3.0 Explanation of Methodology

The follow Section describes the methodology used to delineate vulnerable areas and assess threats for all municipal drinking water supplies.

3.1 Surface Water Systems Methodology

The Municipality of Callander, City of North Bay and the Village of South River all utilize surface water sources for their municipal drinking water. Each was the subject of a detailed technical study in accordance with the Technical Rules set out in the Assessment Report: Technical Rules (December 12, 2008) as amended November 16, 2009 under the *Clean Water Act (2006)*. The findings for each municipal system are summarized in the relevant Sections later in this report (Sections 4, 6 and 8 respectively).

The procedure for assessing a surface water supply consists of

- intake characterization (including water treatment plant and raw water quality);
- intake protection zone (IPZ) delineations; and vulnerability scoring
- uncertainty analysis of IPZ delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

Intake Characterization

Characterization of the water treatment plant in the technical studies includes details on location, type, capacity, population serviced, storage capacity and pumping rates (both average and peak demand) for the plant. The description of the intake includes location, depth, diameter and any other relevant details. The response time to shut down the plant should an emergency occur outside of normal hours of operation was determined. In all cases this meets or is less than the two-hour standard for delineating the Intake Protection Zone 2. During hours when the plants are staffed, shutdown can be completed in a matter of minutes.

The hydrodynamics and hydrological conditions of the supply source itself were also characterized for each system. North Bay and Callander draw from inland lakes. The Village of South River draws from an impounded (dammed) section of the South River and has dominant characteristics of a lake for the purposes of this assessment. Hydrodynamics play an important role in contaminant movement in these systems. For example, deep lakes can stratify into two non-mixing layers which dramatically reduce the risk of surface contaminants reaching an intake located at depth. Since the intake for the Village of South River is located in an impounded river, water levels and flows are regulated, necessitating a review of the operating plan for the dam.

General water chemistry and other water quality parameters were characterized for each source. All available data were reviewed. Raw water quality was assessed to identify potential issues (see below).

Delineation and Scoring of Vulnerable Areas

Defining Vulnerable Areas (Intake Protection Zones – Surface Water Systems)

Source protection planning specifies that three intake protection zones be identified and protected to maintain water quality at the surface water intake. The nature of the water body determines the shape and size of these vulnerable areas. All municipal surface water systems in this source protection area were classified as Type D intakes in accordance with Technical Rule 55; each is located in an impoundment or a lake other than a Great Lake. Of the three protection zones, Intake Protection Zone-1 (IPZ-1) is considered the most vulnerable to contamination. If a contaminant enters this zone, there may be little potential for dilution and limited time to respond before the contaminant reaches the intake.

For all three surface water systems, IPZ-1 was delineated according to Technical Rule 61, generally as the surface area of the water body within a 1 km radius centered on the intake and where this area abuts land, a maximum setback of 120 m inland from the high water mark. However, for the intake for the Village of South River, located in the east basin of the South River Reservoir, the opening under the causeway effectively serves as the outlet of the basin and defines the downstream boundary of the IPZ-1.

Intake Protection Zone-2 (IPZ-2) is the secondary protection zone. If a spill or other event were to occur in the IPZ-2 that may impair water quality at the intake, the plant operator should have sufficient time to respond. IPZ-2 does not include land or water that lies within IPZ-1.

Delineation of IPZ-2 requires consideration of operator response time and potential contaminant flow in the vicinity of the intake. Therefore the delineation of IPZ-2 is unique for each intake and specific details are provided in the relevant Section for each municipality. The presence of transport pathways which are natural or constructed drainage routes (including storm water systems) that have the potential to facilitate the movement of contaminants may expand the vulnerable areas. In all cases, the IPZs were surveyed to identify potential contaminant transport pathways. Where the IPZ-2 abuts land, a 120 m setback is included.

Intake Protection Zone 3 (IPZ-3) is intended to incorporate the area of each surface water body within the Source Protection Area that could contribute water to the intake. Where these areas abut land, a 120 m setback is included.

Vulnerability Scoring

Vulnerability scores provide a comparative assessment of the likelihood that a contaminant originating within an intake protection zone could reach the intake. They consider both the vulnerability of the intake protection zone (area vulnerability) and the inherent vulnerability of the intake based on factors such as depth, distance from shore and history of water quality concerns (source vulnerability). The two factors are multiplied together to give a vulnerability score up to 10. Vulnerability scores were determined for each intake and used to assess the likelihood of a contaminant originating at any given point within the intake protection zones reaching the intake.

These scores were based on:

- the percentage of the area that is composed of land;
- land cover, soil type, permeability of the land, and the slope of setbacks;

- hydrological and hydrogeological conditions in the area that contributes water to transport pathways;
- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

Uncertainty Analysis

As identified in the Technical Rules the process of delineation of each vulnerable area will carry a degree of uncertainty depending on the quality of the data used in the assessment and the professional judgment and skills of the analyst. Rule 13 in Part I.4 requires that an analysis of uncertainty, characterized as high or low, be made in respect of the vulnerability of the surface water throughout the vulnerable area.

Issues Identification

Drinking water issues, as defined in Part XI.1 of the Technical Rules relate to the presence of a "listed parameter" in water at the intake if:

- the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water; or
- there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

Drinking water issues can also relate to a pathogen that has been identified in water at a surface water intake that is not one of the "listed parameters". However, this requires a microbial risk assessment to be conducted with respect to that pathogen. The only pathogens considered in the issues evaluation for each system were total coliforms and E. coli, which are listed parameters.

Drinking water issues were identified by comparing all listed parameters for raw and treated water to the applicable Ontario Drinking Water Quality Standards, Aesthetic Objectives, and Operational Guidelines. The chemical and physical attributes of raw water were also assessed.

Parameters in raw water that had exceeded the applicable benchmark or that had come within 25% of the benchmark were identified and evaluated for trends. Those parameters that had exceeded the applicable benchmark are considered drinking water issues. As well, a parameter would be considered an issue if an increasing trend was observed and a continuation of that trend would result in the inability of the water treatment plant to treat that parameter. If an issue is determined to be the result of natural causes, no further action need be taken.

Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the three Intake Protection Zones (IPZs). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. Ontario Regulation 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 19 activities that may result in threats to drinking water quality. (Two additional prescribed activities pose threats to quantity.) See Table 3-1 below. Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. **No conditions were identified in any of the surface water vulnerable areas.**

Table 3-1. Activities Prescribed to be Drinking Water Threats in O. Reg. 287/07 (General) of the *Clean Water Act (2006)*

O. Reg. 287/07 s. 1.1(1)	Activity
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage
3	The application of agricultural source material to land
4	The storage of agricultural source material
5	The management of agricultural source material
6	The application of non-agricultural source material to land
7	The handling and storage of non-agricultural source material.
8	The application of commercial fertilizer to land
9	The handling and storage of commercial fertilizer
10	The application of pesticide to land
11	The handling and storage of pesticide.
12	The application of road salt.
13	The handling and storage of road salt.
14	The storage of snow
15	The handling and storage of fuel
16	The handling and storage of a dense non-aqueous phase liquid
17	The handling and storage of an organic solvent
18	The management of runoff that contains chemicals used in the de-icing of aircraft
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body
20	An activity that reduces the recharge of an aquifer
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard

Note: "agricultural source material", "application", "commercial fertilizer", "livestock", "non-agricultural source material" and "outdoor confinement area" have the same meanings as in Ontario Regulation 267/03 (General) made under the Nutrient Management Act, 2002; "management" means, with respect to agricultural source material, the collection, handling, treatment, transportation or disposal of agricultural source material; "pesticide" has the same meaning as in the Pesticides Act; "sewage" has the same meaning as in the Ontario Water Resources Act, O. Reg. 385/08, s. 3.

In accordance with Technical Rule 9(ix) areas where activities that are or would be significant, moderate or low drinking water threats were identified and are presented in the relevant municipal Sections.

An activity is deemed a significant, moderate or low threat dependent upon:

- specific circumstances that influence the risk presented by a chemical or pathogen associated with that activity,
- the Intake Protection Zone in which the activity is or would be located, and
- the area's vulnerability score (Vs).

The Ministry of Environment provides reference tables of significant, moderate and low drinking water threats related to activities. Table 1 and Table 2 of the Tables of Drinking Water Threats

list drinking water threats related to chemicals and pathogens, respectively. Further, an activity is also deemed to be a significant or moderate threat if it contributes to a drinking water issue as per Technical Rules 131 and 134.1.

Table 3-2 below provides an example showing the layout of the MOE Tables of Drinking Water Threats for pathogens. In this example, the drinking water threat in Column 1 would be considered to be significant if it were located in an IPZ with a vulnerability score of 8 to 10 under the circumstances set out in Column 2. The same threat would be considered to be low in an IPZ with a vulnerability score of 5.6 or less.

Table 3-2. Example from the MOE`s Tables of Drinking Water Threats

Drinking Water Threat:	Ref. #	Under the following Circumstances:	Vulnerable Areas	Threat Rating based on Vulnerability Score (Vs)		
				Significant Vs	Moderate Vs	Low Vs
The application of agricultural source material to land	1	1. Agricultural source material is applied to land in any quantity. 2. The application may result in the presence of one or more pathogens in groundwater or surface water.	IPZ-1, IPZ-2, IPZ-3 & WHPA-E	8 - 10	6 - 7.2	4.2 - 5.6
			WHPA-A & WHPA-B	10	8	6

Vs = Vulnerability Score

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas using the Ministry of the Environment's Provincial Tables of Circumstances. These tables provide a list of circumstances for each prescribed activity which could pose as a drinking water threat. The risk scores for each vulnerable area then determines the corresponding threat level for each circumstance. The total number of significant, moderate and low threats in vulnerable areas was summarized based on these tables.

Technical Rules 9.(1) (e) and (f) require that an Assessment Report include the number of locations at which:

- a significant drinking water threat activity is being engaged in; and
- a condition resulting from a past activity is a significant drinking water threat.

These are identified in the Sections that follow for each individual municipal water source.

Gap Analysis and Recommendations

This report is organized by municipal water system; each section contains a gap analysis and recommendations pertinent to that system.

3.2 Groundwater Systems Methodology

The Town of Mattawa and Municipality of Powassan rely on groundwater sources for their municipal drinking water systems.

Each of these two systems was the subject of a detailed technical study in accordance with the Technical Rules set out in the Assessment Report: Technical Rules (December 12, 2008) as amended November 16, 2009 under the *Clean Water Act (2006)*. The technical studies revealed thirteen significant threats in Mattawa and two in Powassan.
Broadly speaking, the objectives consist of the following steps:

1. identify the areas which contribute water to the aquifer (or aquifers) being used by the system
2. determine the time that it takes for water to move to the wells, and
3. identify any relevant land use activities (current, historical or possible in the future) which may threaten the quality of the source(s).

Objective 1: Identifying the areas which contribute water to the aquifer(s) is essential to understanding which areas need to be protected from contamination. Those closest to the wellhead are considered most vulnerable. Groundwater generally moves very slowly; distances that surface water would travel in minutes or hours, typically take years for groundwater. Over that time chemical contaminants in ground water are subject to various fates; some break down, some get adsorbed onto soil particles and are immobilized, and those that remain become more and more dilute.

Objective 2: Most bacteria that are pathogenic to humans die off within a matter of months in travelling groundwater. However, some toxic chemicals are highly persistent and in some cases are heavier than water. The latter can be highly problematic if a spill occurs that is not detected and cleaned up promptly. Therefore, the time it would take for contaminated water to reach the wellhead from any location is also important to consider.

Objective 3: The third objective relates to identifying all land use activities that could pose a threat so that they can be managed to reduce the risk. These include historic activities that may have left contaminated conditions. The slow movement of contaminants in groundwater permits far more time to respond to spills than in surface water but it also means that contaminants do not tend to get flushed out of groundwater sources. Clean-ups, when necessary, can be very costly.

Although water underground can travel in three dimensions, the procedure for delineating vulnerable areas based on time of travel only considers horizontal flow in the aquifer to the well. Distances are projected upwards to create a map of vulnerable areas on the surface. It is a conservative approach in that it does not consider the time it may take water to reach the aquifer from the surface.

When technical studies commenced in 2006, the Ministry of Environment provided Source Protection Technical Studies Draft Guidance Modules to guide the work. These modules were updated in March 2007 (MOE 2007). These provided far more detailed information than the

subsequent Technical Rules. Guidance modules 3 to 6 were utilized in identifying vulnerable areas and assessing threats for these three systems.

The procedure for assessing a ground water supply consists of:

- wellhead system characterization (including water treatment plant, relevant local geology, and water quality);
- wellhead protection area (WHPA) delineation through computer modelling and vulnerability scoring;
- uncertainty analysis of WHPA delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

Water Supply Overview

The technical studies reviewed details on location, type, capacity, population serviced, and pumping rates (both average and peak demand) for each municipal system.

Treatment of municipal groundwater in Mattawa and Powassan consists simply of chlorination to ensure adequate contact time prior to distribution and a chlorine residual as water flows through the distribution system. Details of well construction, water demand and the population served are pertinent to understanding the movement of groundwater and to planning for future demand. The rate of pumping affects the speed at which water travels and therefore the size of the vulnerable area (Wellhead Protection Area).

Landscape features such as elevations, types and depths of soil layers, and depth to bedrock are essential to:

- identify recharge areas where water supplying the aquifer first enters the ground;
- determine how fast water can be expected to travel; and
- identify any natural protective features that are barriers to contaminant movement.

A review of water quality, both raw and treated, is used to identify any existing issues with the supply.

Delineation and Scoring of Vulnerable Areas

Defining Vulnerable Areas (Wellhead Protection Areas)

The availability and movement of water hidden underground in aquifers is not readily apparent. Various information sources and techniques such as computer based three-dimensional ground water flow modelling is used to develop an understanding. Well records which are produced when a well is drilled provide valuable information on the type of soils encountered at various depths during well construction and the depth(s) at which water was found. The depths particular layers were encountered at can then be joined mathematically to describe the structure of the ground in three dimensions. The nature of the various layers of soil largely determines the rate at which the water can move, along with any contaminants they might contain.

Water moves readily through soils dominated by large particles such as course sand whereas fine particle soils like tightly packed clay impede the movement of water through them. Since groundwater flows so slowly, computer modelling was used to predict the direction and speed of

water-borne contaminants instead of chemical tracers. It would take at least 25 years to run an appropriate experiment using chemical tracers.

Groundwater tends to flow in a specific direction due to the gradient of the water table. The gradient can be determined by considering the static water level in various wells. Presence of a heavily drawing well such as one supplying a municipal system will affect the speed and direction of flow as well as the water table gradient. To what extent depends on both the rate of extraction and the ease of water movement through the soil.

The movement of contaminants through the soil depends on the nature of the soils between the surface and the aquifer and the thickness of the soils. The hydraulic conductivity of each type of soil can be described by its K-factor as shown in Table 3-3 below. The Intrinsic Susceptibility Index (ISI) is then calculated for each location within the vulnerable area considering the degree of protection provided by the various layers of soil and the thickness of each. Susceptibility of the aquifer at each location is then rated as high, medium or low.

Table 3-3. Representative K-Factors for Selected Geographical Materials

Geological Material	**K-Factor**
Sand and gravel aquifer	1
Sandy till	2
Silty sand	3
Sandy silt	4
Alluvium	4
Clay	8
Bedrock	3

Regional groundwater studies conducted throughout Ontario between 2002 and 2006 included the areas of the North Bay-Mattawa Source Protection Area relevant to the Mattawa and Powassan systems.

The scale of that study (Waterloo Hydrogeologic, 2006) was large but information collected and analyzed for them was still highly valuable in completing the current technical studies. An application called VisualMODFLOW was used at that time. In the current studies, a more recent version (4.3) was used and the model domain and characteristics were modified to reflect the input of additional hydrogeologic data sources. Details on the development of each model may be found in the relevant groundwater technical studies, all of which were completed by Waters Environmental Geosciences Ltd.

Once each model was developed it would be run in steady state mode at the average pumping rates for the system. The regions of the aquifer which contribute flow to the wellhead area were identified by an analysis method known as “particle tracking”. Particle tracking is a feature within the groundwater model which allows the movement of individual particles of water to be traced (on a map view) from the point where recharge enters the groundwater flow system to the point where the water is extracted at the well. The exact pathway that the water particles follow

depends on the subsurface soil and rock types, and the directions of groundwater flow in the aquifer. Within VisualMODFLOW, particle tracking is performed by a sub-program called MODPATH.

By using MODPATH, several dozen particles can be tracked simultaneously as they move through the groundwater flow system being modelled. The position of each particle can be described by the time it takes to travel a fixed distance in the groundwater flow system. Therefore particle tracking is the basis for developing the wellhead protection areas (WHPA) using their respective time of travel (TOT) characteristics. As previously explained, contaminants released closer to the wellhead are considered to pose more risk than those originating further away; the time it takes contaminants to reach the wellhead is an important factor in managing risk. The following capture zones were established for municipal wellheads:

- WHPA-A is the area within 100 m of wellhead
- WHPA-B extends beyond the 100 m zone to a line marking the 2-year TOT
- WHPA-C extends from the WHPA -B limit out to the 5-year TOT
- WHPA-D extends from the WHPA-C limit out to the 25-year TOT

If a municipal well system is classified as obtaining groundwater under the direct influence of surface water (or a GUDI system), additional consideration must be given to the identification of the potential interactions between the groundwater system and the nearby surface water.

Vulnerability Scoring

As well as time of travel within the aquifer to the wellhead, the vulnerability of the aquifer to surface contamination was assessed using the Intrinsic Susceptibility Index (ISI). This method considers the soil characteristics (resistance to flow) and depth to the aquifer and rates the susceptibility of each location as high, medium or low. Final vulnerability scores were established for various locations within the vulnerable area based on both the WHPA and the susceptibility in accordance with Table 2(a) in Rule 83.

Uncertainty Analysis

As identified in the Technical Rules the process of delineation of each vulnerable area will carry a degree of uncertainty depending on the quality of the data used in the assessment and the professional judgment and skills of the analyst. Rule 13 in Part I.4 requires that an analysis of uncertainty, characterized as high or low, be made in respect of the vulnerability of the surface water throughout the vulnerable area.

Issues Identification

Drinking water issues, as defined in Part XI.1 of the Technical Rules relate to the presence of a "listed parameter" in water at the wellhead if:

- the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water; or
- there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

Issues can also relate to the presence of a pathogen. The intention of issues identification is to link observed water quality problems to specific threats where possible, so that the appropriate measures can be taken to eliminate the source of the problem. However, water quality issues may be due to natural sources. These are still listed as issues but no action is required.

The assessment process also has a provision to consider drinking water concerns. These are potential issues which are believed to exist but for which there is no data substantiating the presence of the contaminant. They are generally identified during public consultation.

Threats Identification and Assessment

A groundwater threat is a land use activity (either existing or historical), within the vulnerable area which may impair water quality if managed improperly.

Ontario Regulation 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 19 activities that may result in threats to drinking water quality. (Two additional prescribed activities pose threats to quantity; Table 3-4.) Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats.

Table 3-4. Activities Prescribed to be Drinking Water Threats in O. Reg. 287/07 (General) of the *Clean Water Act (2006)*

O. Reg. 287/07 s. 1.1(1)	Activity
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage
3	The application of agricultural source material to land
4	The storage of agricultural source material
5	The management of agricultural source material
6	The application of non-agricultural source material to land
7	The handling and storage of non-agricultural source material
8	The application of commercial fertilizer to land
9	The handling and storage of commercial fertilizer
10	The application of pesticide to land
11	The handling and storage of pesticide
12	The application of road salt
13	The handling and storage of road salt
14	The storage of snow
15	The handling and storage of fuel
16	The handling and storage of a dense non-aqueous phase liquid
17	The handling and storage of an organic solvent
18	The management of runoff that contains chemicals used in the de-icing of aircraft
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body
20	An activity that reduces the recharge of an aquifer
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard

Note: "agricultural source material", "application", "commercial fertilizer", "livestock", "non-agricultural source material" and "outdoor confinement area" have the same meanings as in Ontario Regulation

267/03 (General) made under the Nutrient Management Act, 2002; "management" means, with respect to agricultural source material, the collection, handling, treatment, transportation or disposal of agricultural source material; "pesticide" has the same meaning as in the Pesticides Act; "sewage" has the same meaning as in the Ontario Water Resources Act, O. Reg. 385/08, s. 3.

In accordance with Technical Rule 9(ix), areas where activities that are or would be significant, moderate or low drinking water threats were identified and are presented in the relevant municipal Sections.

An activity is deemed a significant, moderate or low threat dependent upon:

- specific circumstances that influence the hazard presented by a chemical or pathogen associated with that activity;
- the vulnerable area in which the activity is or would be located; and
- the area's vulnerability score.

The Ministry of Environment (MOE) provides reference tables of significant, moderate and low drinking water threats related to activities. Table 1 and Table 2 of the Tables of Drinking Water Threats list drinking water threats related to chemicals and pathogens, respectively. Further, an activity is also deemed to be a significant or moderate threat if it contributes to a drinking water issue as per Technical Rules 131 and 134.1.

Table 3-5 below provides an example showing the layout of the MOE Tables of Drinking Water Threats for pathogens. In this example, the drinking water threat in Column 1 would be considered to be significant if it were located in an IPZ with a vulnerability score of 8 to 10 under the circumstances set out in Column 3. The same threat would be considered to be low in an IPZ with a vulnerability score of 5.6 or less.

Table 3-5. Example from the MOE`s Tables of Drinking Water Threats

Drinking Water Threat:	Ref. #	Under the following Circumstances:	Vulnerable Areas	Threat Rating based on Vulnerability Score (Vs)		
				Significant Vs	Moderate Vs	Low Vs
The application of agricultural source material to land	1	1. Agricultural source material is applied to land in any quantity. 2. The application may result in the presence of one or more pathogens in groundwater or surface water.	IPZ-1, IPZ-2, IPZ-3 & WHPA-E	8 - 10	6 - 7.2	4.2 - 5.6
			WHPA-A & WHPA-B	10	8	6

Vs = Vulnerability Score

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas using the Ministry of the Environment's Provincial Tables of Circumstances. These tables provide a list of circumstances for each prescribed activity which could pose as a drinking water threat. The risk scores for each vulnerable area then determines the corresponding threat level for each circumstance. The total number of significant, moderate and low threats in vulnerable areas was summarized based on these tables.

Technical Rules 9.(1) (e) and (f) require that an Assessment Report include the number of locations at which:

- a significant drinking water threat activity is being engaged in; and
- a condition resulting from a past activity is a significant drinking water threat.

These are identified in the Sections that follow, relevant to each individual municipal water source.

No conditions were identified in any of the ground water vulnerable areas.

Gap Analysis and Recommendations

This report is organized by municipal water system; each section contains a gap analysis and recommendations pertinent to that system.