Appendix H Ground Water Susceptibility Analysis

Appendix H: Ground Water System Source Water Assessment Example
Medium Town, Delaware

The following is an example of how Delaware's assessment methodology would work to determine the susceptibility to contamination of a ground-water system. The example uses an actual system in an area where the contaminant inventory has already been completed. Some of the information has been changed to make the example generic.

Delineation

Step 1 (Information Gathering): Research and compile all of the information needed to characterize fully the well and wellfield. This information includes well specifics such as pumping rate, screen depth, diameter, the exact latitude and longitude of the well(s), and the aquifer from which the well withdraws water. Additional information about the local hydrology, geology (e.g. geologic logs, pump test data) and other water withdrawls in the area are also needed. This information is used to first determine if the well pumps more than 50,000 gallons per day (GPD), or if it is screened in a confined aquifer.

> In this particular example the two wells are both screened on the unconfined aquifer, both pump more than 50,000 GPD, and the wells are located close enough to each other that they must be modeled together (Table H-1).

Step 2 (Modeling): Use the appropriate delineation method to determine the wellhead protection area to be used for the rest of the susceptibility assessment.

> Because these are unconfined wells pumping over 50,000 GPD the assessment plan requires that a hydrogeologic model be used to delineate the wellhead protection area. Because of the relative simplicity of the geology in the area surrounding these wells, the EPA's WHPA code version 2.2 was used to define the 5-year time-of-travel wellhead area shown in figure H-1.

Contaminant Inventory

Step 3 (Discrete Sources): Use the DNREC GIS to overlay the modeled wellhead protection area with the DNREC discrete sources inventory to compile a list of all known or potential contaminant sources in the wellhead protection area. Because of the information contained in contaminant inventory's Site Index Database the list also provides site-specific contaminant potential for each discrete source.

> Figure H-2 shows the discrete sources in the Medium Town wellhead protection area. Table H-2 provides the contaminant potential summary for these possible sources

Step 4 (Non-Point Sources): Use the DNREC GIS to overlay the modeled wellhead protection area on the most recent land use coverage (currently 1997) to get the acreage of specific land uses in the wellhead protection area. This enables a non-point source contaminant potential determination based upon land use types and acreage.

> Figure H-3 shows the land use in the Medium Town wellhead protection area. Table H-3 provides the contaminant potential summary for these land use areas

Vulnerability Determination

Step 5: Use the well specific information gather in Step 1 and apply it to the vulnerability determination flow chart shown in figure 5.1.

> For these wells the resulting solution(s) in figure H-4 shows that both wells have a medium vulnerability.

Susceptibility Determination

Step 6: Determine the susceptibility of a well or wellfield to contamination by applying all of the above-gathered information to the Susceptibility Determination Matrix shown in figure H-5. The vulnerability is

input on the left side and the contaminant potential is input across the top. Cross-referencing the two gives the susceptibility rating for that particular contaminant category. This is done for each well (or wellfield when the individual wellhead areas overlap) for each of the contaminant categories.

> The Medium Town wells were determined to have a Medium vulnerability (Middle box on left side *Deep Unconfined*). Then nutrient contaminant potential was evaluated as medium (Third box from left on the top). By cross-referencing these values, the susceptibility of the Medium Town wells to nutrient contamination is shown to rate a 4 (moderately susceptible) on a scale from 1 to 7.

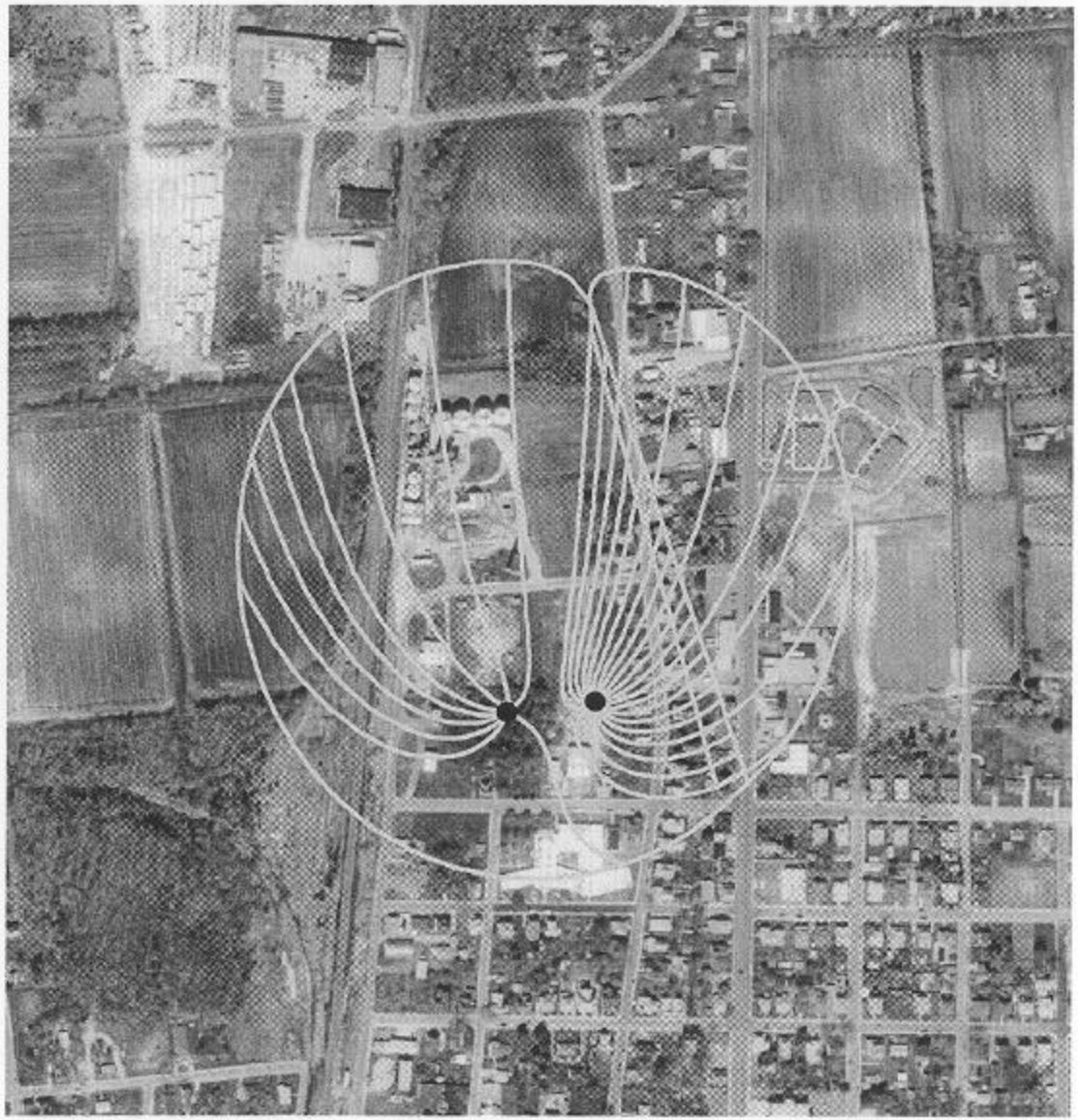
This process will be repeated for all eight contaminant categories for every well/wellfield in the Public Water Supply system.

> For Medium Town there are only two wells in the system and both were modeled together for this assessment. Therefore, once the susceptibility to the other classes of contaminants is determined the susceptibility assessment is complete and a report can be generated for Medium Town and its water consumers.

Medium Town Example - Well Characteristics

MEDIUM TOWN (Wells # 2A & 3A) Well Characteristics		
FACILITY NAME	Medium Town Water	Medium Town Water
DNREC ID	47006	64384
SOURCE TYPE	well	well
LOCAL ID	2A	3A
LONGITUDE	75 34 35.111629585	75 34 36.202656255
LATITUDE	38 27 38.107551175	38 27 39.157564694
COUNTY	S	S
PWS TYPE	C	C
PWS ID	DE0000567	DE0000567
ALLOCATION NUMBER	89-0006B	89-0006A
DATE DRILLED	10/17/80	04/07/86
CAPACITY	1100	750
DIAMETER	unknown	10
AQUIFER	bd	bd
MODGRID	1020048	1020048
BASIN	307	307
SCREEN INTERVAL	155-205	116-146
WATER TREATMENT	unknown	unknown
DGS_ID	None	Rd31-15
OWNER	Town of Medium	Town of Medium
USGS QUAD	Medium	Medium
WELLHEAD STATUS	Preliminary WHPA Done	Preliminary WHPA Done
AQUIFER TYPE	unconfined	unconfined
DELINEATION METHOD	MWC	MWC
CONTAMINANT INVENTORY	Complete	Complete

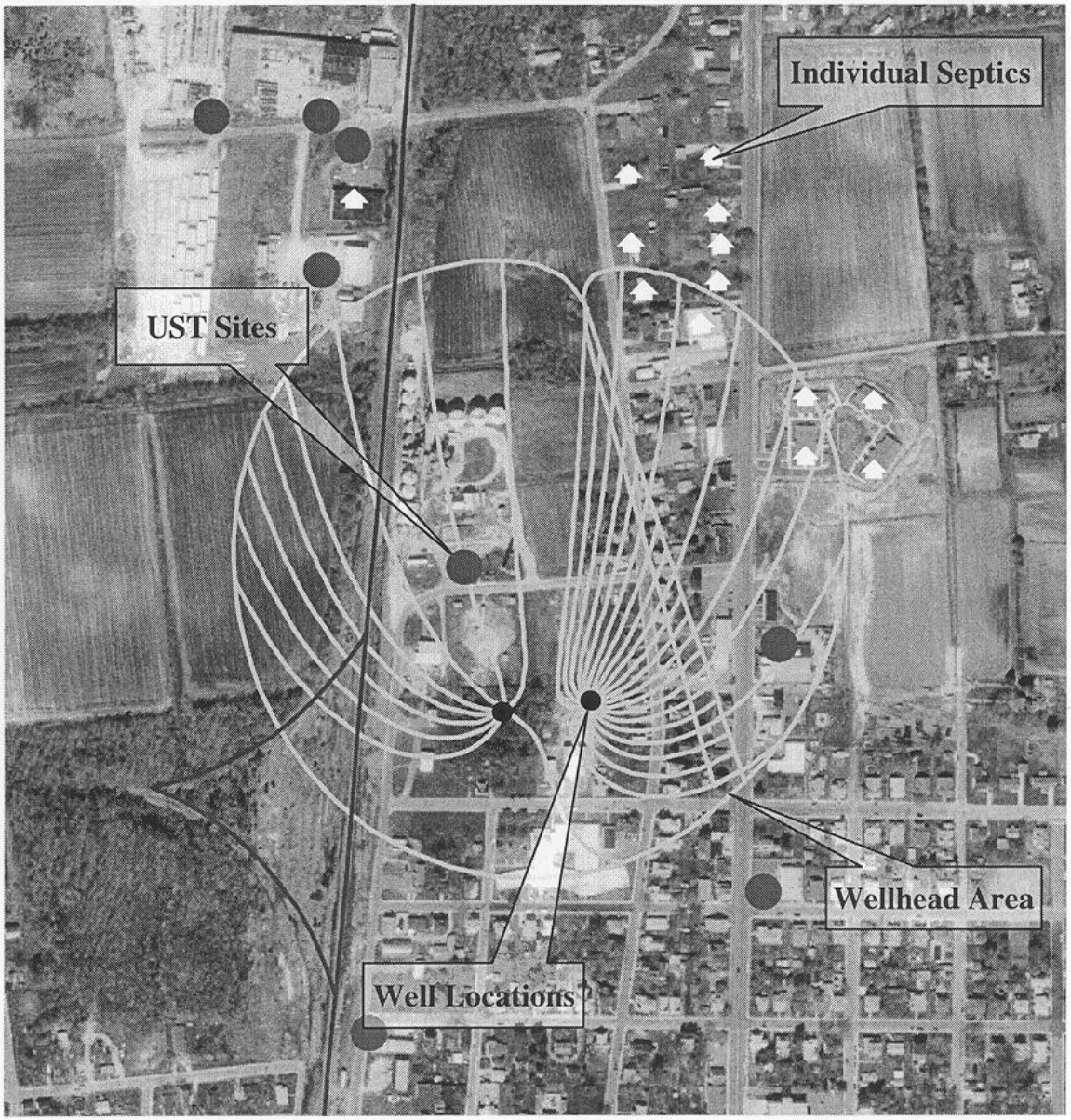
Medium Town Example - Delineated Wellhead Area



Discrete Sources List

- SIRB / CERCLA
- UST / LUST
- Landfills / Dumps
- NPDES
- Tire Piles
- Hazardous Waste Generators
- TRI
- Salvage Yards
- Pesticides L,M, & S
- Large On-Site Septic
- Waste Water Spray Irrigation
- Waste Sludge Application
- CAFOs
- Combined Sewer Overflows
- Dredge Spoils
- Domestic Septic
- Golf Courses

Medium Town Example - Discrete Source Inventory



Contaminant Classes

- Nutrients (Nitrates)
- Pathogens (Coliform, Giardia, Cryptosporidium)
- Petroleum Hydrocarbons (Benzene, Toluene, etc.)
- Pesticides (including Herbicides, Fungicides, etc.)
- PCBs (Poly-Chlorinated Biphenyls)
- Other Organics (Solvents like TCE & PCE etc.)
- Metals (Lead, Arsenic, Mercury, etc.)
- Other Inorganics (Chloride, Sulfates, etc.)

Medium Town Example - Discrete Source Inventory

MEDIUM TOWN (Wells # 2A & 3A) CONTAMINANT POTENTIAL

DISCRETE SOURCES

SITE NAME	SITE TYPE	STATUS	NUTRIENTS		PATHOGENS		PETROLEUM HYDROCARBONS		PESTICIDES		SITE COMMENTS
			GW	COMMENTS	GW	COMMENTS	GW	COMMENTS	GW	COMMENTS	
MEDIUM TOWN WATER TREATMENT FACILITY	Underground Storage Tanks	INACTIVE	N		N		L		N		GWID: 0 FacDesc: Local Government Rel:
JGRC INC	Underground Storage Tanks	INACTIVE	N		N		L		N		GWID: 1 FacDesc: Commercial Rel: GASOLINE
DOMESTIC SEPTIC	Residential	0.1 / Acre	L*		M		N		N		5 Residences

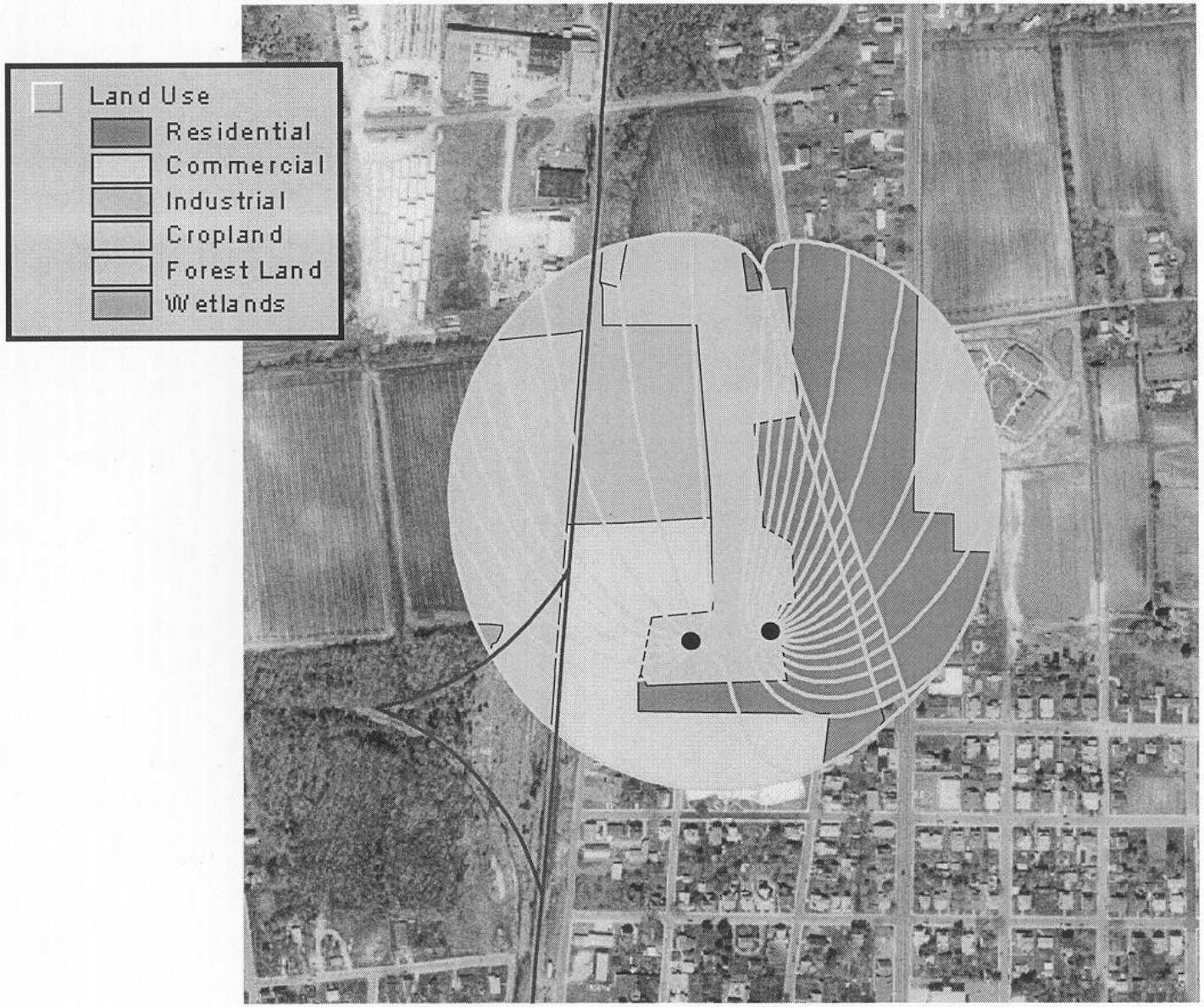
DISCRETE SOURCES (continued)

SITE NAME	SITE TYPE	STATUS	PCBs		OTHER ORGANICS		METALS		OTHER		SITE COMMENTS
			GW	COMMENTS	GW	COMMENTS	GW	COMMENTS	GW	COMMENTS	
MEDIUM TOWN WATER TREATMENT FACILITY	Underground Storage Tanks	ACTIVE	N		N		N		N		GWID: 0 FacDesc: Local Government Rel:
JGRC INC	Underground Storage Tanks	INACT	N		N		N		N		GWID: 1 FacDesc: Commercial Rel: GASOLINE
DOMESTIC SEPTIC	Residential	0.1 / Acre	N		N		N		M		5 Residences

Land Use Categories

- Residential
- Commercial
  - Vehicle Operations
  - Junk/Salvage Yards
- Industrial
- Transportation
  - Highways/Parking Lots
  - Railroads
  - Airports
- Utilities
- Combined Urban
- Recreation
- Cropland
- CAFOs
- Farmsteads
- Rangeland/Pasture
- Forest Land
  - Clear-cut Forest
- Wetlands
- Barren/Open
- Extraction

Figure H-3 Medium Town Example - Land Use Land Cover



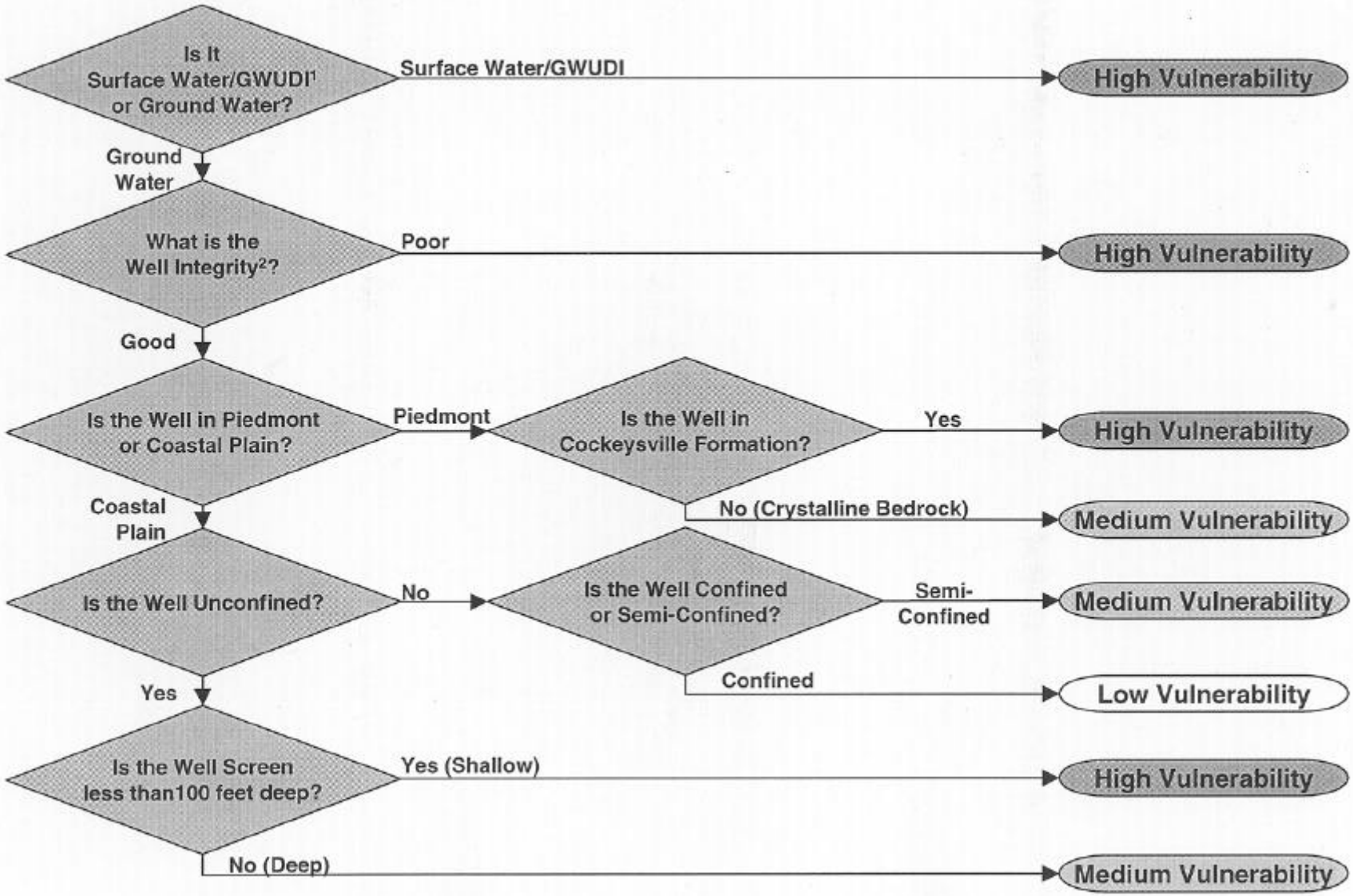
Medium Town Example - Land Use Land Cover

MEDIUM TOWN (Wells # 2A & 3A) LAND USE CONTAMINANT POTENTIAL

LAND USE DATA			NUTRIENTS	PATHOGENS	PETROLEUM HYDROCARBONS	PESTICIDES	SITE COMMENTS
LULC	AREA (acres)	Percent					
CROPLAND	19.8	39.2	M*	N	N	M	* 20% - 50 % of Wellhead Area
RESIDENTIAL	15.9	31.6	L*	L*	N	N	*See Discrete Sources
COMMERCIAL	8.2	16.2	L	N	L*	L	*See Discrete Sources
INDUSTRIAL	6.3	12.5	N	N	H**	N	**Probable "Non-Haz Industry"
FOREST	0.2	0.3	N	N	N	N	
WETLANDS	0.1	0.2	N	N	N	N	
Total Area	50	100					

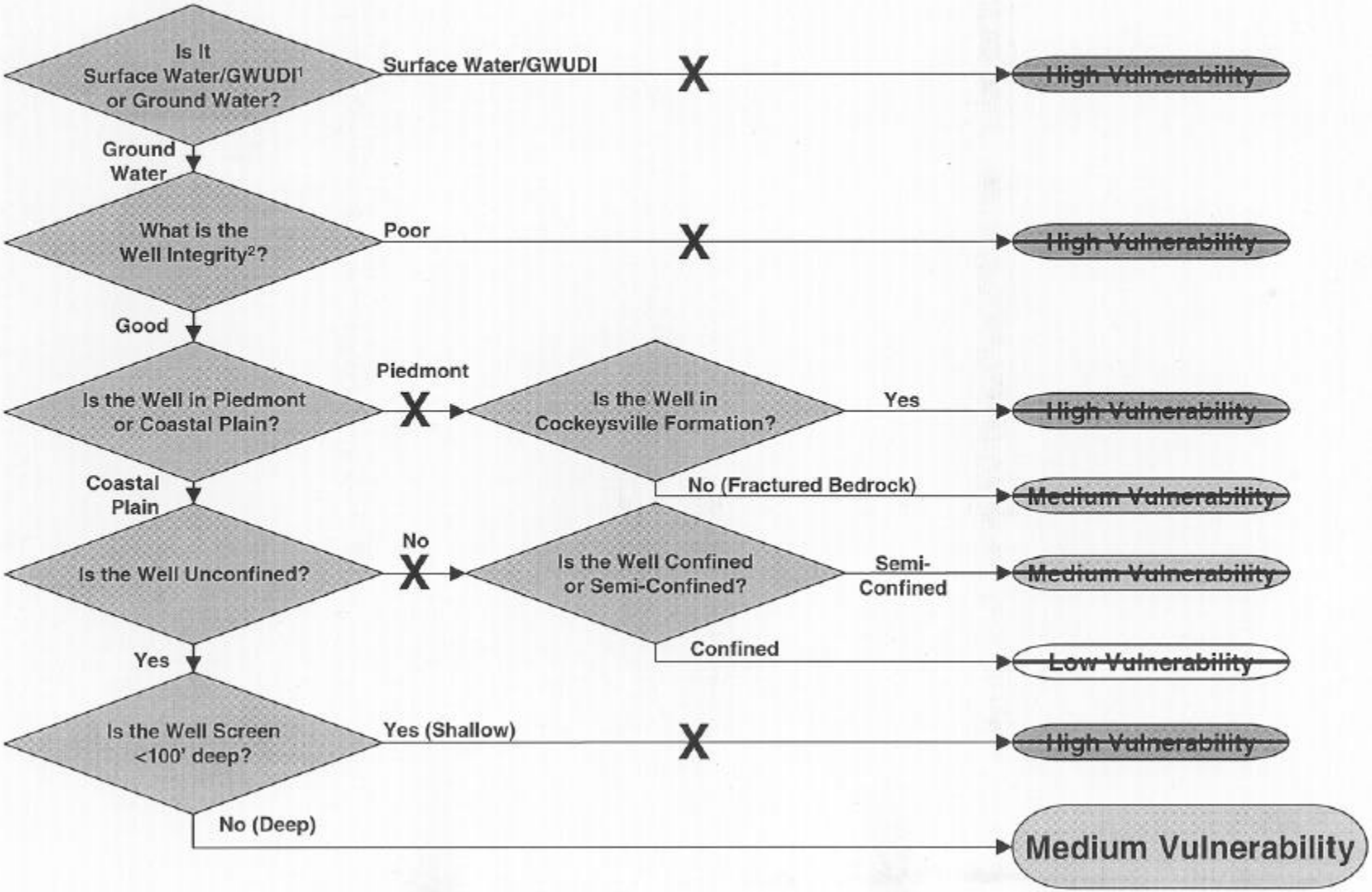
LAND USE DATA			PCBs	OTHER ORGANICS	METALS	OTHER INORGANICS	SITE COMMENTS
LULC	AREA (acres)	Percent					
CROPLAND	19.8	39.2	N	N	N	L	
RESIDENTIAL	15.9	31.6	N	L	N	N	
COMMERCIAL	8.2	16.2	N	M*	L	L	*See Discrete Sources
INDUSTRIAL	6.3	12.5	L	H**	M**	M**	**Probable "Non-Haz Industry"
FOREST	0.2	0.3	N	N	N	N	
WETLANDS	0.1	0.2	N	N	N	N	
Total Area	50	100					

Vulnerability Determination Process



1 - GWUDI = Ground Water Under the Direct Influence of Surface Water (i.e. well located very close to a surface water body)
2 - Well Integrity = The physical well construction if known, or an assumption based upon the effective date of 1969 for the State's Well Regulations

Medium Town Example - Vulnerability Determination

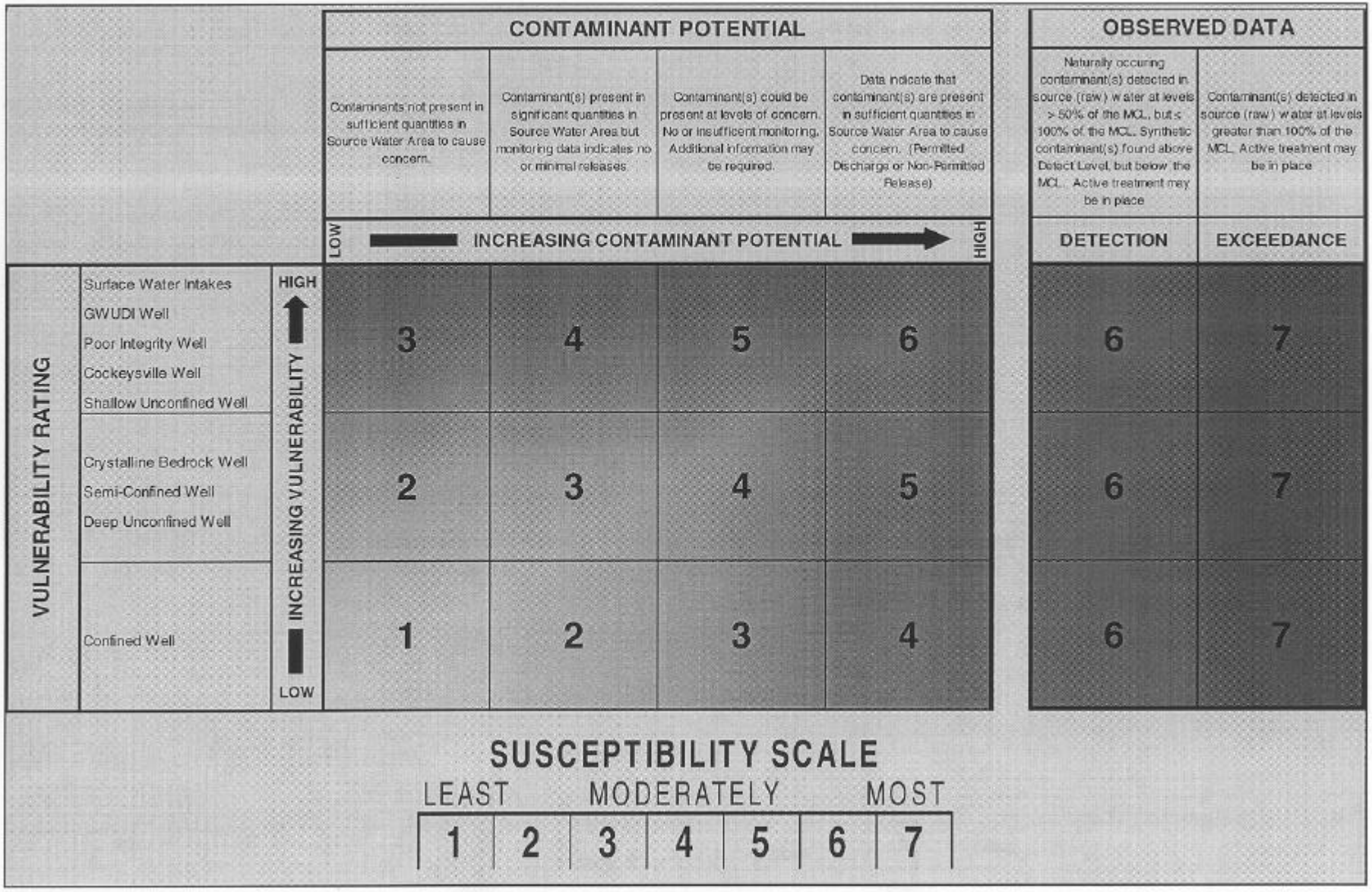


Existing Water Quality Data

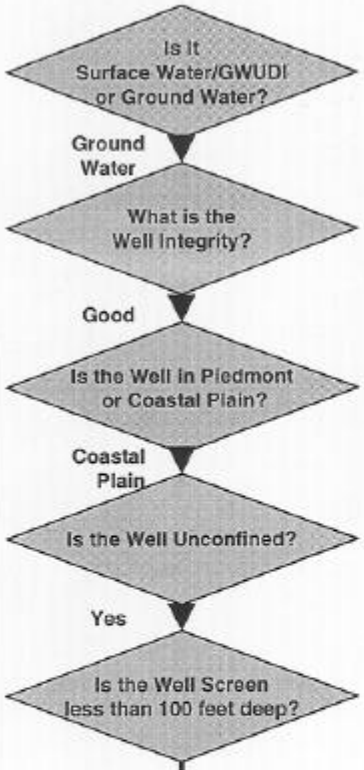
- Historical Information from:
  - Division of Public Health's Office of Drinking Water
- Medium Town Example

– Nutrients (Nitrate)	4.3 mg/l and 4.8 mg/l
– Pathogens	Not Detected
– Petroleum Hydrocarbons	Not Detected
– Pesticides	Not Detected
– PCBs	Not Detected
– Other Organics	Not Detected
– Metals (Iron)	0.08 mg/l and 0.10 mg/l
– Other Inorganics	Not Detected

Source Water Susceptibility Determination Matrix



Nutrient Susceptibility Example



MEDIUM TOWN (Wells # 2A & 3A) CONTAMINANT POTENTIAL

DISCRETE SOURCES

SITE NAME	SITE TYPE	STATUS	NUTRIENTS		SITE COMMENTS
			GW	COMMENTS	
MEDIUM TOWN WATER TREATMENT FACILITY	Underground Storage Tanks	INACTIVE	N		GWID: 0 FacDesc: Local Government Rel:
JGRC INC	Underground Storage Tanks	INACTIVE	N		GWID: 1 FacDesc: Commercial Rel: GASOLINE
DOMESTIC SEPTIC	Residential	0.1 / Acre	L*		5 Residences

LAND USE DATA

LULC	AREA (acres)	Percent		
CROPLAND	19.8	39.2	M*	* 20% - 50% of Wellhead Area
RESIDENTIAL	15.9	31.6	L*	*See Discrete Sources
COMMERCIAL	8.2	16.2	L	
INDUSTRIAL	6.3	12.5	N	
FOREST	0.2	0.3	N	
WETLANDS	0.1	0.2	N	
Total Area	50	100		
SUMMARY			MEDIUM	

VULNERABILITY RATING		INCREASING VULNERABILITY	CONTAMINANT POTENTIAL: Contaminants not present in sufficient quantities in Source Water Area to cause concern	CONTAMINANT POTENTIAL: Contaminant(s) present in significant quantities in Source Water Area but monitoring data indicates no or minimal releases	CONTAMINANT POTENTIAL: Contaminant(s) could be present at levels of concern. No or insufficient monitoring. Additional information may be required.	CONTAMINANT POTENTIAL: Data indicate that contaminant(s) are present in sufficient quantities in Source Water Area to cause concern. (Permitted Discharge or Non-Permitted Release)	OBSERVED DATA: Naturally occurring contaminant(s) detected in source (raw) water at levels > 50% of the MCL, but ≤ 100% of the MCL. Synthetic contaminant(s) found above Detect Level, but below the MCL. Active treatment may be in place	OBSERVED DATA: Contaminant(s) detected in source (raw) water at levels greater than 100% of the MCL. Active treatment may be in place
			LOW ← INCREASING CONTAMINANT POTENTIAL → HIGH				DETECTION	EXCEEDANCE
	Surface Water Intakes GWUDI Well Poor Integrity Well Cockeysville Well Shallow Unconfined Well	HIGH	3	4	5	6	6	7
	Crystalline Bedrock Well Semi-Confined Well Deep Unconfined Well		2	3	**4**	5	6	7
	Confined Well	LOW	1	2	3	4	6	7

Pathogens Susceptibility Example

MEDIUM TOWN (Wells # 2A & 3A) CONTAMINANT POTENTIAL

DISCRETE SOURCES

SITE NAME	SITE TYPE	STATUS	PATHOGENS		SITE COMMENTS
			GW	COMMENTS	
MEDIUM TOWN WATER TREATMENT FACILITY	Underground Storage Tanks	INACTIVE	N		GWID: 0 FacDesc: Local Government Rel:
JGRC INC	Underground Storage Tanks	INACTIVE	N		GWID: 1 FacDesc: Commercial Rel: GASOLINE
DOMESTIC SEPTIC	Residential	0.1 / Acre	N*		* Negligible due to very low density (5 Residences)

LAND USE DATA

LULC	AREA (acres)	Percent		
CROPLAND	19.8	39.2	N*	* 20% - 50% of Wellhead Area
RESIDENTIAL	15.9	31.6	N*	*See Discrete Sources
COMMERCIAL	8.2	16.2	N	
INDUSTRIAL	6.3	12.5	N	
FOREST	0.2	0.3	N	
WETLANDS	0.1	0.2	N	
Total Area	**50**	**100**		
SUMMARY			**NEGLIGIBLE**	

Is the Well Screen less than 100 feet deep?

No (Deep)

VULNERABILITY RATING		CONTAMINANT POTENTIAL: Contaminants not present in sufficient quantities in Source Water Area to cause concern	CONTAMINANT POTENTIAL: Contaminant(s) present in significant quantities in Source Water Area but monitoring data indicates no or minimal releases	CONTAMINANT POTENTIAL: Contaminant(s) could be present at levels of concern. No or insufficient monitoring. Additional information may be required.	CONTAMINANT POTENTIAL: Data indicate that contaminant(s) are present in sufficient quantities in Source Water Area to cause concern. (Permitted Discharge or Non-Permitted Release)	OBSERVED DATA: Naturally occurring contaminant(s) detected in source (raw) water at levels ≥ 50% of the MCL, but ≤ 100% of the MCL. Synthetic contaminant(s) found above Detect Level, but below the MCL. Active treatment may be in place.	OBSERVED DATA: Contaminant(s) detected in source (raw) water at levels greater than 100% of the MCL. Active treatment may be in place.
		LOW ← INCREASING CONTAMINANT POTENTIAL → HIGH				DETECTION	EXCEEDANCE
INCREASING VULNERABILITY ↑ HIGH	Surface Water Intakes GWUDI Well Poor Integrity Well Cockeysville Well Shallow Unconfined Well	3	4	5	6	6	7
	Crystalline Bedrock Well Semi-Confined Well Deep Unconfined Well	**2**	3	4	5	6	7
↓ LOW	Confined Well	1	2	3	4	6	7

Petroleum Hydrocarbons Susceptibility Example

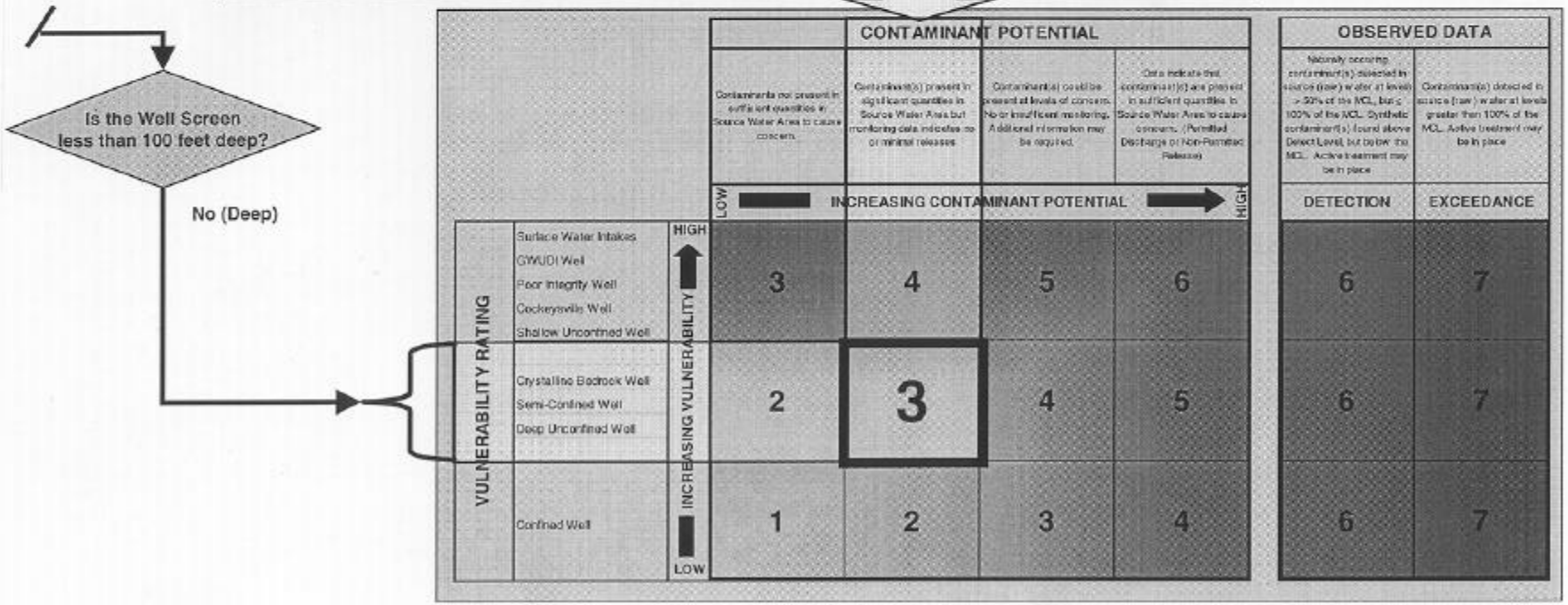
MEDIUM TOWN (Wells # 2A & 3A) CONTAMINANT POTENTIAL

DISCRETE SOURCES

SITE NAME	SITE TYPE	STATUS	PETROLEUM HYDROCARBONS		SITE COMMENTS
			GW	COMMENTS	
MEDIUM TOWN WATER TREATMENT FACILITY	Underground Storage Tanks	INACTIVE	L		GWID: 0 FacDesc: Local Government Rel:
JGRC INC	Underground Storage Tanks	INACTIVE	L		GWID: 1 FacDesc: Commercial Rel: GASOLINE
DOMESTIC SEPTIC	Residential	0.1 / Acre	N		(5 Residences)

LAND USE DATA

LULC	AREA (acres)	Percent		
CROPLAND	19.8	39.2	N	
RESIDENTIAL	15.9	31.6	N	
COMMERCIAL	8.2	16.2	L*	*See Discrete Sources
INDUSTRIAL	6.3	12.5	L**	**Adjusted based on Ground Truth
FOREST	0.2	0.3	N	
WETLANDS	0.1	0.2	N	
Total Area	50	100		
SUMMARY			LOW	



MEDIUM TOWN
EXAMPLE
ASSESSMENT
SUMMARY
7
6
5
4
3
2
1
Is It
Surface Water/GWUDI¹
or Ground Water?
Ground
Water
What is the
Well Integrity²?
Good
Nutrients
Pesticides
Is the Well in Piedmont
or Coastal Plain?
Coastal
Plain
Petroleum Hydrocarbons
Other Organics
Other Inorganics
Metals
Is the Well Unconfined?
Yes
Is the Well Screen
<100' deep?
No (Deep)
Pathogens
PCBs
Medium Vulnerability
MOST
SUSCEPTIBLE
MODERATELY
SUSCEPTIBLE
LEAST
SUSCEPTIBLE
Discrete Sources
Non-Point Sources