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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
LKSD Akiuk Memorial School  
Drinking Water System,  
Kasigluk, Alaska

PWSID # 270621.001

April 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1409  
Alaska Department of Environmental Conservation

Source Water Assessment for  
LKSD Akiuk Memorial School  
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DRINKING WATER PROTECTION PROGRAM REPORT 1409

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.

## CONTENTS

EXECUTIVE SUMMARY .....	1	INVENTORY OF POTENTIAL AND EXISTING	
PUBLIC DRINKING WATER SYSTEM .....	1	CONTAMINANT SOURCES .....	2
DRINKING WATER PROTECTION AREA .....	2	RANKING OF CONTAMINANT RISKS .....	2
		VULNERABILITY OF DRINKING WATER	
		SYSTEM .....	3

## TABLES

Table 1. Definition of Zones .....	2
Table 2. Susceptibility .....	3
Table 3. Contaminant Risks .....	4
Table 4. Overall Vulnerability .....	4

## APPENDICES

APPENDIX	A. LKSD Akiuk Memorial School Drinking Water Protection Area (Map A)
	B. Contaminant Source Inventory for LKSD Akiuk Memorial School (Table 1)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Bacteria and Viruses (Table 2)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Nitrates/Nitrites (Table 3)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Volatile Organic Chemicals (Table 4)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Heavy Metals, Cyanide and Other Inorganic Chemicals (Table 5)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Synthetic Organic Chemicals (Table 6)
	Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School – Other Organic Chemicals (Table 7)
	C. LKSD Akiuk Memorial School Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)
	D. Vulnerability Analysis for Contaminant Source Inventory and Risk Ranking for LKSD Akiuk Memorial School Public Drinking Water Source (Charts 1 – 14)

# Source Water Assessment for LSKD Akiuk Memorial School Source of Public Drinking Water, Kasigluk, Alaska

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## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

The LKSD Akiuk Memorial School has one Public Water System (PWS) well. The well (PWS No. 270621.001) has been used as a drinking water source since it was drilled in 1963.

The well is a Class A (community and non-transient non-community) water system located approximately 50 feet east of the Johnson River in Kasigluk, Alaska. Available records indicate that there is secondary storage of drinking water, with a capacity of 6,000-gallons, and that the drinking water source is treated with calcium hypochlorite. This system operates year round and serves approximately 1 resident and 91 non-residents through three service connections. The wellhead received a susceptibility rating of **Very High** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produce a **High** rating for the natural susceptibility of the well.

Identified potential and current sources of contaminants for the public drinking water source include: Laundromats, domestic wastewater collection systems, domestic wastewater treatment plant disposal ponds/lagoons, honey bucket disposal areas, aboveground fuel tanks, fuel drums, water supply wells, cemeteries, glycol storage or disposal, petroleum product bulk stations/terminals, roads, pipelines, and electric power generation. 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 **Very High** for the bacteria and viruses, nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, and other organic chemicals, and a vulnerability rating of **High** for the synthetic organic chemicals contaminant categories.

### PUBLIC DRINKING WATER SYSTEM

The LKSD Akiuk Memorial School well is a Class A (community/non-transient/non-community) public water system. The system is located approximately 50 feet east of the Johnson River in Kasigluk, Alaska (Sec. 2, T9N, R75W, Seward Meridian; see Map A of Appendix A). Kasigluk is located on the Johnson River in the Kuskokwim River Delta. The community is comprised of Old and New Kasigluk, and is surrounded by the Johnson River and a network of lakes. Kasigluk is 26 miles northwest of Bethel. The community has a population of 529 (ADCED, 2003). Average annual precipitation in Kasigluk is 16 inches, with 50 inches of snowfall. Temperatures range from 42 to 62°F in summer and -2 to 19°F in winter.

The community of Kasigluk obtains most of their water supply from community wells. Honey buckets are hauled to sewage bunkers (ADCED, 2003). Kasigluk receives electrical power from AVEC, a REA Cooperative. Power generating facilities are fueled by diesel. Refuse is collected by the Village Council and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the LKSD Akiuk Memorial School PWS, the depth of the primary water well is 165 feet below the ground surface. Based on available well construction details, it appears that the well is screened in a confined aquifer. The well is located within a floodplain.

Information acquired from a September 1998 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 most of the area west of the Kuskokwim River appears 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 (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 LKSD Akiuk Memorial School 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**

Zone	Definition
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 LKSD Akiuk Memorial School 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 LKSD Akiuk Memorial School 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.

Susceptibility of the Wellhead (0 – 25 Points)  
(Chart 1 of Appendix D)

+

Susceptibility of the Aquifer (0 – 25 Points)  
(Chart 2 of Appendix D)

=

Natural Susceptibility (Susceptibility of the Well)  
(0 – 50 Points)

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 LKSD Akiuk Memorial School’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	20	Very High
Susceptibility of the Aquifer	15	High
Natural Susceptibility	35	High

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	25	Medium
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:

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

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	85	Very High
Nitrates and Nitrites	85	Very High
Volatile Organic Chemicals	85	Very High
Heavy Metals, Cyanide and		
Other Inorganic Chemicals	85	Very High
Synthetic Organic Chemicals	60	High

Other Organic Chemicals      85      Very High

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is **Very High**. The risk is primarily attributed to the presence of domestic wastewater treatment plant disposal ponds/lagoons and honey bucket disposal areas in Zone A (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).

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 **Very 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 domestic wastewater treatment disposal ponds/lagoons and honey bucket disposal areas in Zone A (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 low levels of nitrates have been detected in recent sampling events. However, the reported concentrations of nitrates do not exceed the maximum contaminant level (MCL) of 10 mg/L. 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 **Very High**.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the

presence of petroleum product bulk stations/terminals in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

All recent sampling data for VOCs were below detection levels for the LKSD Akiuk Memorial School (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 **Very 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 electric power generation in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 5 – Appendix B).

Based on review of recent sampling records for this public water system, low levels of thallium and arsenic have been detected. Arsenic has exceeded the MCL of 0.05 mg/L (see Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

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 **Very High**.

### **Synthetic Organic Chemicals**

The contaminant risk for synthetic organic chemicals is **Medium**. The risk is primarily attributed to the presence of a cemetery in Zone A. 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 LKSD Akiuk Memorial School (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 petroleum product bulk stations/terminals, pipelines, and electric power generation in Zone A. 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 LKSD Akiuk Memorial School (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 **Very 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 LKSD Akiuk Memorial School and the community of Kasigluk 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.



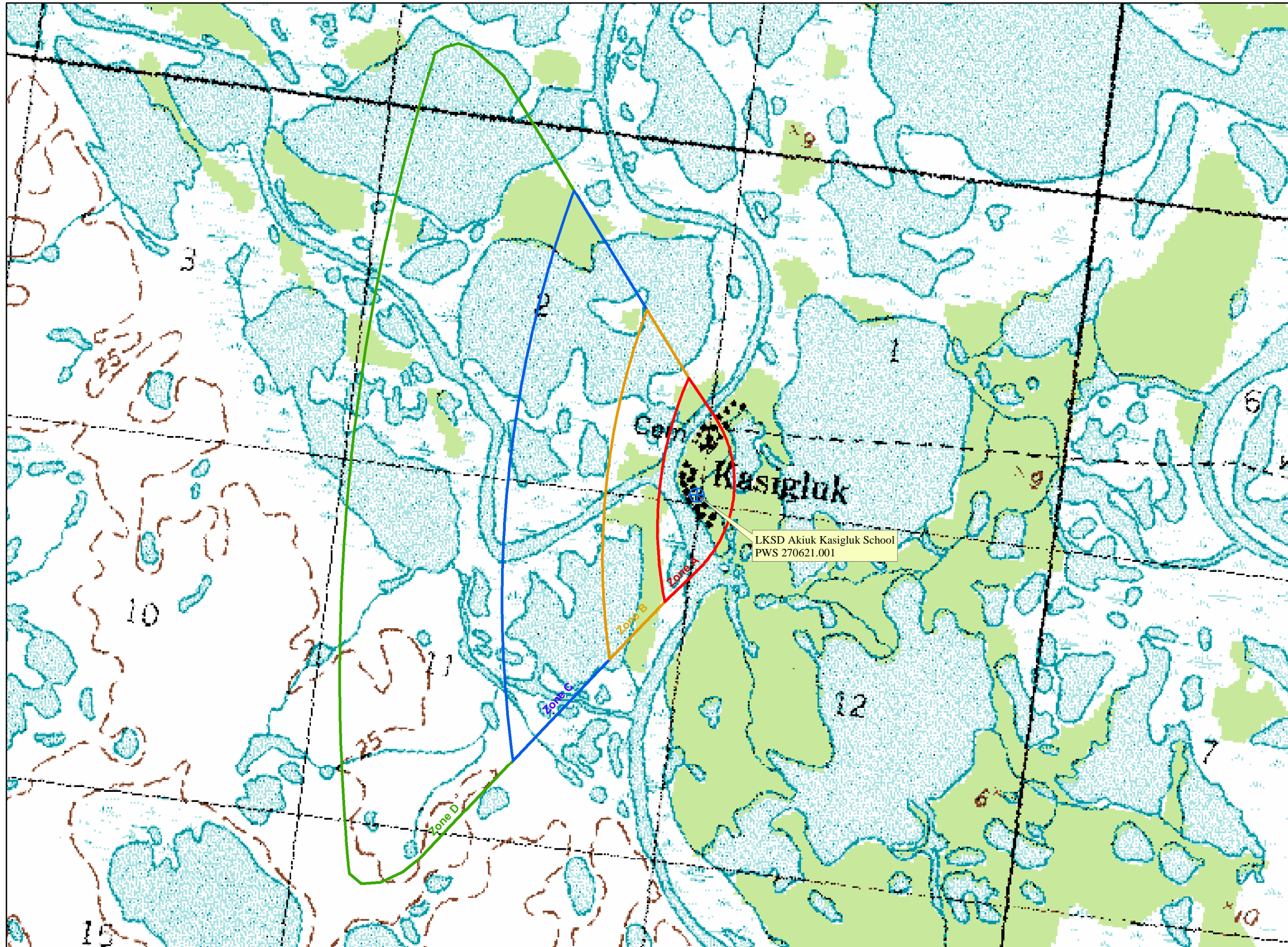
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# **APPENDIX A**

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

Public Water Well System for PWS #270621.001 LKSD Akiuk Kasigluk School



**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

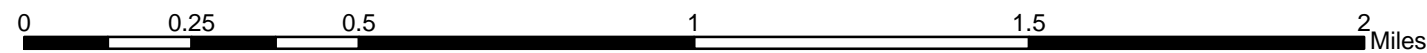
Data Sources:  
Contaminant Sources, Public Water System Wells, Contours  
Alaska Department of Environmental Conservation (ADEC)

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.



LKSD Akiuk Kasigluk School  
PWS 270621.001

Appendix A Map A

## **APPENDIX B**

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

**Table 1**

**Contaminant Source Inventory for  
LKSD Akiuk Kasigluk**

**PWSID 270621.001**

<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>
Laundromats without dry cleaning	C22	C22-01	A	C	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	A	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	C	Old BIA lagoon
Honey bucket disposal areas (community)	D07	D07-01	A	C	Assume 5 or less honey bucket pits in Zone A
Tanks, heating oil, residential (above ground)	R08	R08-01	A	C	Assume 50 or less residential heating oil tanks in Zone A
Fuel drums (above ground)	T01	T01-01	A	C	Used Oil
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	Old Village Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	Akiuk School emergency operations center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	C	Army National Guard
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	C	Akiuk School
Water supply wells	W09	W09-01	A	C	2 water supply wells in Zone A
Cemeteries	X01	X01-01	A	C	Assume cemetery located in Zone A
Glycol (disposal or storage)	X07	X07-01	A	C	
Petroleum product bulk station/terminals	X11	X11-01	A	C	Village Council
Petroleum product bulk station/terminals	X11	X11-02	A	C	LKSD
Petroleum product bulk station/terminals	X11	X11-03	A	C	Kasigluk, Inc.
Petroleum product bulk station/terminals	X11	X11-04	A	C	Army National Guard
Petroleum product bulk station/terminals	X11	X11-05	A	C	Old BIA Tank Farm
Highways and roads, dirt/gravel	X24	X24-01	A	C	Assume 1-20 roads in Zone A
Pipelines (oil and gas)	X28	X28-01	A	C	
Electric power generation (fossil fuels)	X36	X36-01	A	C	BIA Utility Building

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Bacteria and Viruses*

*PWSID 270621.001*

**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>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	High	C	Old BIA lagoon
Honey bucket disposal areas (community)	D07	D07-01	A	High	C	Assume 5 or less honey bucket pits in Zone A
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A

Table 3

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Nitrates/Nitrites*

PWSID 270621.001

<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>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	High	C	Old BIA lagoon
Honey bucket disposal areas (community)	D07	D07-01	A	High	C	Assume 5 or less honey bucket pits in Zone A
Cemeteries	X01	X01-01	A	Medium	C	Assume cemetery located in Zone A
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Volatile Organic Chemicals*

*PWSID 270621.001*

**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>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	Low	C	Old BIA lagoon
Honey bucket disposal areas (community)	D07	D07-01	A	Low	C	Assume 5 or less honey bucket pits in Zone A
Tanks, heating oil, residential (above ground)	R08	R08-01	A	Low	C	Assume 50 or less residential heating oil tanks in Zone A
Fuel drums (above ground)	T01	T01-01	A	Low	C	Used Oil
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	Old Village Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Akiuk School emergency operations center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Army National Guard
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Akiuk School
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	Village Council
Petroleum product bulk station/terminals	X11	X11-02	A	Very High	C	LKSD
Petroleum product bulk station/terminals	X11	X11-03	A	Very High	C	Kasigluk, Inc.
Petroleum product bulk station/terminals	X11	X11-04	A	Very High	C	Army National Guard
Petroleum product bulk station/terminals	X11	X11-05	A	Very High	C	Old BIA Tank Farm
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Pipelines (oil and gas)	X28	X28-01	A	Medium	C	
Electric power generation (fossil fuels)	X36	X36-01	A	Low	C	BIA Utility Building



*Table 4 (continued)*

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Volatile Organic Chemicals*

*PWSID 270621.001*

<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>
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*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk*

*PWSID 270621.001*

**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>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	Low	C	Old BIA lagoon
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	Old Village Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Akiuk School emergency operations center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Army National Guard
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Akiuk School
Cemeteries	X01	X01-01	A	Low	C	Assume cemetery located in Zone A
Glycol (disposal or storage)	X07	X07-01	A	Low	C	
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	Village Council
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	LKSD
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Kasigluk, Inc.
Petroleum product bulk station/terminals	X11	X11-04	A	Low	C	Army National Guard
Petroleum product bulk station/terminals	X11	X11-05	A	Low	C	Old BIA Tank Farm
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Pipelines (oil and gas)	X28	X28-01	A	Low	C	
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	BIA Utility Building

Table 6

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Synthetic Organic Chemicals*

PWSID 270621.001

<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	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	Low	C	Old BIA lagoon
Cemeteries	X01	X01-01	A	Medium	C	Assume cemetery located in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	Village Council
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	LKSD
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Kasigluk, Inc.
Petroleum product bulk station/terminals	X11	X11-04	A	Low	C	Army National Guard
Petroleum product bulk station/terminals	X11	X11-05	A	Low	C	Old BIA Tank Farm

*Contaminant Source Inventory and Risk Ranking for  
LKSD Akiuk Kasigluk  
Sources of Other Organic Chemicals*

*PWSID 270621.001*

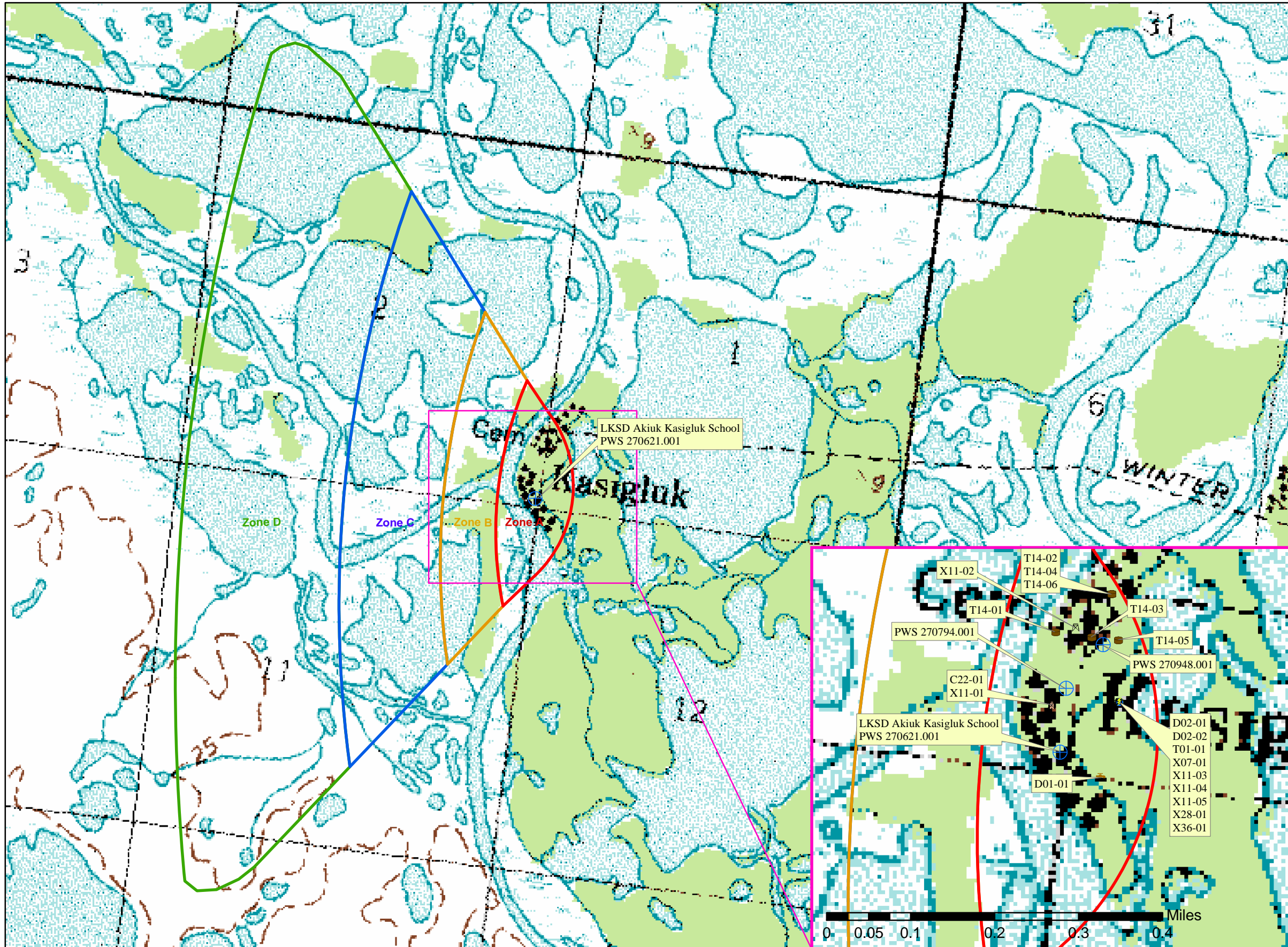
**Table 7**

<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>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	LKSD Akula
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-02	A	Low	C	Old BIA lagoon
Petroleum product bulk station/terminals	X11	X11-01	A	High	C	Village Council
Petroleum product bulk station/terminals	X11	X11-02	A	High	C	LKSD
Petroleum product bulk station/terminals	X11	X11-03	A	High	C	Kasigluk, Inc.
Petroleum product bulk station/terminals	X11	X11-04	A	High	C	Army National Guard
Petroleum product bulk station/terminals	X11	X11-05	A	High	C	Old BIA Tank Farm
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Pipelines (oil and gas)	X28	X28-01	A	High	C	
Electric power generation (fossil fuels)	X36	X36-01	A	High	C	BIA Utility Building

## **APPENDIX C**

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

**Public Water Well System for PWS #270621.001 LKSD Akiuk Kasigluk School  
Showing Potential and Existing Sources of Contamination**



**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

**Existing or Potential Contaminant Sources**

- Washeteria (C22)
- Domestic wastewater collection systems (sewer lines) (D01)
- Domestic wastewater treatment plant disposal pond (D02)
- Aboveground fuel drums (T01)
- Nonresidential aboveground heating oil tanks (T14)
- Glycol (X07)
- Petroleum product bulk station/terminal (X11)
- Oil and gas pipelines (X28)
- Electric power generation (fossil fuels) (X36)

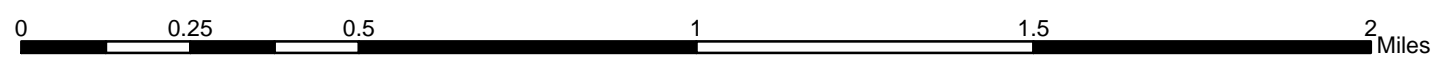
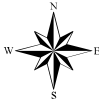
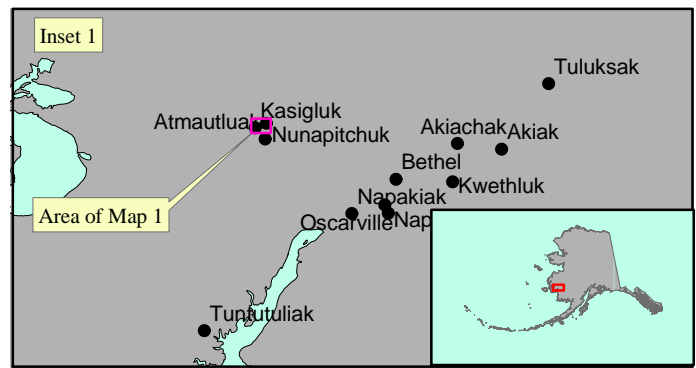
Data Sources:

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

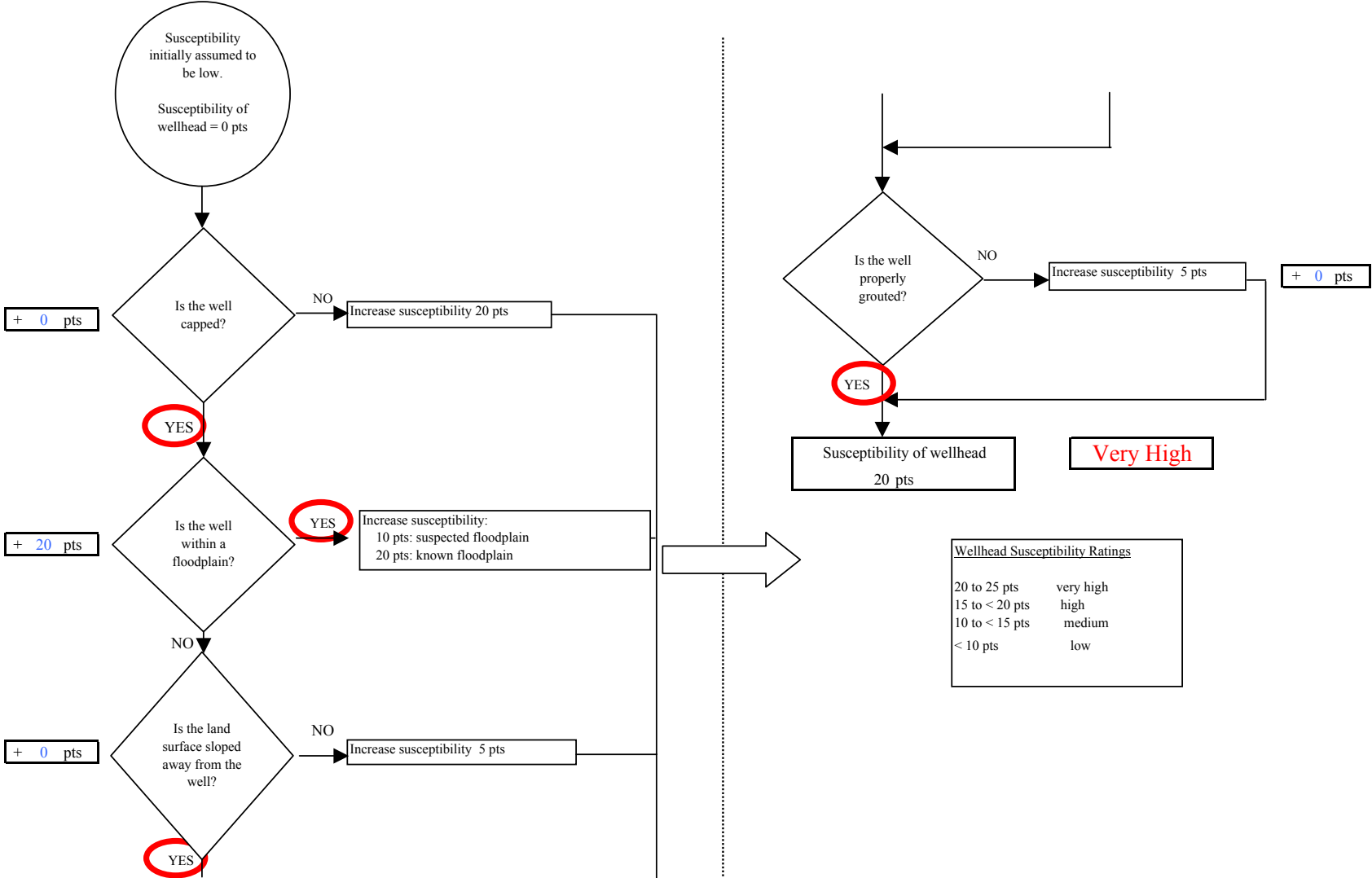
URS Corporation does not guarantee the accuracy or validity of the data provided.



## **APPENDIX D**

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

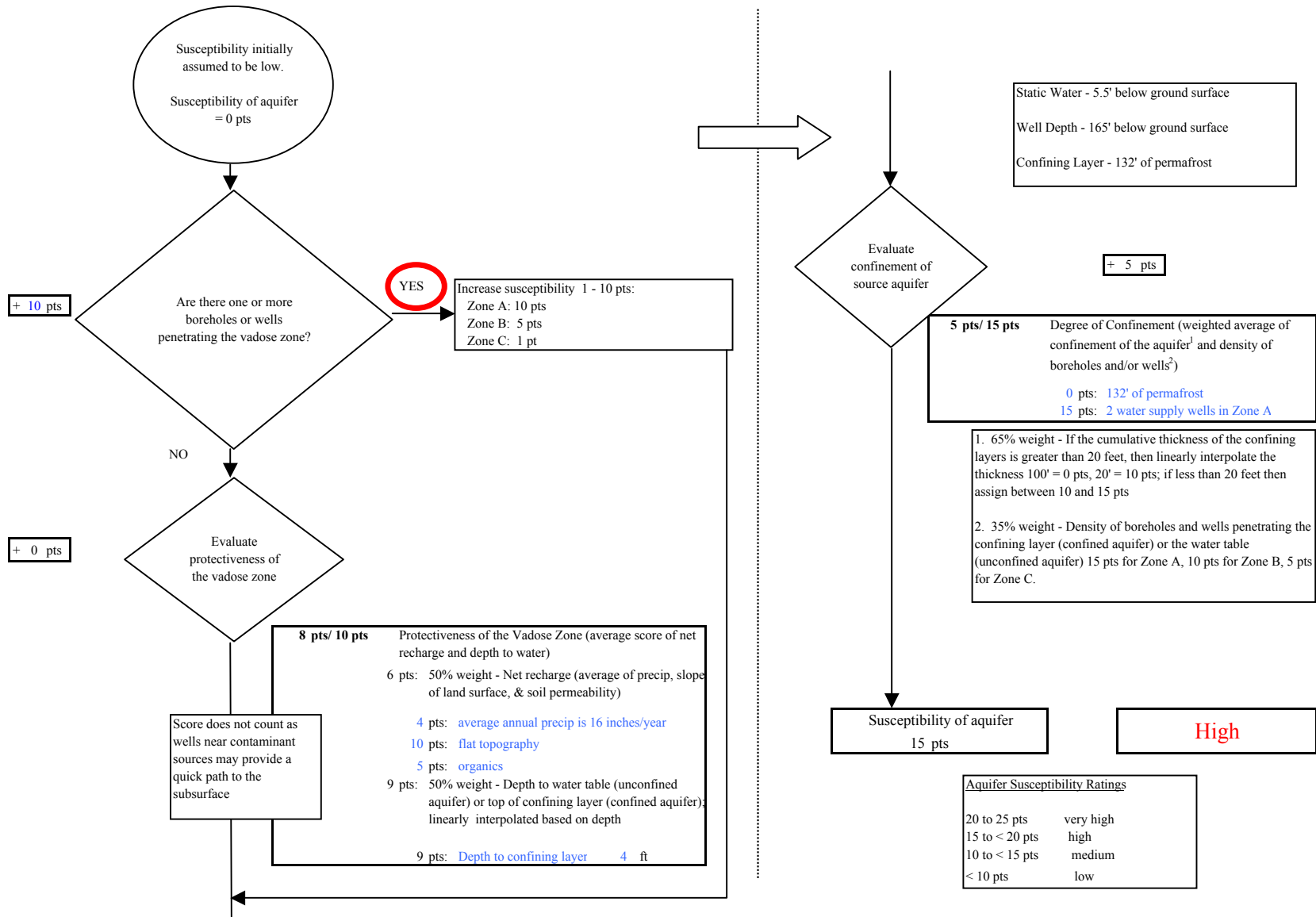
**Chart 1. Susceptibility of the wellhead - LKSD Akiuk Memorial School (PWS No.270621.001)**



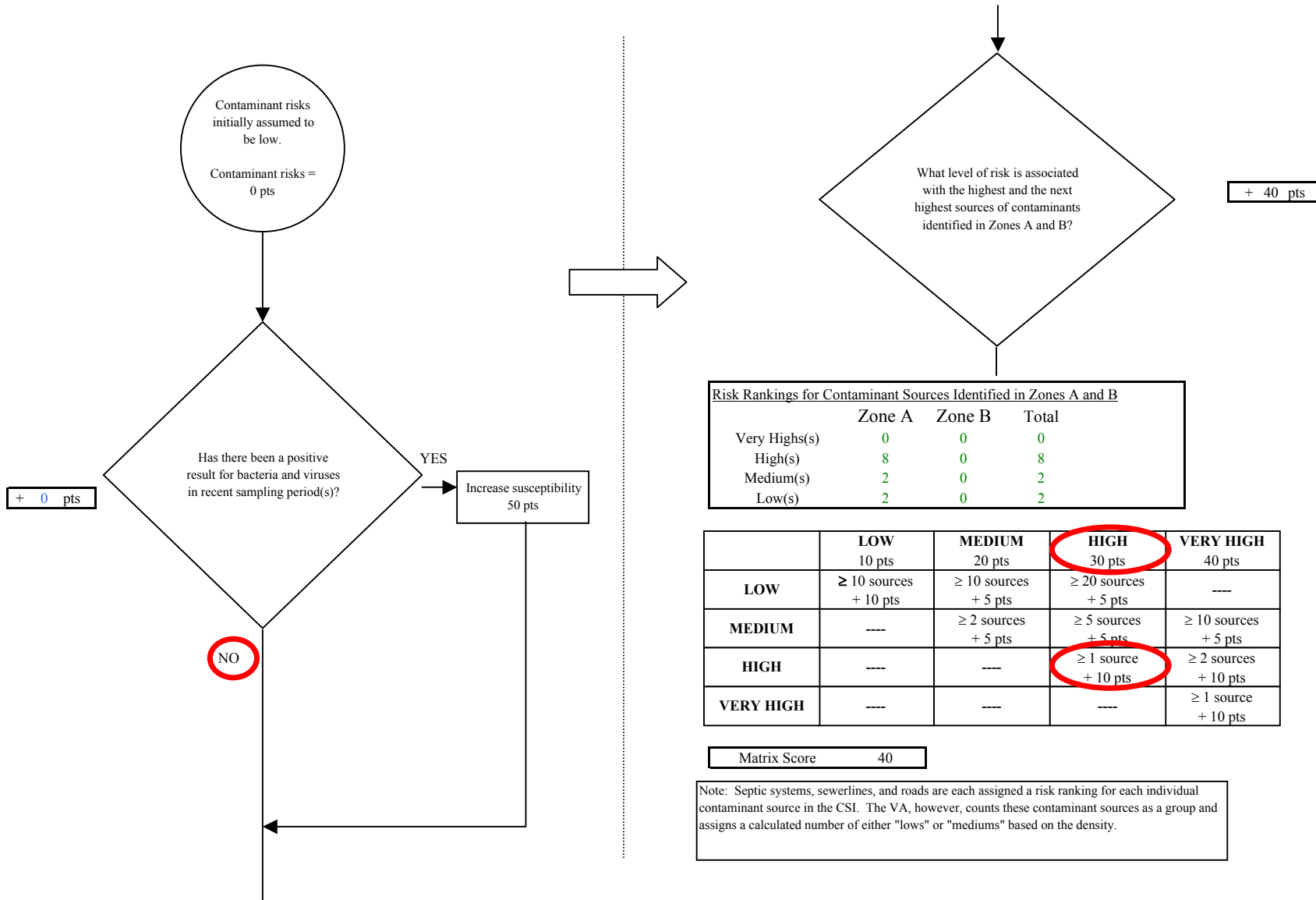
Wellhead Susceptibility Ratings	
20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10 pts	low



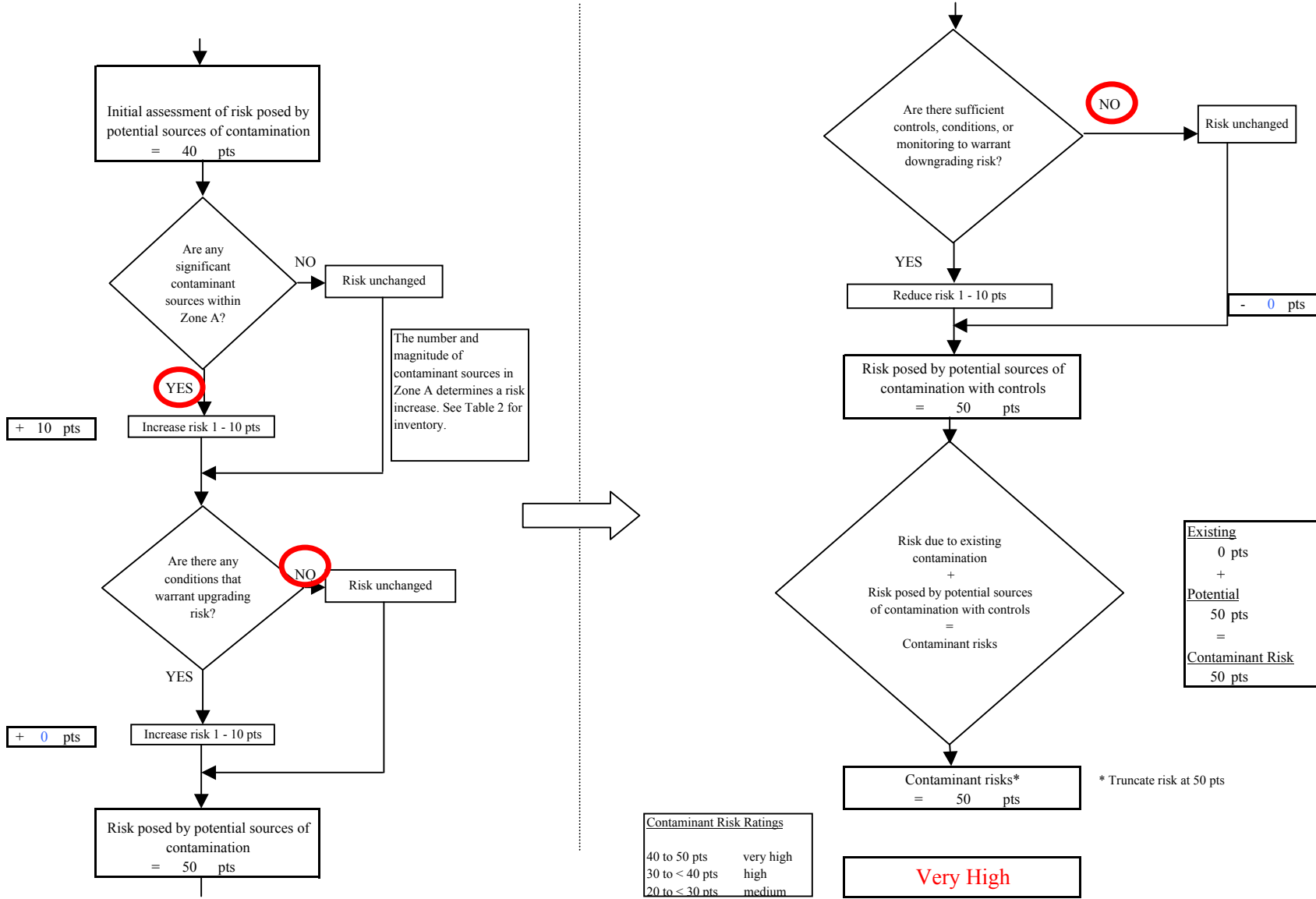
**Chart 2. Susceptibility of the aquifer LKSD Akiuk Memorial School (PWS No.270621.001)**



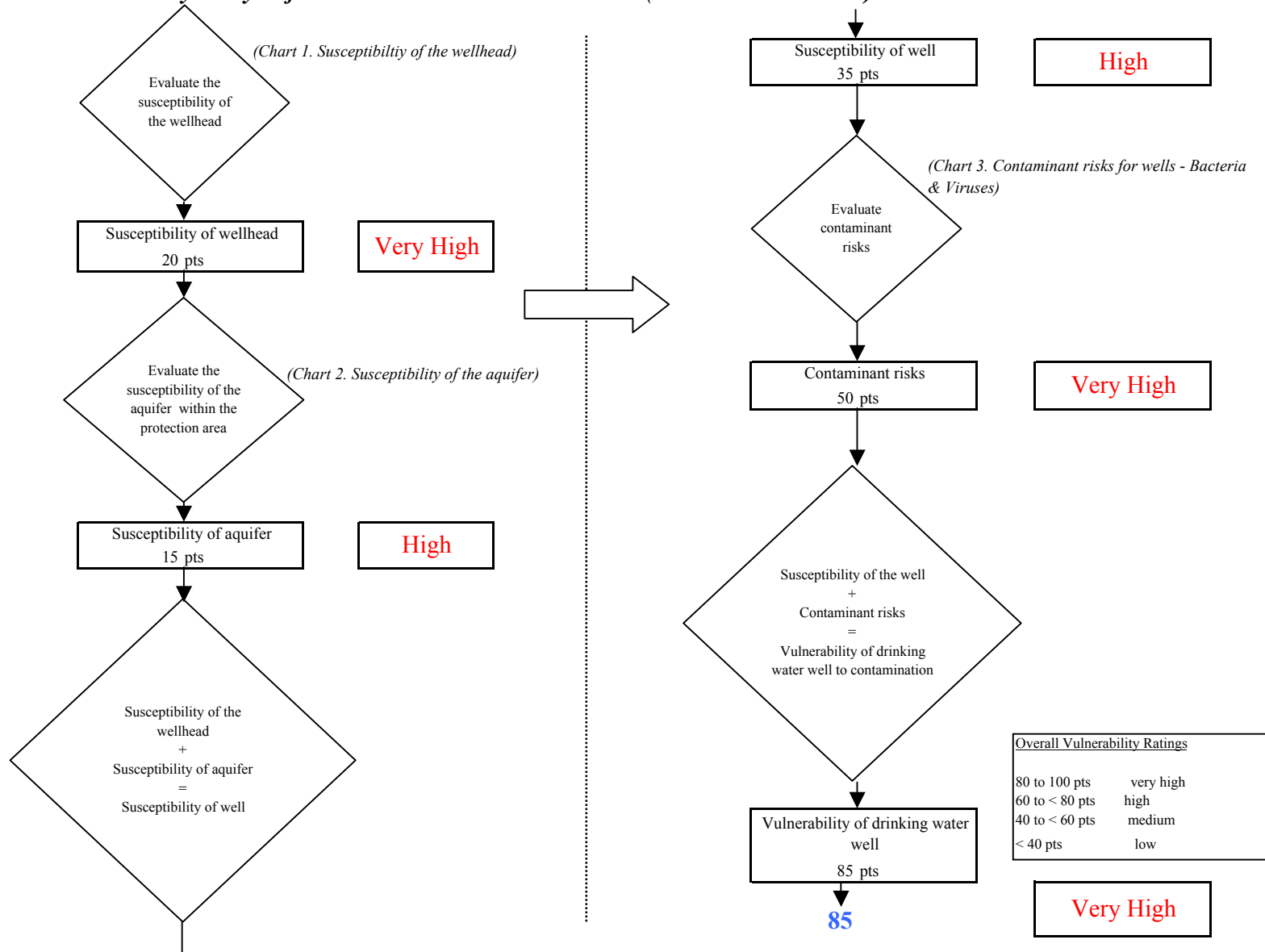
**Chart 3. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Bacteria & Viruses**



**Chart 3. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Bacteria & Viruses**



**Chart 4. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Bacteria & Viruses**



**Chart 5. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Nitrates and Nitrites**

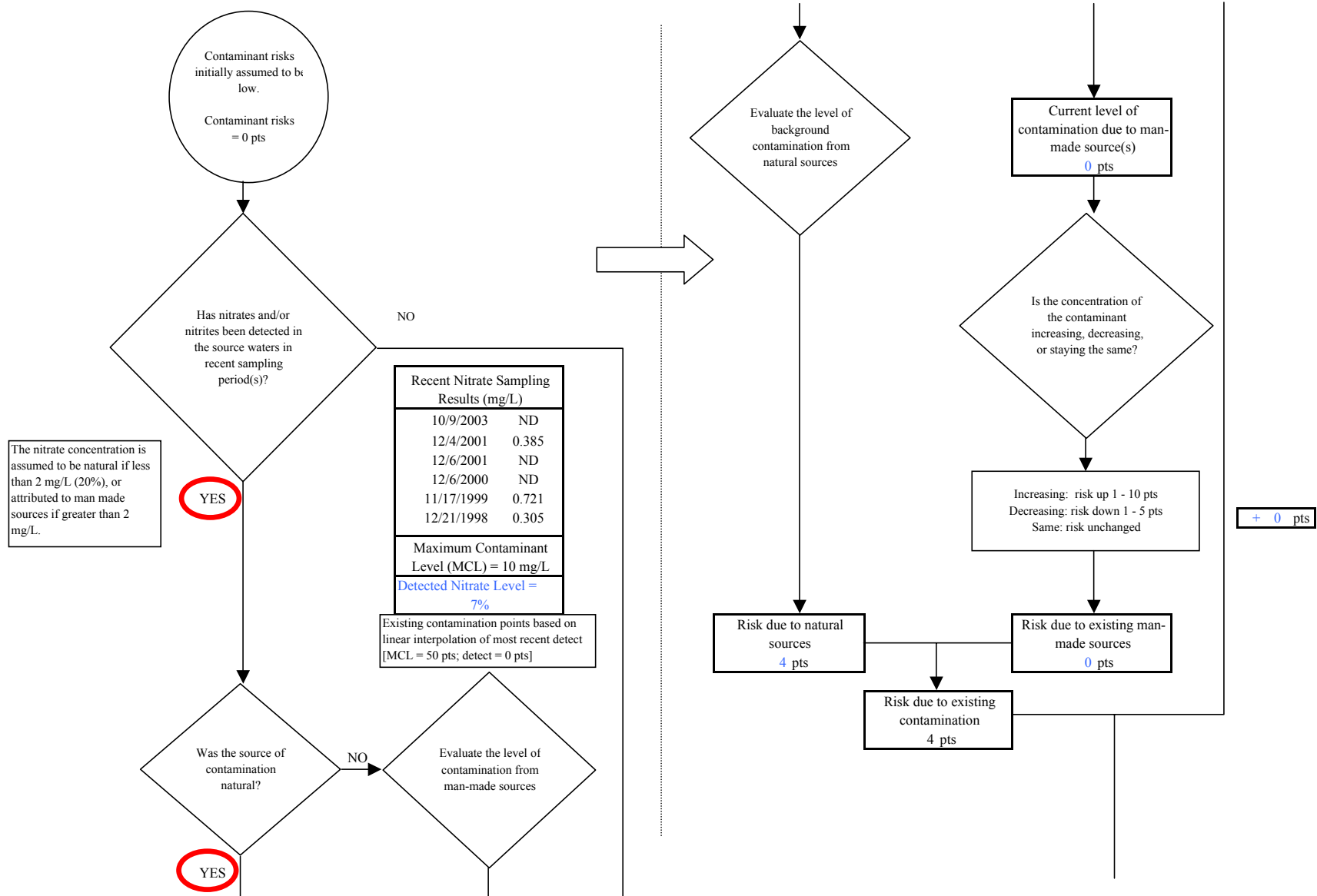
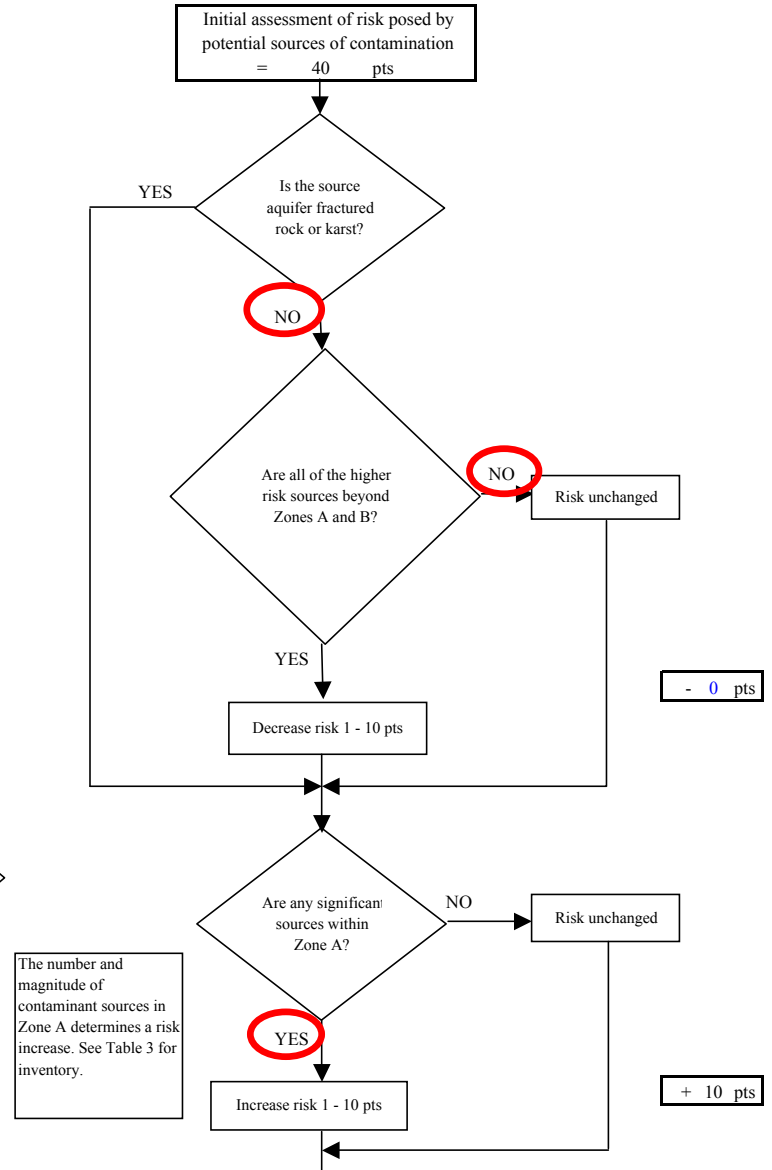
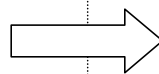
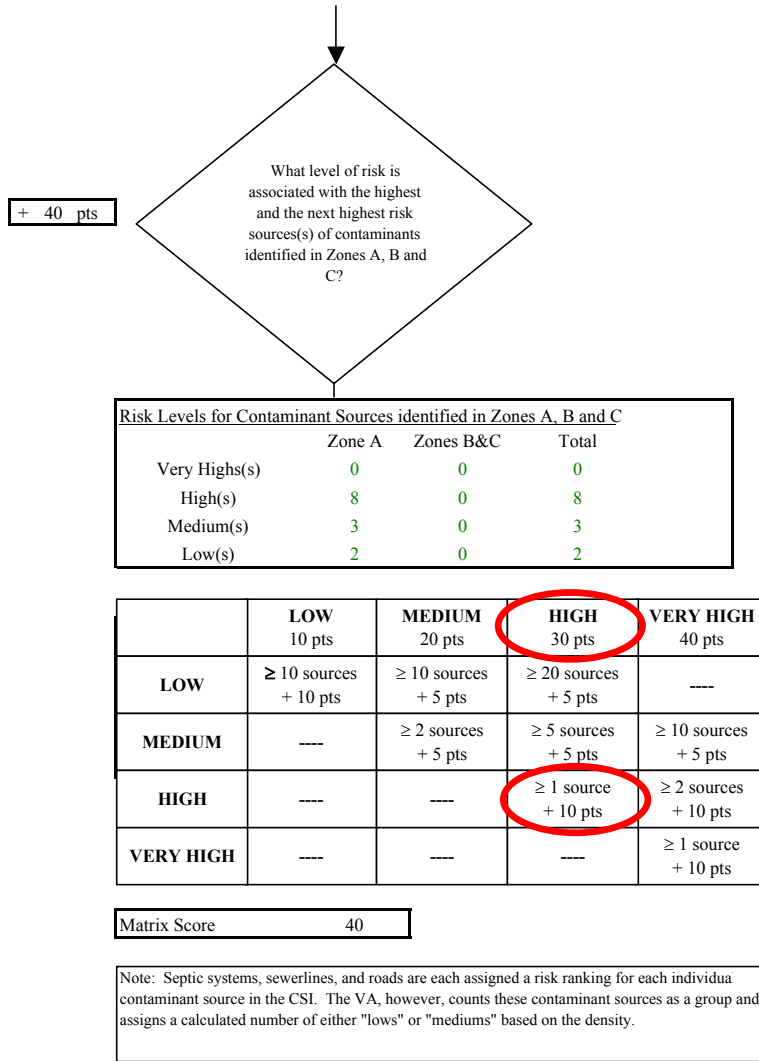
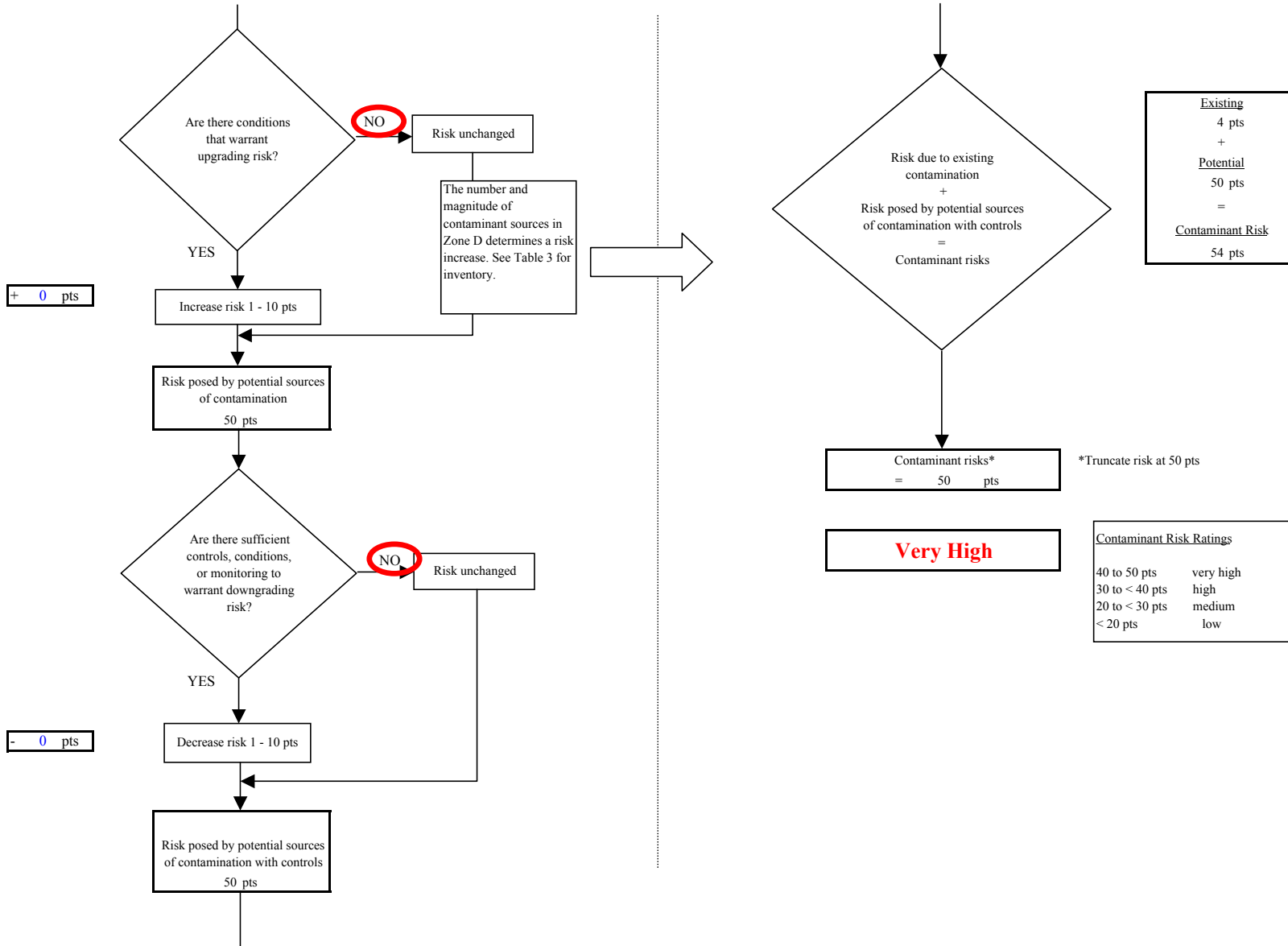


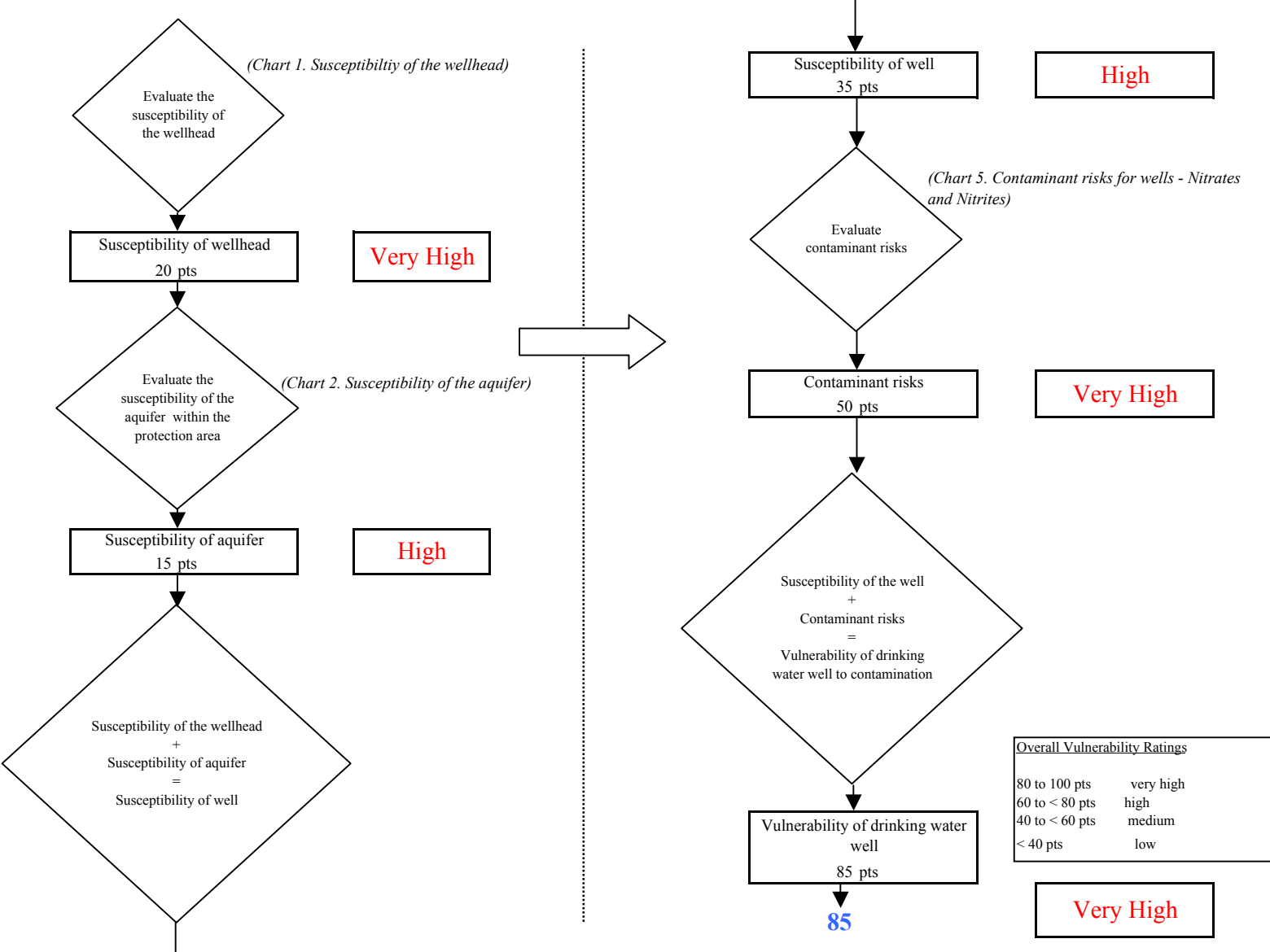
Chart 5. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Nitrates and Nitrites



**Chart 5. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Nitrates and Nitrites**



**Chart 6. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Nitrates and Nitrites**





**Chart 7. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Volatile Organic Chemicals**

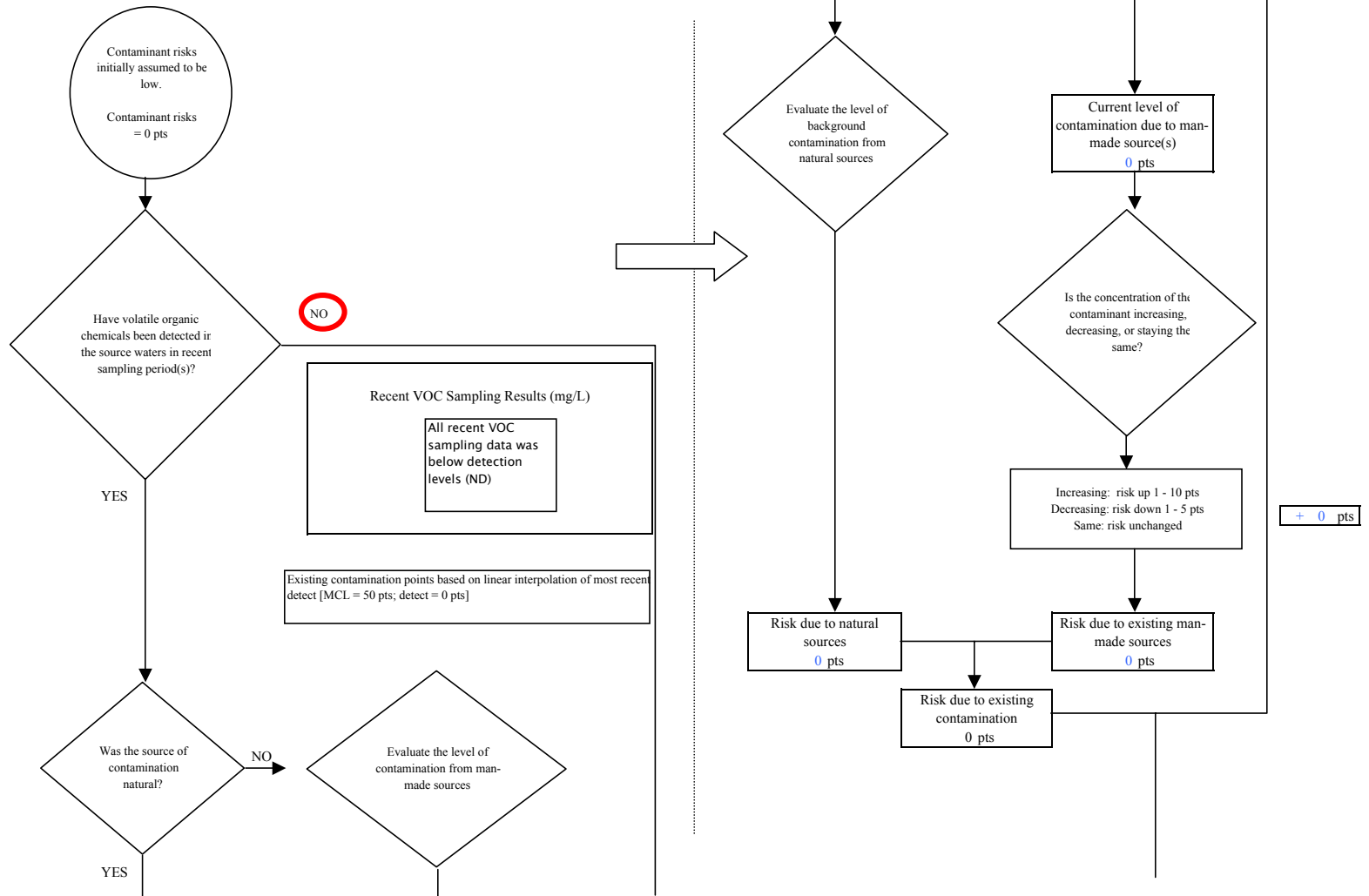


Chart 7. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Volatile Organic Chemicals

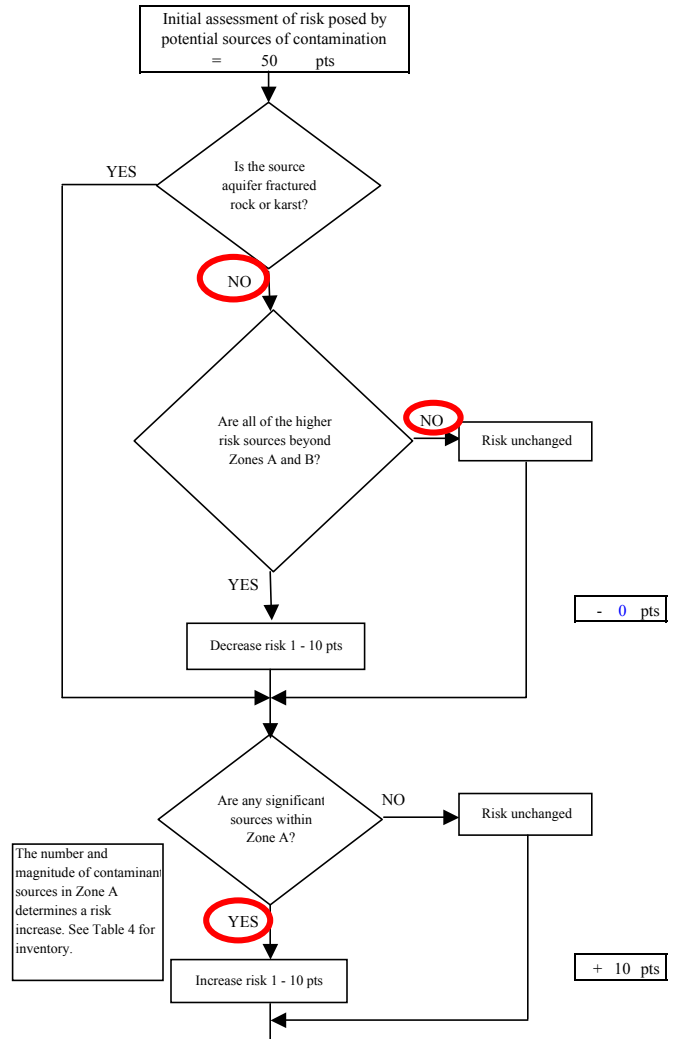
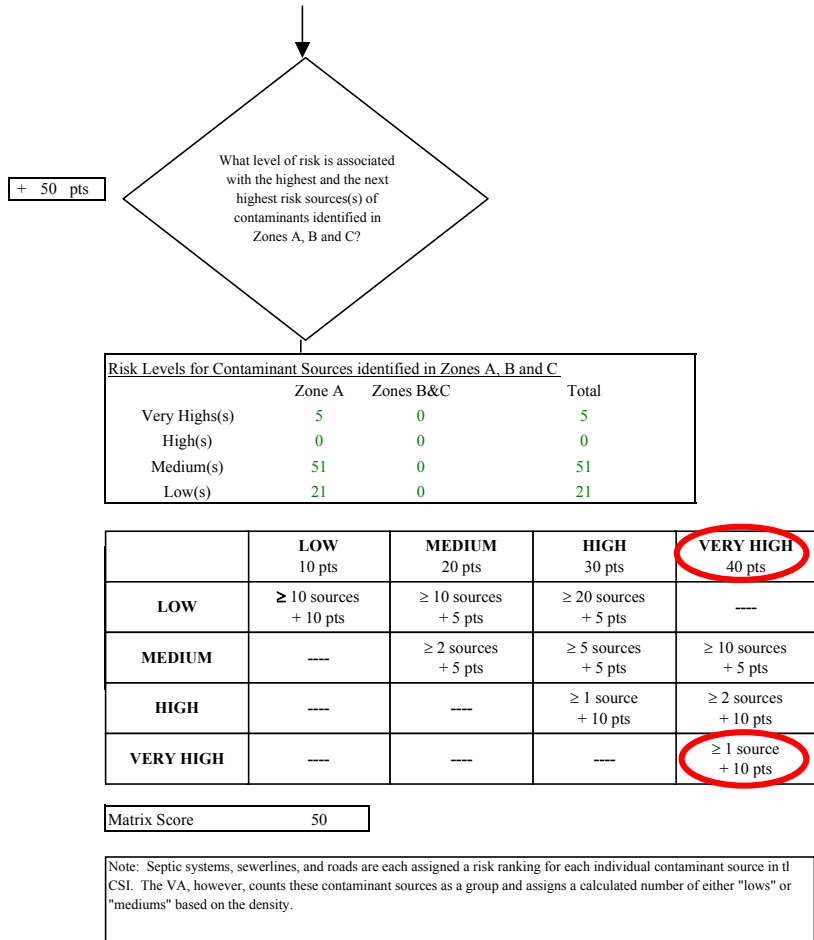
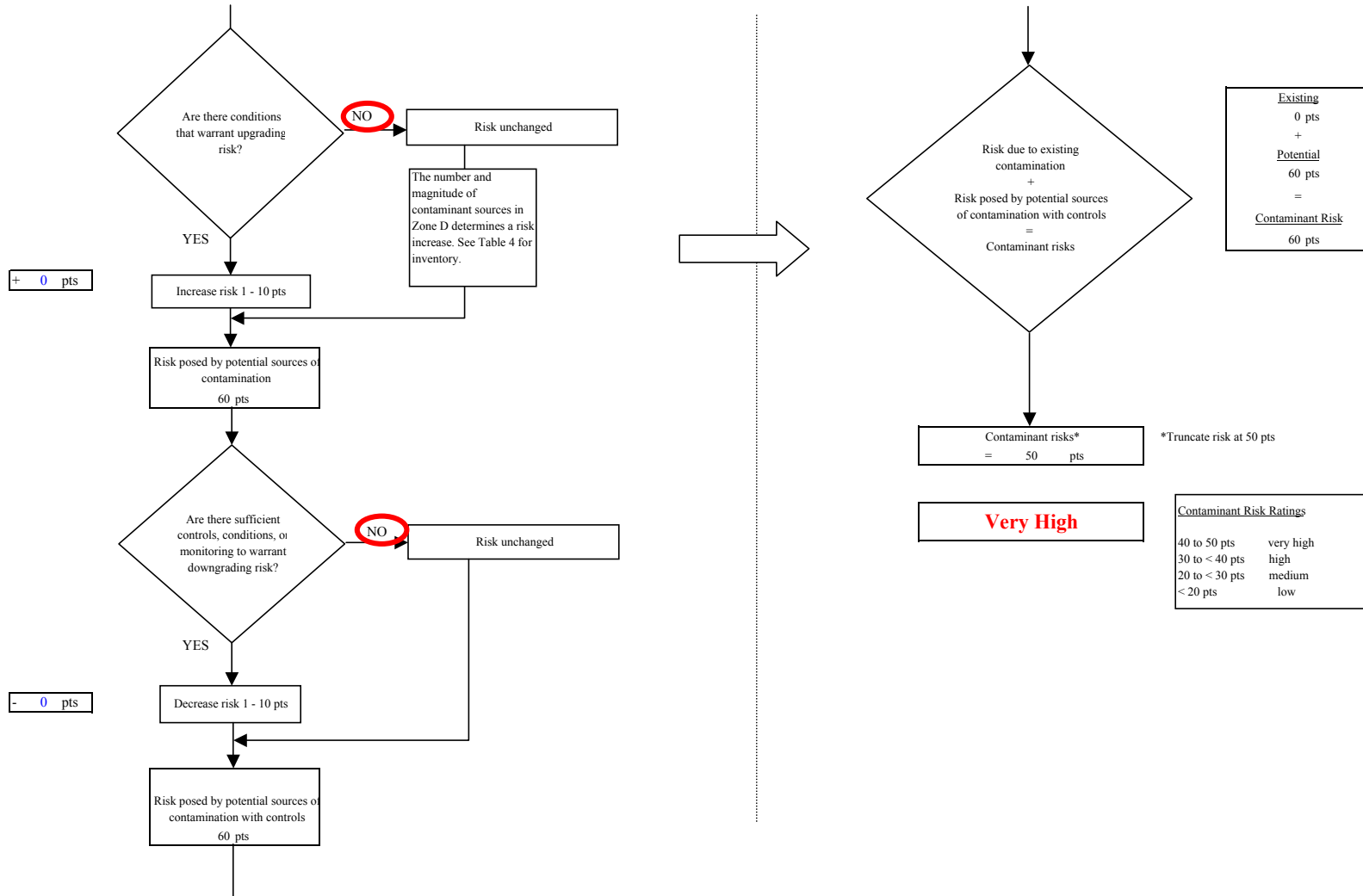
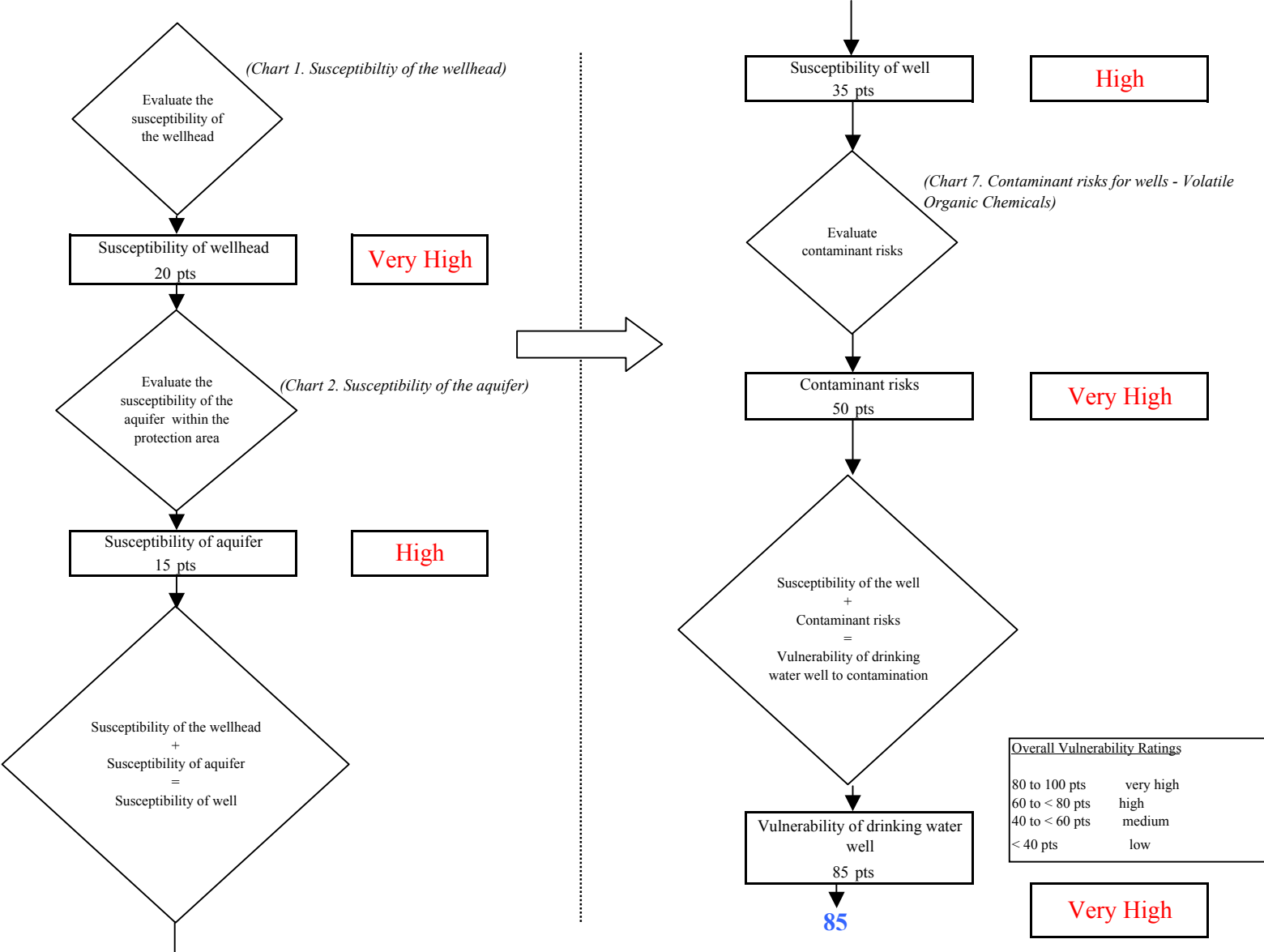


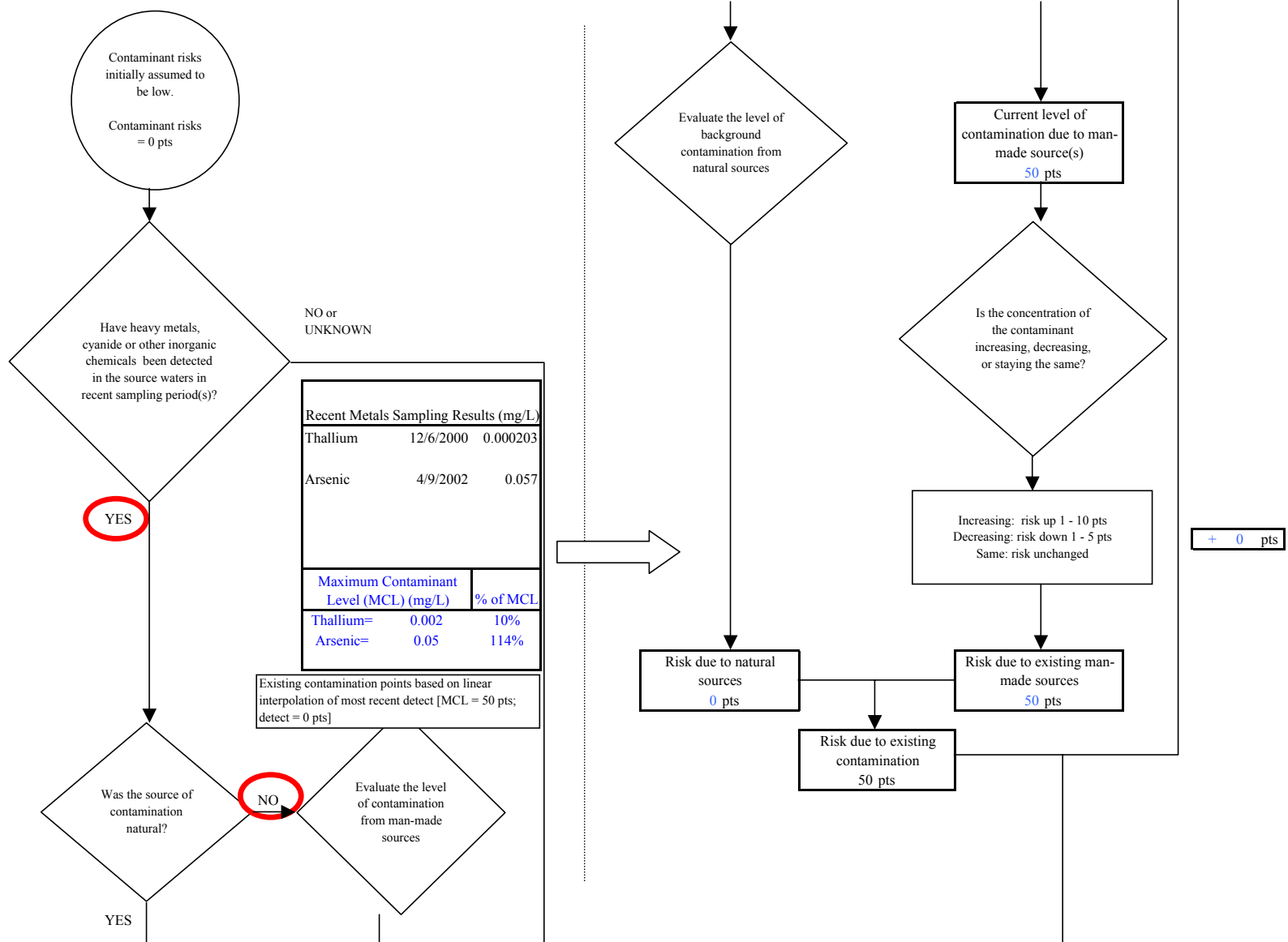
Chart 7. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Volatile Organic Chemicals



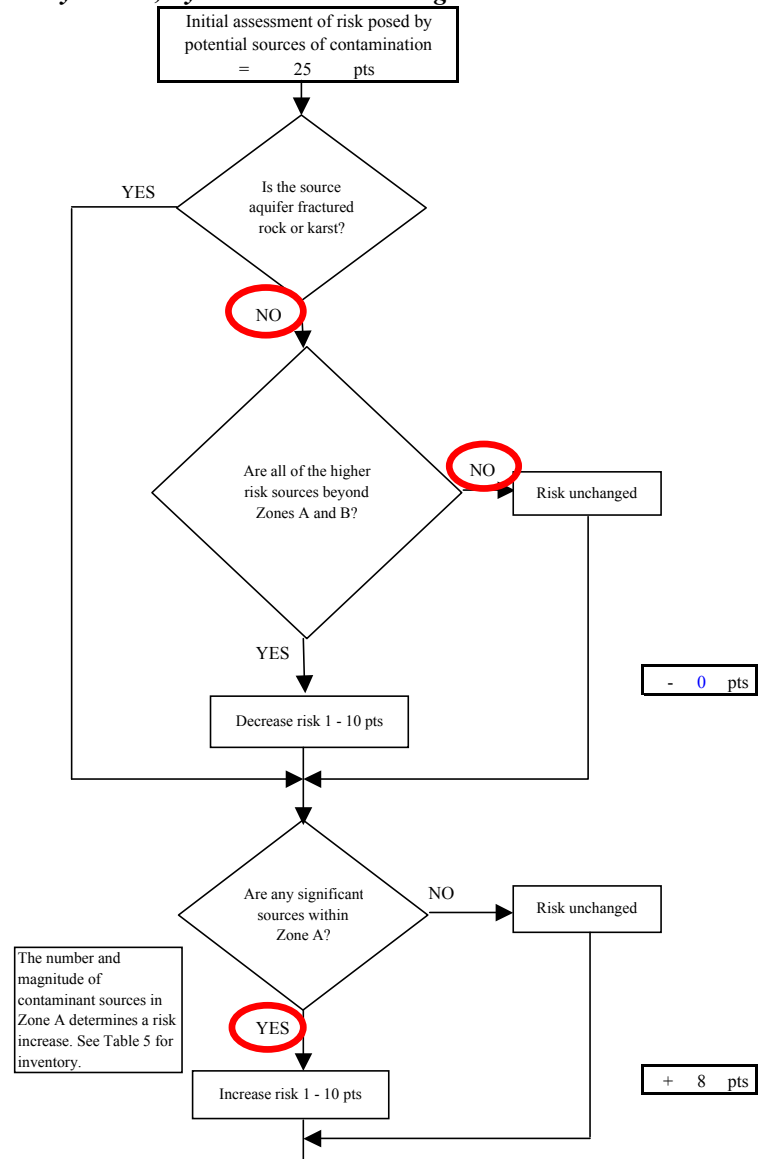
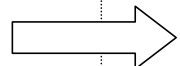
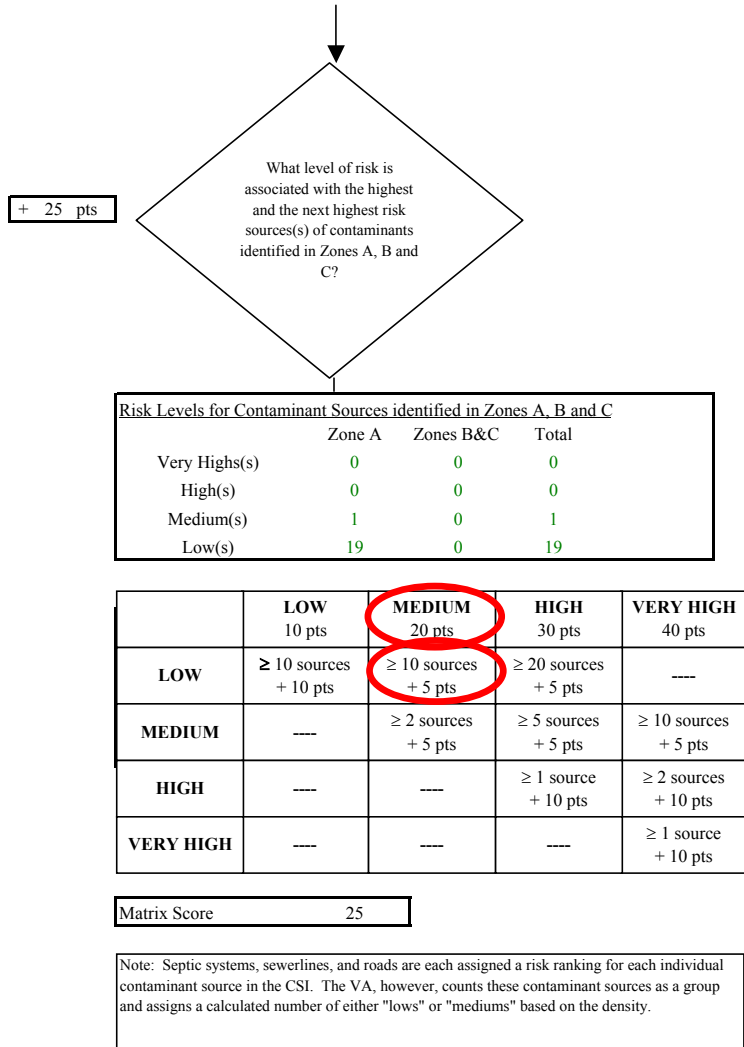
**Chart 8. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Volatile Organic Chemicals**



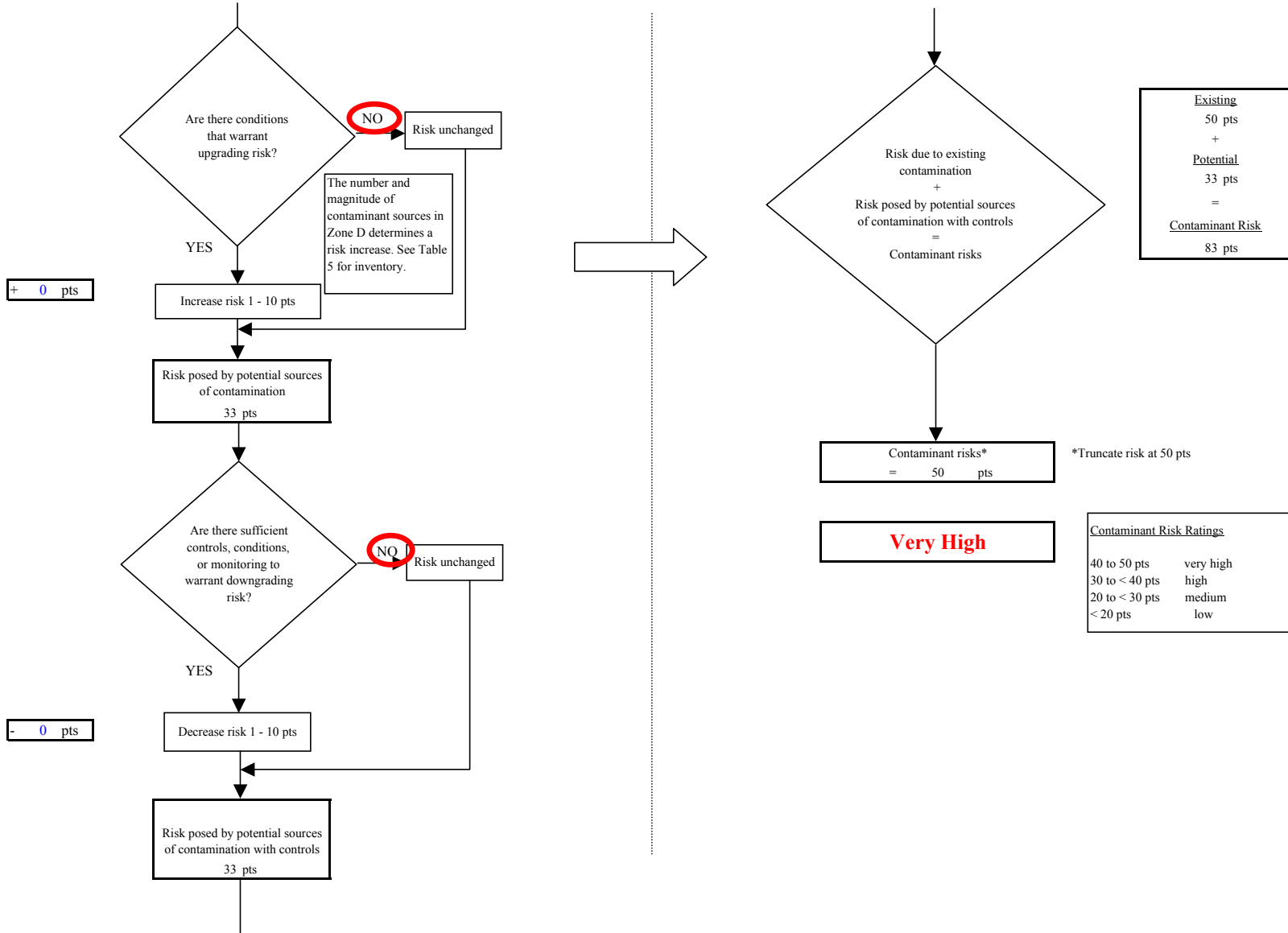
**Chart 9. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



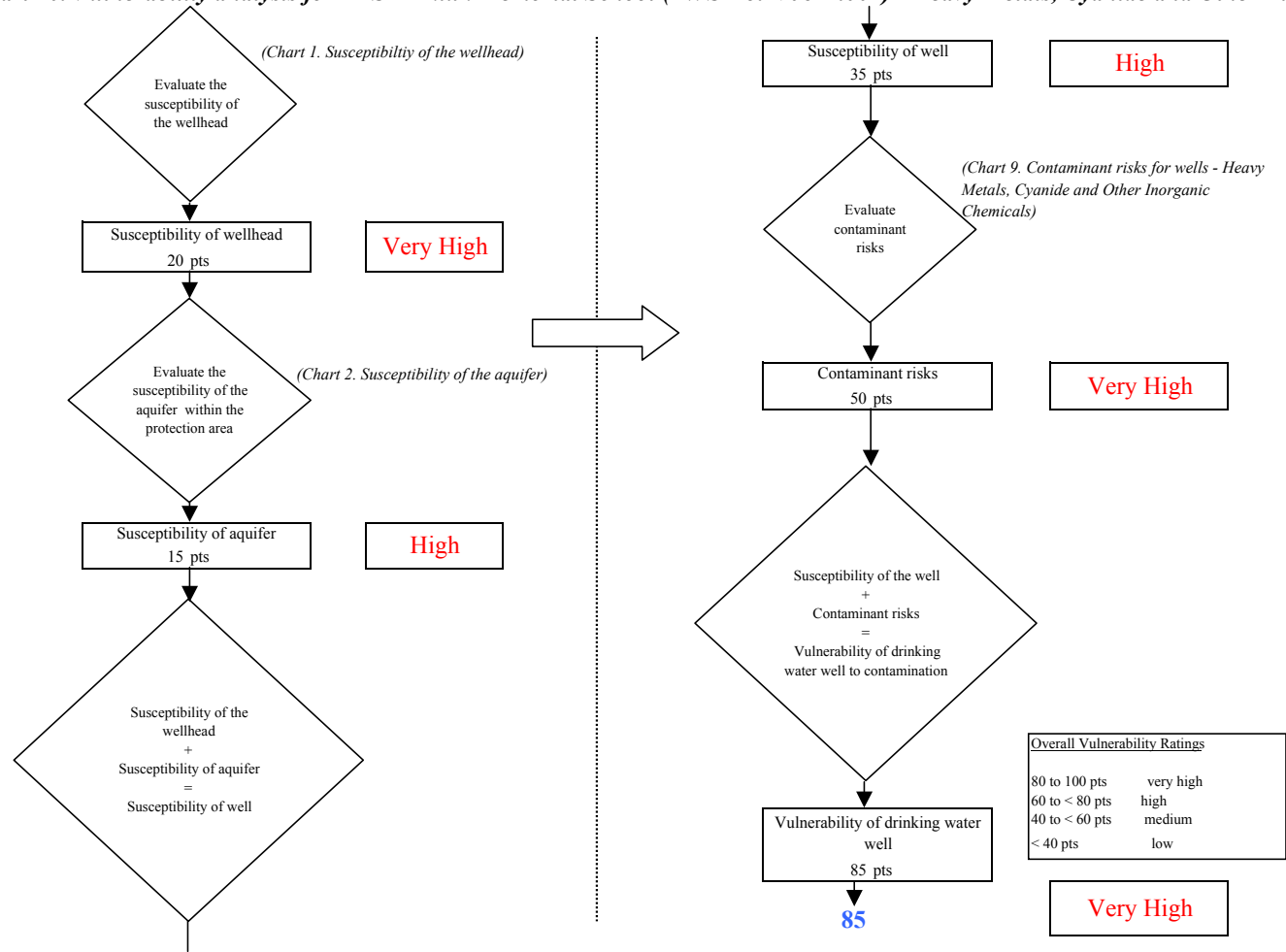
**Chart 9. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 9. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 10. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals**





**Chart 11. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Synthetic Organic Chemicals**

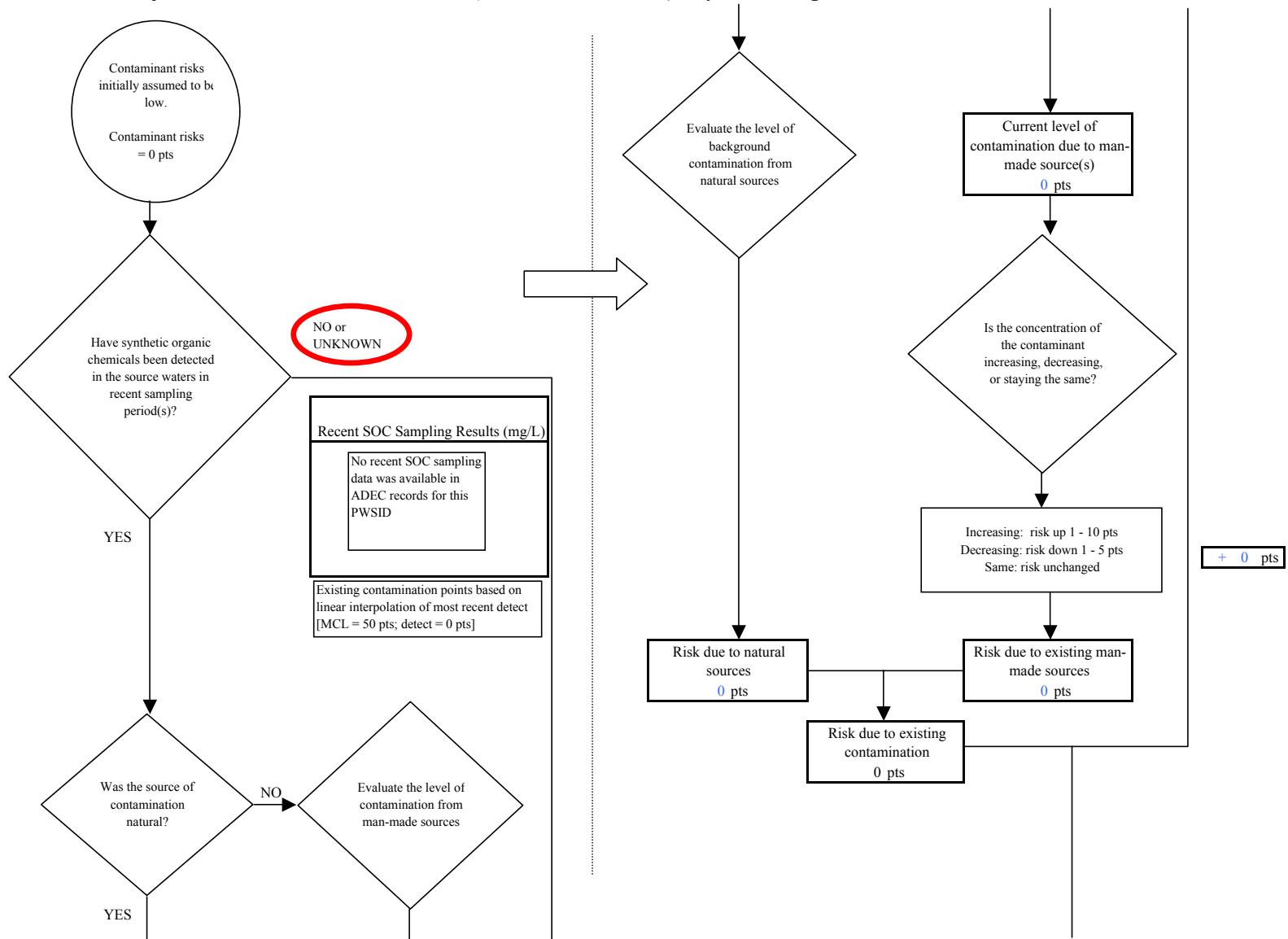
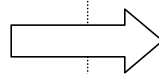
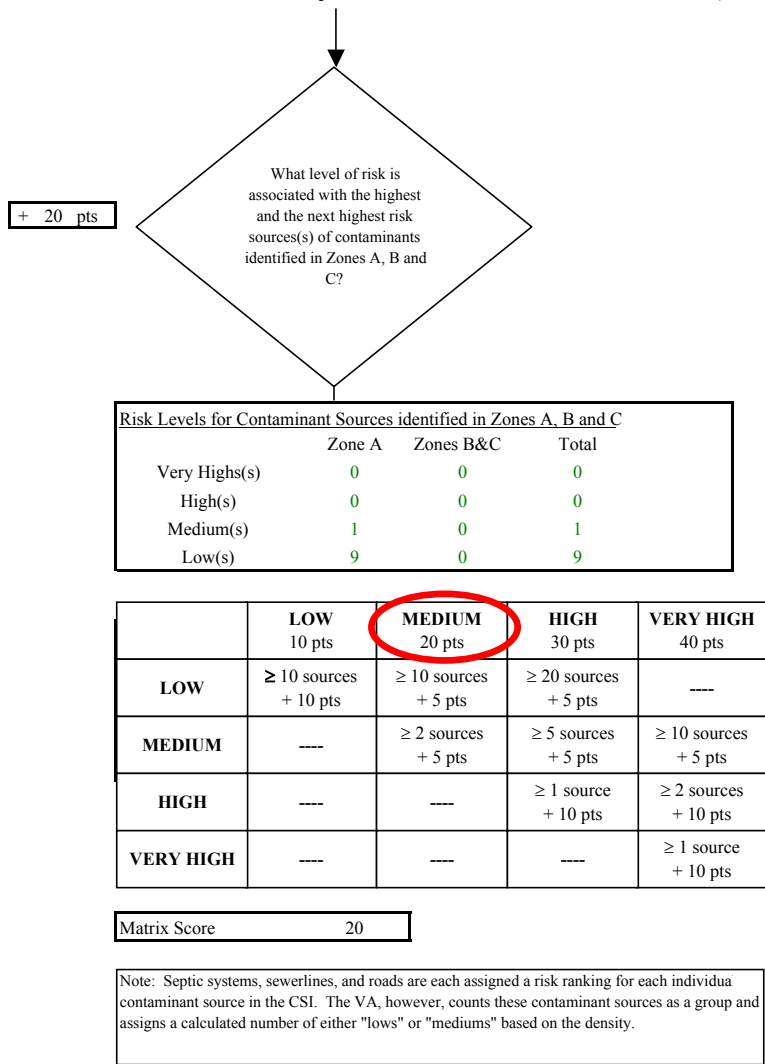
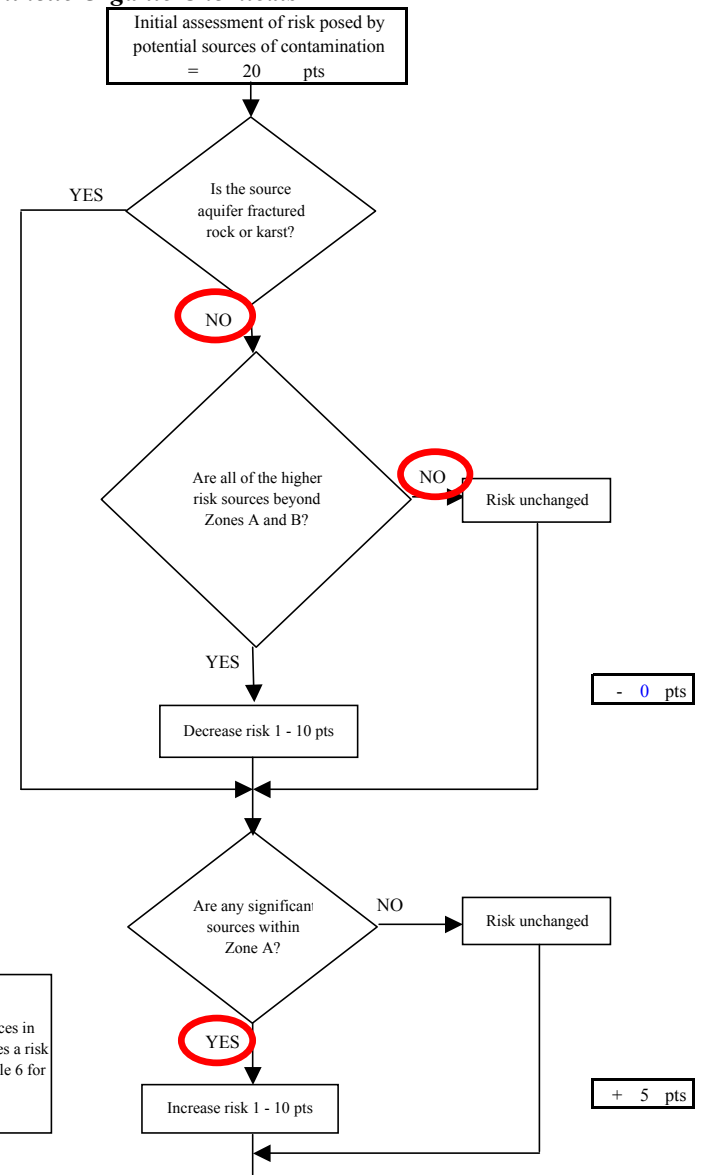


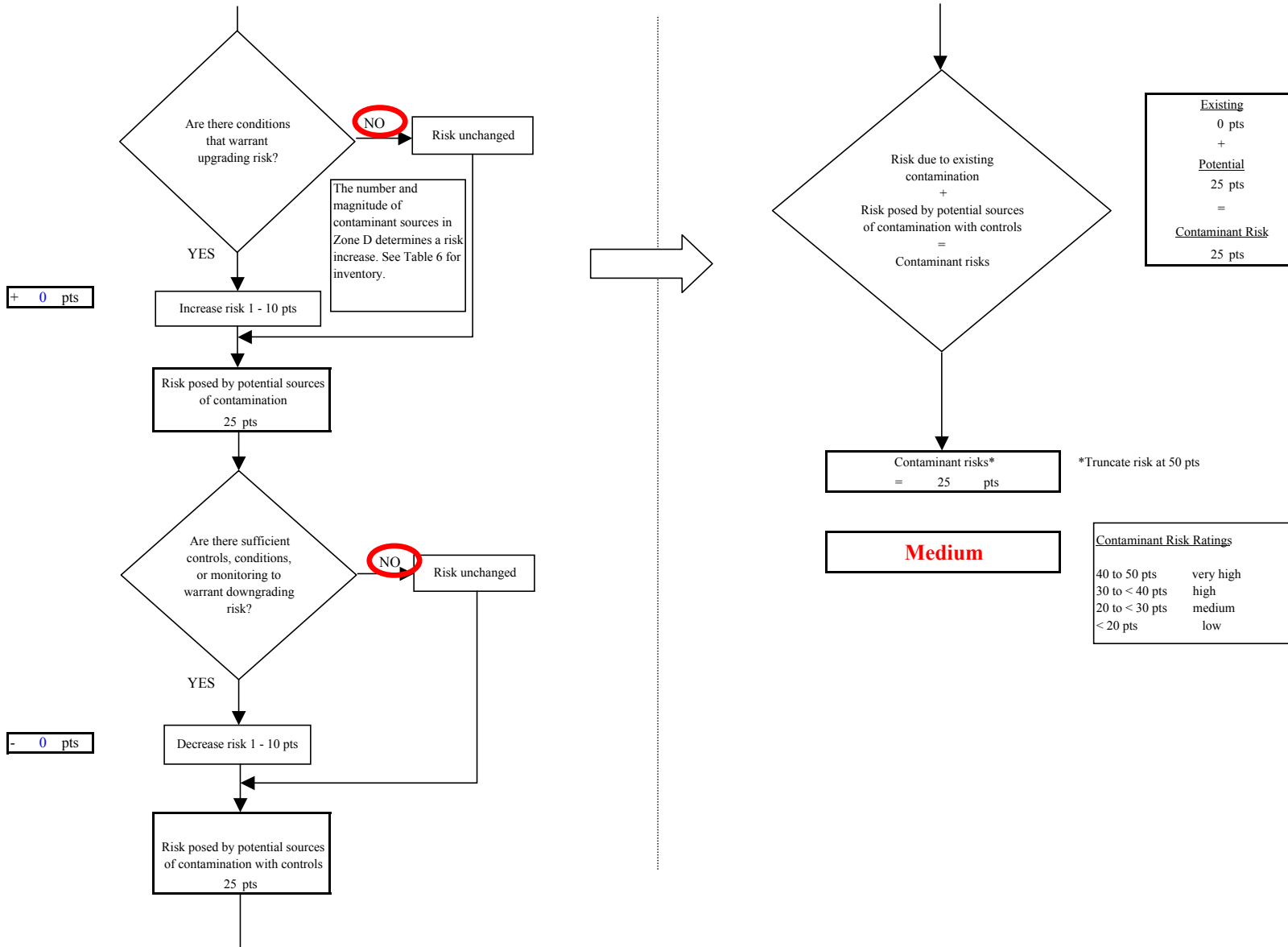
Chart 11. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Synthetic Organic Chemicals



The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 6 for inventory.



**Chart 11. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Synthetic Organic Chemicals**



**Chart 12. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Synthetic Organic Chemicals**

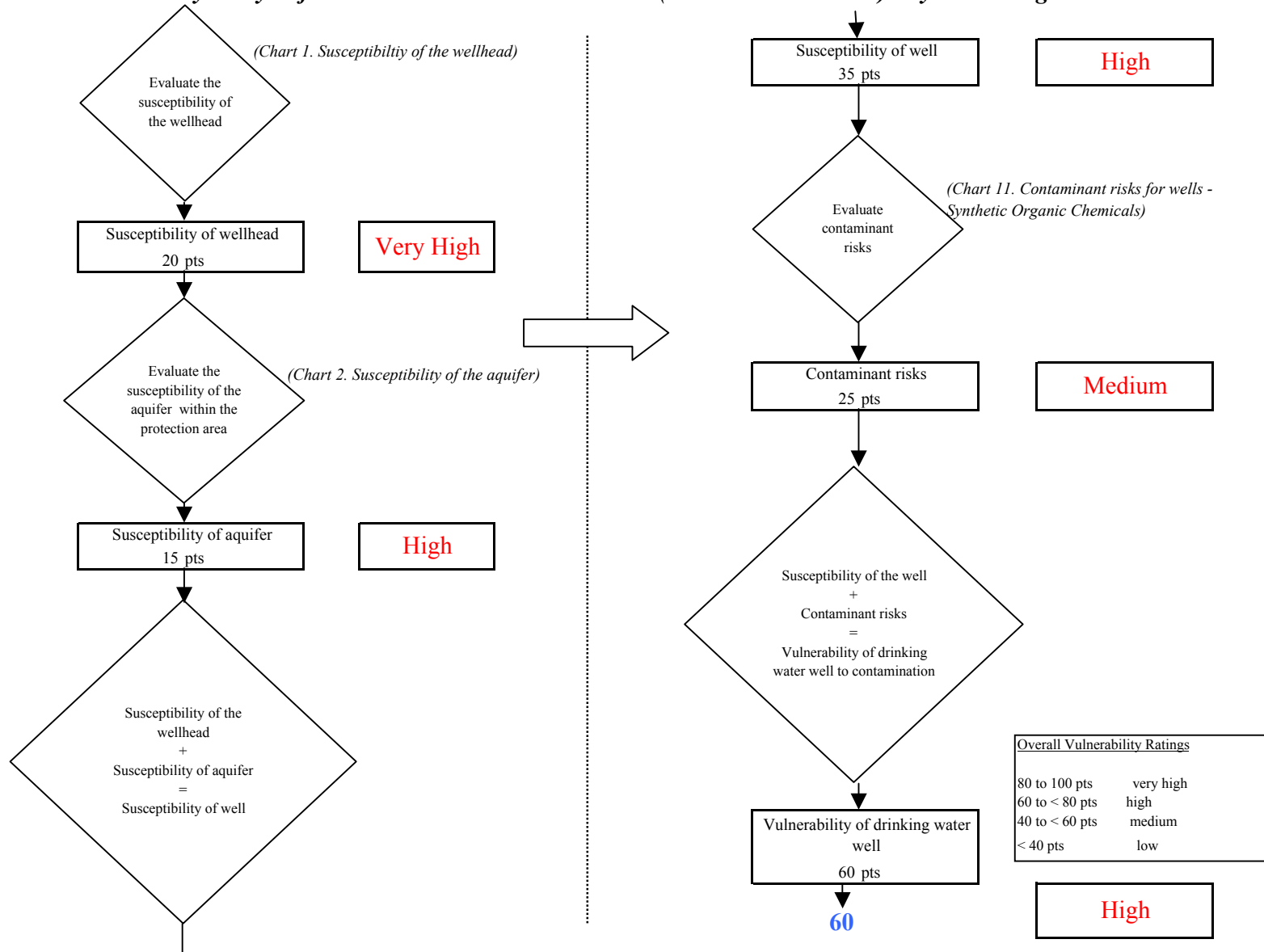


Chart 13. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Other Organic Chemicals

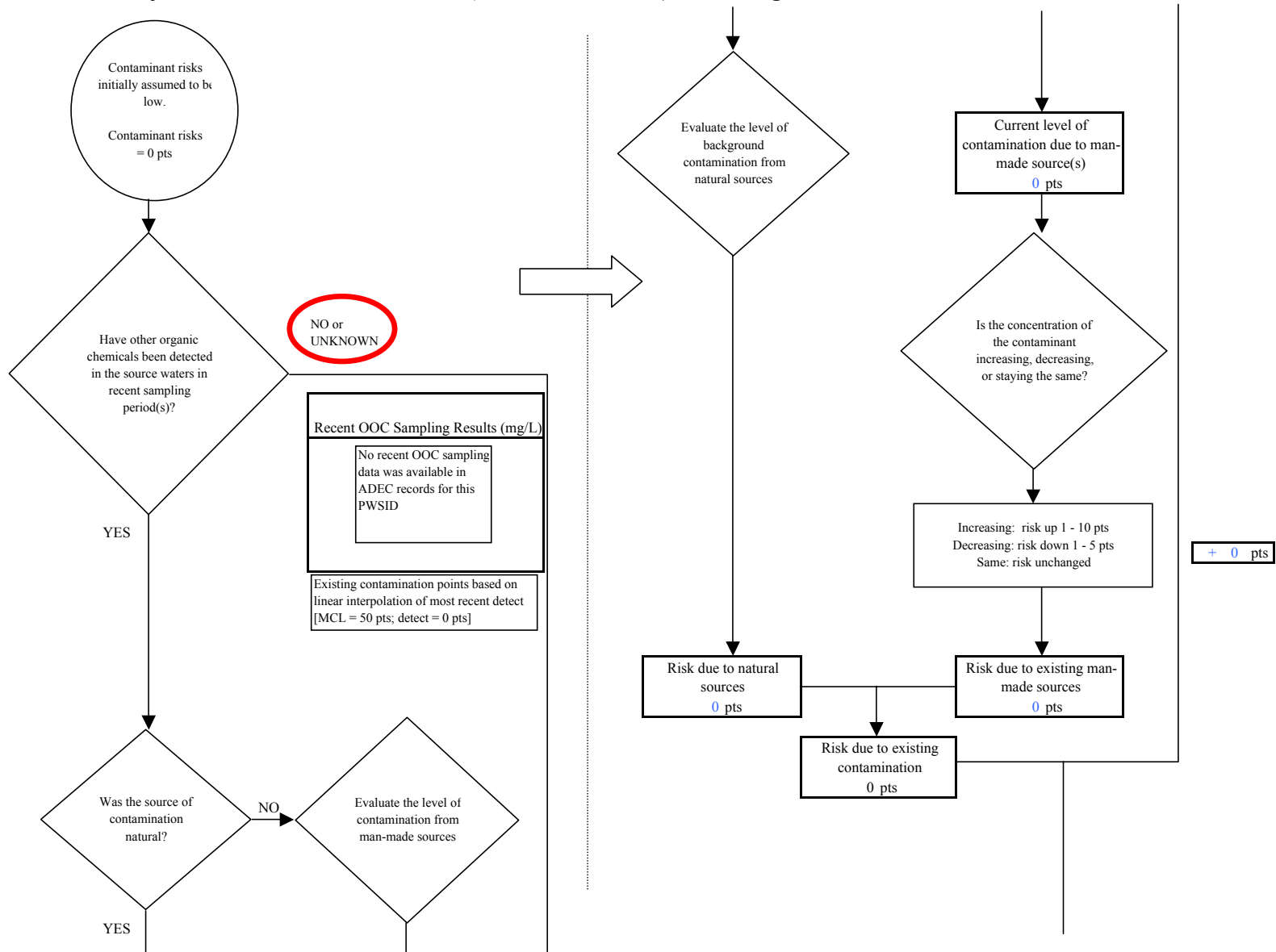
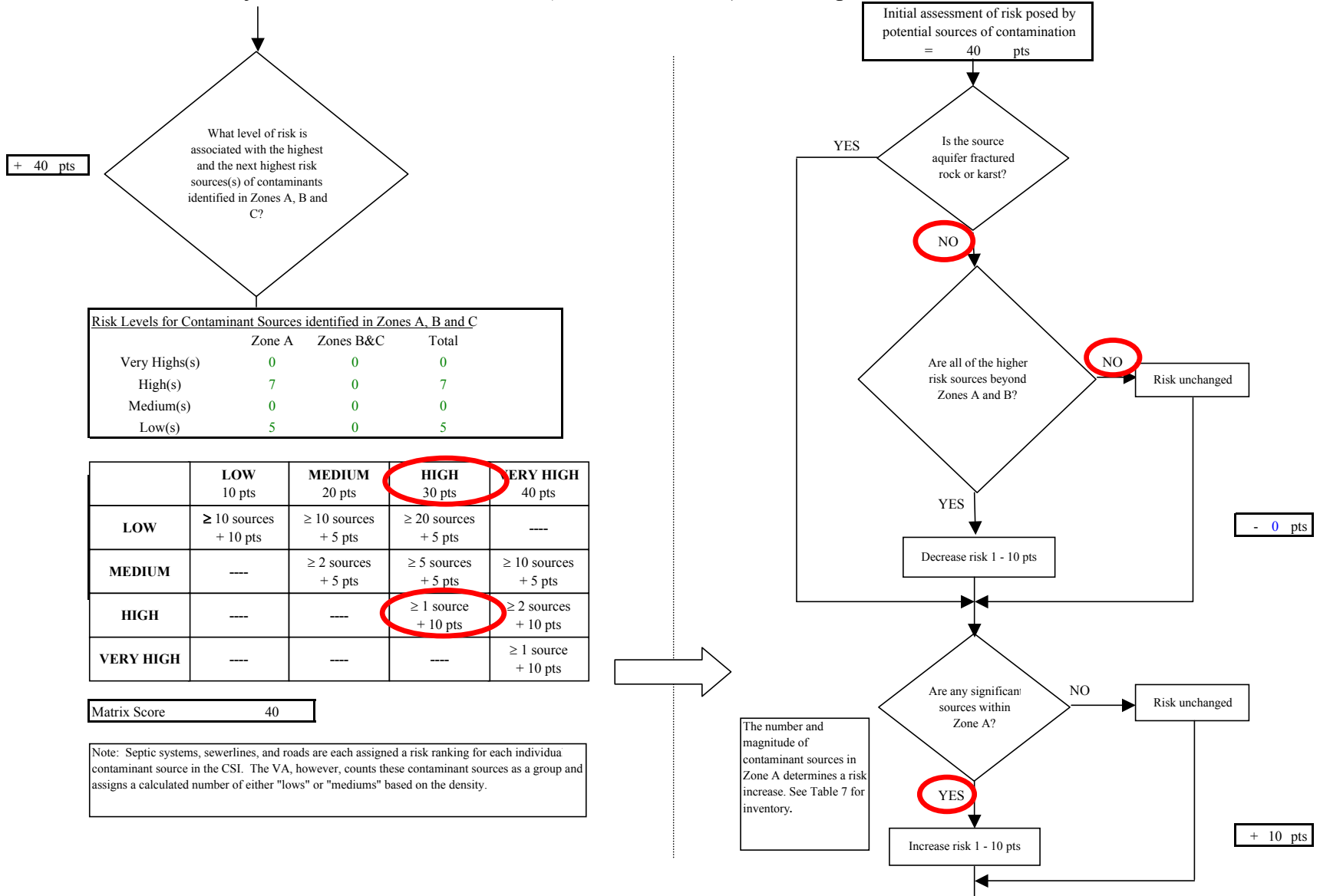


Chart 13. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Other Organic Chemicals



What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

+ 40 pts

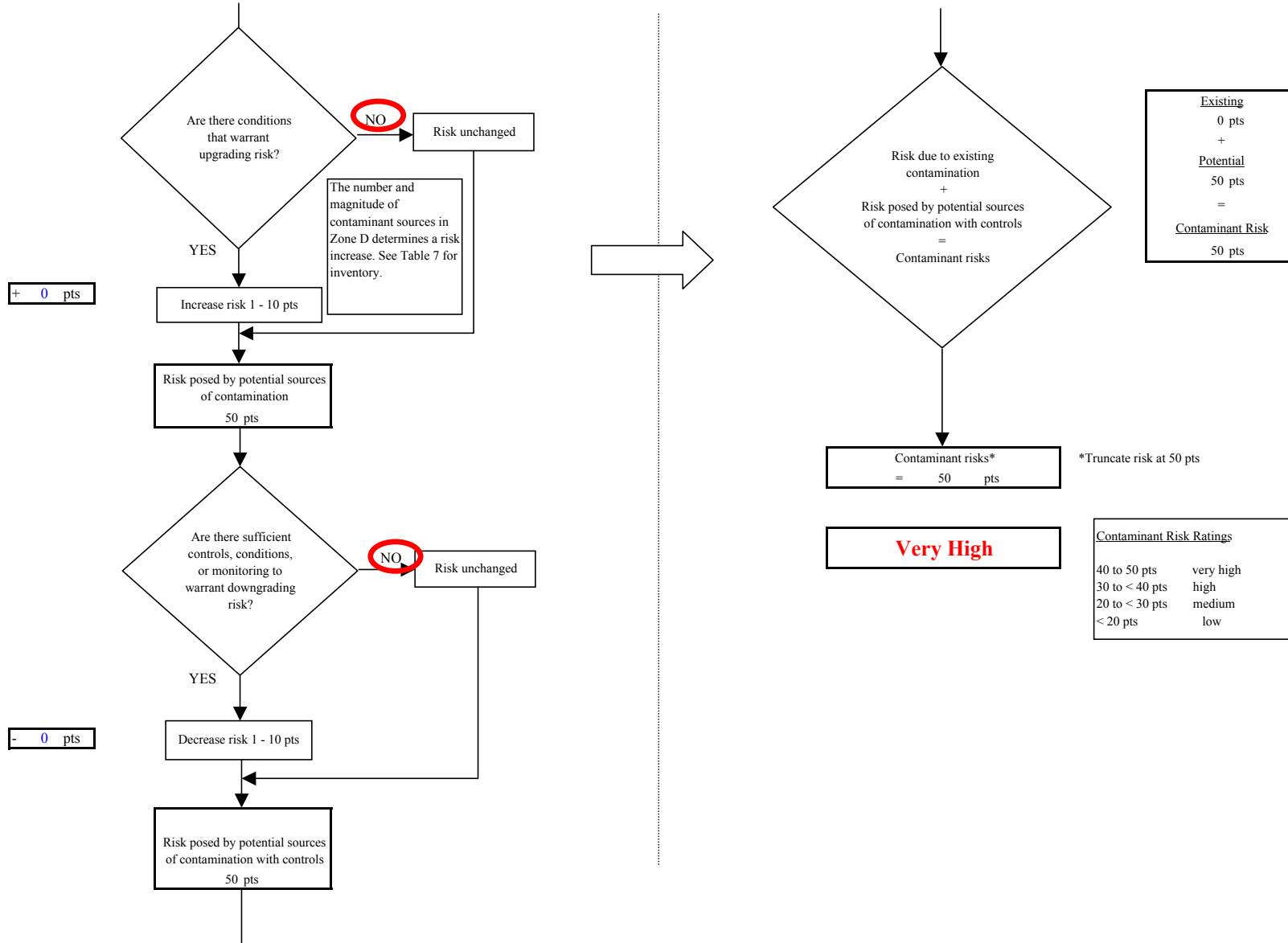
Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	7	0	7
Medium(s)	0	0	0
Low(s)	5	0	5

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	---
MEDIUM	---	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	---	---	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	---	---	---	≥ 1 source + 10 pts

Matrix Score 40

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

**Chart 13. Contaminant risks for LKSD Akiuk Memorial School (PWS No.270621.001) - Other Organic Chemicals**



**Chart 14. Vulnerability analysis for LKSD Akiuk Memorial School (PWS No.270621.001) - Other Organic Chemicals**

