

# Description of GIS-Based Methodology Used to Conduct Source Water Assessments for Small Community Water Systems in Pennsylvania

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## 1.0 INTRODUCTION

Under Task 15 of an existing open-ended technical services contract with the State of Pennsylvania (ME#359494), the Environmental Resources Research Institute (ERRI) at Penn State University was asked to assist the Source Water Protection Branch within the Bureau of Watershed Management at the Pennsylvania Department of Environmental Protection (PaDEP) in a project to assess potential contamination threats to small drinking water systems in Pennsylvania. For the purposes of this project, small systems were defined as any community water supply system serving a population of less than 3,300 people using groundwater as their source of drinking water. Within Pennsylvania, there are approximately 6,000 water systems (with many having more than one well) that meet this criterion.

To facilitate the daunting task of conducting relatively complex assessments on such a large number of wells, an automated, GIS-based approach was developed to rapidly complete the required analyses using as much existing GIS (i.e., digital map) data as possible. In all, assessments (with associated reports) were completed for over 14,000 wells. Due to the large number of source water assessments that were required to be produced, it was felt that it would be better to eliminate redundant descriptions of the assessment methodology in these smaller reports, and to provide a concise description in this companion report.

## 2.0 OVERVIEW OF ASSESSMENT METHODOLOGY

For each groundwater well evaluated, a series of steps were conducted as part of the overall source water assessment process. These steps were automated so that groups of 1,000 or more wells could be assessed in “batch” mode on a dedicated computer. The steps that were completed in sequence for each well assessed include:

- 1) *Delineation of a wellhead protection area (WHPA) around the well.* For the purposes of this effort, the WHPA was the “capture zone” calculated on the basis of local hydrogeologic conditions (see Section 3.0 for more details on how these zones were calculated).
- 2) *Identification/quantification of potential threats to drinking water supplies located within the WHPA.* This activity was accomplished using a multitude of existing GIS data sets available with the state (see Section 4.0 for a detailed descriptions of these data sets).
- 3) *Susceptibility analysis of groundwater sources to contamination.* This analysis was based on a methodology previously developed by PaDEP. In this case, the “overlay and analysis” steps were automated via the use of customized programming (i.e., “scripts”) done using Avenue, the programming language used with the ArcView GIS software (see Section 5.0 for additional details).

- 4) *Generation of a site-specific “SWAP” report.* For each source (i.e., well) evaluated, a concise report (i.e., MS-Word document) was automatically generated, complete with introductory text, tables and maps (see Section 6.0 for more details).

### 3.0 DELINEATION OF WELLHEAD PROTECTION ZONES

As described by Kraemer et al. (2001), the calculation of radii for wellhead protection zone (i.e., zone II) delineation can be based on a simple two-dimensional static water balance analysis, assuming negligible ambient flow in the aquifer. If it is assumed that radial flow toward a well in an aquifer has a constant saturated thickness  $H$  (m), the cylindrical boundary of radius  $R$  (m) can be delineated by an isochrone of residence time  $t$  (days), which means that any water particle that enters the cylinder or is present in the cylinder will travel no longer than  $t$  days before being pumped up by the well (see Figure 1). The pumping rate of the well is  $Q$  ( $\text{m}^3 / \text{day}$ ), the areal recharge to the water table due to precipitation is

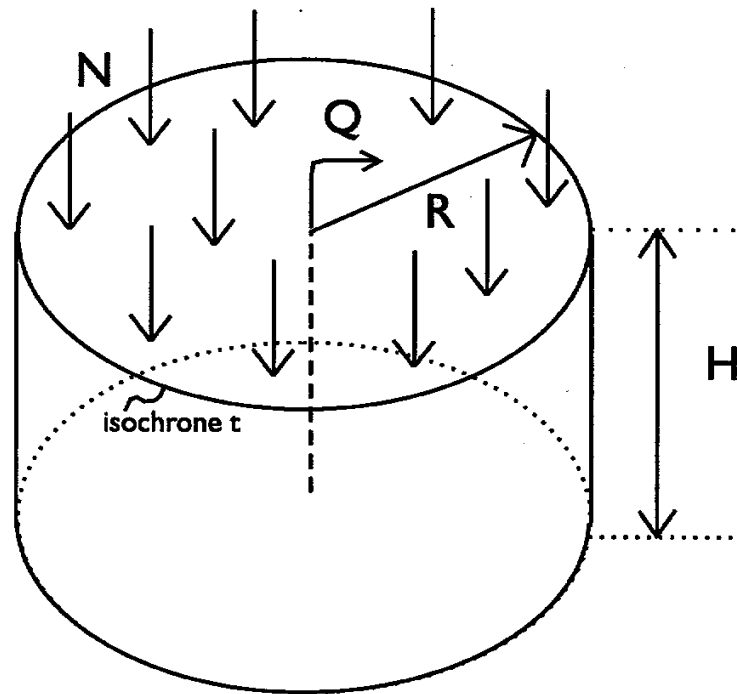


Figure 1. Water balance for radial flow to a well in a domain bounded by an isochrone of residence time  $t$  (from Kraemer et al., 2001).

$N$  (m / day), and the aquifer porosity is  $n$  (-). A water balance for the period  $t$  yields:

$$N\pi R^2 t + n\pi R^2 H = Qt \quad (1)$$

The first term represents the inflow due to aquifer recharge, the second term represents the amount of water contained inside the cylindrical aquifer, and the term on the right-hand side is the total amount of water removed by the well for the pumping period. In this case, the radius  $R$  can be expressed as:

$$R = (Qt / (N\pi t + n\pi H))^{-1/2} \quad (2)$$

When  $t$  becomes infinitely large, the radius  $R$  represents the complete capture zone as follows:

$$R \simeq (Q / \pi N)^{-1/2} \quad (3)$$

Use of this particular equation in delineating capture zones is called the “recharge method” (USEPA, 1993).

If the term  $N\pi t$  becomes small due to a small value of  $t$  or  $N$  or both, equation 3 can be reduced to:

$$R \simeq (Qt / n\pi H)^{-1/2} \quad (4)$$

Use of this second equation in delineating capture zones is called the “volumetric method” (USEPA, 1993).

For the GIS-based application described herein, capture zone delineation is done using the recharge method. Parameter values required by the recharge method are estimated using default values or information contained in either of two GIS data layers (themes) as shown in Table 1. Algorithmically, if a given well had mean annual yield (i.e., discharge or pumping rate) information associated with it in the “well” GIS layer used (see Section 2.0 for additional information on GIS data sets), then this value was used as an estimate of “Q”. Otherwise, the “geolphys” GIS data layer was used to estimate this parameter based on the geologic/physiographic setting in which the well was located. As described in Section 4.0, representative values of well discharge for different geologic/physiographic settings were based on information presented in various reports and databases.

Subsequent to defining the general shape of the WHPA using the technique described above, an adjustment is made to better reflect the effect that groundwater flow gradient and direction might have on the shape of the WHPA boundary. More specifically, the calculated WHPA circle is extended in the up-

Table 1. GIS data layers used to estimate WHPA parameters.

PARAMETER	GIS THEME	ATTRIBUTE FIELD
Q N	<i>geolphys</i> or <i>public water wells</i> <i>geolphys</i>	Dschrg_cmd (m <sup>3</sup> /d) / Avgylid (gpd) Org_rech (in/yr)

gradient direction of groundwater flow as shown in Figure 2. This is accomplished by :

- Extending a vector ("A") in the direction of groundwater flow. This line has a distance of  $1.5r$  from the edge of the calculated capture zone, where  $r$  equals the radius of the capture zone based on the recharge method as described above. Groundwater flow direction is calculated using a GIS data layer depicting groundwater elevation. To simplify additional calculations, predominant flow can only be one of eight compass directions: N ( $0^\circ$ ), NE ( $45^\circ$ ), E ( $90^\circ$ ), SE ( $135^\circ$ ), S ( $180^\circ$ ), SW ( $225^\circ$ ), W ( $270^\circ$ ), and NW ( $315^\circ$ ).
- Extending two lines on either side of the circle that are at an angle of  $20^\circ$  from two imaginary lines parallel with vector "A" that run in the same direction as vector "A".

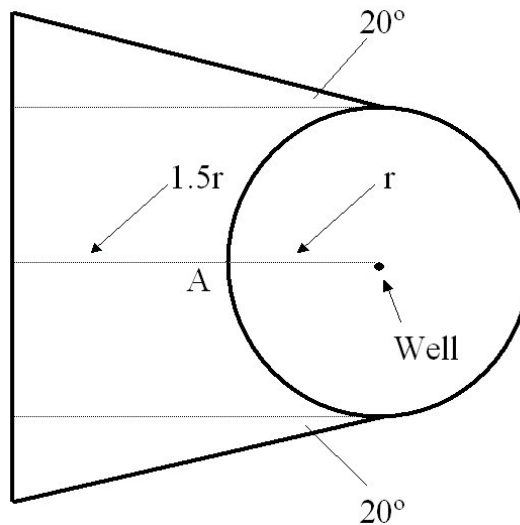


Figure 2. Adjusted capture zone boundary.

#### 4.0 IDENTIFICATION/QUANTIFICATION OF POTENTIAL THREATS

Potential threats to drinking water supplies were identified and quantified using a number of GIS map layers depicting various features such as agricultural land, industrial and commercial sites, railroad tracks, waste disposal sites, etc. that could potentially adversely affect the integrity of nearby groundwater wells. A listing of the specific GIS layers used for the source water assessment work described in this document is provided in Table 2. As part of the GIS-based assessment methodology, the presence and number of mapped features of concern were recorded and subsequently used as input to a “susceptibility analysis” routine that was used to rate the relative importance of potential threats around each well associated with a given water supply system. This susceptibility analysis procedure is discussed in greater detail in Section 5.0.

Table 2. GIS layers used for source water assessment.

GIS Layer (i.e., File) Name	Description	Purpose
Pubws	Public water supplies	Used to identify locations of wells or surface water intakes that can be assessed
Geolphys	Polygons representing combination of surface geology mapping unit and physiographic section	Used for derivation of representative well pumping rate (if not known) and an estimate of mean annual recharge
Drastic	Index indicating the relative vulnerability of underlying groundwater due to various hydrogeologic factors. Higher values indicate greater inherent vulnerability.	Used to evaluate potential sensitivity of a well nearby contaminants.
RailrdsII	Railroad lines.	Used in the susceptibility assessment for a given site.
Mines	Map depicting locations of coal mine operations and related facilities.	Used in the susceptibility assessment for a given site.
PipeInslI	Major pipelines.	Used in the susceptibility assessment for a given site.
OilgasII	Locations of oil and gas wells.	Used in the susceptibility assessment for a given site.

Table 2 (cont.). GIS layers used for source water assessment.

GIS Layer (i.e., File) Name	Description	Purpose
Roads	Locations of primary roads.	Used in the susceptibility assessment for a given site.
Golfcoll	Locations of golf courses as derived from satellite images and USGS topographic maps.	Used in the susceptibility assessment for a given site.
T21997II	Locations of toxic release sites as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Rcratsdll	Locations of RCRA treatment, storage, and disposal facilities as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Rcrasqgll	Locations of small quantity RCRA sites as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Rcralqgll	Locations of large quantity RCRA sites as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Npdes	Locations of national pollution discharge elimination (NPDES) sites as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Cerclisll	Locations of CERCLIS sites as mapped by the U.S. EPA.	Used in the susceptibility assessment for a given site.
Lustll	Locations of leaking underground storage tanks as mapped by Penn State using a DEP-created database.	Used in the susceptibility assessment for a given site.
Palumrlc	A map of land use/cover map derived from the MRLC data set produced by U.S. EPA and U.S. Geological Survey.	Used in the susceptibility assessment for a given site.



Table 2 (cont.). GIS layers used for source water assessment.

GIS Layer (i.e., File) Name	Description	Purpose
water_pol_ctrl_facil	Locations of water pollution control facilities including treatment plants, conveyance systems, pump stations, outfalls, storage units, etc.	Used in the susceptibility assessment for a given site.
UIC_class2	Class 2 underground injection wells.	Used in the susceptibility assessment for a given site.
UIC_class5	Class 5 underground injection wells.	Used in the susceptibility assessment for a given site.
storage_tanks	DEP primary facility type related to Storage Tanks Program.	Used in the susceptibility assessment for a given site.
oil_gas_wells	Locations of oil and gas wells, tanks, beneficial uses, land applications and pits.	Used in the susceptibility assessment for a given site.
muni_waste_operations	Locations of landfills, land applications, processing facilities, transfer stations, resource recovery, and composting	Used in the susceptibility assessment for a given site.
comm._haz_waste	Primary facilities including treatment facilities, storage, incinerators, recycling facilities, generators, boiler and industrial furnaces, and disposal facilities.	Used in the susceptibility assessment for a given site.
captive_haz_waste	Primary facilities including treatment facilities, large and small quantity generators, storage facilities, incinerators, recycling facilities, boiler and industrial furnaces, and disposal facilities.	Used in the susceptibility assessment for a given site.

## 5.0 SUSCEPTIBILITY ANALYSIS PROCEDURE

The susceptibility analysis routine (i.e., sub-program) used within the GIS-based methodology described in this document is based on the one developed previously by PaDEP's Source Water Protection Branch (2000). A generalized

schematic of this methodology is shown in Figure 3. This methodology is intended to provide a qualitative measure of relative priority for concern of the different potential and existing sources of contamination based on the following:

- Drinking water sensitivity.
- Potential impacts posed by sources of contamination to the public water supply source.
- Potential for release of contaminants of concern.

With the susceptibility analysis methodology, a series of matrices are used to determine high, medium and low values for the factors in the process. These various factors (i.e., matrices) are given in Figures 4 and 5. The parameters used in these matrices include time of travel (TOT), persistence, and quantity.

For the purposes of this assessment of smaller systems (i.e., with populations served of 3,300 or less), it was assumed that the time of travel within the relatively small calculated capture zones was always “short”. The persistence of a potential contaminant is based on its ability to move in the environment, and is rated as high, medium or low. For ground water sources, the ability of potential contaminants to move through different soils and geologic settings is considered in assigning these ratings.

Similarly, the quantity factor is set as high, medium or low also. Low quantities are generally those that are clearly on a domestic scale and can be categorized as non-reportable or non-regulated releases, volumes or events. Medium quantities are those that can be categorized as reportable releases, regulated minimum volumes or events (or the equivalent), up to an amount about 10 times such a quantity, or those quantities associated with commercial- or industrial-sized operations and distribution. High quantities are those that are clearly associated with commercial- or industrial-sized operations and distribution (with a minimum of 10 times a reportable release, regulated minimum volume, event, or the equivalent).

The sensitivity of a ground water source is most critical in areas where the attenuation of infiltrating water is minimal due to less than ideal overlying soils and geologic material. To evaluate sensitivity, DEP uses a relative ranking of aquifer vulnerability based on the DRASTIC method developed by Aller et al. (1987). DRASTIC stands for: **D**epth to ground water, **R**echarge, **A**quifer media, **S**oil permeability, **T**opography, **I**mpact of the vadose zone, and **C**onductivity. With this methodology, an index of relative vulnerability is produced, with the higher values indicating greater ground water vulnerability.

The first step in the susceptibility analysis procedure is to assess the potential for contamination of the drinking water source if all possible contaminants were released from the potential contaminant source without consideration of any

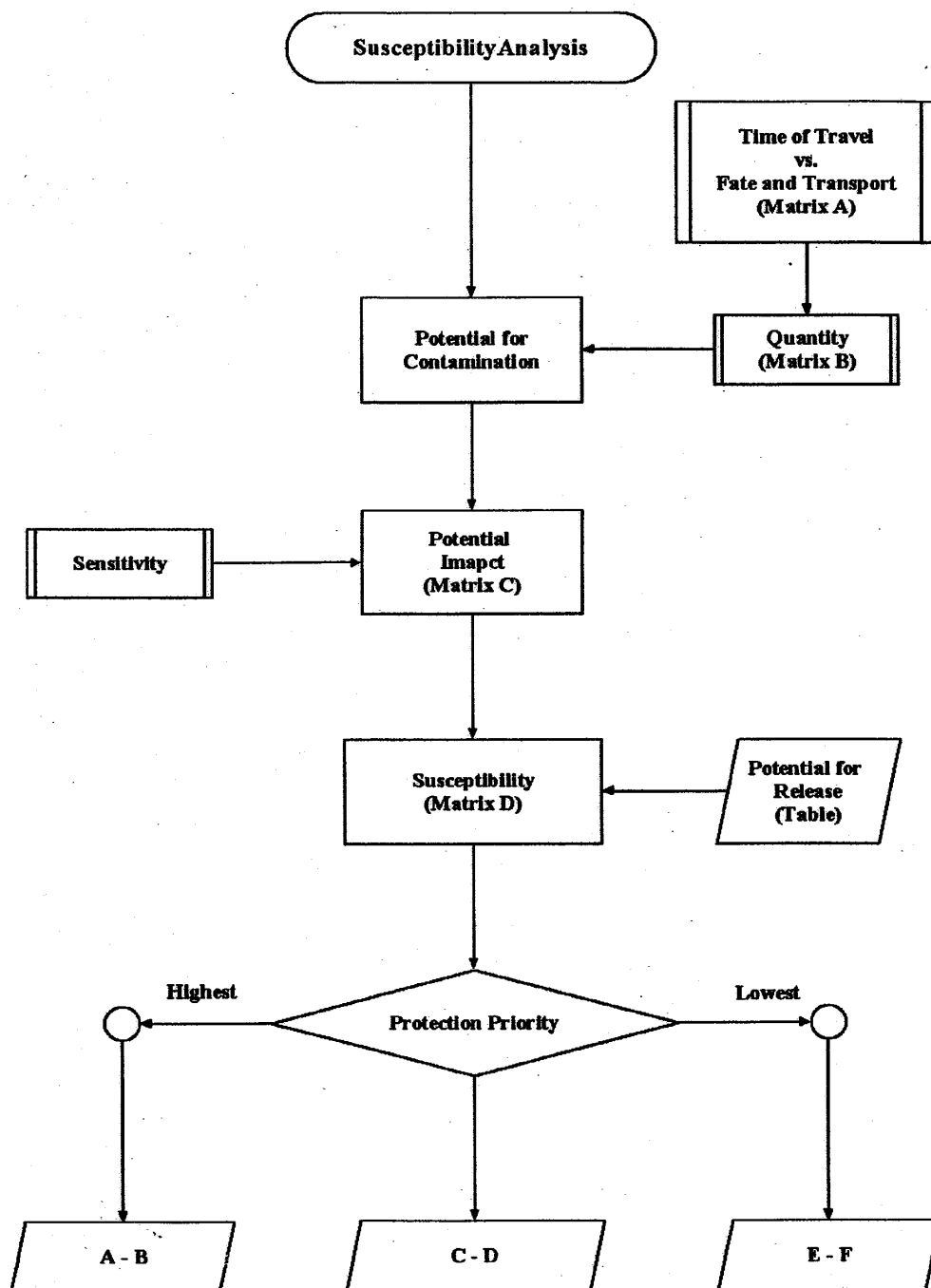


Figure 3. Schematic of susceptibility analysis procedure.

## Potential for Contamination

### Matrix A (Step 1)

Time of Travel (TOT) vs. Fate & Transport (persistence)

\ Persistence TOT \	High	Medium	Low
Short	High	High	Medium
Medium	High	Medium	Low
Long	Medium	Low	Low

### Matrix B (Step 2)

Matrix A vs. Quantity

\ Quantity Matrix A Result\	High	Medium	Low
High	High	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Low

## Potential Impact

### Matrix C

Potential for Contamination vs. Sensitivity

\ Sensitivity Potential for Contamination \ (from Matrix B)	High	Medium	Low
High	High	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Low

Figure 4. Potential for Contamination and Potential Impact tables.

**Potential for Release  
Table**

Potential for Release Control Practice \	Low	Medium	Medium-High	High
Regulated Containment &/or ERP	X			
Unregulated Containment / no ERP		X		
Regulated Discharge in Compliance			X	
" " Not in Compliance				X
NPS w/ Best Management Practices		X		
BMPs Not Operating			X	
No Control Practices				X

(ERP = Emergency Response Plan, NPS = Non-Point Source, BMP = Best Management Practice)

**Susceptibility Rating  
Matrix D**

Potential for Release vs. Potential Impact

\ Potential Impact (from Maxtrix C) Pot. For Release \ (from Table)	High	Medium	Low
High	A	B	C
Medium High	B	C	D
Medium	C	D	E
Low	D	E	F

Figure 5. Potential for Release and Final Susceptibility tables.

source protection. Factors controlling the potential for contamination from a release are the fate and transport of the contaminant, the amount of contaminant of concern that might be released and the time of travel (or distance) to the drinking water source. As shown in Figure 4, the relative ratings for this potential are determined from Matrix A and Matrix B. By relating the potential for impact to the potential for release, the susceptibility rating (often referred to as "protection priority") is then determined as shown in Matrix D (see Figure 5). As shown in this matrix, the final ratings range from A (high) to F (low).

For the GIS-based susceptibility analysis procedure, various algorithms were implemented to mimic the methodology described above. A more detailed discussion of the sequence of steps used in this procedure is provided in Appendix A.

## 6.0 SWAP REPORT GENERATION/DESCRIPTION

As part of the GIS-based methodology, MS-Word and Acrobat Reader (.pdf) files were automatically created for each well evaluated. To facilitate this process, pre-formatted covers, tables and map templates were used so that each well was documented in exactly the same manner, with only the information contained within each table and the final map content varying from site to site. An example of an automatically-generated report for a specific well is given in Appendix B. Brief descriptions of the headings and tables included with each report are as follows:

**County:** Name of the county in which the evaluated water supply well is located.

**WHPA Size (Acres):** Size (in acres) of the calculated wellhead protection area (WHPA).

**USGS Map:** 7.5-minute USGS topographic quadrangle map that the particular source is located on.

**Pumping Rate (gdp):** Pumping rate of the supply well in gallons per day (gpd). This may have been recorded for the well within the “pubws” GIS file. If not recorded, the rate was estimated using the data contained within the “geolphys” GIS data layer based on the specific geologic/physiographic setting in which the well is located.

**Recharge Rate (in/year):** Mean annual recharge rate (in inches per year) of the area in which the given well is located. This is derived from representative information in the “geolphys” GIS layer computed for each geologic/physiographic setting in the state.

**Aquifer Porosity (%):** Average porosity based on geologic rock type as determined from information provided in Freeze and Cherry (1979). This value is actually read from an attribute field in the “geolphys” GIS data layer.

**Aquifer Conductivity (gpd/ft<sup>2</sup>):** Estimated hydraulic conductivity of the source aquifer based on information derived from multiple sources, including Fleeger et al. (2001) and DEP (2000). This value is actually read from an attribute field in the “geolphys” GIS data layer.

**Aquifer Thickness (ft.):** Estimate of source aquifer thickness. If not recorded with the specific well, the rate was estimated using the data contained within the “geolphys” GIS data layer based on the specific geologic/physiographic setting in which the well is located. Estimates of thickness values for different aquifers were derived primarily from Fleeger et al. (2001) and Geyer and Wilshusen (1982).

**GW Flow Gradient (%):** Estimate of groundwater gradient in the predominant direction of groundwater flow. This is calculated using a statewide groundwater elevation map (GIS layer) created by Penn State (*gwelev*). Estimates of gradient are obtained using surface slope routines within ArcView GIS software.

**GW Flow Direction (deg.):** Similar to GW Flow Gradient, ArcView routines are used to derive predominant flow direction (ranging from 0° – 360°) based on the “gwelev” GIS data layer.

**Mean DRASTIC Score:** This is the average DRASTIC index calculated for the WHPA, and is based on the DRASTIC GIS data layer. Higher DRASTIC values indicate greater potential groundwater vulnerability. The calculated range for the entire state of Pennsylvania is 30 – 215.

**No. NPDES Sites:** Number of NPDES sites found within the WHPA.

**No. TRI Sites:** Number of TRI sites found within the WHPA.

**No. UIC Class 2:** Number of UIC Class 2 sites found within WHPA.

**No. Com. Haz. WOP:** Number of commercial hazardous waste operations found within the WHPA.

**No. Storage Tanks:** Number of storage tanks found within the WHPA.

**No. Wat. Pol. Cont. Fac.:** Number of water pollution control facilities found within the WHPA.

**No. RCRA-TSD Sites:** Number of RCRA (treatment, storage & disposal) sites found within the WHPA.

**No. RCRA-SQG Sites:** Number of RCRA (small quantity generators) sites found within the WHPA.

**No. RCRA-LQG Sites:** Number of RCRA (large quantity generators) sites found within the WHPA.

**No. NPL Sites:** Number of NPL (national priority list) sites found within the WHPA.

**No. CERCLIS Sites:** Number of CERCLIS sites found within the WHPA.

**No. Tier II Sites:** Number of Tier II sites found within the WHPA.

**No. UST Sites:** Number of UST sites found within the WHPA.

**No UIC Class 5:** Number of UIC Class 5 sites found within the WHPA.

**No. Muni. Waste:** Number of municipal waste sites found within the WHPA.

**No. Captive Haz. WOP:** Number of captive hazardous waste operations found within the WHPA.

**No. Oil/Gas Wells:** Number of oil/gas well sites found within the WHPA.

**Land Use/Land Cover Distribution:** Distribution of land use/cover within the WHPA based on use of the MRLC GIS data layer.

**Potential Contaminants by Activity:** This table provides the relative susceptibility ratings for different activities/features found within the evaluated WHPA. The ratings range from A (high priority) to F (low priority), and the process for deriving them is described in Section 5.0 and Appendix A. Also provided in this table is an indication of the primary (P) and secondary (s) contaminants typically associated with the listed activities. The contaminants listed include: microbial pathogens (MP), nitrate/nitrite (NN), volatile organic compounds (VOC), heavy metals (HM), metals (M), synthetic organic compounds (SOC), turbidity (T), radionuclides (R), petroleum hydrocarbons (PH), and acidity (Acid).



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## **Appendix A. Detailed Susceptibility Analysis Procedures**

### **Step 1: Evaluate Potential for Contamination**

#### **a) Assign “persistence” values**

- If Tier 2 or NPDES sites, use Table 2; otherwise, use Table 1 (Note: the ratings in these tables were jointly developed by Penn State and DEP personnel)
- Time-of-Travel is always “short” for small water system WHPAs

#### **b) Complete Matrix A**

- If “persistence” = H, “matrixa” = H
- If “persistence” = M, “matrixa” = H
- If “persistence” = M, “matrixa” = M

#### **c) Assign “quantity” values**

- If feature/activity is in WHPA zone, “quantity” = high; otherwise “quantity” = low

#### **d) Complete Matrix B**

- Assign scores using Matrix B table

### **Step 2: Evaluate Potential Impact**

#### **a) Assign “sensitivity” values**

- If DRASTIC index is  $\leq 105$ , “sensitivity” = L
- If DRASTIC index is between 106-121, “sensitivity” = M
- If DRASTIC index is  $>121$ , “sensitivity” = H

#### **b) Complete Matrix C**

- Assign scores using Matrix C table

### **Step3: Assign Final Susceptibility Ratings**

#### **a) Assign “Potential for Release” Values**

- If Tier 2 or NPDES, use Table 2; if “water pollution control facility”, use Table 3; otherwise, use Table 1

#### **b) Assign Final Susceptibility Ratings**

- Assign ratings for each activity using Matrix D table
- Assign a rating for the entire source based on the highest activity rating

**Table A1. Contaminants and Persistence/PR values by activity**

ACTIVITY	S	MP	NN	VOC	HM	M	SOC	T	R	PH	Acid	Persistence	P for R
Agriculture	G	S	P				P					High	MH
Low-Density Dev.	G		P				P					High	M
High-Density Dev.	G		P				P					High	M
Quarries	G			S	S	S		P				Low	M
Coal Mines	S				S	S		S			P	High	H
Golf Courses	S		P		S	S	P	S				High	M
Railroad Tracks	S			P	S		S					High	L
Major Roads	S					P	P	S				High	L
Oil/Gas Wells	S			P		S				P		High	M
Other Munic. Waste	S	S		P	S	S	S					High	H
UST Sites	S			P								High	MH
TRI Sites	S			P	P	P	P			P		High	L
RCRA-SQG Sites	S			P	P	P	P			P		High	L
RCRA-LQG Sites	S			P	P	P	P			P		High	L
RCRA-TSD Sites	S			P	P	P	P			P		High	L
NPL Site	S			P	P	P	P			P		High	L
Pipelines	S			P						P		High	M
NPDES Sites	S	*	*	*	*	*	*	*	*	*	*	*	*
Tier II Sites	S	*	*	*	*	*	*	*	*	*	*	*	*
Storage Tanks	S			P	S						S	High	MH
Water Poll. Ctrl. Fac.	S	+	+	+	+	+	+	+	+	+	+	+	+
UIC_Class2	S	P	P	P	P	P	P	P	P	P	P	High	M
UIC_Class5	S	P	P	P	P	P	P	P	P	P	P	High	MH
Comm. Haz. WOP	S			P	P	P	P			P		High	L
Captive Haz. WOP	S			P	P	P	P			P		High	L

Source (S): S = Shape File  
G = Grid (palumrlc)

P = Primary pollutant , S = Secondary pollutant , \* or + Means go to Table 2 or 3 for values

MP = microbiological pathogen, NN = nitrate nitrogen, VOC = volatile organic compounds, HM = heavy metal, M = metals, SOC = synthetic organic compounds, T = turbidity, R = radionuclides, PH = "PH" as in acidity, Acid = acidity, P for R = Potential for Release

**Table A2. Look-Up Table for Tier2 and NPDES Sites**

ACTIVITY	SIC CODES	MP	NN	VOC	HM	M	SOC	T	R	PH	Acid	Per.	PR
Agriculture	0200 - 0299	S	P			S	P					High	M
Silviculture	0800 - 0899						S	P				Low	MH
Food Processing	2000 – 2099	S	P	S	S	S						High	M
Airports	4500 – 4599			S	S	S				P		High	L
Auto Repair Shops	7500 – 7599			S	S	S				P		High	MH
Bus/Truck Terminals	4100 – 4199			S	S		S			P		High	MH
Car Washes	7542					S		P				Low	MH
Laund./Dry Cleaners	7215			P				S				High	MH
Funeral Homes	7261	S		P			P					High	MH
Gas/Service Stations	5541			S		S				P		High	MH
Golf Courses	7900 – 7999		P		S	S	S	S				High	M
Medical Facilities	8000 – 8099	S		P	S	S	S		S			Med	M
Photo/Print Shops	2700 - 2799			P	S		S					High	MH
Railroad Tracks/Yards	4000 – 4099			P	S		S			S		High	H
Sand/gravel/quarries	1400 – 1499			S	S	S		P				Low	MH
Chemical Manufacture	2800 – 2899			P	S	S	S					High	MH
Deep Coal Mining	1222				S	S		S			P	High	H
Deep Non-coal Mining	1000 – 1099				S	S		P			S	Low	H
Electronics Manufact.	3600 – 3699			P	S	S	S					High	MH
Electroplating	3471			P	P	S	S					High	MH
Metalworking/Fabricat.	3300 – 3499			P	P	S	S					High	MH
Fuel Oil Distributers	5983			P						P		High	MH
Oil & Gas Well/Prod.	1300 – 1399			P		S				P		High	M
Oil Refineries	2900 – 2999			P	S	S				P		High	MH
Plastics Manufacture	3000 - 3099			P	S					P		High	MH

**Table A2 (cont.). Look-Up Table for Tier2 and NPDES Sites**

ACTIVITY	SIC CODES	MP	NN	VOC	HM	M	SOC	T	R	PH	Acid	Per.	PR
Electric Power Plants	4911	P	S		P	S						Med	MH
Surface Coal Mining	1221				S	S		P			P	High	MH
Non-coal Surface Mine	1000 – 1099				S	S		P				Low	MH
Tanneries	3111			S	P	S						Med	MH
Wood Preserving	2491				P		S					Med	MH
Fuel Oil Storage	2900 – 2999			P						P		High	MH
Wastewater Treatment	4952 or 4959			S	S	S	S					High	M
Drink. Water Treat.	4941			P		S		S				Med	M
Boatyards/Marinas	4493			P			S			P		High	H
Recycling Facilities	4953			P	S							High	MH
Road Maint. Depot	4231			P	S		S					High	MH
Elec. Utility Substation	4911			S	S		P					Low	MH

**Table 3. Contaminants and Persistence/PR values for Water Pollution Control Facilities**

Category	Risk	MP	NN	VOC	HM	M	SOC	T	R	PH	Acid	Persistence	P for R
CAFO	2	P	P					S				High	MH
IWW	1			P	P	P	S	S		S	S	High	L
IWW	2			P	P	P	S	S		S	S	High	M
DWW	1	P	P					S				High	L
DWW	2	P	P					S				High	M

CAFO = Concentrated Animal Feeding Operation

IWW = Industrial wastewater facility

DWW = Domestic wastewater facility

Risk = 1 (includes groundwater monitoring site, internal monitoring site, production service unit, or pump station)

Risk = 2 (includes biosolids treatment, conveyance system, discharge point, land discharge, septage land application, treatment plant, or storage)

## **Appendix B. Example SWAP Report**



# Source Water Assessment Report

For:

**System Name:** BCWSA - RIVERWOOD  
**PWSID No.:** 1090155  
**Source ID No.:** 002



Environmental Resources Research Institute

October 15, 2003

### **Disclaimer**

Please note that the source water protection area delineation(s) in this report is (are) provided for source water assessment purposes only. A more rigorous delineation of the source water protection area may be necessary for source water protection program development purposes, such as a wellhead protection program.

### **Note**

The methodology used to conduct this assessment, as well as the terms used in this report, are described in a companion report entitled "Description of GIS-based Methodology Used to Conduct Source Water Assessments for Small Community Water Systems in Pennsylvania", which is also available in Adobe portable document (pdf) format (SWAPGIS\_Overview.pdf) from the Source Water Protection Branch of the Pennsylvania Department of Environmental Protection.

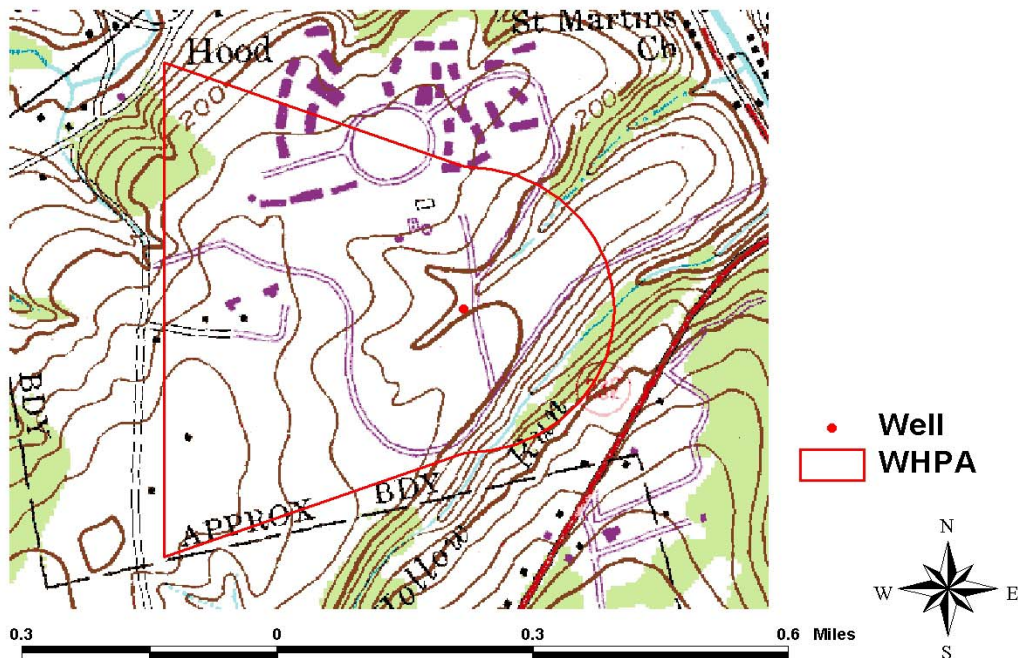
### Estimated Site/Well/WHPA Data

County: Bucks	Aquifer Porosity (%): 0.20000
USGS Map: LAMBERTVILLE	Aquifer Conductivity (gpd/ft <sup>2</sup> ): 0.43333
WHPA Size (Acres): 139.32	Aquifer Thickness (ft.): 6000.66
Pumping Rate (gpd): 40000	GW Flow Gradient (%): 2.17924
Recharge Rate (in/year): 8.62205	GW Flow Direction (deg.): 90.00000

**Overall WHPA Susceptibility Rating (Protection Priority): B**

### Area Map for w1090155002

## w1090155002



### Potential Contaminant Source/Vulnerability Data

<b>Mean DRASTIC Score: 114.4</b>	<b>No. NPL Sites: 0</b>
<b>No. NPDES : 0</b>	<b>No. CERCLIS Sites: 0</b>
<b>No. TRI Sites: 0</b>	<b>No. Tier II Sites: 0</b>
<b>No. IC Class 2: 0</b>	<b>No. UIC Class 5: 0</b>
<b>No. Com. Haz. WOP: 0</b>	<b>No. Muni. Waste: 0</b>
<b>No. Storage Tanks: 0</b>	<b>No. Captive Haz. WOP: 0</b>
<b>No. Wat. Pol. Cont. Fac.: 0</b>	<b>No. RCRA-LQG Sites: 0</b>
<b>No. RCRA-TSD Sites: 0</b>	<b>No. UST Sites: 0</b>
<b>No. RCRA-SQG Sites: 0</b>	<b>No. Oil/Gas Wells: 0</b>

### Land Use/Land Cover Distribution

<b>Category:</b>	<b>Acres in WHPA</b>	<b>% of Total WHPA</b>
Urban	16.46	11.84
Agricultural Land	57.82	41.6
Woodland	55.38	39.84
Water	2.67	1.92
Disturbed Land	6.67	4.8

## Potential Contaminants by Activity

[illegible]