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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
Bethel Heights Water System  
Drinking Water System,  
Bethel, Alaska

PWSID # 270346.002

April 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1090b  
Alaska Department of Environmental Conservation

# Source Water Assessment for Bethel Heights Water System Drinking Water System Bethel, Alaska

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DRINKING WATER PROTECTION PROGRAM REPORT 1090b

The Drinking Water Protection Program (DWPP) is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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# Source Water Assessment for Bethel Heights Water System Source of Public Drinking Water, Bethel, Alaska

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## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

The Bethel Heights Water System has two Public Water System (PWS) wells. The well (PWS No. 2703463.002) has been used as a drinking water source since it was drilled in 1999. This source water assessment is exclusively limited to PWSID #270346.002.

The well is a Class A (community and non-transient/non-community) water system located at 900 Ridgecrest Drive in Bethel, Alaska. Available records indicate that there is water storage with a capacity of 425,000-gallons, and that the drinking water is treated with calcium hypochlorite. This system operates year round and serves approximately 800 residents and 100 non-residents through 265 service connections. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produce a **Low** rating for the natural susceptibility of the well.

Identified potential and current sources of contaminants for the public drinking water source include: motor/motor vehicle repair shops, domestic wastewater collection systems, injection wells, above ground fuel tanks, wastewater holding tanks, ADEC recognized contaminated sites and leaking underground storage tank (LUST) sites, abandoned wells, monitoring wells, water supply wells, cemeteries, glycol storage or disposal, motor vehicle/general storage yards/facilities, pipelines, electric power generation, firehouses, landfills, domestic wastewater treatment plant disposal ponds/lagoons, and a floatplane dock/refueling area. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals contaminant categories.

Overall, the water well received a vulnerability rating of **High** for bacteria and viruses, nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide and

other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

### PUBLIC DRINKING WATER SYSTEM

The Bethel Heights Water System well is a Class A (community/non-transient/non-community) public water system. The system is located at 900 Ridgecrest Drive in Bethel, Alaska (Sec. 8, T8N, R71W, Seward Meridian; see Map A of Appendix A). Bethel serves as the regional center for 56 villages in the Yukon-Kuskokwim Delta. Food, fuel, transportation, medical care, and other services for the region are provided by Bethel. Bethel is located at the mouth of the Kuskokwim River, 40-miles inland from the Bering Sea, and approximately 400-air miles west of Anchorage. The community has a population of 5,736 (ADCED, 2003). Average annual precipitation for Bethel is 16 inches, including approximately 50 inches of snowfall. Temperatures range from 42 to 62°F in summer and -2 to 19°F in winter.

The community of Bethel obtains a portion of their water supply from city wells. Some households are served by the central piped water and sewage collection system; however, approximately 75% of households have water delivered and sewage hauled by truck. Several facilities have individual wells and septic tanks (ADCED, 2003). Bethel receives electrical power from the Bethel Utilities Corporation. Power generating facilities are fueled by diesel. Refuse is collected by the City of Bethel and transported to the City operated landfill (ADCED, 2003).

According to information supplied by ADEC for the Bethel Heights Water System PWS, the depth of the primary water well is 492 feet below the ground surface and is screened in a confined aquifer based on available construction details. The well is not located within a floodplain.

Information acquired from a March 2000 sanitary survey for the public water system indicated that the land surface was sloped away from the well. Generally, land surfaces that slope away from the

wellhead promote surface water drainage, which reduces the potential of contaminant migration down the well casing annulus. The sanitary survey indicates that the well is grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing annulus and into source waters.

The Bethel area is near the southern border of the continuous permafrost zone and the City, and most of the area west of the Kuskokwim River, appear to be underlain with permafrost. The permafrost generally extends to a depth of at least 300 feet bgs, with depths of over 600 feet bgs recorded in some areas. The geology in the area consists primarily of unconsolidated floodplain alluvium, silt deposits, and reworked silt. The Bethel area consists of poorly drained wetlands that have permanently ponded water in local depressions. Sloughs, small lakes, ponds, and marshes in meander scars surround Bethel (Dames & Moore, 1996).

#### **DRINKING WATER PROTECTION AREA**

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area (DWPA). Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. An analytical calculation was used to determine the size and shape of the DWPA for the Bethel Heights Water System PWS. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (Freeze and Cherry, 1979). Available geology and groundwater contours were also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well (Please refer

to the Guidance Manual for Class A Public Water Systems for additional information).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four protection area zones for wells and the calculated time -of-travel for each:

**Table 1. Definition of Zones**

<b>Zone</b>	<b>Definition</b>
A	¼ the distance for the 2-yr. time -of-travel
B	Less than the 2 year time-of-travel
C	Less Than the 5 year time -of-travel
D	Less than the 10 year time -of-travel

The DWPA for the Bethel Heights Water System PWS was determined using an analytical calculation and includes Zones A, B, C, and D (See Map A of Appendix A).

#### **INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES**

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Bethel Heights Water System DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses,
- Nitrates and/or nitrites,
- Volatile organic chemicals,
- Heavy metals, cyanide and other inorganic chemicals,
- Synthetic organic chemicals,
- Other organic chemicals.

The sources are displayed on Map C of Appendix C and summarized in Table 1 of Appendix B.

## RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a “potential” or “existing” source of contamination is a function of toxicity and volumes of specific contaminants associated with that source. Rankings include:

- Low,
- Medium,
- High, and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only “Very High” and “High” rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well. Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

## VULNERABILITY OF THE DRINKING WATER SYSTEM

Vulnerability of a drinking water source to contamination is a combination of two factors:

- Natural susceptibility, and
- Contaminant risks.

Appendix D contains fourteen charts, which together form the ‘Vulnerability Analysis’ for a source water assessment for a public drinking water source. Chart 1 analyzes the ‘Susceptibility of the Wellhead’ to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the ‘Susceptibility of the Aquifer’ to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes ‘Contaminant Risks’ for the drinking water source with respect to bacteria and viruses. The ‘Contaminant Risks’ portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Chart 4

contains the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

A score for the Natural Susceptibility is reached by considering the properties of the well and the aquifer.

$$\begin{aligned}
 &\text{Susceptibility of the Wellhead (0 – 25 Points)} \\
 &\quad \text{(Chart 1 of Appendix D)} \\
 &\qquad\qquad\qquad + \\
 &\text{Susceptibility of the Aquifer (0 – 25 Points)} \\
 &\quad \text{(Chart 2 of Appendix D)} \\
 &\qquad\qquad\qquad = \\
 &\text{Natural Susceptibility (Susceptibility of the Well)} \\
 &\quad \text{(0 – 50 Points)}
 \end{aligned}$$

A ranking is assigned for the Natural Susceptibility according to the point score:

Natural Susceptibility Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

The Bethel Heights Water System’s water well is in a confined aquifer. Confined aquifers are less susceptible to potential groundwater quality impacts posed by the migration of surface water contaminants downward from the surface. Table 2 shows the susceptibility scores and ratings for this PWS.

**Table 2. Susceptibility**

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	15	High
Natural Susceptibility	15	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score has been derived from an examination of existing and historical contamination that has been detected at the drinking

water source through routine sampling. It also evaluates potential sources of contamination. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

**Table 3. Contaminant Risks**

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	50	Very High
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide and Other Inorganic Chemicals	50	Very High
Synthetic Organic Chemicals	50	Very High
Other Organic Chemicals	50	Very High

Finally, an overall vulnerability score is assigned for each water system by combining each of the contaminant risk scores with the natural susceptibility score:

$$\begin{array}{r}
 \text{Natural Susceptibility (0 – 50 points)} \\
 + \\
 \text{Contaminant Risks (0 – 50 points)} \\
 = \\
 \text{Vulnerability of the} \\
 \text{Drinking Water Source to Contamination (0 – 100)}.
 \end{array}$$

Again, rankings are assigned according to a point score:

Overall Vulnerability Ratings	
80 to 100 pts	Very High
60 to < 80 pts	High
40 to < 60 pts	Medium
< 40 pts	Low

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

**Table 4. Overall Vulnerability**

Category	Score	Rating
Bacteria and Viruses	65	High
Nitrates and Nitrites	65	High
Volatile Organic Chemicals	65	High
Heavy Metals, Cyanide and Other Inorganic Chemicals	65	High
Synthetic Organic Chemicals	65	High
Other Organic Chemicals	65	High

#### Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High**. The risk is primarily attributed to the presence of landfills and a domestic wastewater treatment plant disposal pond/lagoon in Zones C and D (see Table 2 – Appendix B).

Coliforms (a bacteria) are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli, which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2003). Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination.

A positive bacteria count has been reported in recent (within five years) sampling events (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D). Only a small amount of bacteria and viruses are required to endanger public health.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

#### Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High**. The risk to this source of public drinking water is primarily attributed to the presence of an abandoned well, landfills, and a domestic wastewater treatment plant disposal pond/lagoon in Zones A, C, and D (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately

the same rate as water. The sampling history for this well indicates that nitrates have not been detected in recent sampling events. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L; therefore, nitrate concentrations above 2 mg/L may be indicative of man-made sources (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Nitrate levels are often derived from the decomposition of organic matter in soils. Although the nitrate source is unknown, such occurrences may be attributed to septic systems or other sources. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to nitrate and nitrite contamination is **High**.

### **Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the presence of an injection well, an abandoned well, landfills, and ADEC recognized contaminated sites and LUST sites located in Zones A, C, and D. Numerous other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

No recent sampling data was available in ADEC records for the Bethel Heights Water System (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

### **Heavy Metals, Cyanide and Other Inorganic Chemicals**

The contaminant risk for heavy metals, cyanide and other inorganic chemicals is **Very High**. The risk is primarily attributed to the presence of an injection well, an abandoned well, landfills, and an ADEC recognized LUST site located in Zones A, C, and D. Numerous other potential contaminant sources are also found within the protection area (see Table 5 – Appendix B).

Copper and lead have been detected in recent sampling history, but have not exceeded their respective MCLs of 1.3 mg/L and 0.015 mg/L (see Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

The reported concentrations of copper and lead in recent sampling events are not likely to be representative of source water conditions. These two analytes are likely attributed to either the water treatment process or water distribution network. Therefore, risk points were not assigned based on the presence of these analytes.

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

### **Synthetic Organic Chemicals**

The contaminant risk for synthetic organic chemicals is **Very High**. The risk is primarily attributed to the presence of an abandoned well and landfills in Zones A, C, and D. Numerous other potential contaminant sources are also found within the protection area (see Table 6 – Appendix B).

No recent sampling data was available in ADEC records for the Bethel Heights Water System (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

### **Other Organic Chemicals**

The contaminant risk for other organic chemicals is **Very High**. The risk is primarily attributed to the presence of an abandoned well, pipelines, electric power generation, and landfills in Zones A, C, and D. Numerous other potential contaminant sources are also found within the protection area (see Table 7 – Appendix B).

No recent sampling data was available in ADEC records for the Bethel Heights Water System (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

After combining the contaminant risk for other organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **High**.

### **Using the Source Water Assessment**

This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of the Bethel Heights Water System and the



community of Bethel to protect public health. It is anticipated that Source Water Assessments will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the drinking water source.

## REFERENCES

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# **APPENDIX A**

## **Drinking Water Protection Area Location Map (Map A)**

Public Water Well System for PWS #270346.002 Bethel Heights Water System



**LEGEND**

- Public Water System Well

**Hydrography/Physical**

- Parcels
- Stream
- Lake or Pond
- Contours

**Transportation**

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)

**Groundwater Protection Zones**

- Zone A Protection Area- Several Months Travel Time
- Zone B Protection Area- 2 Years Travel Time
- Zone C Protection Area- 5 Years Travel Time
- Zone D Protection Area- 10 Years Travel Time

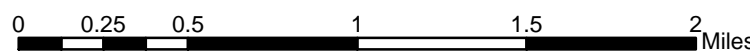
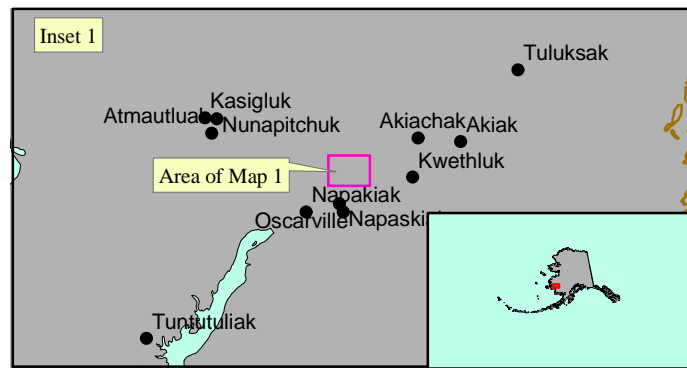
Data Sources:  
Contaminant Sources, Public Water System Wells, Contours  
Alaska Department of Environmental Conservation (ADEC)

Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:  
United States Geological Survey (USGS)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



Bethel Heights Water System  
PWS 270346.002  
Appendix A Map A

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking (Tables 1-7)**

**Table 1**

**Contaminant Source Inventory for  
Bethel Heights Water System**

**PWSID 270346.002**

<b>Contaminant Source Type</b>	<b>Contaminant Source ID</b>	<b>CS ID tag</b>	<b>Zone</b>	<b>Map Number</b>	<b>Comments</b>
Motor /motor vehicle repair shops	C31	C31-01	A	C	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	A	C	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-02	A	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	C	The Shop
Tanks, diesel (above ground)	T06	T06-01	A	C	
Tanks, diesel (above ground)	T06	T06-02	A	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	United Pentacostal Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	344 Owl Street, diesel
Wastewater Holding Tank	T22	T22-01	A	C	
Wastewater Holding Tank	T22	T22-02	A	C	
Wastewater Holding Tank	T22	T22-03	A	C	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-01	A	C	AKARNG Bethel OMS, RecKey #1998250103002, Status: Inactive, petroleum contamination in soil near fuel tank and former ASTs.
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-02	A	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-03	A	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Open Leaking Underground Fuel Storage Tank (LUST) Sites	U07	U07-01	A	C	AKANG Bethel OMS Alaska Army National Guard Armory, RecKey #1993250002151, Event ID 1341, Facility ID 3133, 1,000-gallon gasoline tank, approved long term stockpiling plan, stockpile located at the Bethel Airport.
Abandoned wells	W01	W01-01	A	C	
Monitoring wells	W06	W06-01	A	C	

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Map Number</i>	<i>Comments</i>
Water supply wells	W09	W09-01	A	C	9 water supply wells in Zone A
Cemeteries	X01	X01-01	A	C	United Pentecostal Church
Glycol (disposal or storage)	X07	X07-01	A	C	
Glycol (disposal or storage)	X07	X07-02	A	C	
Motor vehicle/general storage yards/facilities	X27	X27-01	A	C	Arctic Moving & Delivery
Pipelines (oil and gas)	X28	X28-01	A	C	
Electric power generation (fossil fuels)	X36	X36-01	A	C	
Firehouses	X38	X38-01	A	C	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-03	B	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	C	
Landfills (municipal; Class II)	D50	D50-01	C	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	C	
Landfills (industrial; type of industrial waste?)	D52	D52-01	D	C	
Floatplane dock/refueling area	X17	X17-01	D	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Bacteria and Viruses*

*PWSID 270346.002*

**Table 2**

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Medium	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	Low	C	The Shop
Wastewater Holding Tank	T22	T22-01	A	Low	C	
Wastewater Holding Tank	T22	T22-02	A	Low	C	
Wastewater Holding Tank	T22	T22-03	A	Low	C	
Abandoned wells	W01	W01-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	High	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	Low	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	High	C	



*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Nitrates/Nitrites*

*PWSID 270346.002*

**Table 3**

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Medium	C	
Wastewater Holding Tank	T22	T22-01	A	Low	C	
Wastewater Holding Tank	T22	T22-02	A	Low	C	
Wastewater Holding Tank	T22	T22-03	A	Low	C	
Abandoned wells	W01	W01-01	A	High	C	
Cemeteries	X01	X01-01	A	Medium	C	United Pentecostal Church
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	High	C	
Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	
Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	Low	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	Very High	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Volatile Organic Chemicals*

PWSID 270346.002

Table 4

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Low	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	High	C	The Shop
Tanks, diesel (above ground)	T06	T06-01	A	Medium	C	
Tanks, diesel (above ground)	T06	T06-02	A	Medium	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	United Pentacostal Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	344 Owl Street, diesel
Wastewater Holding Tank	T22	T22-01	A	Medium	C	
Wastewater Holding Tank	T22	T22-02	A	Medium	C	
Wastewater Holding Tank	T22	T22-03	A	Medium	C	
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-01	A	High	C	AKARNG Bethel OMS, RecKey #1998250103002, Status: Inactive, petrol contamination in soil near fuel tank and former ASTs.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-02	A	High	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-03	A	High	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Open Leaking Underground Fuel Storage Tank (LUST) Sites	U07	U07-01	A	High	C	AKANG Bethel OMS Alaska Army National Guard Armory, RecKey #1993250002151, Event ID 1341, Facility ID 3133, 1,000-gallon gasoline tank, approved long term stockpiling plan, stockpile located at the Bethel Airport.
Abandoned wells	W01	W01-01	A	High	C	
Motor vehicle/general storage yards/facilities	X27	X27-01	A	Low	C	Arctic Moving & Delivery

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Volatile Organic Chemicals*

*PWSID 270346.002*

*Table 4 (continued)*

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Pipelines (oil and gas)	X28	X28-01	A	Medium	C	
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	
Firehouses	X38	X38-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	Low	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	High	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	High	C	
Floatplane dock/refueling area	X17	X17-01	D	Low	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System*

PWSID 270346.002

Table 5

*Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Low	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	High	C	The Shop
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	United Pentecostal Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	344 Owl Street, diesel
Wastewater Holding Tank	T22	T22-01	A	Medium	C	
Wastewater Holding Tank	T22	T22-02	A	Medium	C	
Wastewater Holding Tank	T22	T22-03	A	Medium	C	
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-01	A	Low	C	AKARNG Bethel OMS, RecKey #1998250103002, Status: Inactive, petrol contamination in soil near fuel tank and former ASTs.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-02	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-03	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Abandoned wells	W01	W01-01	A	Very High	C	
Cemeteries	X01	X01-01	A	Low	C	United Pentecostal Church
Glycol (disposal or storage)	X07	X07-01	A	Low	C	
Glycol (disposal or storage)	X07	X07-02	A	Low	C	
Pipelines (oil and gas)	X28	X28-01	A	Low	C	
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System*

*PWSID 270346.002*

*Table 5 (continued)*

*Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Firehouses	X38	X38-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	Low	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Landfills (municipal; Class II)	D50	D50-01	C	High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	Very High	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	High	C	
Floatplane dock/refueling area	X17	X17-01	D	Low	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Synthetic Organic Chemicals*

PWSID 270346.002

Table 6

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Low	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	Low	C	The Shop
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-01	A	Low	C	AKARNG Bethel OMS, RecKey #1998250103002, Status: Inactive, petrol contamination in soil near fuel tank and former ASTs.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-02	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-03	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Open Leaking Underground Fuel Storage Tank (LUST) Sites	U07	U07-01	A	Low	C	AKANG Bethel OMS Alaska Army National Guard Armory, RecKey #1993250002151, Event ID 1341, Facility ID 3133, 1,000-gallon gasoline tank, approved long term stockpiling plan, stockpile located at the Bethel Airport.
Abandoned wells	W01	W01-01	A	High	C	
Cemeteries	X01	X01-01	A	Medium	C	United Pentecostal Church
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	Low	C	
Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	
Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	Low	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	Very High	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Other Organic Chemicals*

PWSID 270346.002

Table 7

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-02	A	Low	C	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	A	Medium	C	The Shop
Wastewater Holding Tank	T22	T22-01	A	Medium	C	
Wastewater Holding Tank	T22	T22-02	A	Medium	C	
Wastewater Holding Tank	T22	T22-03	A	Medium	C	
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-01	A	Low	C	AKARNG Bethel OMS, RecKey #1998250103002, Status: Inactive, petrol contamination in soil near fuel tank and former ASTs.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-02	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Contaminated sites, DEC recognized, non-Superfund non-RCRA	U04	U04-03	A	Low	C	Owl Street Residence, RecKey #1992250124701, Status: Closed, diesel contaminated soils due to an undetermined amount of heating oil released from a leaking storage tank.
Open Leaking Underground Fuel Storage Tank (LUST) Sites	U07	U07-01	A	Low	C	AKANG Bethel OMS Alaska Army National Guard Armory, RecKey #1993250002151, Event ID 1341, Facility ID 3133, 1,000-gallon gasoline tank, approved long term stockpiling plan, stockpile located at the Bethel Airport.
Abandoned wells	W01	W01-01	A	High	C	
Motor vehicle/general storage yards/facilities	X27	X27-01	A	Low	C	Arctic Moving & Delivery
Pipelines (oil and gas)	X28	X28-01	A	High	C	
Electric power generation (fossil fuels)	X36	X36-01	A	High	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-03	B	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	C	Low	C	
Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	

*Contaminant Source Inventory and Risk Ranking for  
Bethel Heights Water System  
Sources of Other Organic Chemicals*

*PWSID 270346.002*

*Table 7 (continued)*

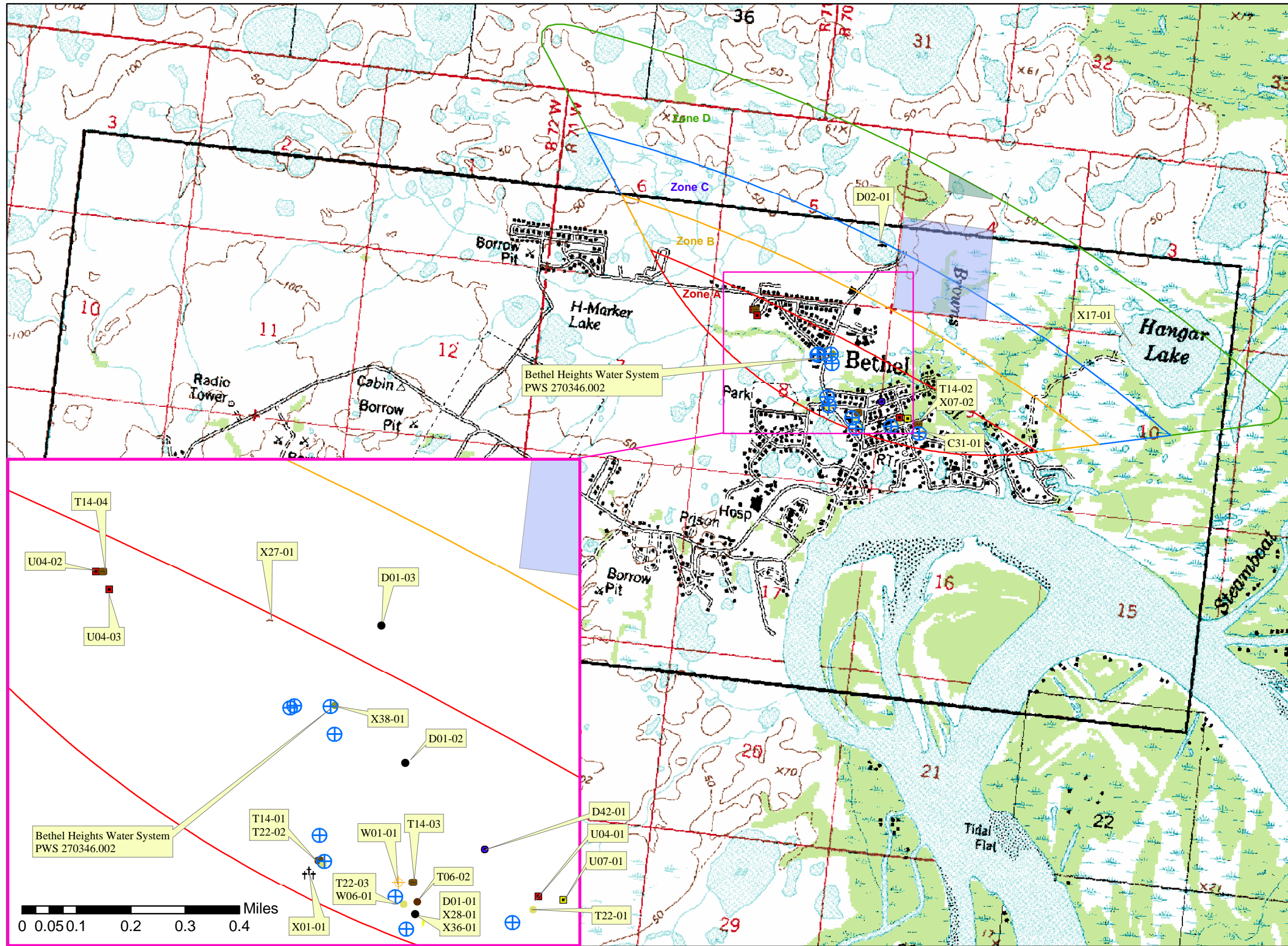
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Landfills (municipal; Class II)	D50	D50-01	C	Very High	C	
Closed leaking fuel storage tank (LUST) (aviation)	U12	U12-01	C	Low	C	Bethel Dump, RecKey #1990250120701, Status: Closed, old oil drums amounting in the hundreds leaking in the dump.
Landfills (municipal; Class II)	D50	D50-02	D	Very High	C	
Landfills (industrial; type of industrial waste?)	D52	D52-01	D	Very High	C	



## **APPENDIX C**

### **Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)**

**Public Water Well System for PWS #270346.002 Bethel Heights Water System  
Showing Potential and Existing Sources of Contamination**



**LEGEND**

	Public Water System Well
<b>Hydrography/Physical</b>	
	Parcels
	Stream
	Lake or Pond
	Contours
<b>Transportation</b>	
	Primary Route (Class 1)
	Secondary Route (Class 2)
	Road (Class 3)
	Road (Class 4)
	Road (Class 5, Four-wheel drive)
<b>Groundwater Protection Zones</b>	
	Zone A Protection Area— Several Months Travel Time
	Zone B Protection Area— 2 Years Travel Time
	Zone C Protection Area— 5 Years Travel Time
	Zone D Protection Area— 10 Years Travel Time
<b>Existing or Potential Contaminant Sources</b>	
	Domestic wastewater collection systems (sewer lines of lift stations) (D01)
	Domestic wastewater treatment plant disposal pond (D02)
	Injection well (Class V) Motor Vehicle Waste Disposal Well (D42)
	Contaminated sites, DEC recognized, non-superfund, non-RCRA (U04)
	Open leaking underground fuel storage tank (LUST) (U07)
	Tanks, diesel (above ground) (T06)
	Tanks, heating oil, nonresidential (aboveground) (T14)
	Wastewater holding tank (T22)
	Abandoned wells (W01)
	Monitoring wells (W06)
	Cemeteries (X01)
	Floatplane dock/refueling area (X17)
	Motor vehicle/general storage yards/facilities (X27)
	Pipelines (oil and gas) (X28)
	Electric power generation (fossil fuels) (X36)
	Landfill (municipal; Class II) (D50)
	Landfill (industrial) (D52)

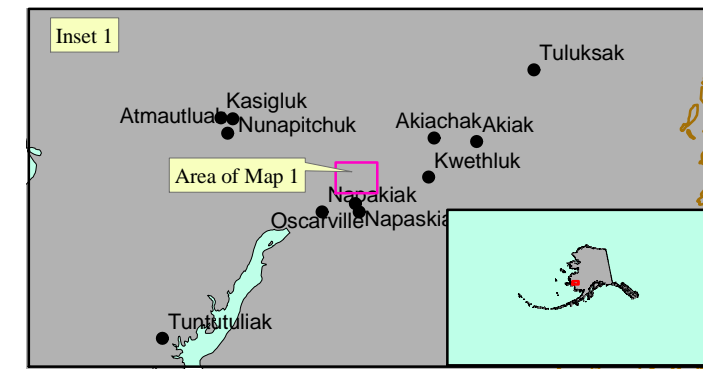
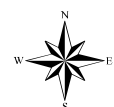
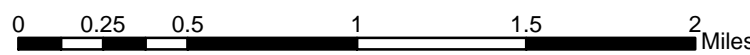
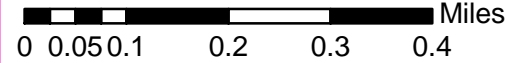
Data Sources:  
Contaminant Sources, Public Water System Wells, Contours  
Alaska Department of Environmental Conservation (ADEC)

Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:  
United States Geological Survey (USGS)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

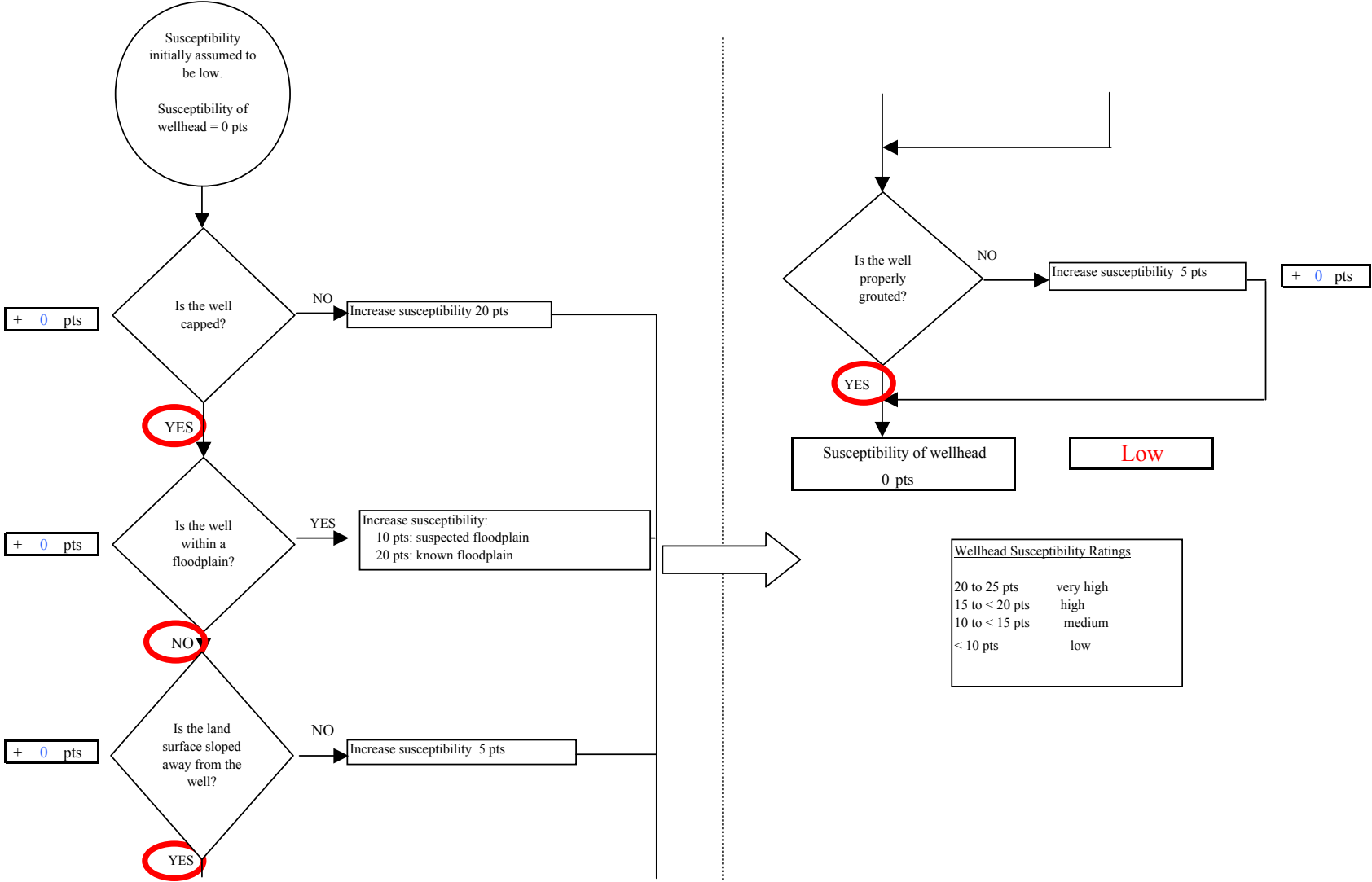
URS Corporation does not guarantee the accuracy or validity of the data provided.



## **APPENDIX D**

### **Vulnerability Analysis for Public Drinking Water Source (Charts 1-14)**

**Chart 1. Susceptibility of the wellhead - Bethel Heights Water System (PWS No.270346.002)**



**Chart 2. Susceptibility of the aquifer Bethel Heights Water System (PWS No.270346.002)**

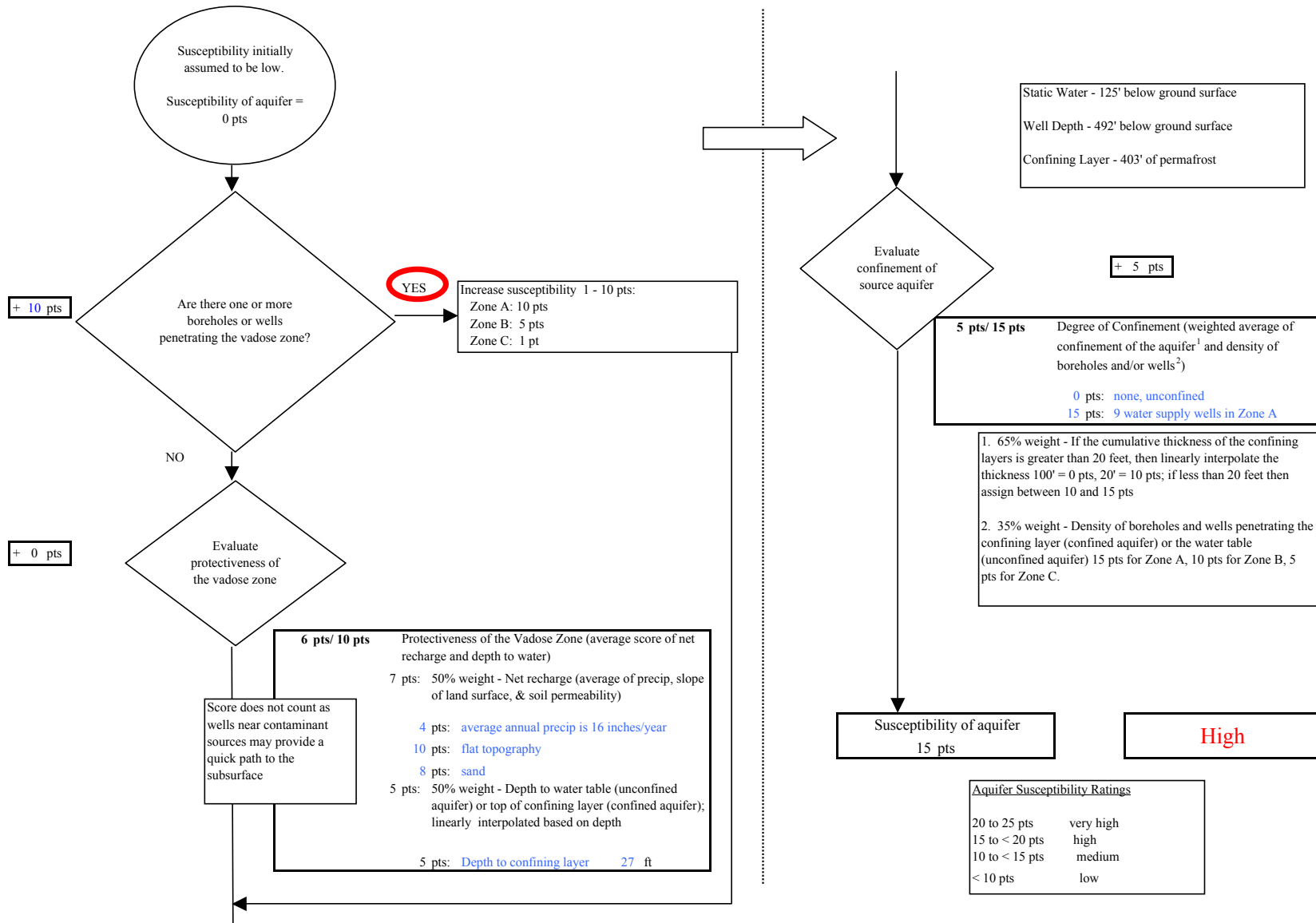


Chart 3. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Bacteria & Viruses

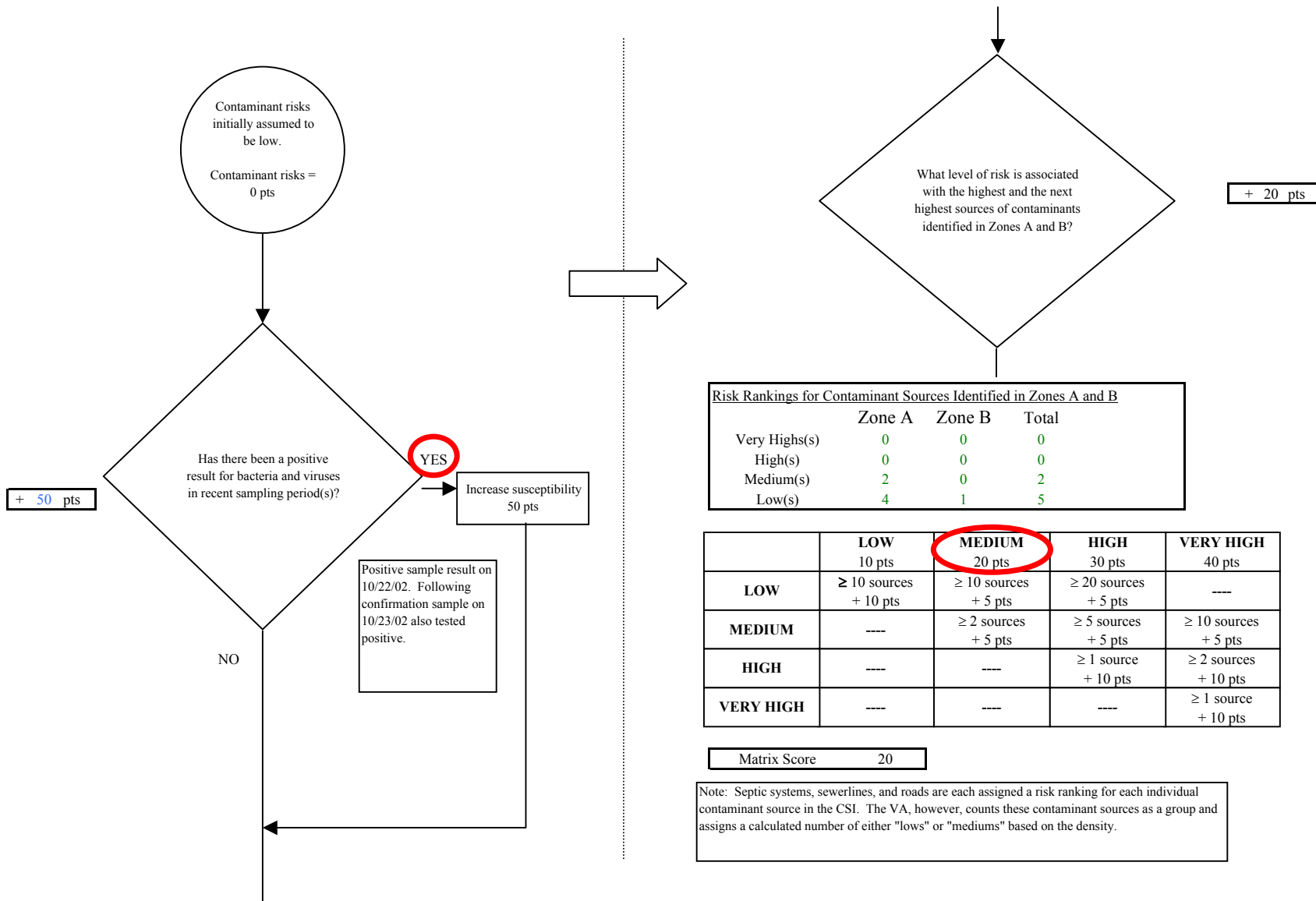
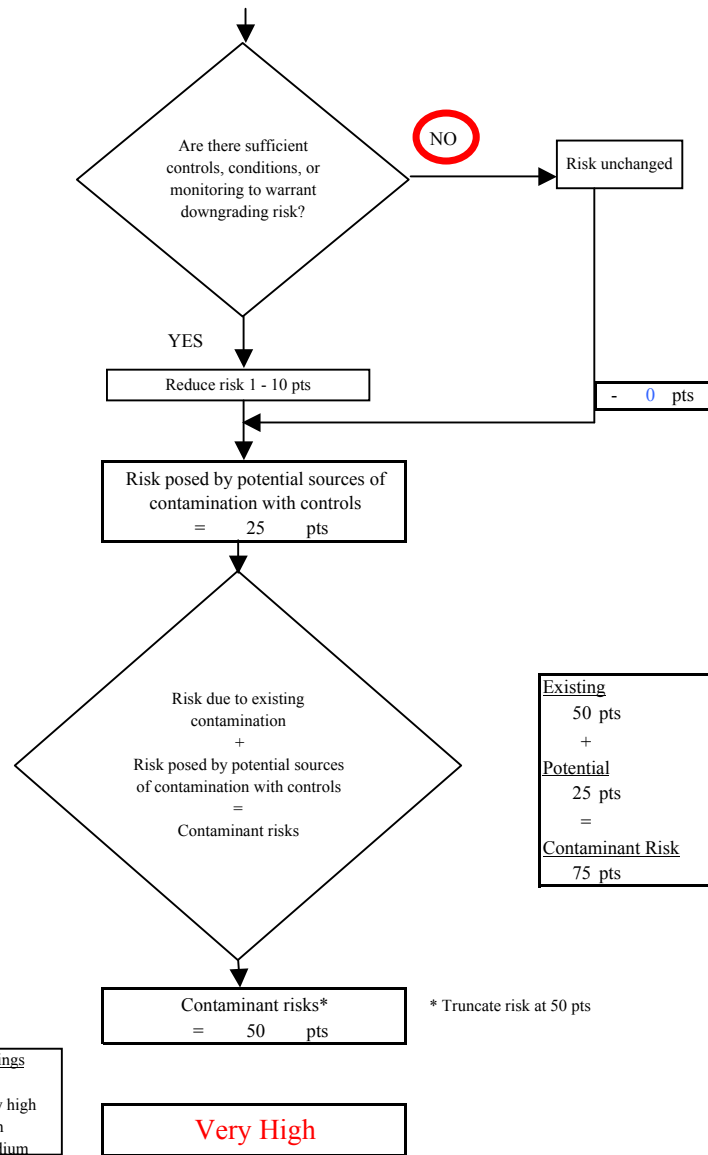
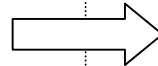
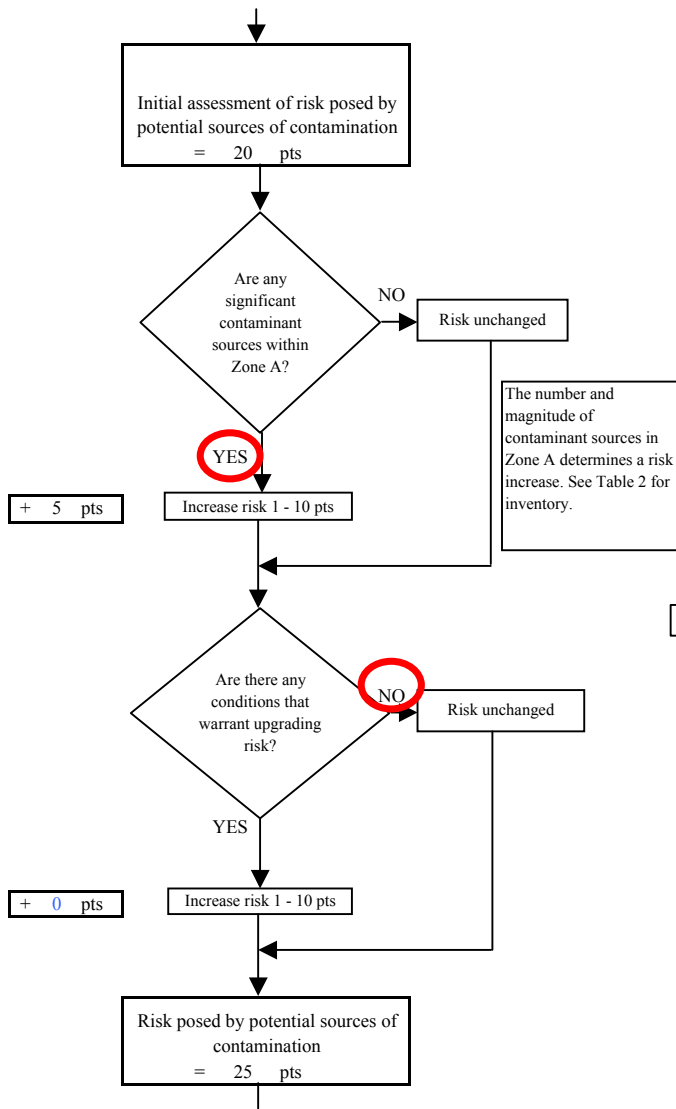
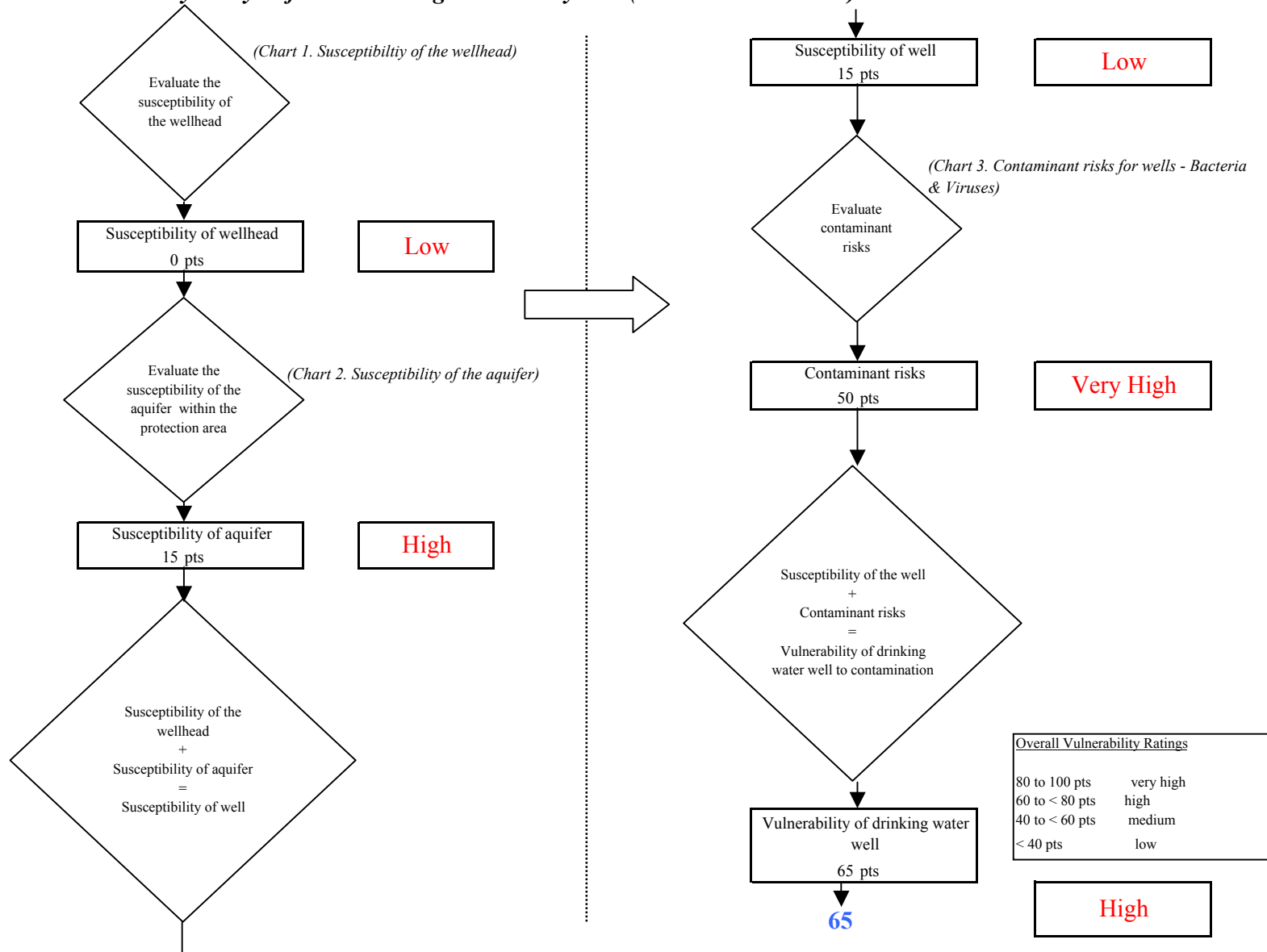


Chart 3. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Bacteria & Viruses



**Chart 4. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Bacteria & Viruses**





**Chart 5. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Nitrates and Nitrites**

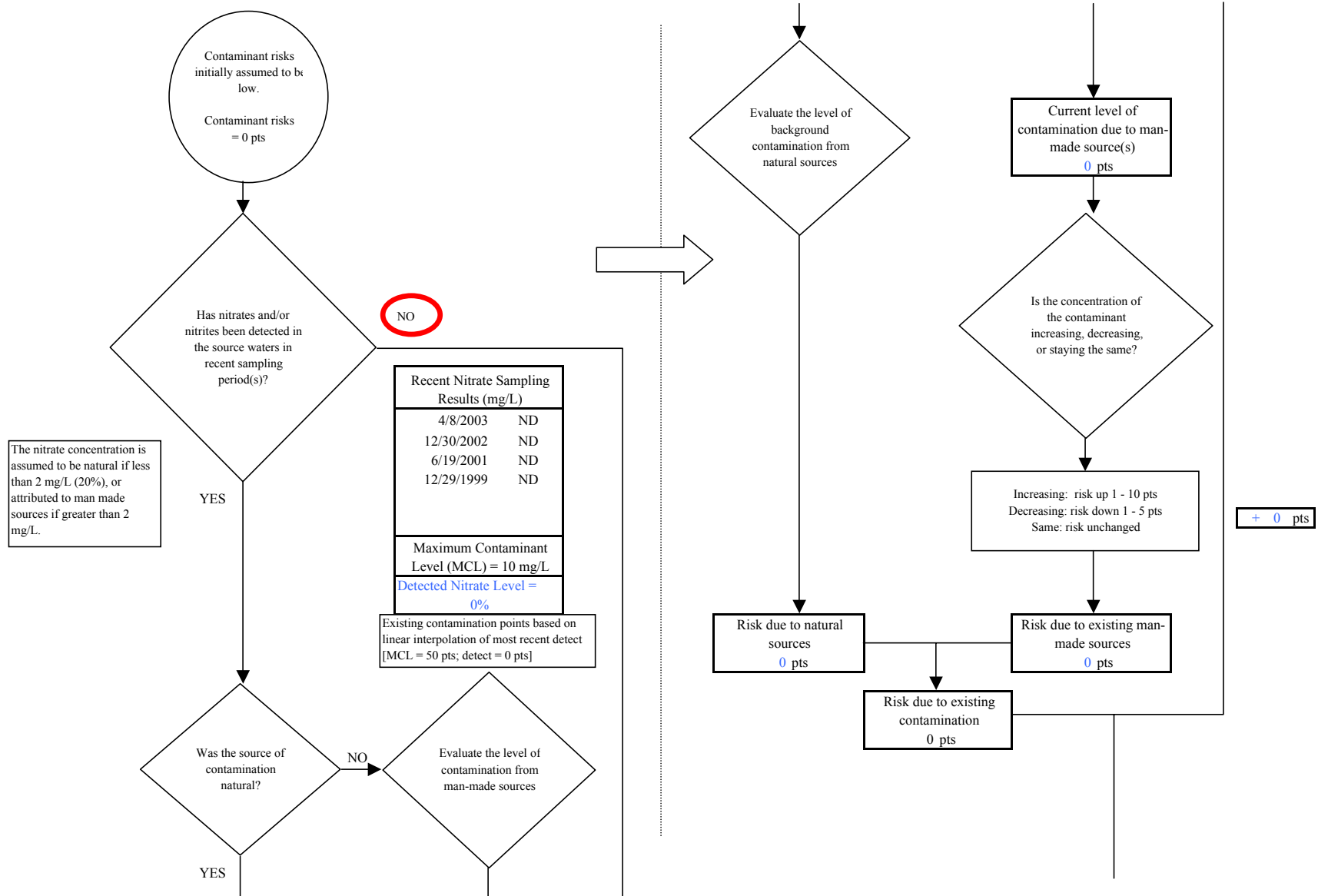
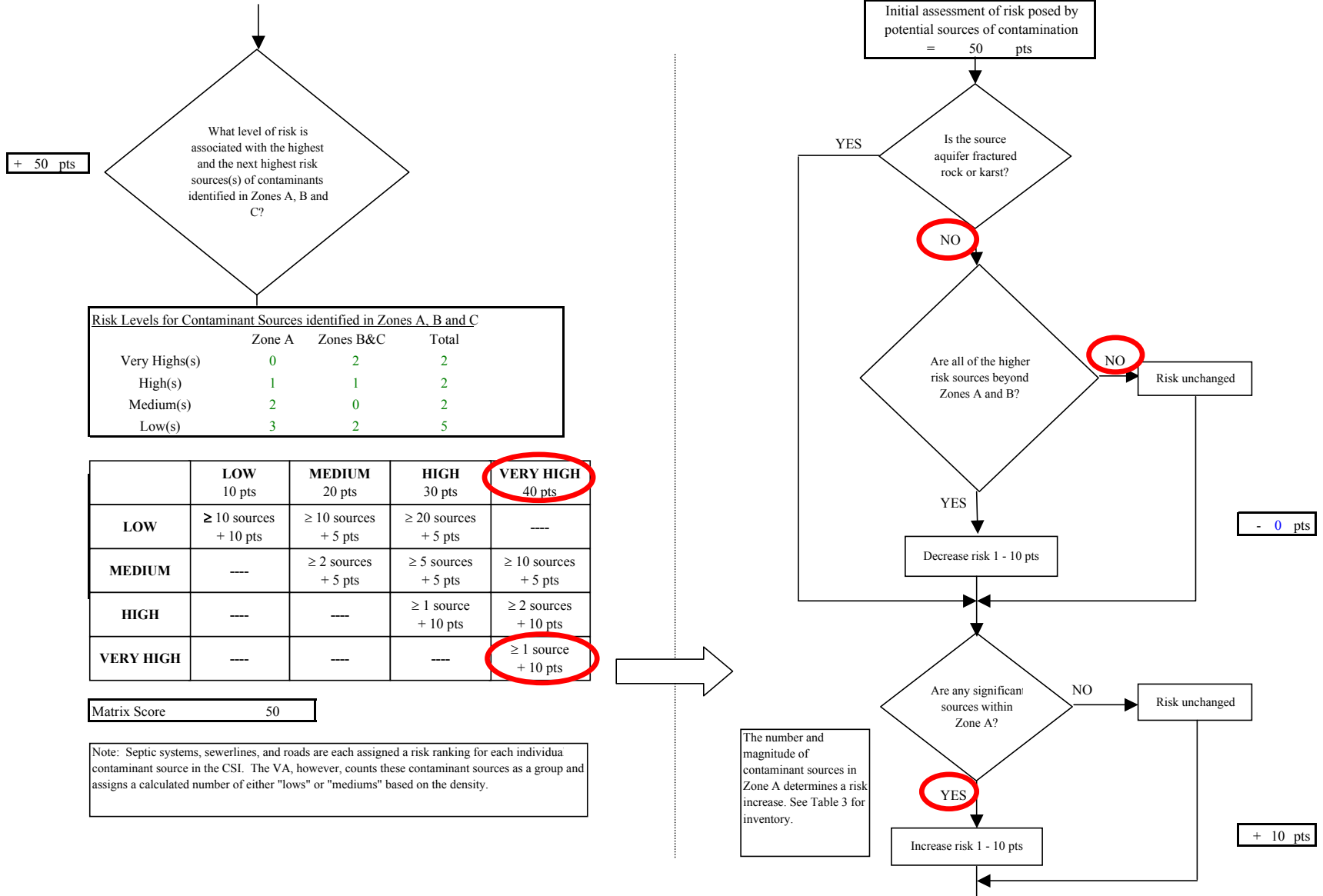
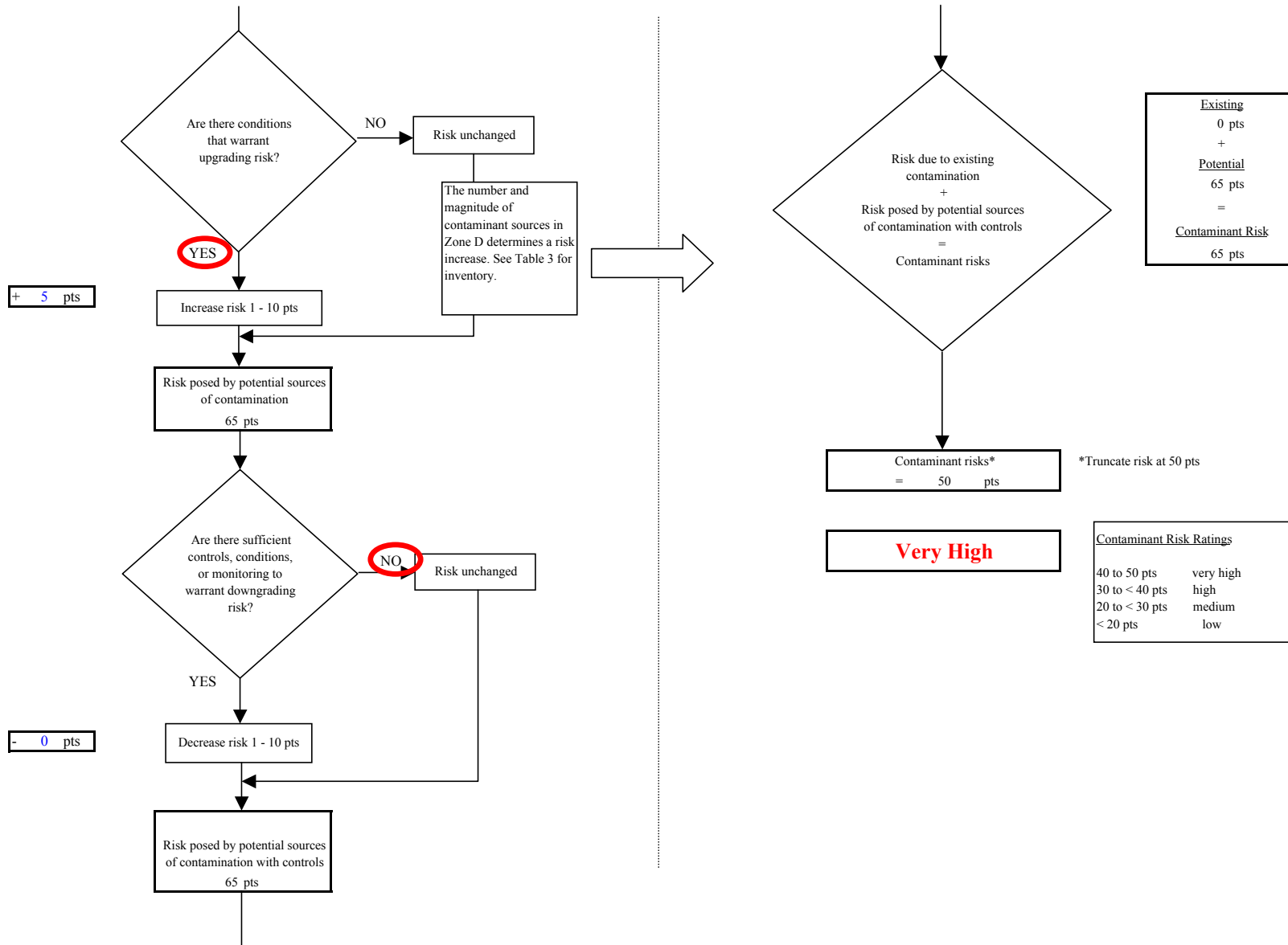


Chart 5. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Nitrates and Nitrites



**Chart 5. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Nitrates and Nitrites**



**Chart 6. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Nitrates and Nitrites**

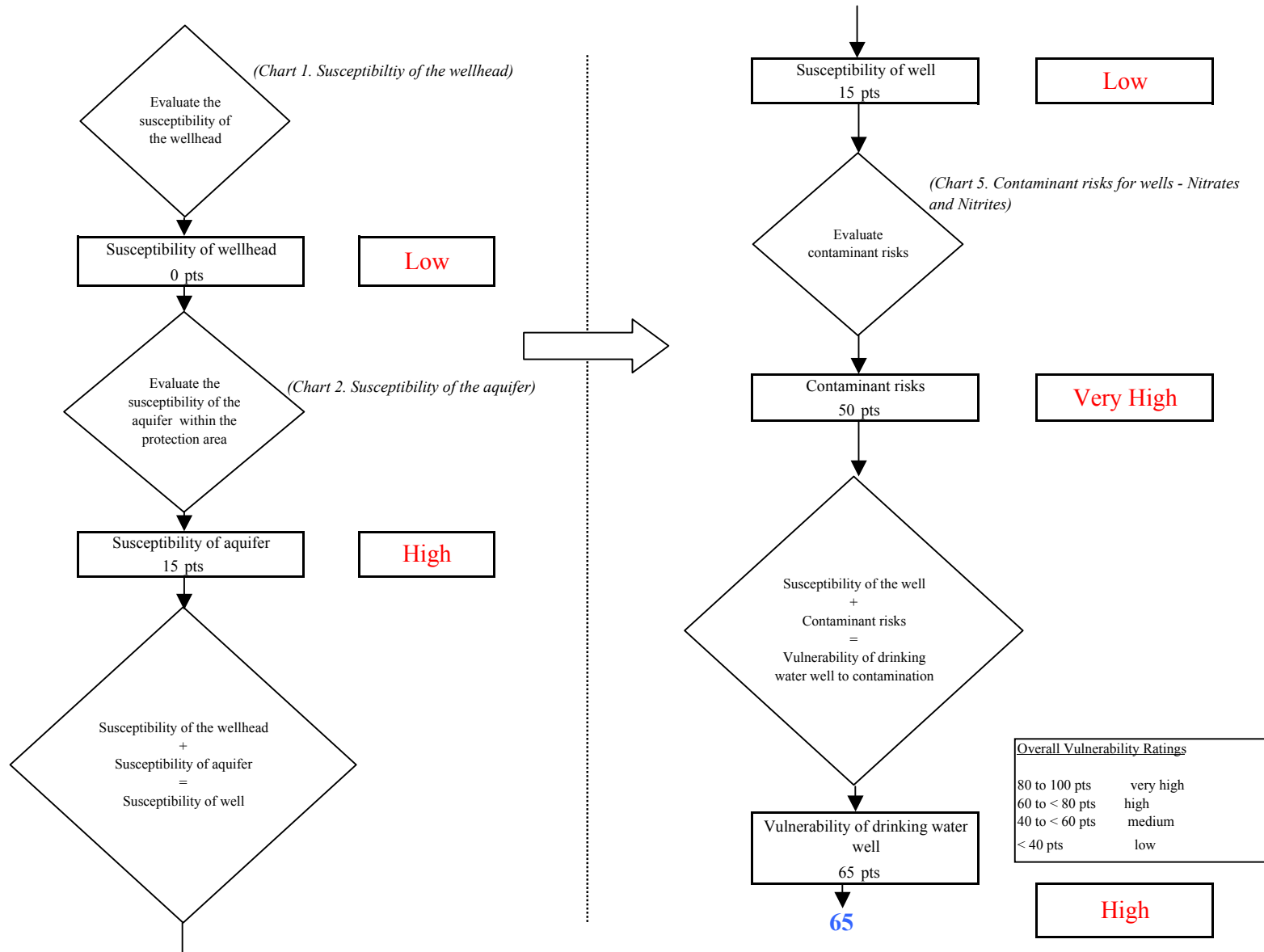


Chart 7. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Volatile Organic Chemicals

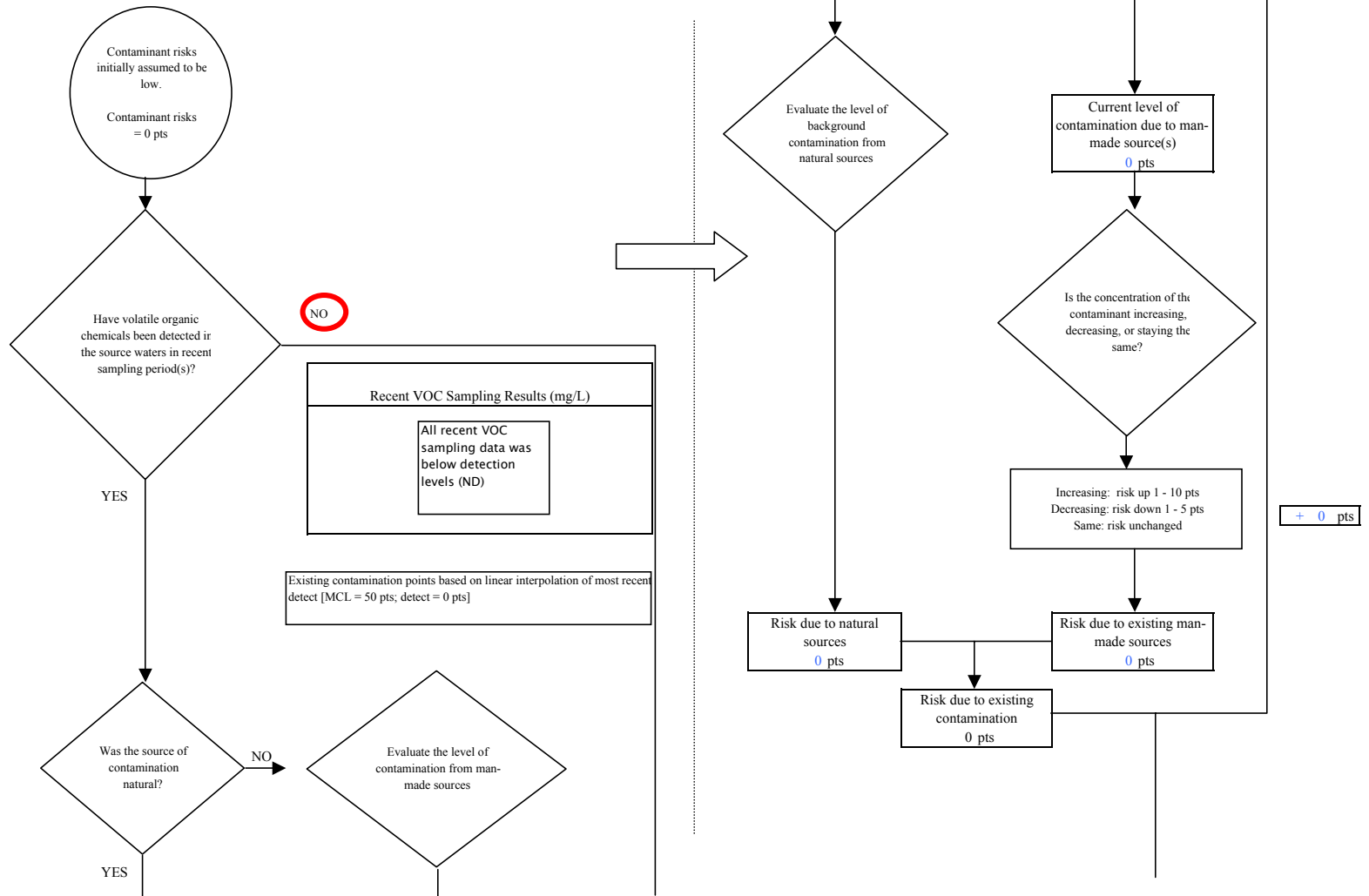
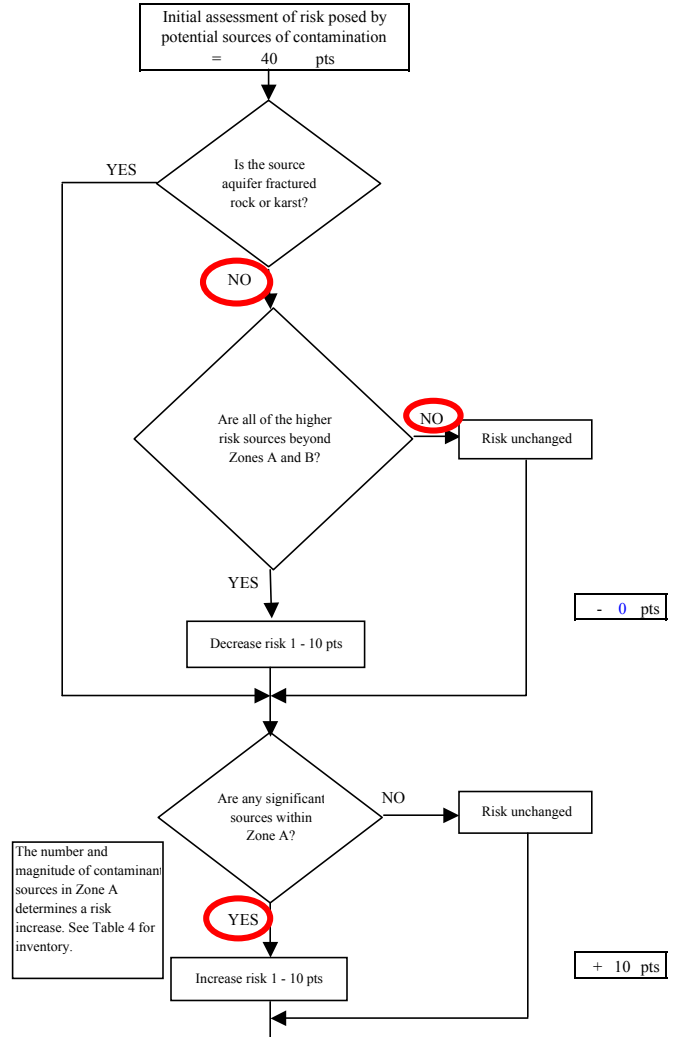
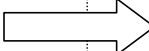
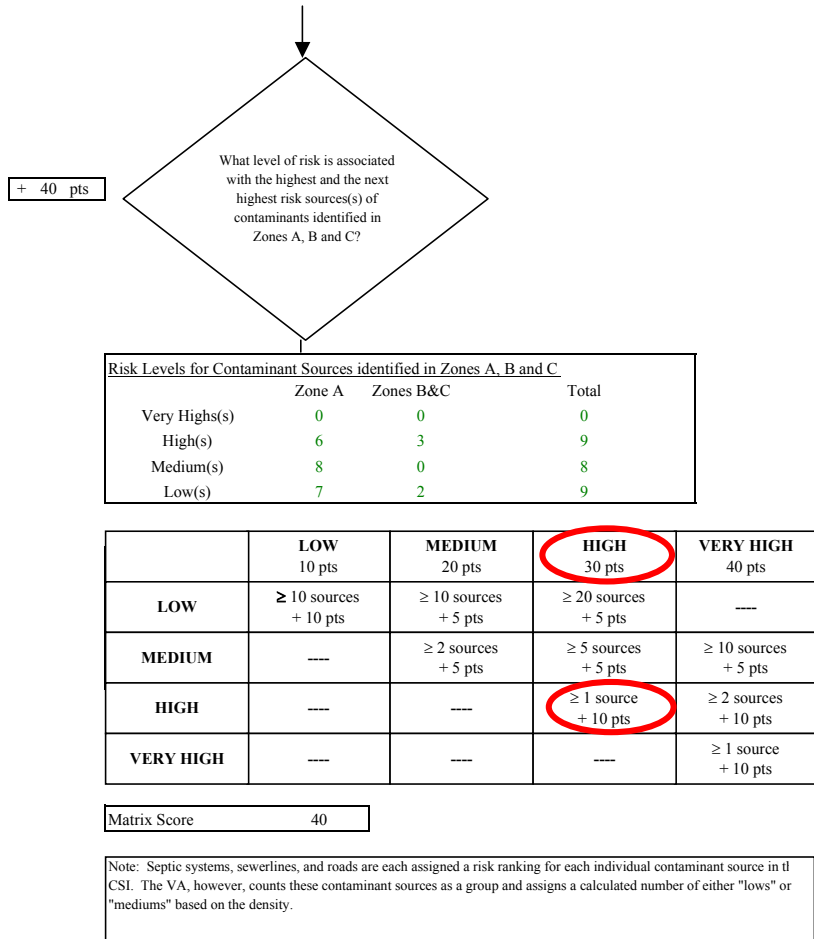
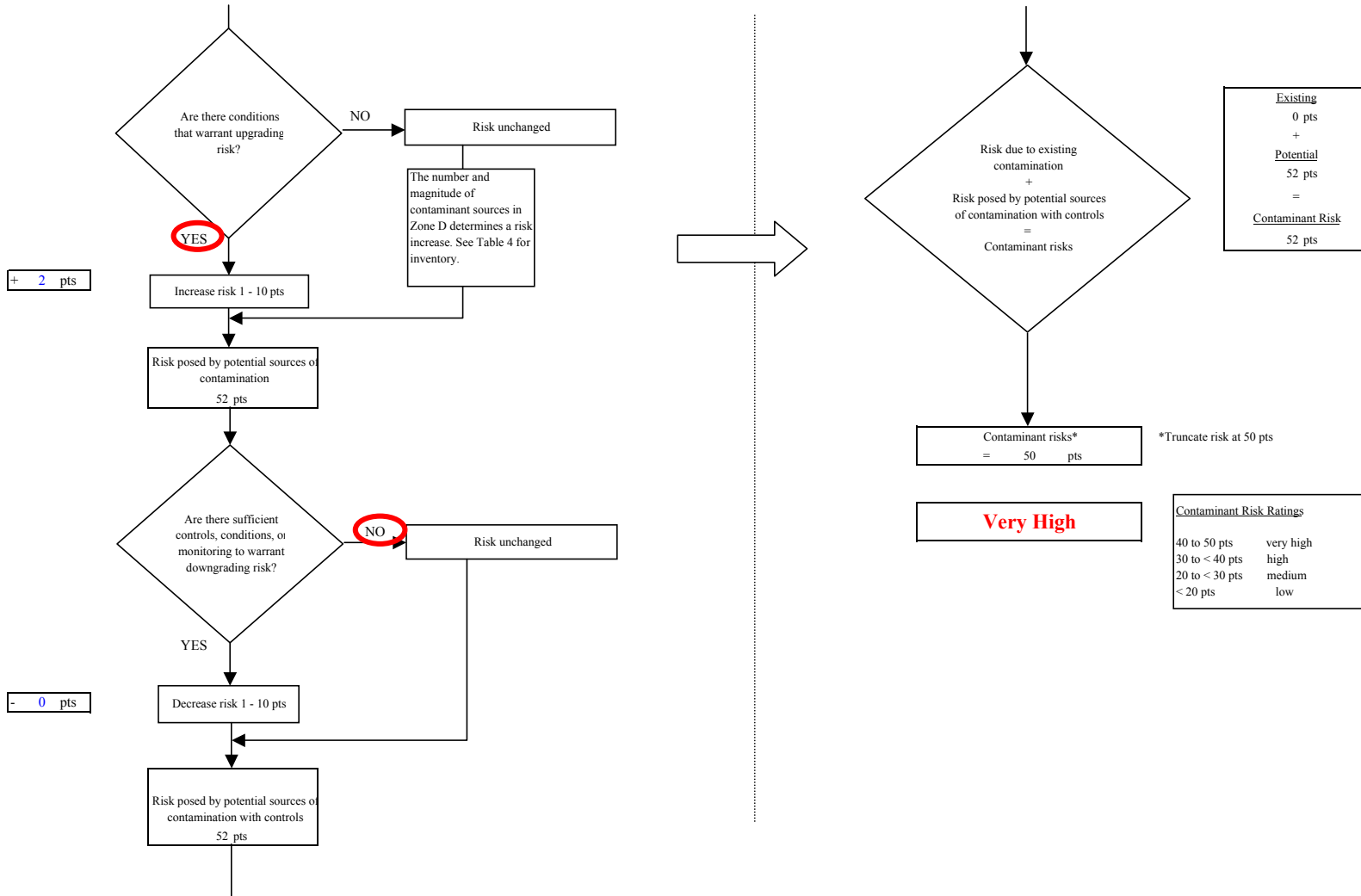


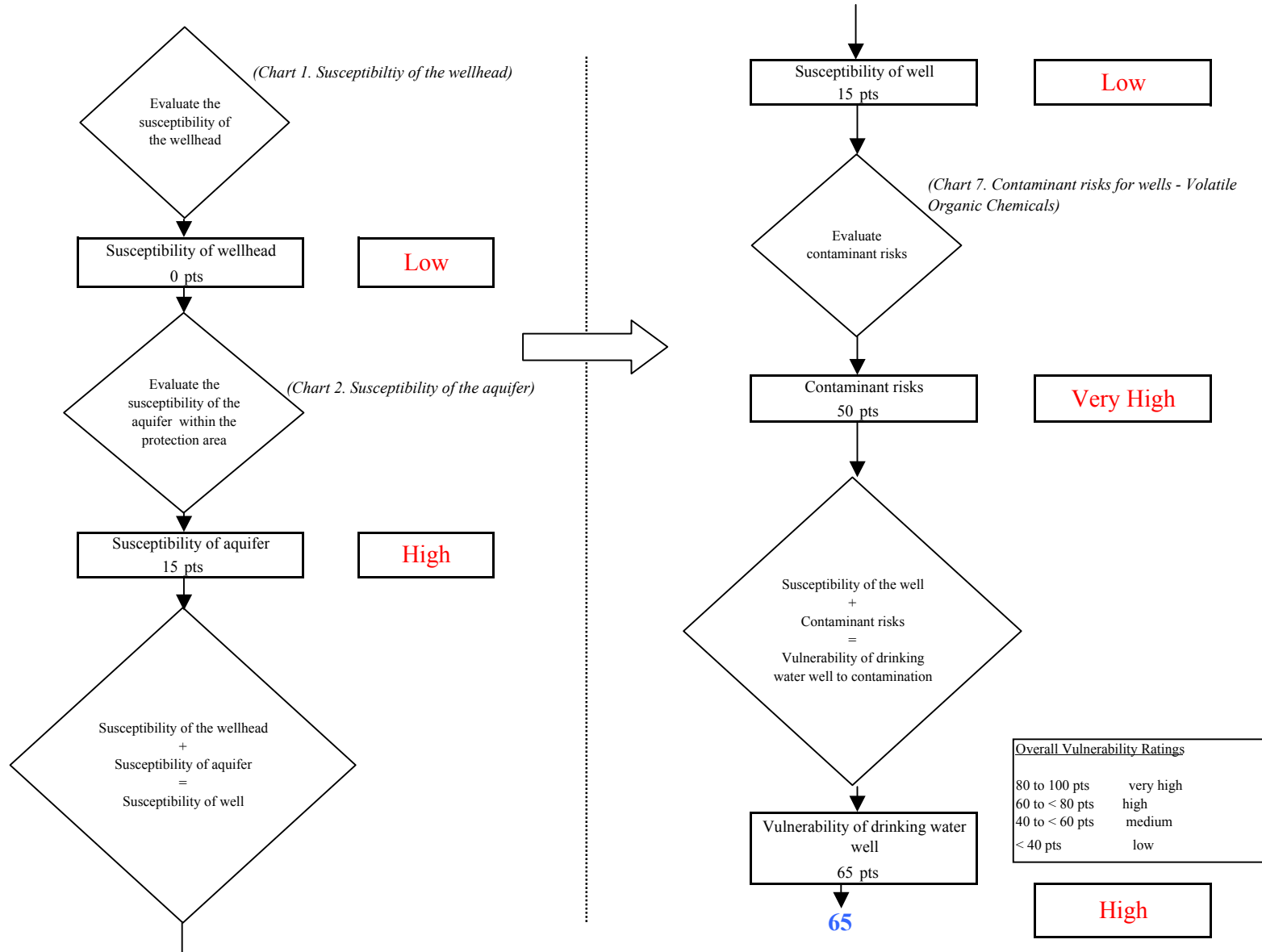
Chart 7. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Volatile Organic Chemicals



**Chart 7. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Volatile Organic Chemicals**

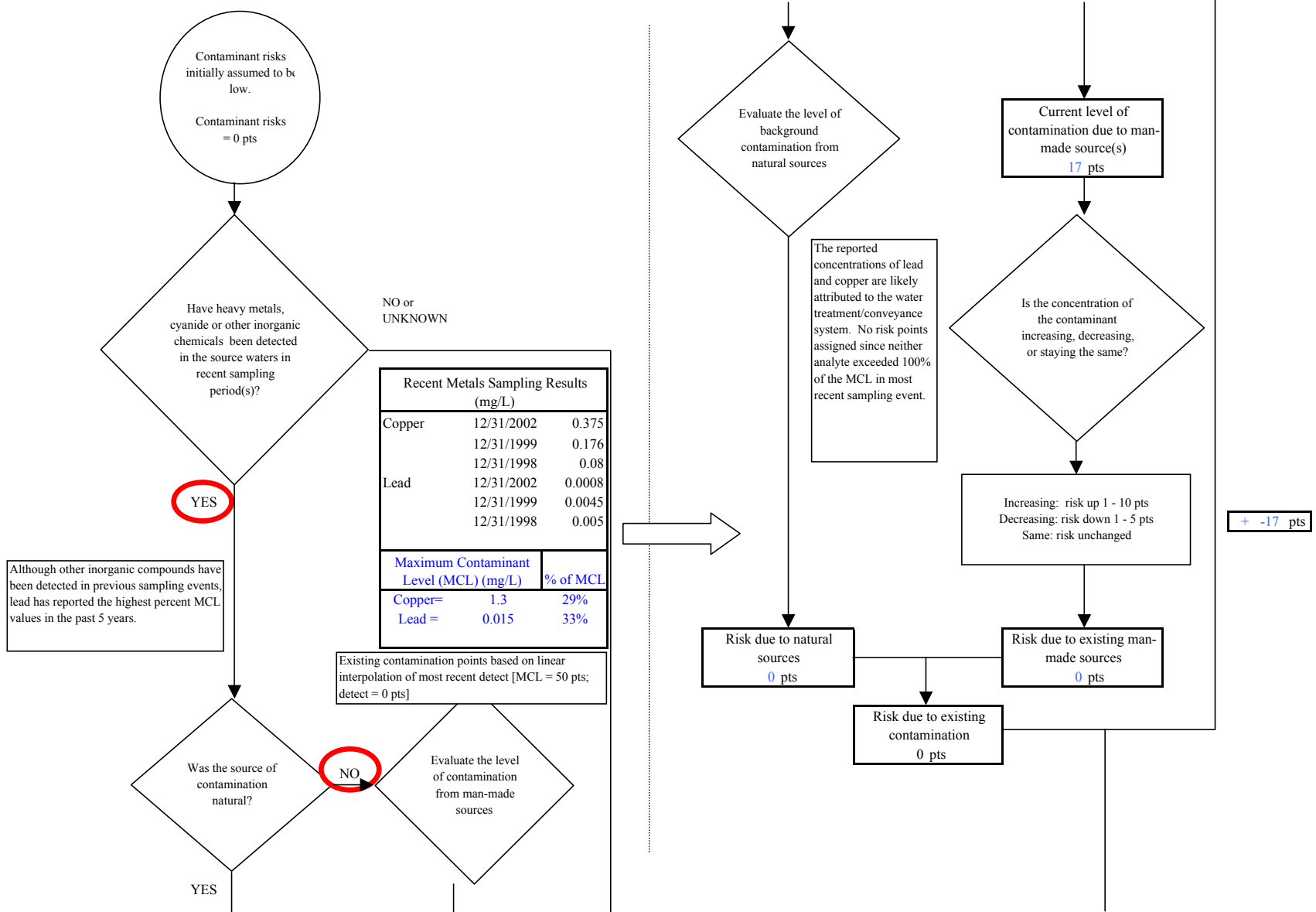


**Chart 8. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Volatile Organic Chemicals**

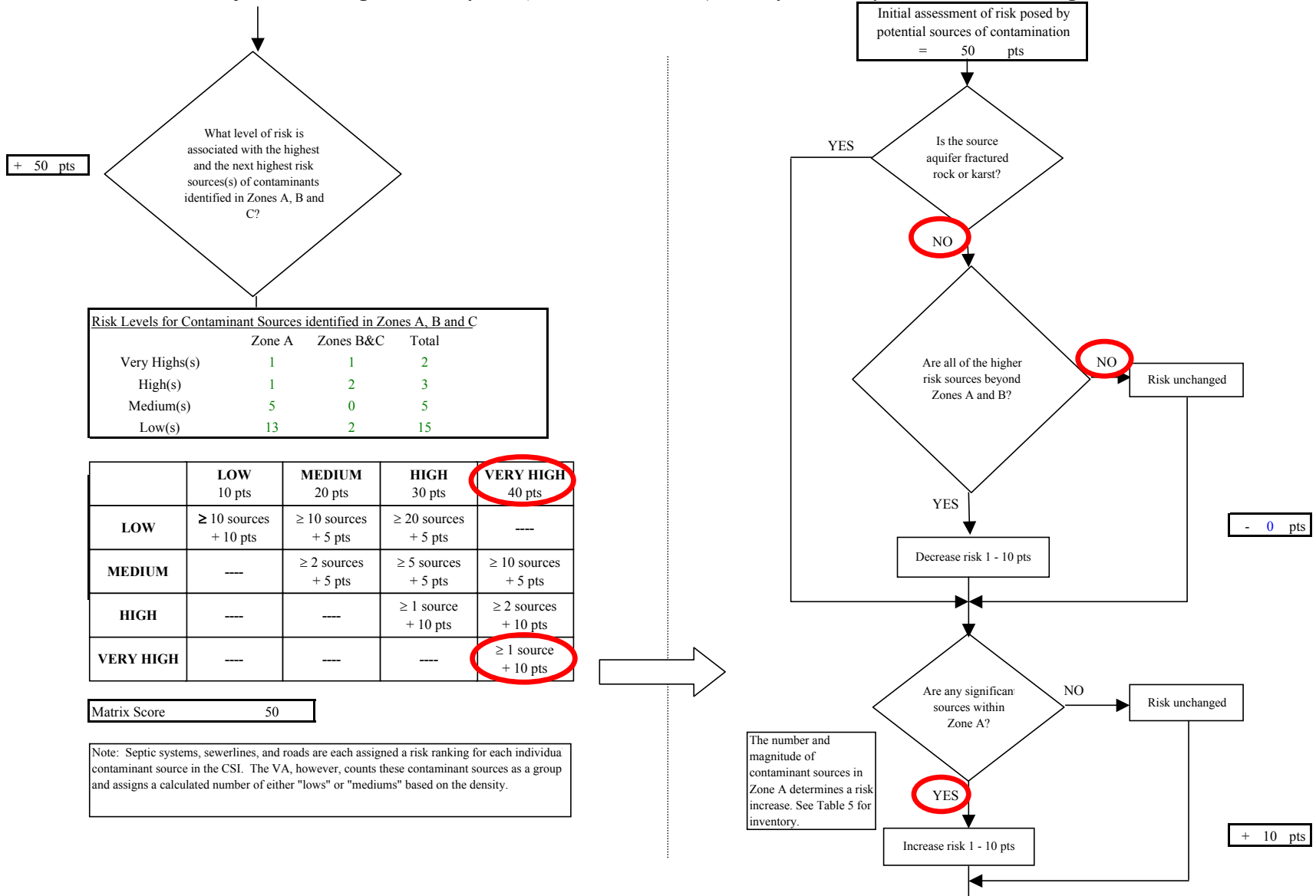




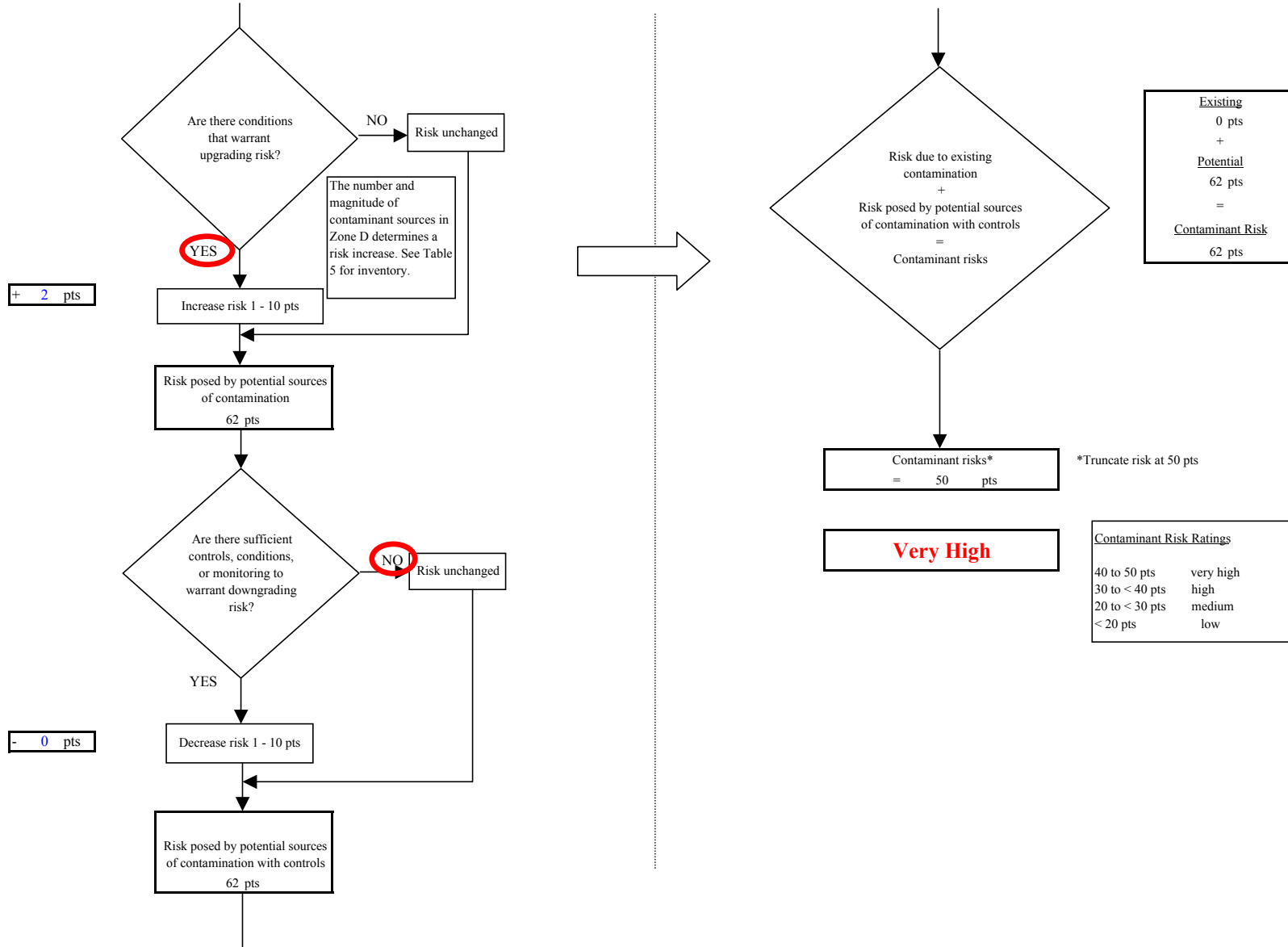
**Chart 9. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 9. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 9. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 10. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Heavy Metals, Cyanide and Other Inorganic Chemicals**

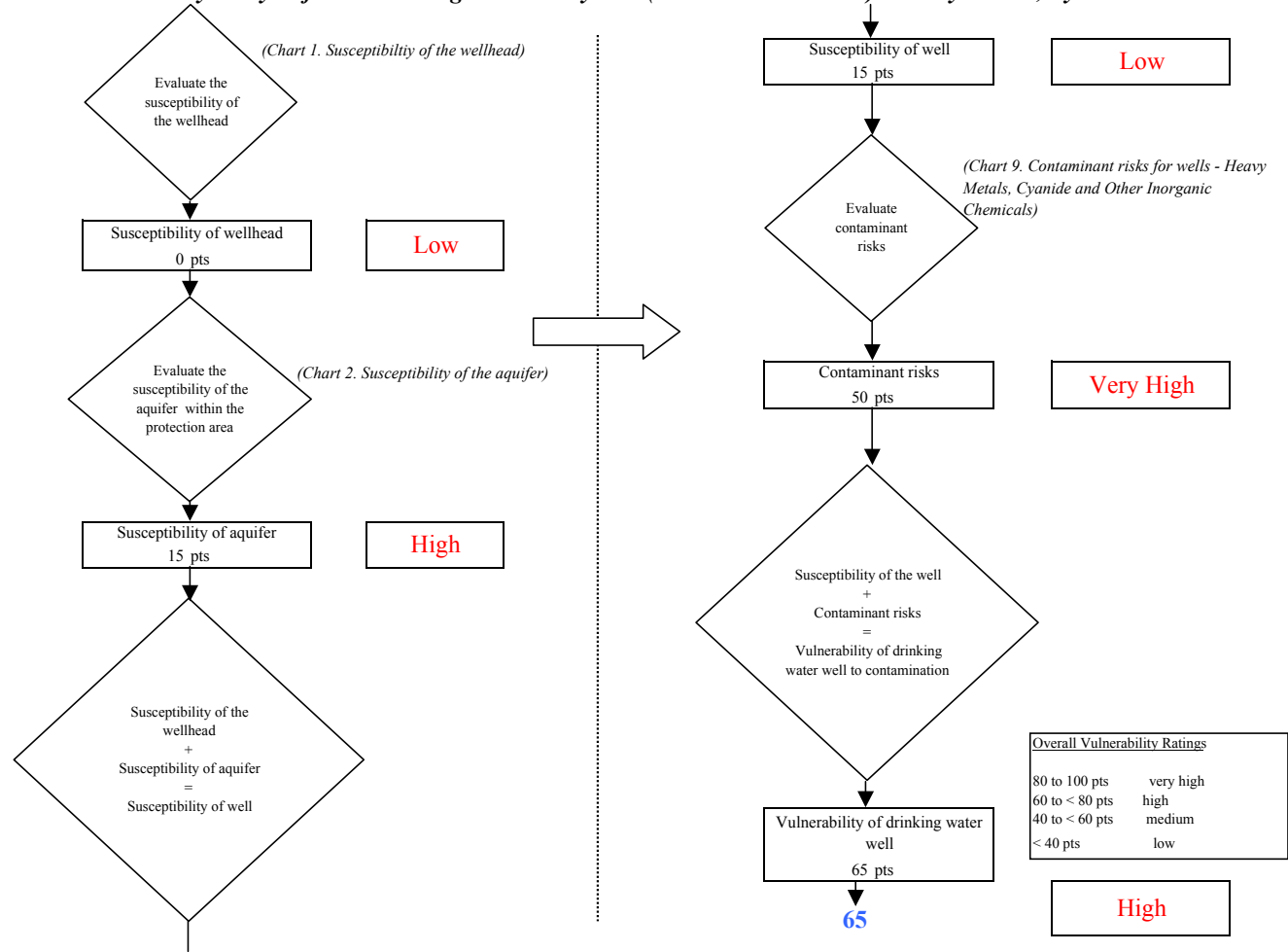
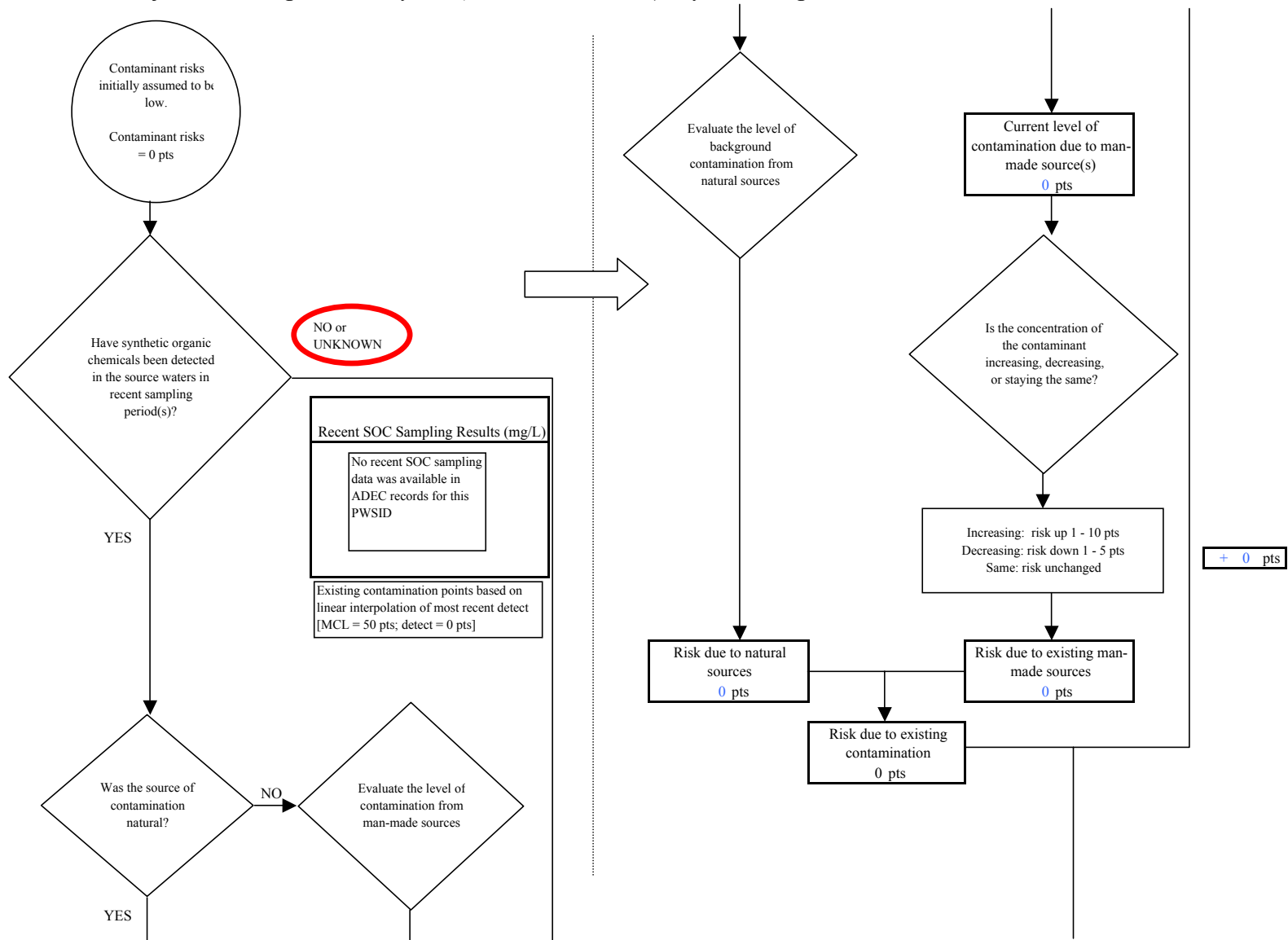
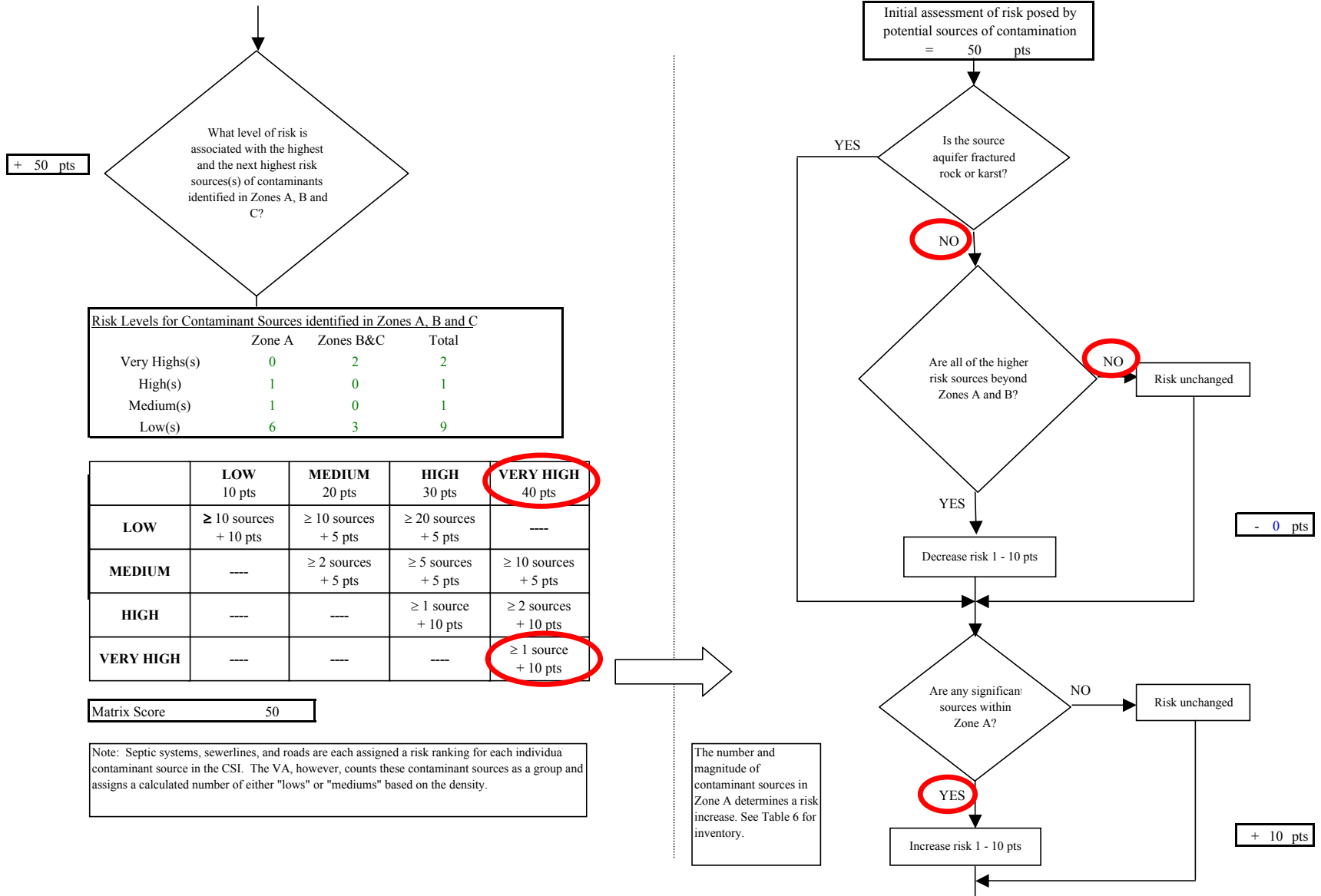


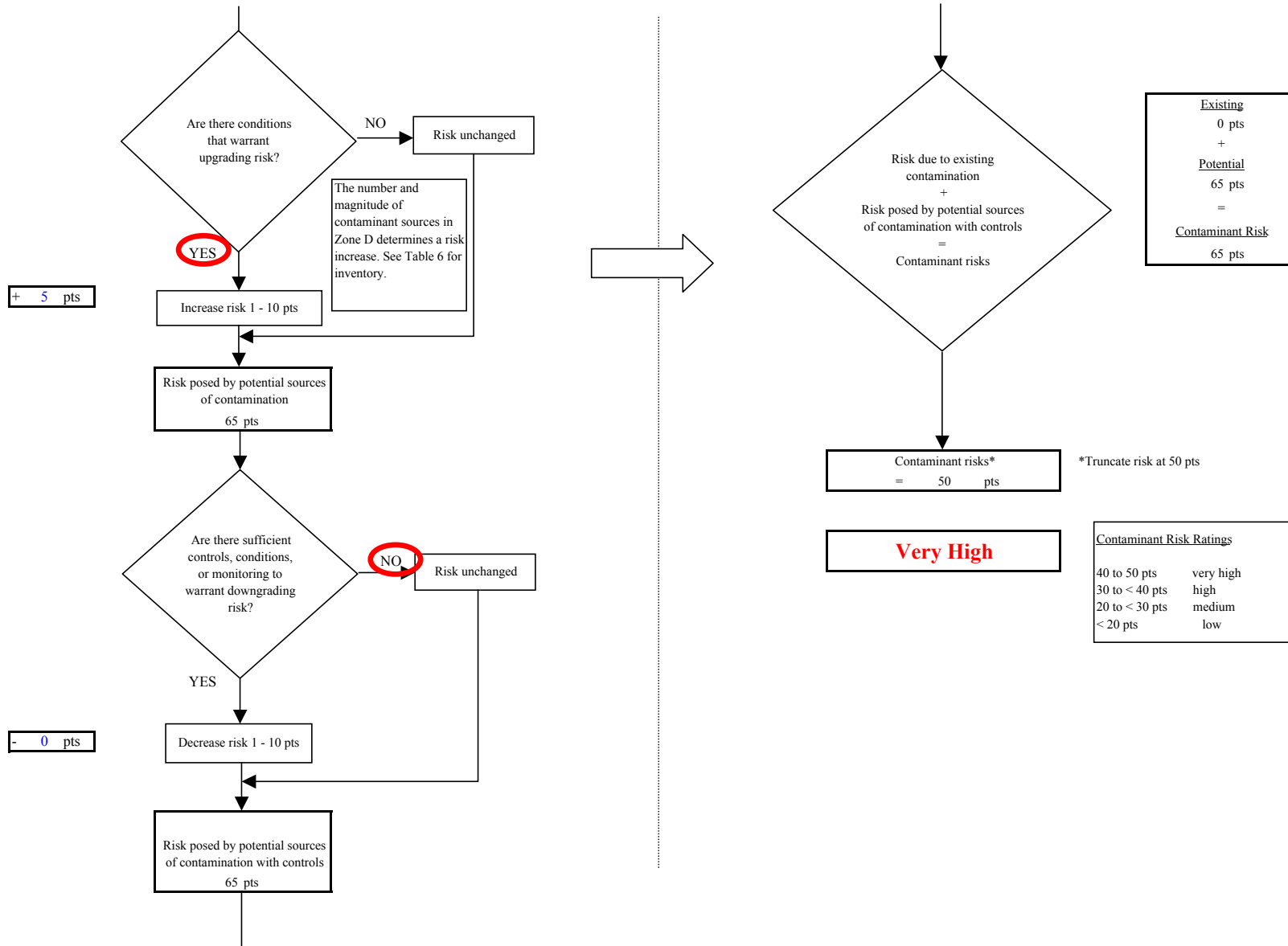
Chart 11. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Synthetic Organic Chemicals



**Chart 11. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Synthetic Organic Chemicals**



**Chart 11. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Synthetic Organic Chemicals**



**Chart 12. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Synthetic Organic Chemicals**

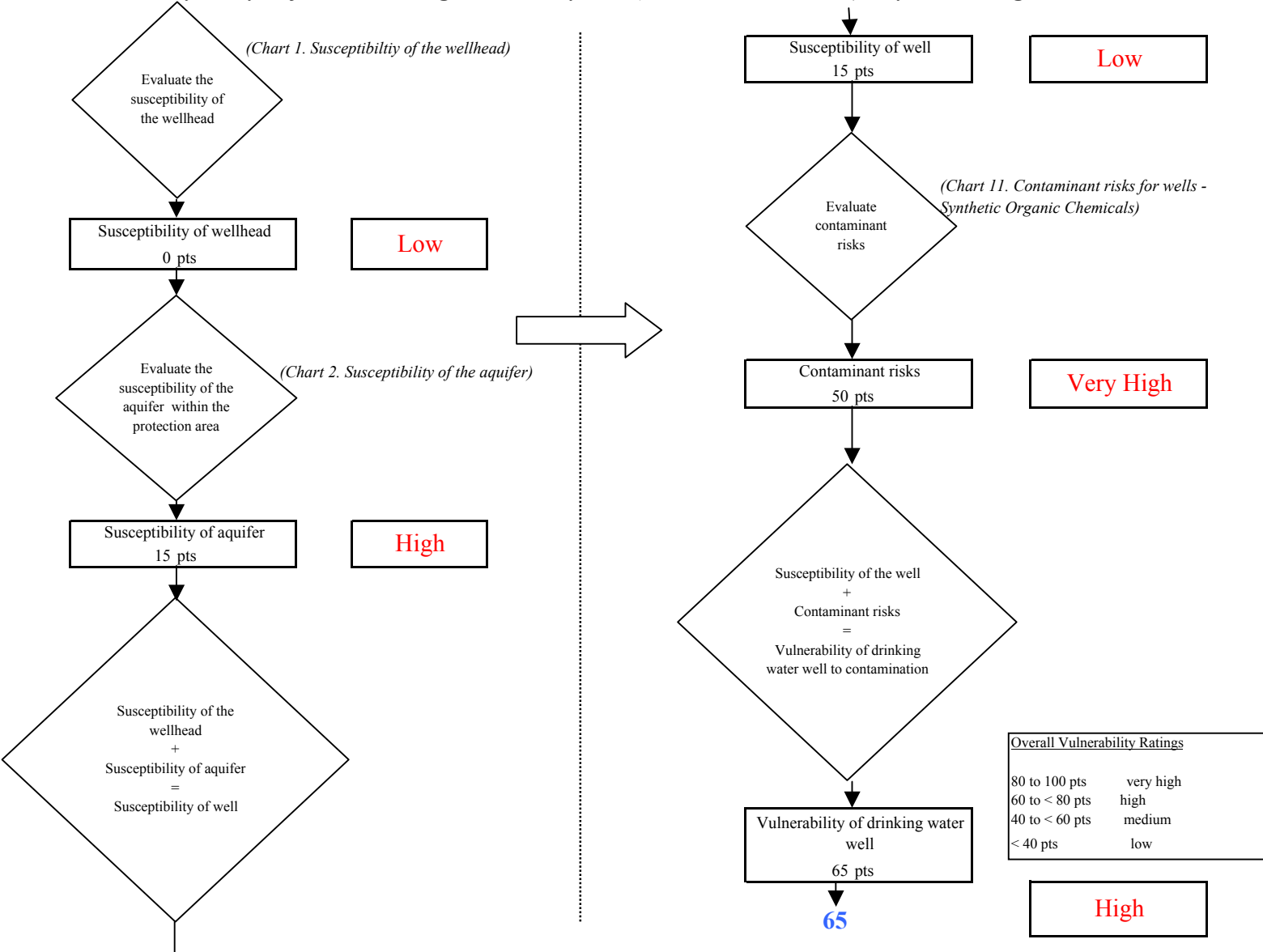




Chart 13. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Other Organic Chemicals

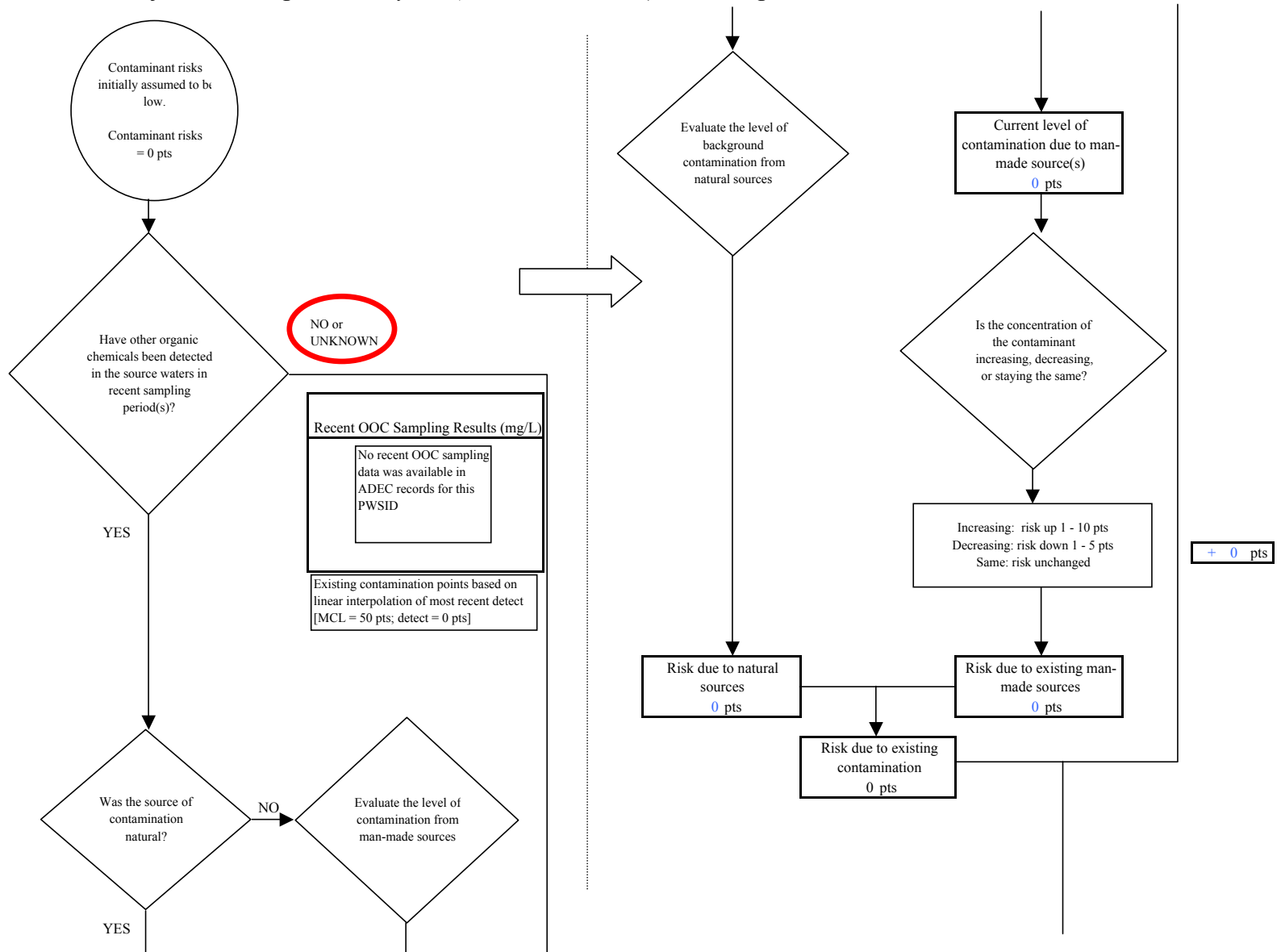
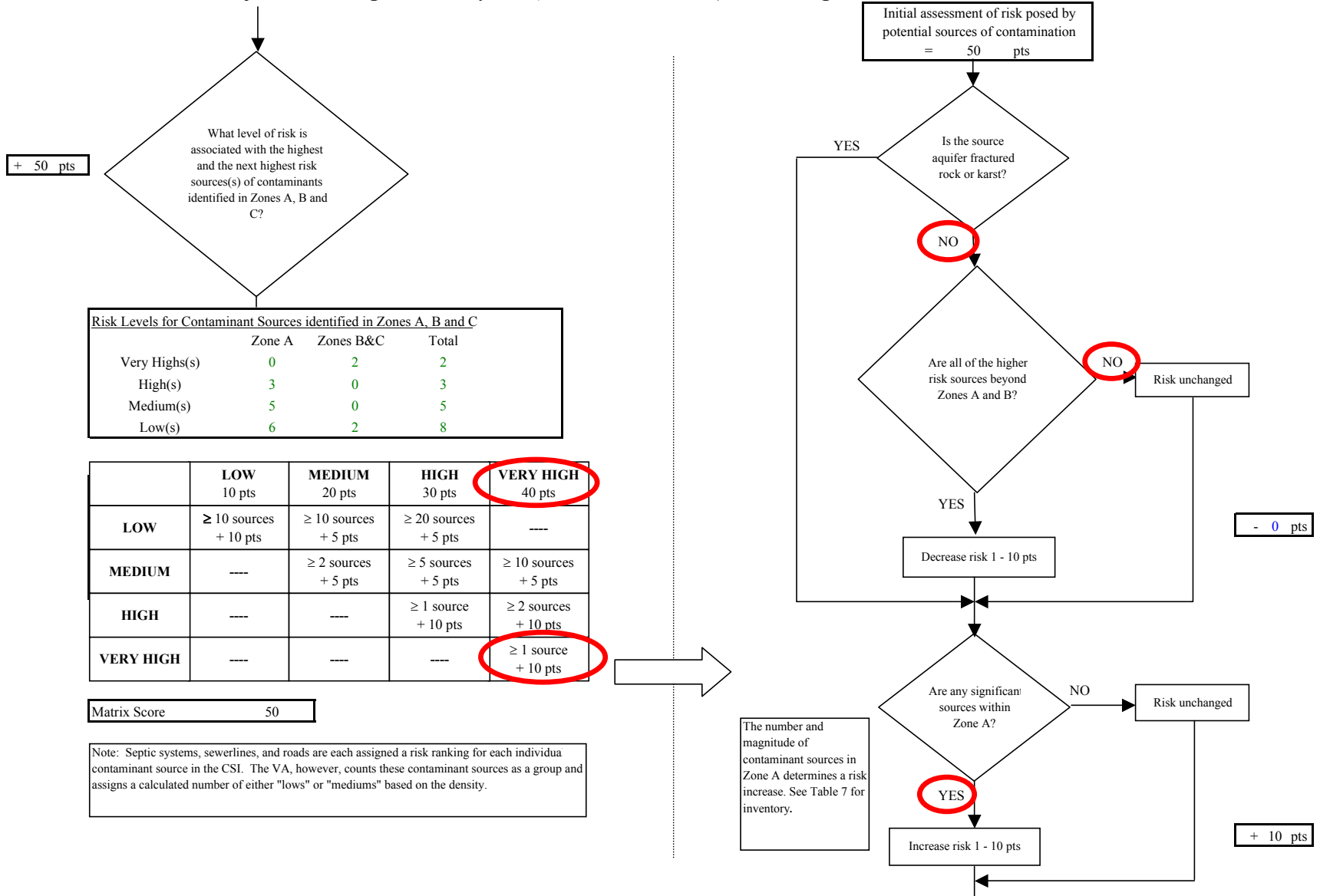
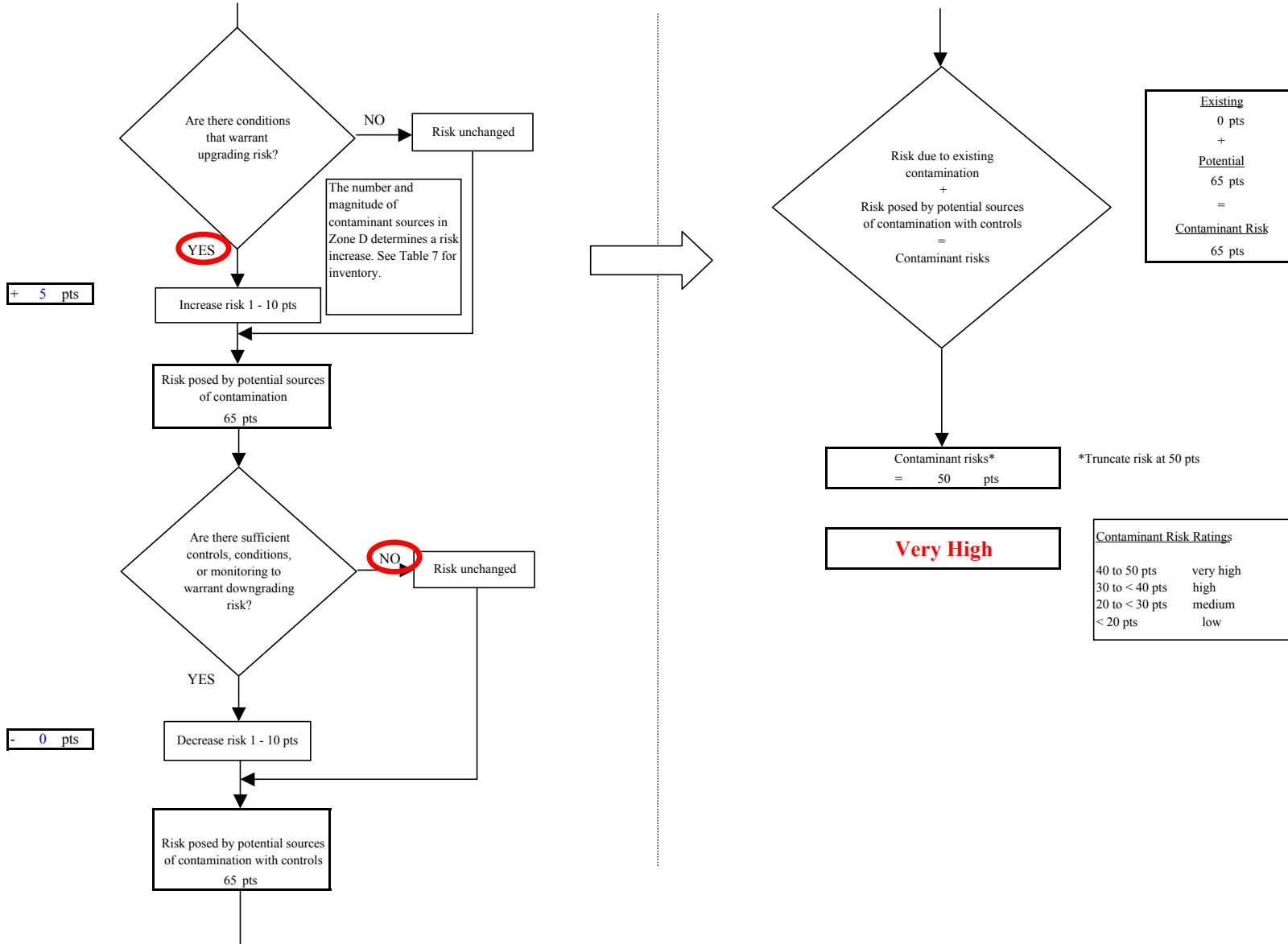


Chart 13. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Other Organic Chemicals



**Chart 13. Contaminant risks for Bethel Heights Water System (PWS No.270346.002) - Other Organic Chemicals**



**Chart 14. Vulnerability analysis for Bethel Heights Water System (PWS No.270346.002) - Other Organic Chemicals**

