated occur in WHPA-A and WHPA-B. A list of all significant threat types identified in Drumbo are located in Error! Reference source not found. below. The threats are current to the end of 2014.

Table 11-10: Significant Drinking Water Quality Threats for the Drumbo-Princeton Water System (current to the end of 2014)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage System or Sewage Works- Onsite Septic System	2	WHPA A
	Sewage System or Sewage Works- Sanitary Sewers and related pipes	3	WHPA A
	Sewage System Or Sewage Works - Sewage Treatment Plant Effluent Discharges (Includes Lagoons)	1	WHPA-A
	Sewage System Or Sewage Works - Sewage Works Storage – Treatment or Holding Tanks	1	WHPA-A
3	Application of Agricultural Source Material to Land	4	WHPA A
8	Application of Commercial Fertilizer	4	WHPA A
21	Management or handling of Agricultural Source Material- Agricultural Source Material (ASM) Generation	1	WHPA A
Total Number of Properties		**8**	
Total Number of Activities		**16**	

1: Prescribed Drinking Water Quality Threat Number refers to the prescribed drinking water threat listed in O.Reg 287/07 s.1.1.(1).
2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category

Note: The threat point representing linear feature infrastructure such as sanitary sewers was not added into the total number of properties, since this feature is not attached to one specific property.

Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential

Table 11-10: Significant Drinking Water Quality Threats for the Drumbo-Princeton Water System (current to the end of 2014)			
PDWT[1] #	**Threat Subcategory[2]**	**Number of Activities**	**Vulnerable Area**
properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas. *Note: Storm sewer piping is not considered to be part of a storm water management facility.*			

Enumeration of Significant Drinking Water Quality Threats for the Plattsville Water System

Within Plattsville, inventoried significant threats occur in WHPA-A and WHPA-B. A list of all significant threat types identified in the Plattsville WHPA is presented in **Table 11-11** below. The threats are current to the end of 2014.

Table 11-11: Significant Drinking Water Quality Threats for the Plattsville Water System (current to the end of 2014)			
PDWT[1] #	**Threat Subcategory[2]**	**Number of Activities**	**Vulnerable Area**
1	Waste Disposal Site- Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste	1	WHPA-B
2	Sewage System or Sewage Works- Sanitary Sewers and related pipes	1	WHPA-B
3	Application of Agricultural Source Material to Land	2	WHPA-A
10	Application of Pesticides to Land	1	WHPA-A
15	Handling and Storage of Fuel	3	WHPA-B
16	Handling and Storage of DNAPLs	3	WHPA-B
17	Handling and Storage of Organic Solvents	2	WHPA-B
Total Number of Properties		**6**	
Total Number of Activities		**13**	

1: Prescribed Drinking Water Quality ThreatNumber refers to the prescribed drinking water threat listed in O.Reg 287/07 s.1.1.(1).
2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category

Note: The threat point representing linear feature infrastructure such as sanitary sewers was not added into the total number of properties, since this feature is not attached to one specific property.

Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facility.

Uncertainty and Limitations in the Enumeration of Significant Drinking Water Quality Threats

There was a general lack of information on the presence/absence of contamination associated with historical land uses. As a result, no condition-related drinking water threats (if present) were identified. In addition, the type and amount of chemicals stored at the commercial and industrial operations within the wellhead protection areas is unknown. Further, for other land use types, the types and amounts of potential contaminants often had to be assumed based on the land use practice. Where assumptions had to be made, often a worst case scenario approach was taken and circumstance values were assigned based on that assumption so significant threats would be flagged for follow-up.

In terms of data limitations, the most problematic dataset was septic systems. The records maintained by the County Board of Health lack accurate locational information. The sanitary sewer infrastructure layer was used to determine which properties were serviced by municipal services. Using this method, there remained instances where service connection was questionable. At present County Public Works has not yet digitized all of the sanitary sewer infrastructure in the County, although this is a work in progress.

For the impervious surface dataset, digitizing was completed by both Oxford County and the Lower Thames River Conservation Authority (LTRCA). Heads-up digitizing from two different sources could introduce error when identifying impervious surfaces in Oxford County. Also, each organization may have access to different supplementary data sets to complete the analysis. Since the County has access to more current roads data, road centre lines were buffered to average road widths to create the initial impervious surface layer. Edits were then made to ensure the roadways were accurately represented and to add in sidewalks, driveways and parking lots. Human error may have occurred while digitizing the impervious surfaces.

Since there is no agricultural census information available to the County at the property scale, reasonable assumptions about the type of livestock housed in a farm structure were based on the best available information. This information ranged from local knowledge of County and municipal staff to land use information recorded in various County records. Where this information was unavailable, air photo interpretation was used to determine barn type, and therefore, livestock type. Air photo interpretation and the use of GIS for area calculations could be considered limitations to the work, since the resulting shapefiles are representations and not 100 percent accurate. This limitation also applies to the layer extraction step when delineating managed lands. Certain structures, in particular residential dwellings, do not necessarily reflect actual foot prints of the structures. However, manual edits to the shapefile were completed for larger layers if deemed necessary through air photo interpretation.

11.1.7 Conditions Evaluation for the County of Oxford’s Well Supply Systems

The Technical Rules state that if there is evidence that a Condition is causing off-site contamination, a hazard rating of 10 is applied. If there is no evidence of off-site contamination, the hazard rating is 6, which results in a moderate or low drinking water threat within the WHPA.

After review of the available data, no conditions were identified in the Bright, Drumbo-Princeton and Plattsville drinking water systems.

11.1.8 Drinking Water Quality Issues Evaluation

The objective of the Issues evaluation is to identify drinking water Issues where the existing or trending concentration of a parameter or pathogen at an intake, well or monitoring well could result in the deterioration of the quality of water for use as a source of drinking water. The parameter or pathogen must be listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards (ODWQS) or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (Technical Rules XI.1 (114 – 117)). Elevated concentrations of selected parameters that are naturally occurring or where effective treatment is in place are not considered drinking water Issues.

Methodology for Drinking Water Quality Issues Evaluation

The water quality data used in this evaluation was compiled by the Oxford County Public Works Department. The data comprises the analytical results taken as part of operating the systems in addition to water quality results received as part of other programs/projects. The majority of the data used in this evaluation dates from 2001 to 2017 for the Bright water supply system and from 2001 to 2014 for the Drumbo-Princeton and Plattsville water supply systems. Older data has been used where relevant.

Drinking Water Quality Issues Evaluation for the Bright Water Supply

The system has several operational or aesthetic parameters that exceed the associated objectives or guidelines as detailed below.

Hardness, which has a guideline range from 80 to 100 mg/L, is typically exceeded in groundwater systems. The Bright hardness concentration is typically between 300 to 500 mg/L. This parameter is naturally occurring in the groundwater and does not pose a health risk nor does it impact the treatment process.

The sodium concentration ranges from 39 to 64 mg/L, which is above the reporting level of 20 mg/L, but well below the aesthetic objective of 200 mg/L. Chloride concentrations are quite low; this suggest that the sodium concentrations are not related to the application of road salt application but may be naturally occurring. No increasing trend is evident in the results.

Total Dissolved Solids (TDS) levels in the Bright system exceed the objective of 500 mg/L and are around 600 mg/L. TDS is an aesthetic parameter and does not impact health or the treatment process. No increasing trend is evident in the results.

The raw water in the system exceeds the objective of 0.3 mg/L for iron. The raw water iron concentrations range from 0.5 to 0.8 mg/L. Iron is an aesthetic parameter and does not interfere with the treatment process. No increasing trend is evident.

Summary of the Drinking Water Quality Issues Evaluation for the Bright Water Supply

The parameters in the Bright Water Supply System that meet the screening threshold are hardness, TDS and iron. These parameters are all naturally occurring and typical of groundwater sources. They do not affect the treatment process and there is no evidence of upward trending. No Issues were identified under Technical Rule 114.

Drinking Water Quality Issues Evaluation for the Drumbo-Princeton Water Supply

No health-related parameters were found to exceed their MAC. Microbiological results are consistently good at Well 3. Well 2A has had periodic positive low level results for total coliforms while not in regular service. This is not uncommon where wells are only periodically pumped as is the case with Well 2A and does not necessarily indicate a concern. The well recently began a rotational production schedule.

With the exception of hardness, no operational or aesthetic parameters exceed the associated objectives or guidelines. Hardness, which has a guideline range from 80 to 100 mg/L, is typically exceeded in groundwater systems. The Drumbo-Princeton hardness concentration is typically between 230 to 330 mg/L.

Summary of Drinking Water Quality Issues Evaluation for the Drumbo-Princeton Water Supply

The only parameters in the Drumbo-Princeton Water Supply System that meets the screening threshold are total coliform and hardness. The total coliform presence is likely the result of Well 2A being maintained in standby mode and not operated frequently. Hardness is naturally occurring and typical to groundwater sources. It does not affect the treatment process and there is no evidence of upward trending. No Issues were identified for the Drumbo-Princeton Water Supply under Technical Rule 114.

Drinking Water Quality Issues Evaluation for the Plattsville Water Supply

No parameters were found to exceed their MAC.

The system has several operational or aesthetic parameters which exceed the associated objectives or guidelines as detailed below.

Hardness, which has a guideline range from 80 to 100 mg/L, is typically exceeded in groundwater systems. The system's hardness concentration is very high, typically around 1000 to 1340 mg/L. This parameter is naturally occurring in the groundwater and is not a heath risk nor does it hinder the treatment process.

Total Dissolved Solids (TDS) levels in the system exceed the objective of 500 mg/L and are 1620 to 1880 mg/L. TDS is an aesthetic parameter and does not impact health or the treatment process. No increasing trend is evident in the results.

The raw water in the system exceeds the objective of 0.3 mg/L for iron. The raw water is around 0.48 to 0.6 mg/L. Iron is an aesthetic parameter and does not interfere with the treatment process. No increasing trend is evident.

Sulphates have an objective of 500 mg/L and in the Plattsville system, concentrations range from 870 to 1000 mg/L. Sulphates are an aesthetic concern and are naturally occurring in the groundwater.

The system typically exceeds the aesthetic objective of 0.05 mg/L for manganese with concentrations in the 0.06 – 0.08 mg/L range. There is no increasing trend to the concentration and its presence does not interfere with the treatment process.

Summary of Drinking Water Quality Issues Evaluation for the Plattsville Water Supply

The parameters in the Plattsville System that meet the screening threshold are hardness, TDS, iron, manganese and sulphates. These parameters are all naturally occurring and do not affect the treatment process. There is no evidence of upward trending. No Issues have been identified for the Plattsville water supply under Technical Rule 114.