Source Water Assessment
Of the Public Water Supply Wells
For
Town of Blades,
Sussex County, Delaware

January 29, 2002

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Summary

The Delaware Department of Natural Resources and Environmental Control's (DNREC) Division of Water Resources has completed the Source Water Assessment for the public water supply wells for the Town of Blades as required under the 1996 amendments to the Safe Drinking Water Act. This assessment has been performed using the methods specified in the State of Delaware Source Water Assessment Plan (DNREC, 1999).

There are two supply wells used by Blades for their drinking water supply. Both of these wells are in the shallow portion of the unconfined Columbia aquifer and have a high vulnerability to contaminants.

There are seven discrete potential sources of contamination located within the wellhead protection areas around these wells. These sources include: three underground storage tank facilities, three hazardous waste generators, and one superfund site. The dominant land use above these wells is combined urban areas.

Data from the Department of Health and Social Services' drinking water program was reviewed for raw/untreated water quality data for the past five years. One raw water sample was found to contain Iron at 0.67 mg/L above the 0.30 mg/L secondary drinking water standard. However, it should be noted that Blades' water supply system utilizes certain treatment methods that remove contaminants or impurities from the drinking water before it is delivered to the public.

A system-wide susceptibility is based on the most conservative rating from the wells that summarizes the most susceptible portion to this system. Overall, Blades' drinking water supply system has exceeded the drinking water standard for metals (iron), has a high susceptibility to petroleum hydrocarbons, pesticides, other organic compounds, and other inorganic compounds, and a moderate susceptibility to nutrients, pathogens, and PCBs. The iron is most likely naturally occurring and is quite common in most aquifers in Delaware. The other susceptibilities are mainly a result of various discrete contaminant sources and land uses above relatively shallow (highly vulnerable) wells.

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Introduction

The 1996 amendments to the Safe Drinking Water Act (SDWA) require that source water assessments be performed for all sources of public drinking water in each state. Because of this, each state was required to develop a Source Water Assessment Plan (SWAP). The State of Delaware's SWAP was developed by a committee of scientists, water industry professionals, conservation groups, government agencies, and interested citizens in 1998 and approved by the United States Environmental Protection Agency in October, 1999.

This assessment for the Town of Blades has been performed using the methods specified in the State of Delaware Source Water Assessment Plan (DNREC, 1999)

The assessment consists of these four critical steps:

1) Delineation of source water areas;
2) Determination of the vulnerability of a well or intake to contamination;
3) Identification of existing and potential sources of contamination; and
4) Determination of the susceptibility of the source water area to contamination.

Step 1 consists of mapping the land surface area that contributes to the water supply. For ground water systems, this is called the wellhead protection area. The Town of Blades uses two wells to provide drinking water to the public. All of these wells withdraw water from the unconfined Columbia aquifer. All of these wells are classified as "shallow unconfined" wells because each has open screen closer than 100 feet below the ground surface. As shallow unconfined wells pumping over 50,000 gallons per day, the wellhead protection areas were delineated using a computer model that attempts to simulate ground-water flow.

Step 2 uses a step-by-step decision making process by which each well or surface water intake for a particular system is examined to determine its vulnerability to contamination. Vulnerability is the relative ease with which contaminants, if released into a source water area, could move and enter a public water supply well or intake at concentrations of concern. Vulnerability includes consideration of such factors as aquifer characteristics, well or surface water intake integrity, and well screen depth. A series of questions about the type of system (surface water or ground water), hydrologic setting, and well construction are used in the decision-making process.

Step 3 consists of creating an inventory of all existing and potential sources of contamination within the delineated source water protection areas. This was done utilizing DNREC's contaminant site inventories, 1997 land use maps, analytical data compiled by the Office of Drinking Water and through visual examination during site visits.

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Step 4 consists of determining the susceptibility of the source water area to contamination. This process combines steps 1, 2, 3, water quality reports, and other information.

This information must be summarized into a report and provided to the public. It is the goal of the Division of Water Resources that the summaries provided from the source water assessment and protection program will help communities understand the potential threats to their drinking water supply and to work to protect these drinking water resources.

Study Area

The Town of Blades is located west of Route.13 and south of the Nanticoke River. (Map 1 Base Map for Blades Water). The Blades Water Department serves a population of nearly 960 persons and has approximately 320 service connections. Water for the city is supplied through two public wells. All of these wells draw water from the unconfined Columbia aquifer.

Public Water Supply Well Data

Information about the construction and operation of these wells is summarized in Table 1. This information was gathered from various sources (DNREC, Delaware Geological Survey, Department of Health and Social Services), and a letter requesting confirmation from the system.

Table 1: Town of Blades Well Construction Data

Well #	Permit #	Allocation #	Year Constructed	Allocated Capacity (gpm)	Diameter (inches)	Screen Interval (fbgs*)	Aquifer
1	Ex. 9 Wells	89-0001	1978	150	8	66-96	Columbia
2		89-0001	1978	150	8	66-96	Columbia

* fbgs = feet below ground surface

Geology and Hydrogeology

The Town of Blades withdraws water from two wells in the Columbia aquifer. In the vicinity of Blades, the Columbia aquifer consists of the Beaverdam Formation with a hydraulic connection to the Manokin aquifer at depth. The Beaverdam Formation ranges from white to brown, fine to coarse sand, with coarse gravel and even large cobbles in some areas (DNREC, 2000). The upper unit (Unit B) of the Manokin Formation is in connection with the Beaverdam Formation in this area. This unit is a gray to red-orange medium to coarse sand with interspersed gravelly sand. These two formations make for an unconfined, or water-table, aquifer thickness of close to 150 feet capable of producing very substantial volumes of water (Andres and Ramsey, 1996).

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Source Water Protection Area Delineation

The State of Delaware's Source Water Assessment Plan describes the methods to be used for the delineation of the areas that contribute water to public drinking water supplies. The Town of Blades uses ground water pumped from two public supply wells as its source of drinking water. Wellhead protection areas have therefore, been mapped for each of the City's wells.

Based upon the geologic and hydrologic setting of the Blades area, both wells have been determined, through review of well logs and well construction information, to be screened in the unconfined aquifer. Using this information and the methodology described in section 3.5 of the Delaware SWAP, the source water areas for these wells were delineated using EPA's WhAEM ground-water modeling software (see Table 2a). In order to have this model produce reasonable and accurate results the characteristics of both the wells and the geology must be determined and input into the model. A review of the well construction data provided the needed information for the wells, and a literature review provided the needed data to represent the various hydrogeologic factors. Table 2b below summarizes these data with references where appropriate. Using these data, the well locations, and same regional hydrology, it should be possible to recreate the model output using the same model (WhAEM 2000 v2.03).

Because of the differences between the complexity of the real-world and the simplifications necessary for the model, a brief discussion of the methodology for the source water area delineation is appropriate. This particular model uses the regional stream flow to generate a representative water table surface. From this, the model then "pumps" the wells and calculates the changes to this surface caused by the water being withdrawn from the wells. During this time the model tracks "particles" over the duration of the model run to detail how water flows into the wells over that time period. Because of the lack of site-specific real world data across the entire modeled area assumptions have to be made and the results scrutinized. Some of the key assumption that were made are as follows:

- Although the hydrogeology varies with depth and distance, the exact details of the subsurface are not know. Therefore the model parameters that represent these features need to be varied (multiple model runs then make a composite of the results);
- This is a Steady State Model, meaning that the wells must be pumping continuously over the model duration (yields a conservative, larger, wellhead area)
- The specifics of the interactions between the aquifer and the smaller streams are not well known. Therefore it is assumed that these streams are not significant sources of water to the aquifer (wellhead areas can extend across smaller streams)
- More discussion on specific model assumptions can be found in the EPA model documentation (USEPA, 2000)

Based upon this methodology, the resulting delineated Source Water Areas are conservative and may be larger than the true capture zones for each well; however without more data and more complex modeling requirements this method results in

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Source Water Protection Areas that more reliably protect the water supply. As more data and more time become available, it may be possible to further refine the areas and more closely simulate real-world conditions.

The area delineated by this process is shown on Map 2 Delineation Map for Blades Water. The two wells are located so close to each other their individual wellhead areas were indistinguishable in the model output. Therefore, a single source water protection area, covering 83, acres was mapped for the combined wellfield.

Table 2a: Aquifer type and Delineation Method

Well #	DNREC Permit#	Aquifer	Aquifer Type	Delineation Method
1	Ex. 9 Wells	Columbia	Unconfined	WhAEM 2000 v2.03
2		Columbia	Unconfined	WhAEM 2000 v2.03

Table 2b: Model Parameters and Settings (WhAEM)

Well Parameters				
Well	Pumping rate (ft^3 / day)	Radius (feet)	# Particles	Release Depth (elevation)
1	28,875	0.66	15	-66
2	28,875	0.66	15	-66

Model Settings			
Property	Value	Units	Reference
Duration	5	years	DNREC, 1999
Recharge	14	inches/yr	Johnston, 1976; Denver, 1986
Porosity	23 - 30	percent	Standard Range Inferred from Andres and Ramsey, 1996
Hydraulic Conductivity	75 – 125	feet/day	Andres, 1994; Denver, 1986; Johnston, 1976
Base of Aquifer	100	feet below sea level	Andres and Ramsey, 1996; Andres, 1994
Aquifer Thickness	125	feet	Andres and Ramsey, 1996; Andres, 1994

Vulnerability Determination

The vulnerability is the relative ease with which contaminants, if released into a source water area, could move and enter a public water supply well or surface water intake at concentrations of concern. Individual intakes or wells are ranked as having high, medium, or low vulnerability according to the process described in section 5.1 of the Delaware SWAP. The determination of this vulnerability is conducted through a series of questions about the type of intake (surface or ground water), hydrogeologic setting,

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and construction. Because all of the wells withdraw water from the shallow unconfined aquifer, their vulnerability determinations are all similar (see Figure 1).

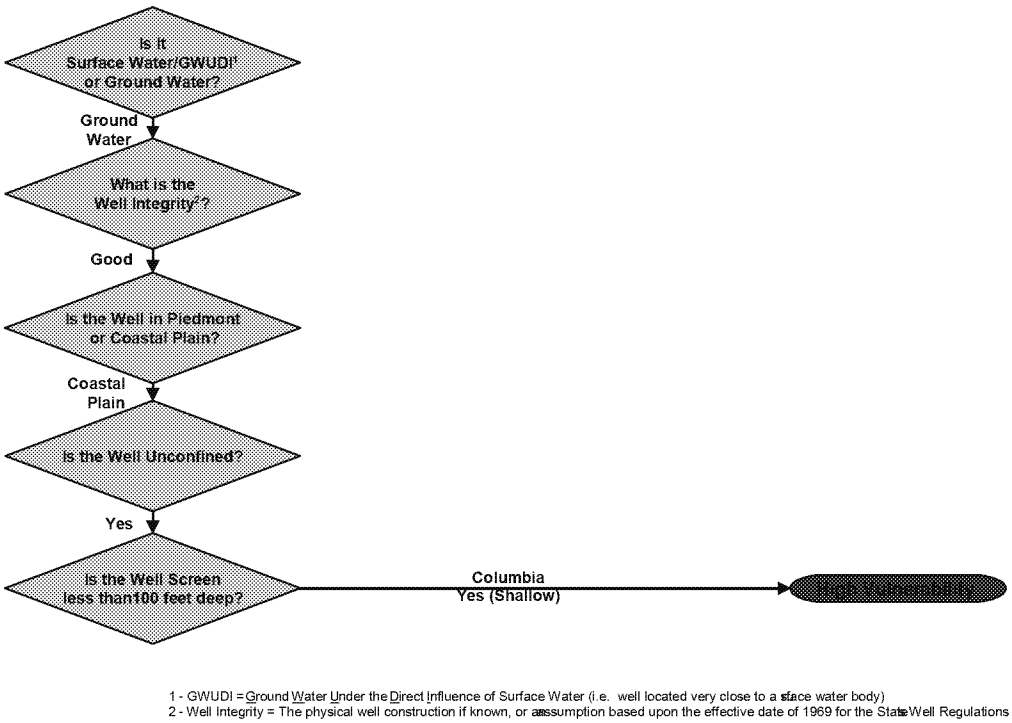

Figure 1: Vulnerability Determination process

All wells for the Town of Blades are located in the coastal plain and are screened less than 100 feet into the unconfined aquifer. According to the Delaware SWAP these wells are classified as having **High Vulnerability**.

Existing and Potential Sources of Contamination

There are a multitude of potential contaminant sources that, if present, could degrade drinking water quality. Most of these sources are anthropogenic, however, natural "contaminants" such as salt water or iron deposits can also impact water supplies. Most human impacts occur at or just below the ground surface and therefore are much more of a concern for shallow water supplies that lack a protective confining layer.

Discrete Sources

Discrete sources are defined as existing or potential sources of pollution to surface or ground water supplies at well defined, usually manufactured "points" or locations. The Source Water Program has divided the discrete sources into the following categories:

Underground Storage Tanks
Landfills / Dumps
National Pollutant Discharge Elimination Sys.
Tire Piles
Hazardous Waste Generators
Toxic Release Inventory
Salvage Yards
Pesticide Loading, Mixing, & Storage Facility
State and Federal Superfund Sites
Large On-Site Septic
Wastewater Spray Irrigation
Waste Sludge Application
Animal Feedlot Operations
Combined Sewer Overflows
Dredge Spoils
Golf Courses
Domestic Septic Systems

These discrete sources can contaminate source waters depending upon their location, the severity of a release, and other factors. For example, golf courses may contribute both pesticides and nutrients to the surface and ground waters by means of surface application for landscaping purposes, whereas tire piles generally do not pose a threat to the waters of the state unless they begin to burn.

There are seven discrete sources within Blades' wellhead protection area. The majority of these sites pose little or no threat to the drinking water sources. However, a few of these sites have elevated contaminant potentials.

Blades Wellfield (Well 1 – Ex. 9 Wells and Well 2 - Ex. 9 Wells

Procino Plating Inc. (MAP ID: HW7481 and HW7480)

This is a hazardous waste generating facility. This site has a **medium** contaminant potential for metals and other inorganic compounds. A medium contaminant potential signifies that these substances are present in significant quantities on site with no or little monitoring data. This site also has a **low** contaminant potential for other organic compounds. A low contaminant potential signifies that these substances are present in significant quantities on site, however, monitoring data indicates no or minimal releases.

Blades Kindergarten (MAP ID: UT5710)

This is an underground storage tank facility. This site has a **low** contaminant potential for petroleum hydrocarbons. A low contaminant potential signifies that these substances are present in significant quantities on site, however, monitoring data indicates no or minimal releases.

Anchor Enterprises (MAP ID: HW7539)

This is a hazardous waste generating facility. This site has a **low** contaminant potential for other organic compounds, and other inorganic compounds. A low contaminant potential signifies that these substances are present in significant quantities on site, however, monitoring data indicates no or minimal releases.

Wyoming Concrete Industries (MAP ID: UT5191)

This is an underground storage tank facility. This site has a **negligible** contaminant potential for all contaminant categories. A negligible rating signifies that contaminants are not present in sufficient quantities to cause concern.

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Continental Baking Co (MAP ID: UT5235)

This is an underground storage tank facility. This site has a **negligible** contaminant potential for all contaminant categories. A negligible rating signifies that contaminants are not present in sufficient quantities to cause concern.

Peninsula Plating (MAP ID: SF6833)

This is a State superfund site. This site has a **negligible** contaminant potential for all contaminant categories. A negligible rating signifies that contaminants are not present in sufficient quantities to cause concern.

Additional information for these contaminant sources can be found on the state web site (www.dnrec.state.de.us) using the Environmental Navigator. The inventory contains categorized data for multiple forms of media (surface water, ground water, etc). A list of discrete sources found for the Town of Blades' WHPA is available in Appendix B Table 5.

Land Use / Land Cover

Anthropogenic activities associated with various land uses have the potential to contribute to ground-water quality problems, particularly when examining potential "non-point" source contamination. There is, however, some overlap between discrete sources of contamination and some land use categories. For instance, individual domestic septic systems may be considered discrete sources, however, the regional impact of a number of systems in a large development might also be considered as "non-point".

Map 4 shows the land use within the delineated areas. The table on Map 4 summarizes the system-wide land use that is the percent of the entire system's source water area overlain by that particular land use. This is different from the well specific data shown in Appendix B Table 6, which shows the land use over each of the individual wellhead areas. Based upon the SWAP, the contaminant potential could be adjusted depending on the percentage of land use within the WHPA, with land uses occupying the greatest portion of the wellhead areas having a more significant potential impact.

Using the most recent GIS information, over 71 percent of the total wellhead protection area for Blades contains combined urban land uses. The next largest land use is commercial areas, covering approximately just under 14 percent of the total land use area.

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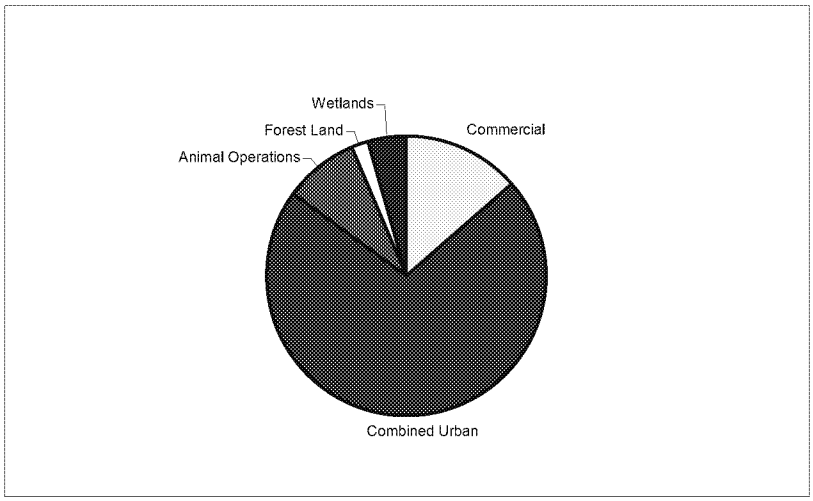

Figure 2: System-Wide Land Use

Roads and Railroads

Roads and railroads represent potential conduits for the entry of contaminants into soils and ground water. The possibility exists that an accident, such as a spill, could impact water quality. Furthermore, certain upkeep and maintenance practices such as road salting, or pesticides applications could also introduce contaminants along these transportation pathways. Table 3 summarizes the lengths and types of conduits that run through the various wellhead areas. These are the highlighted roads and railroads shown on Map 3 Discrete Sources Map for Blades Water and Map 4 Land Use Map for Blades Water. Smaller (tertiary), or private roads are not included in the assessment because of the lack of consistent data across the State.

Table 3: Roads and Railways found within WHPA

Wellfield	Conduit	Mileage	Type
Blades	Road	1.20	Primary
	Road	0.79	Secondary
	Rail	0.80	Main

Water Quality Data

This portion of the source water assessment evaluates the water quality of raw water *before* it enters into any treatment process (i.e. filtration, disinfection, fluoridation, softening, etc.) and/or the distribution system. However, it should be noted that many water supply systems utilize certain treatment methods that remove contaminants or impurities from the drinking water before it is delivered to the public.

The Delaware SWAP classifies contaminants into eight (8) categories. Examples of contaminants within each of the eight categories are as follows:

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Other Inorganics:	Fluoride, Chloride, pH, Sulfate, Radon, Radium, Strontium,
Metals:	Copper, Arsenic, Iron, Manganese
Nutrients:	Nitrate, Nitrite
Other Organics:	Vinyl Chloride, PCE, TCE
Pathogens:	Coliform Bacteria, Cryptosporidium, Giardia lambia
Pesticides:	Alachlor, Atrazine, Glyphosphate
Petroleum Hydrocarbons:	Gasoline, Heating Oil, Benzene, Toluene
Polychlorinated Biphenyls:	PCB

The Source Water Assessment and Protection Program has reviewed the available analytical data for this system for the previous five years (1996-2001). While this report may show that a drinking water standard was exceeded for a particular contaminant at one instance, the Department of Health and Social Services, Division of Public Health, Office of Drinking Water, which regulates drinking water quality, may not consider it a violation based upon more detailed procedures detailed within their regulations. In the event that a contaminant, which is not naturally found in the source water, has been detected as a result of maintenance to the water distribution system, its results will be noted and explained within the text. These results may not be considered when determining the final susceptibility for a well and/or public water system.

Naturally Occurring Contaminants

There are several naturally occurring potential contaminants that will be identified as part of the assessments of public water supplies. These include iron, chloride, sodium, radon, radium, manganese, sulfate and others. These will be identified as part of the susceptibility determination for each well and listed as being naturally occurring if detected.

Analytical Data

Data from the Department of Health and Social Services' Division of Public Health's Office of Drinking Water's (DPH-ODW) analytical database was reviewed for raw/untreated water quality data for the past five years. If any naturally occurring compound was detected above 50% of the drinking water standard or any synthetic compound was detected, then all data for that compound was recorded. These results, grouped by contaminant category, are provided in Appendix C. For more information regarding water quality and drinking water standards please contact the Division of Public Health, Office of Drinking Water at (302) 739-5410.

Data obtained through the Division of Public Health, Office of Drinking Water database, showed that of the few raw water samples available, only one sample in one well had a regulated compound detected above drinking water standards.

Iron was detected at 0.67 mg/L in the Dulaney Street Well. The drinking water standard for this naturally occurring compound is 0.30 mg/L

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Although pH has a drinking water standard, it is not used as a primary factor in determining the susceptibility to other inorganic compounds. This is because the major effects of high/low pH are mainly related to plumbing issues in the water system. These may take the form of deposits on the inside of pipes or leaching of lead and copper from older water service lines.

Water Treatment Methods

According to the DPH-ODW and the Town of Blades this system utilizes the following treatment processes.

The two raw water wells are treated with sodium Hypochlorite, for disinfection, at the entrance point to the pump house. The next treatment that is injected is potassium permanganate for the purpose of iron removal as well as to regenerate the green-sand filter, which is the next treatment for the water. The final treatment is the injection of sodium hydroxide (caustic soda 50%) for the purpose of pH control.

The town of Blades is currently in the process of constructing a new water treatment plant that will include the preceding treatment. The new plant will also include the introduction of fluoride as required by the state of Delaware. In addition, the plant will have two green-sand filters instead of one. The town expects the plant to be operational by August or September of 2002

For more information about the water treatment used by the Town of Blades please contact the Blades Water Department at (302) 629-7366.

Susceptibility Determination

The key part of a source water assessment is the determination of the likelihood that a particular public water supply system will capture contaminants at concentrations of concern. This analysis, termed susceptibility determination, combines the source water protection area delineation, the vulnerability determination for the wells, the contaminant source inventory, and the water quality information to yield a relative susceptibility for the public water system. Each individual water source is rated for each of the eight-contaminant categories on a scale ranging from no susceptibility to having been documented as having exceeded drinking-water standards.

Vulnerability

As stated in the Vulnerability Determination section, Blades' wells are all characterized as shallow unconfined wells, and as such have **high** vulnerability.

Contaminant Inventory

As detailed in the Existing and Potential Sources of Contamination section, discrete sources of contamination were found within the delineated wellhead protection area.

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Refer to Appendix B Table 5 and Map 3 Discrete Sources for Blades Water for more specific information.

Commercial and combined urban land uses have the greatest potential non-point influence in the WHPA Refer to Appendix B Table 6 and Map 4 Land Use Map for Blades Water for more specific information.

Water Quality

As reported in the Water Quality Data section iron concentrations in Well 1 (40024) exceeded the secondary drinking water standard. Refer to Appendix C for more specific information.

Individual Source Susceptibility

Both of Blades' public wells obtain their water from the shallow portion of the unconfined aquifer and are therefore all considered to have high vulnerabilities. However, each of the wells in Blades' public water supply system have unique properties, such as depth, location, date drilled, and pumping rate. These influence the delineated area, the vulnerability determination, and the contaminant inventory. Because the individual capture zones for each of the wells are not easily identified in the modeled output the susceptibility for this system will be based on the combined wellfield. A brief discussion for the wellfield follows and the results are further summarized in Appendix B Table 7: Well Specific Susceptibility.

Blades Wellfield (Well 1 – Ex. 9 Wells

This well has exceeded drinking water standards for metals because of elevated iron concentrations. The well has a high susceptibility to petroleum hydrocarbons, pesticides, other organic compounds, and other inorganic compounds, and a moderate susceptibility to nutrients, pathogens, and PCBs because of the predominance of urban and commercial land uses in the wellhead area.

Blades Wellfield (Well 2 – Ex. 9 Wells

This well has a high susceptibility to petroleum hydrocarbons, pesticides, other organic compounds, metals, and other inorganic compounds, and a moderate susceptibility to nutrients, pathogens, and PCBs because of the predominance of urban and commercial land uses in the wellhead area.

System Wide Susceptibility

The individual susceptibilities of each of this system's wells are detailed in the previous section. On a source-by-source basis these wells could have very different susceptibility ratings. When looked at as a group for the entire system some generalized, conservative statements can be made. For instance, if one assumes that the system is only as protected as it's weakest link, then the system-wide susceptibility to any given contaminant category is determined by the most susceptible water source. Using this methodology, a drinking water system with five wells that have a low susceptibility to metals, and one well that is highly susceptible to metals would be rated as having a high susceptibility to

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that contaminant category. In many instances this could mean that a particular land use overlying an unconfined well could drive the system-wide susceptibility higher. However, it is also possible that a confined-aquifer well that withdraws iron-rich water could dramatically raise this system's susceptibility rating for metals.

As stated, this system-wide susceptibility is a conservative rating that summarizes the most susceptible portions of any system. This susceptibility is the relative likelihood that a public water supply might draw water contaminated at concentrations of concern to public health. This Susceptibility Assessment is a summary of the vulnerability and contaminant potential to raw water supplies. The actual water quality delivered to the consumer is reported in the Consumer Confidence Reports and is not part of this assessment.

Overall, the Town of Blades' drinking water supply system has exceeded drinking water standard for metals, has a high susceptibility to petroleum hydrocarbons, pesticides, other organic compounds, metals, and other inorganic compounds, and a moderate susceptibility to nutrients, pathogens, and PCBs. The individual well contributions to the system-wide susceptibility are explained below with a further summary provided in Appendix B Table 8: Overall System Susceptibility.

Analytical data from raw water for Well 1 Ex. 9 Wells had one sample reporting iron at 0.67 mg/L just above the 0.30 mg/L secondary drinking water standard, most likely from a natural source. Other than that sample, the susceptibility assessments for both the wells are identical because of the shared wellfield. It is the predominance of combined urban and commercial land uses coupled with some hazardous waste generating facilities in the wellfield that determine the final susceptibility ratings.

Table 4: Overall Susceptibility Rating For Blades Water

Overall Susceptibility	Contaminant Class	Primary Cause for Susceptibility Rating
Exceeds Standards	Metals	Naturally occurring iron found in raw water above drinking water standard.
Very High		
High	Nutrients Pathogens Petroleum Hydrocarbons Pesticides PCBs Other Organics Other Inorganics	Combined Urban, Commercial, and Animal Operation land uses and Hazardous Waste Generators
Medium		
Low		
Very Low		
Not Susceptible		

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Appendix A: Maps

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Map 1: Base Map

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Please contact the Source Water Assessment and Protection Program at Phone: (302) 739-9945 or Fax: (302) 739-2296 to request more information regarding this map.

Map 2: Delineation Map

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Map 3: Discrete Source Map

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Map 4: Land Use Map

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Appendix B: Tables

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Table 5: Discrete Sources Within Wellhead Areas

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Table 5: Discrete Sources Within WHPA

Well	Site Type	Site Name	Site ID	Nutrients	Pathogens	Petroleum	Pesticides	PCBs	Organics	Metals	Inorganics	Site Comments
Blades	Underground Storage Tanks	Wyoming Concrete Industries	5000027	N	N	N	N	N	N	N	N	
	Underground Storage Tanks	Continental Baking Co	5000075	N	N	N	N	N	N	N	N	
	Underground Storage Tanks	BLADES KINDERGARTEN	5000620	N	N	L	N	N	N	N	N	
	Superfund Sites	PENINSULA PLATING	DE-287	N	N	N	N	N	N	N	N	
	Hazardous Waste Generators	Procino Plating Inc.	DED98236254	N	N	N	N	N	L	N	L	
	Hazardous Waste Generators	Procino Plating Inc.	DED982362543	N	N	N	N	N	N	M	M	
	Hazardous Waste Generators	Anchor Enterprises	DED98267964	N	N	N	N	N	L	N	L	
Summary				N	N	L	N	N	L	M	M	

H = High, M = Medium, L = Low, N = Negligible

Table 6: Land Use Within Wellhead Areas

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Table 6: Land Use Data

Wellfield	LULC	Area (acres)	Percent	Nutrients	Pathogens	Petroleum	Pesticides	PCBs	Organics	Metals	Inorganics	Site Comments
Blades	Combined Urban	59.1560	71.22	N	N	M	M	N	M	N	M	
	Forested	1.6445	1.98	N	N	N	L	N	N	N	N	
	Commercial	11.4009	13.73	L	N	L	L	L	L	L	L	
	Wetlands	3.7096	4.47	N	N	N	N	N	N	N	N	
	Animal Operations	7.1459	8.60	L	L	N	N	N	N	N	N	
Summary		83.06		L	L	M	M	L	M	L	M	

H = High, M = Medium, L = Low, N = Negligible

Table 7: Well Specific Susceptibility

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Table 7: Well Specific Susceptibility

	Nutrients	Pathogens	Petroleum Hydrocarbons	Pesticides	PCBs	Other Organics	Metals	Other Inorganics
Blades Wellfield (Well 1 - Ex. 9 Wells			**Vulnerability: HIGH**					
Contaminant Potential Summary								
From Discrete Sources	Negligible	Negligible	Low	Negligible	Negligible	Low	Medium	Medium
From Land Use	Low	Low	Medium	Medium	Low	Medium	Low	Medium
Highest Potential	Low	Low	Medium	Medium	Low	Medium	Medium	Medium
Susceptibility								
Based Only on Vulnerability	Moderate	Moderate	High	High	Moderate	High	High	High
Adjusted Due to Analytical Data							Exceeds	
Final Susceptibility Determination	**Moderate**	**Moderate**	**High**	**High**	**Moderate**	**High**	**Exceeds Standards**	**High**

Blades Wellfield (Well 2 - Ex. 9 Wells			**Vulnerability: HIGH**					
Contaminant Potential Summary								
From Discrete Sources	Negligible	Negligible	Low	Negligible	Negligible	Low	Medium	Medium
From Land Use	Low	Low	Medium	Medium	Low	Medium	Low	Medium
Highest Potential	Low	Low	Medium	Medium	Low	Medium	Medium	Medium
Susceptibility								
Based Only on Vulnerability	Moderate	Moderate	High	High	Moderate	High	High	High
Adjusted Due to Analytical Data								
Final Susceptibility Determination	**Moderate**	**Moderate**	**High**	**High**	**Moderate**	**High**	**High**	**High**

Table 8: Overall System Susceptibility

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Table 8: Overall System Susceptibility

	Nutrients	Pathogens	Petroleum Hydrocarbons	Pesticides	PCBs	Other Organics	Metals	Other Inorganics
Blades Wellfield (Well 1 - Ex. 9 Wells	Moderate	Moderate	High	High	Moderate	High	Exceeds Standards	High
Blades Wellfield (Well 2 - Ex. 9 Wells	Moderate	Moderate	High	High	Moderate	High	High	High
Overall	**Moderate**	**Moderate**	**High**	**High**	**Moderate**	**High**	**Exceeds Standards**	**High**

Appendix C: Analytical Data

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Appendix D: Data Sources

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Data Sources Used in Source Water Assessments			
Data Type	**Organization**	**Section**	**Phone Number**
Public Water Supply Well Data	Department of Natural Resources and Environmental Control	Water Supply Section	(302) 739-4793
Public Water Supply Well Data	Delaware Geological Survey		(302) 831-2833
Water Quality Data	Department of Health and Social Services	Division of Public Health Office of Drinking Water	(302) 739-5410
Land Use / Land Cover GIS Coverage	Delaware Office of State Planning Coordination		(302) 739-3090
Animal Feedlot Operations	County Conservation Districts		Kent: (302) 697-2600 New Castle: (302) 832-3100 Sussex: (302) 856-3990
Combined Sewer Overflows (CSOs)	Department of Natural Resources and Environmental Control	Surface Water Discharges Section	(302) 739-5731
Dredge Spoil Disposal Areas	Department of Natural Resources and Environmental Control	Soil and Water Conservation	(302) 739-4411
Hazardous Waste Generator Sites	Department of Natural Resources and Environmental Control	Solid and Hazardous Waste Management Branch	(302) 739-3689
Landfills and Dumps	Department of Natural Resources and Environmental Control	Solid and Hazardous Waste Management Branch	(302) 739-3689
Large On-site Septic Systems	Department of Natural Resources and Environmental Control	Ground Water Discharges Section	(302) 739-4762
NPDES Wastewater Outfalls	Department of Natural Resources and Environmental Control	Surface Water Discharges Section	(302) 739-5731
Pesticide Loading, Mixing, and Storage Facilities	Delaware Department of Agriculture	Pesticide Management Section	(302) 739-4811
Salvage Yards	Department of Natural Resources and Environmental Control	Solid and Hazardous Waste Management Branch	(302) 739-3689
Site Investigation and Restoration Branch (SIRB) [Superfund] Sites	Department of Natural Resources and Environmental Control	Site Investigation and Restoration Branch	(302) 395-2600
Sludge Application Sites	Department of Natural Resources and Environmental Control	Surface Water Discharges Section	(302) 739-5731
Spray Irrigation Sites	Department of Natural Resources and Environmental Control	Ground Water Discharges Section	(302) 739-4762
Tire Piles	Department of Natural Resources and Environmental Control	Solid and Hazardous Waste Management Branch	(302) 739-3820
Toxic Release Inventory Sites	Department of Natural Resources and Environmental Control	Air Quality Management Section	(302) 739-4791
Underground Storage Tanks	Department of Natural Resources and Environmental Control	Underground Storage Tank Branch	(302) 395-2500

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