# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Mountain Village Water System Drinking Water System, Mountain Village, Alaska

PWSID # 270150.004

April 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1074
Alaska Department of Environmental Conservation

# Source Water Assessment for Mountain Village Water System Drinking Water System Mountain Village, Alaska

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DRINKING WATER PROTECTION PROGRAM REPORT 1074

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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# TABLES



# APPENDICES

# Source Water Assessment for Mountain Village Water System Source of Public Drinking Water, Mountain Village, Alaska

**Drinking Water Protection Program**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

The Mountain Village Water System has three Public Water System (PWS) wells. The well (PWS No. 270150.004) has been used as a drinking water source since it was drilled in 1985. This source water assessment report is exclusively limited to PWSID #270150.004.

The well is a Class A (community and non-transient non-community) water system located off of the west end of Peterson Street in Mountain Village, Alaska. Available records indicate that there is secondary storage of drinking water, with a combined capacity of 200,000-gallons, and that the drinking water is treated with calcium hypochlorite. This system operates year round and serves approximately 700 residents through 196 service connections. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Medium**. 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: aboveground heating oil tanks, nonresidential pit toilets, landfills, and roads. 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 the bacteria and viruses, nitrates and nitrites, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals and a vulnerability rating of **Medium** for the volatile organic chemicals contaminant categories.

## PUBLIC DRINKING WATER SYSTEM

The Mountain Village Water System well is a Class A (community/non-transient/non-community) public water system. The system is located off of the west end of Peterson Street in Mountain Village, Alaska (Sec. 14, T23N, R79W, Seward Meridian; see Map A of Appendix A). Mountain Village is on the north bank of the Yukon River, approximately 20 miles west of St. Mary's and 470 miles northwest of Anchorage. It is at the foot of Azachorok Mountain. The community has a population of 757 (ADCED, 2003). Average annual precipitation in Mountain Village is 16 inches, including approximately 44 inches of snowfall. Temperatures range from -44 to 80°F.

The community of Mountain Village obtains most of their water supply from community wells. Most households are served by the piped sewage collection system (ADCED, 2003). Mountain Village receives electrical power from AVEC. Refuse is collected by individuals and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the Mountain Village Water System PWS, the depth of the primary water well is 245 feet below the ground surface. Based on available information for the well, it is in an unconfined aquifer resulting from fractured bedrock. The well is not located within a floodplain.

Information acquired from a July 2003 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 bedrock in the Mountain Village area consists primarily of sandstone, which form well defined northeast trending hills. These hills are composed of a thick sequence of interbedded marine and nonmarine deposits. The area is underlain by a layer of discontinuous permafrost and has three basic soil types: poorly drained mineral soils, organic rich

soils, and well-drained mineral soils (Nakanishi and Dorava, 1994).

## 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 Mountain Village 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**

| 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 Mountain Village Water System PWS was determined using an analytical calculation and includes Zone A (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 Mountain Village 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.

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 Mountain Village Water System's water well is in an unconfined aquifer. Unconfined aquifers are more 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 | 13 | Medium |
| Natural Susceptibility | 13 | 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 | 45 | 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:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the Drinking Water Source to Contamination (0 – 100).

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 | 55 | Medium |
| 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 a landfill 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). 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 a landfill 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 **High**.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the presence of a landfill, ADEC recognized contaminated sites, and petroleum product bulk station/terminals in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

Detectable concentrations of trihalomethanes were reported in sampling events for this public water system. However, the detectible concentrations of trihalomethanes reported in 1999 were well below the MCL of 0.08 mg/L. Trihalomethanes are considered byproducts of the water treatment process and are not from the source waters. Since the reported concentration of TTHM's in recent sampling events did not exceed the applicable MCLs, risk points were not retained.

Aside from being byproducts of the drinking water treatment process, possible sources of volatile organic chemicals include facilities with automobiles, residential areas, fuel tanks, roads, and airports. See Table 4 in Appendix D for a complete listing.

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 **Medium**.

**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 a landfill located 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, moderate levels of copper, lead, and arsenic have been detected, but have not exceeded their respective MCLs of 1.3 mg/L, 0.015 mg/L, and 0.05 mg/L (see Chart 8 – 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, no risk points were assigned based on the presence of these analytes. However, risk points were assigned based on the presence of arsenic.

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 a landfill located 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 Mountain Village 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 a landfill, petroleum product bulk station/terminals, and electric power generation located 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 Mountain Village 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 community of Mountain Village 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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Nakanishi, Allan S. and Joseph M. Dorava. 1994, Overview of Environmental and Hydrogeologic Conditions at St. Mary's, Alaska, U.S. Geological Survey, Open File Report 94-481, prepared in cooperation with the FAA.

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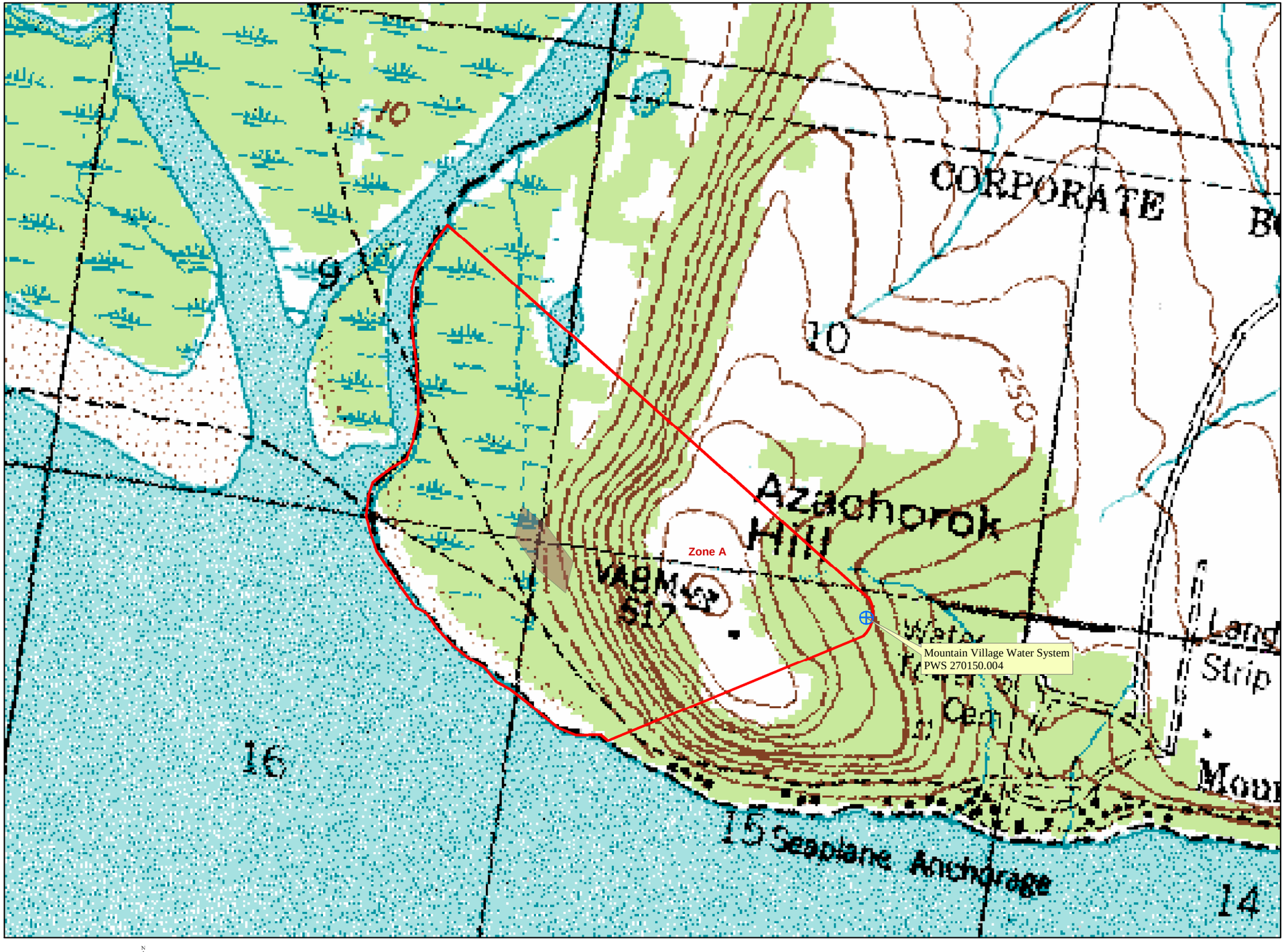
# APPENDIX A

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

# Public Water Well System for PWS #270150.004 Mountain Village 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 or Watershed Boundary

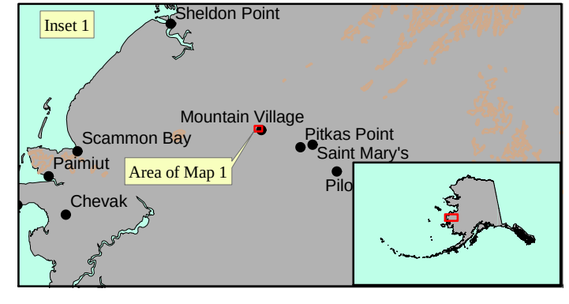
Data Sources:
Contaminant Sources, Public Water System Wells, Contours
Alaska Department of Environmental Conservation (ADEC)

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.




N W E S

0 0.125 0.25 0.5 0.75 1 Miles

Mountain Village Water System
PWS 270150.004

**Appendix A Map A**

# APPENDIX B

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

***Table 1***

*Contaminant Source Inventory for*

***Mountain Village Water System***

***PWSID 270150.004***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Map Number* | *Comments* |
|---|---|---|---|---|---|
| Pit toilets (open hole), nonresidential (one or more) | D16 | D16-01 | A | C | Assume 1 honey bucket pit in Zone A |
| Landfills (municipal; Class III) | D51 | D51-01 | A | C | |
| Tanks, heating oil, residential (above ground) | R08 | R08-01 | A | C | Assume 20 or less residentail heating oil tanks in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | C | Assume 1-20 roads in Zone A |

***Table 2***

# *Contaminant Source Inventory and Risk Ranking for Mountain Village Water System Sources of Bacteria and Viruses*

***PWSID 270150.004***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Pit toilets (open hole), nonresidential (one or more) | D16 | D16-01 | A | Medium | C | Assume 1 honey bucket pit in Zone A |
| Landfills (municipal; Class III) | D51 | D51-01 | A | High | C | |
| 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 Mountain Village Water System Sources of Nitrates/Nitrites*

***PWSID 270150.004***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Pit toilets (open hole), nonresidential (one or more) | D16 | D16-01 | A | Medium | C | Assume 1 honey bucket pit in Zone A |
| Landfills (municipal; Class III) | D51 | D51-01 | A | Very High | C | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |

***Table 4***

# *Contaminant Source Inventory and Risk Ranking for Mountain Village Water System Sources of Volatile Organic Chemicals*

***PWSID 270150.004***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Pit toilets (open hole), nonresidential (one or more) | D16 | D16-01 | A | Low | C | Assume 1 honey bucket pit in Zone A |
| Landfills (municipal; Class III) | D51 | D51-01 | A | High | C | |
| Tanks, heating oil, residential (above ground) | R08 | R08-01 | A | Medium | C | Assume 20 or less residentail heating oil tanks in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |

**Table 5**

# *Contaminant Source Inventory and Risk Ranking for Mountain Village Water System*
## *Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Pit toilets (open hole), nonresidential (one or more) | D16 | D16-01 | A | Low | C | Assume 1 honey bucket pit in Zone A |
| Landfills (municipal; Class III) | D51 | D51-01 | A | High | C | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |

***Table 6***

# *Contaminant Source Inventory and Risk Ranking for Mountain Village Water System Sources of Synthetic Organic Chemicals*

***PWSID 270150.004***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Landfills (municipal; Class III) | D51 | D51-01 | A | Very High | C | |

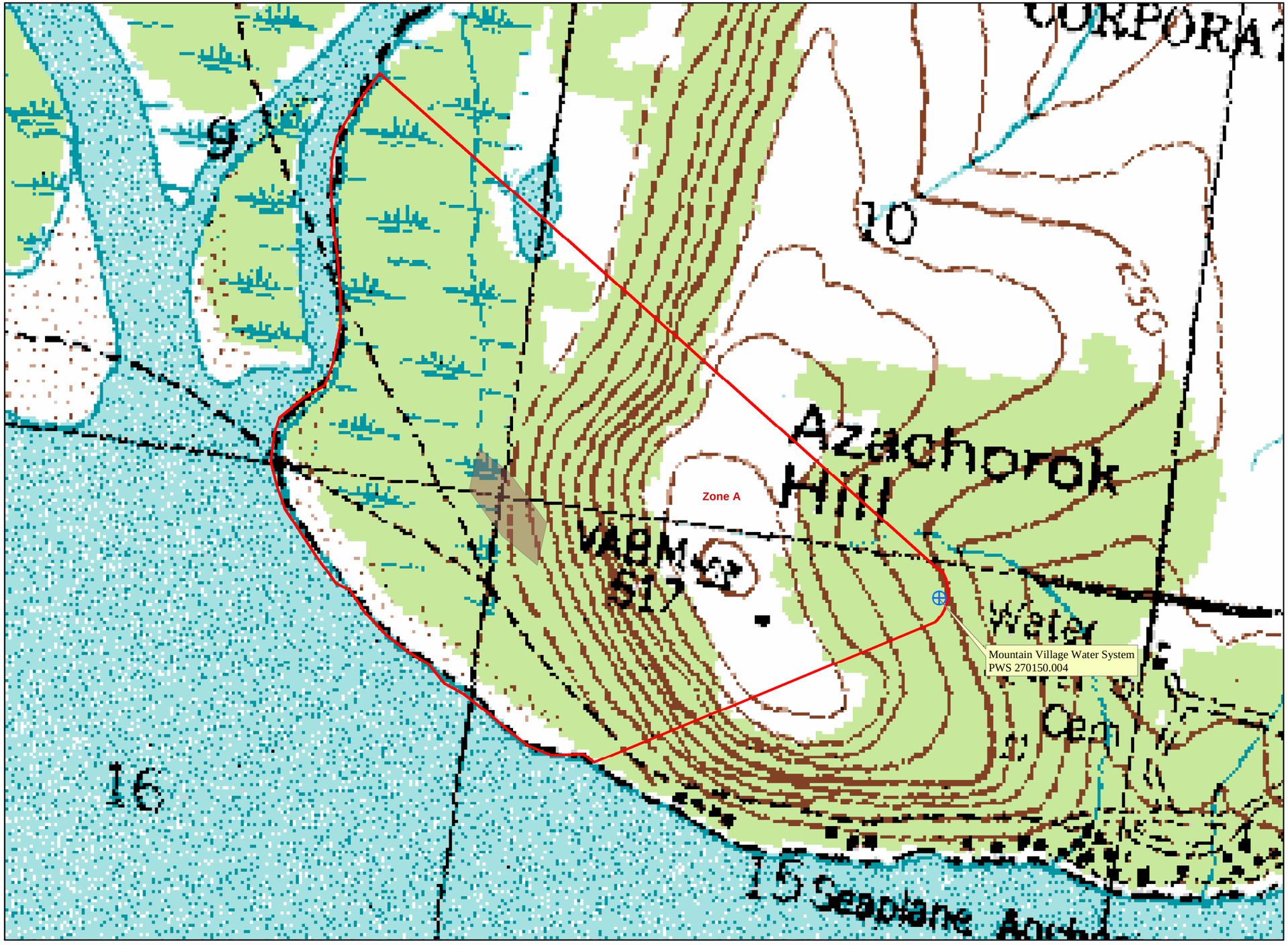
# *Contaminant Source Inventory and Risk Ranking for Mountain Village Water System Sources of Other Organic Chemicals*

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Landfills (municipal; Class III) | D51 | D51-01 | A | Very High | C | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |

# APPENDIX C

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

# Public Water Well System for PWS #270150.004 Mountain Village Water System
# 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 or Watershed Boundary

***Existing or Potential Contaminant Sources***

- Landfills (municipal; Class III) (D51)

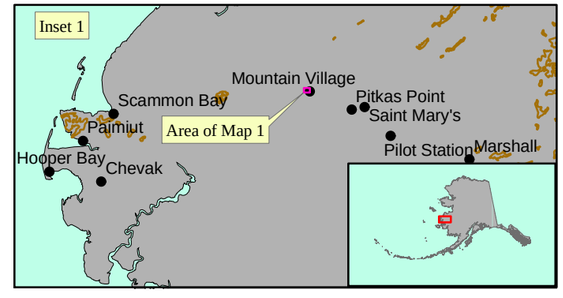
Data Sources:

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.




0 0.125 0.25 0.5 0.75 1 Miles

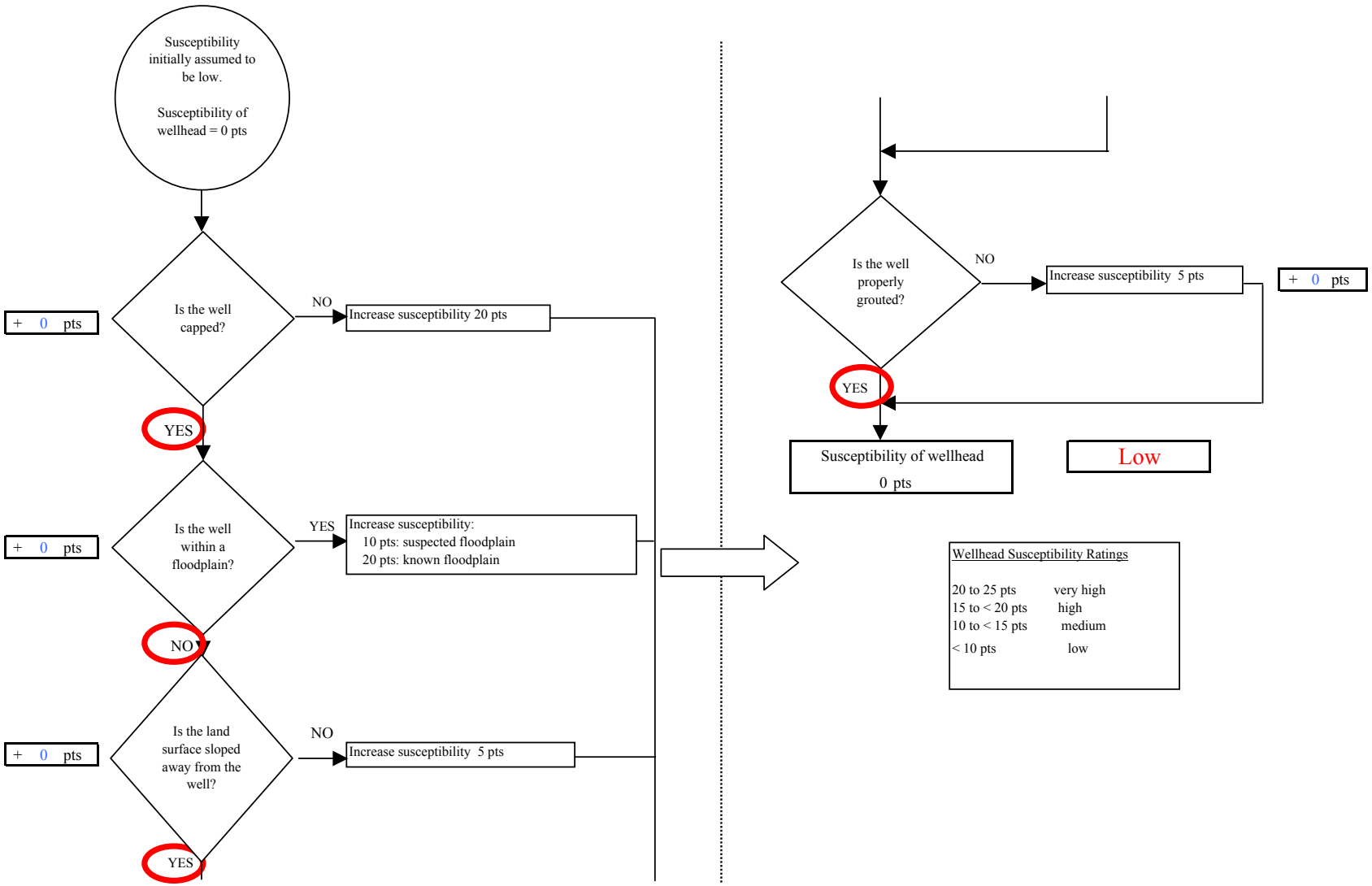
Mountain Village Water System
PWS 270150.004

**Appendix C Map C**

# APPENDIX D

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

***Chart 1. Susceptibility of the wellhead - Mountain Village Water System (PWS No. 270150.004)***



## *Chart 2. Susceptibility of the aquifer Mountain Village Water System (PWS No. 270150.004)*

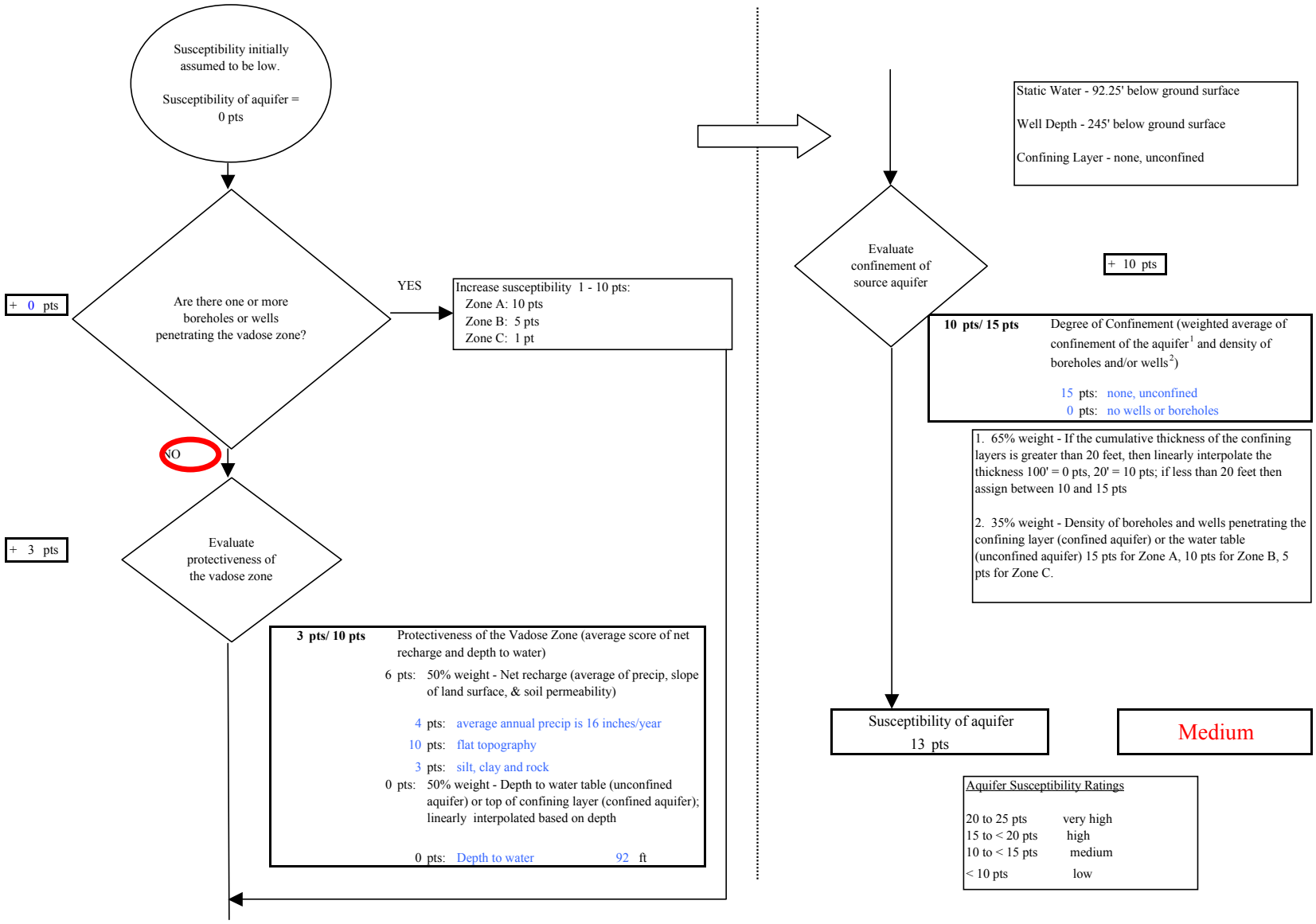
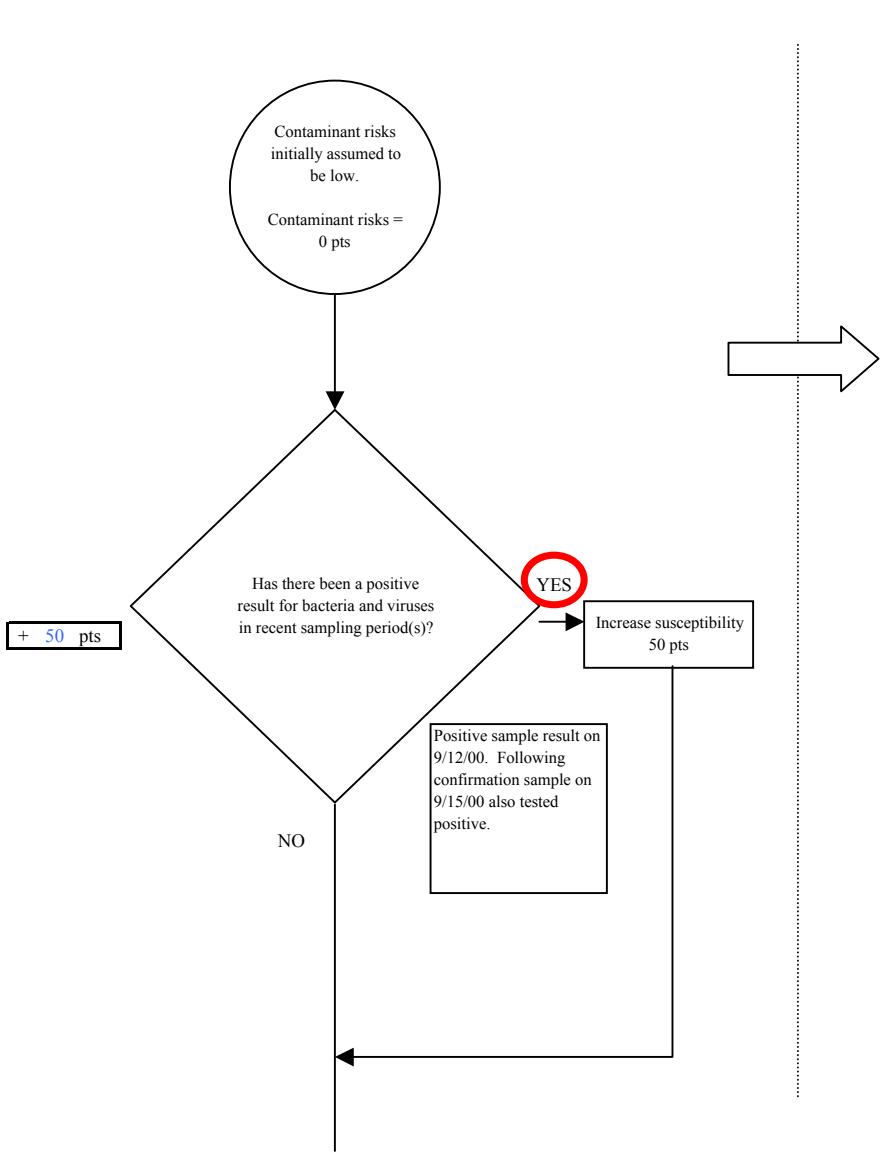
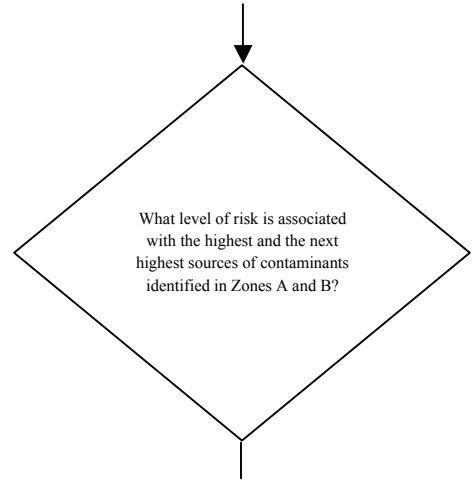


***Chart 3. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Bacteria & Viruses***




+ 30 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

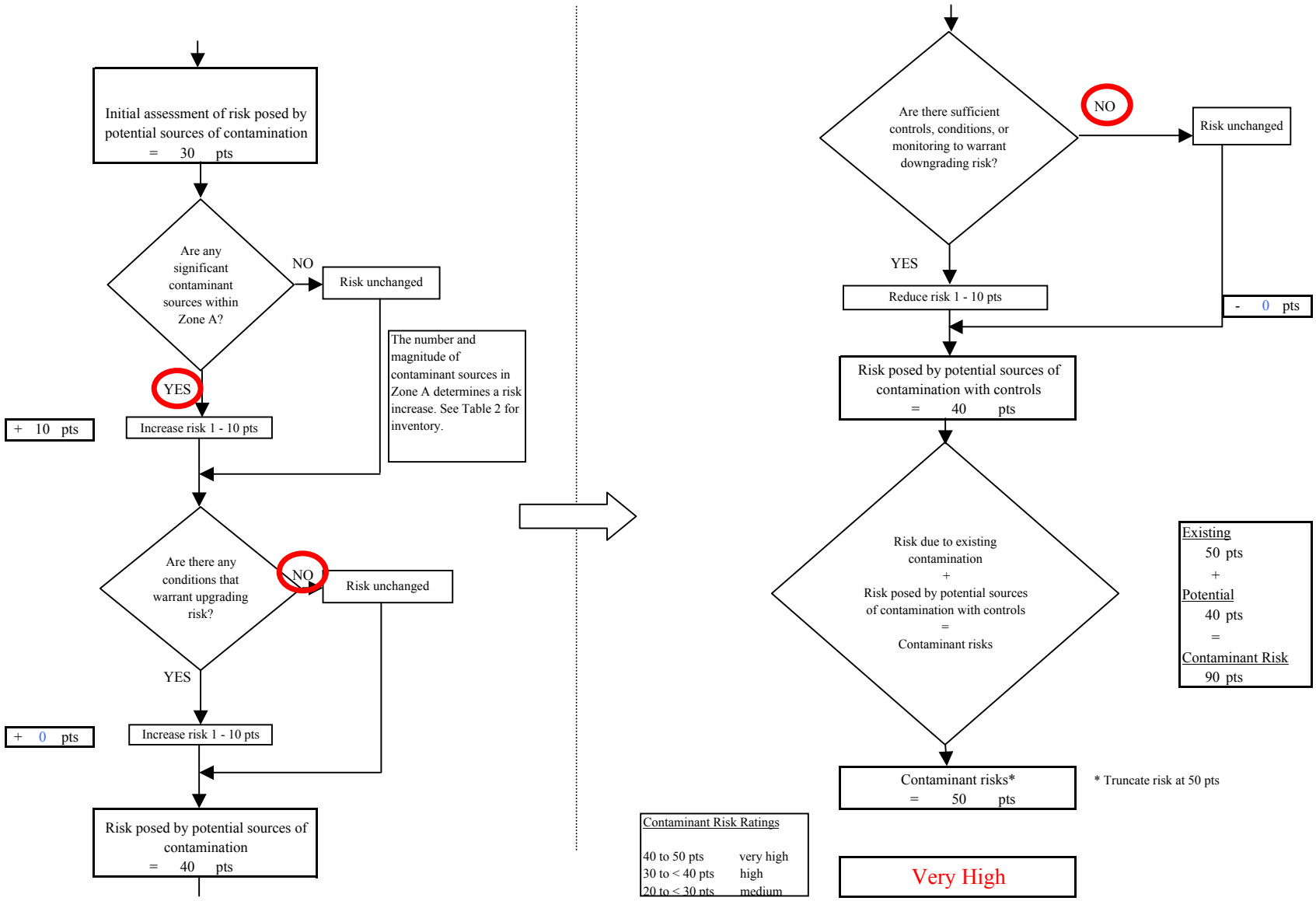
| | Zone A | Zone B | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 1 | 0 | 1 |
| Medium(s) | 1 | 0 | 1 |
| Low(s) | 1 | 0 | 1 |

| | **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 30

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 3. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Bacteria & Viruses***



## *Chart 4. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Bacteria & Viruses*

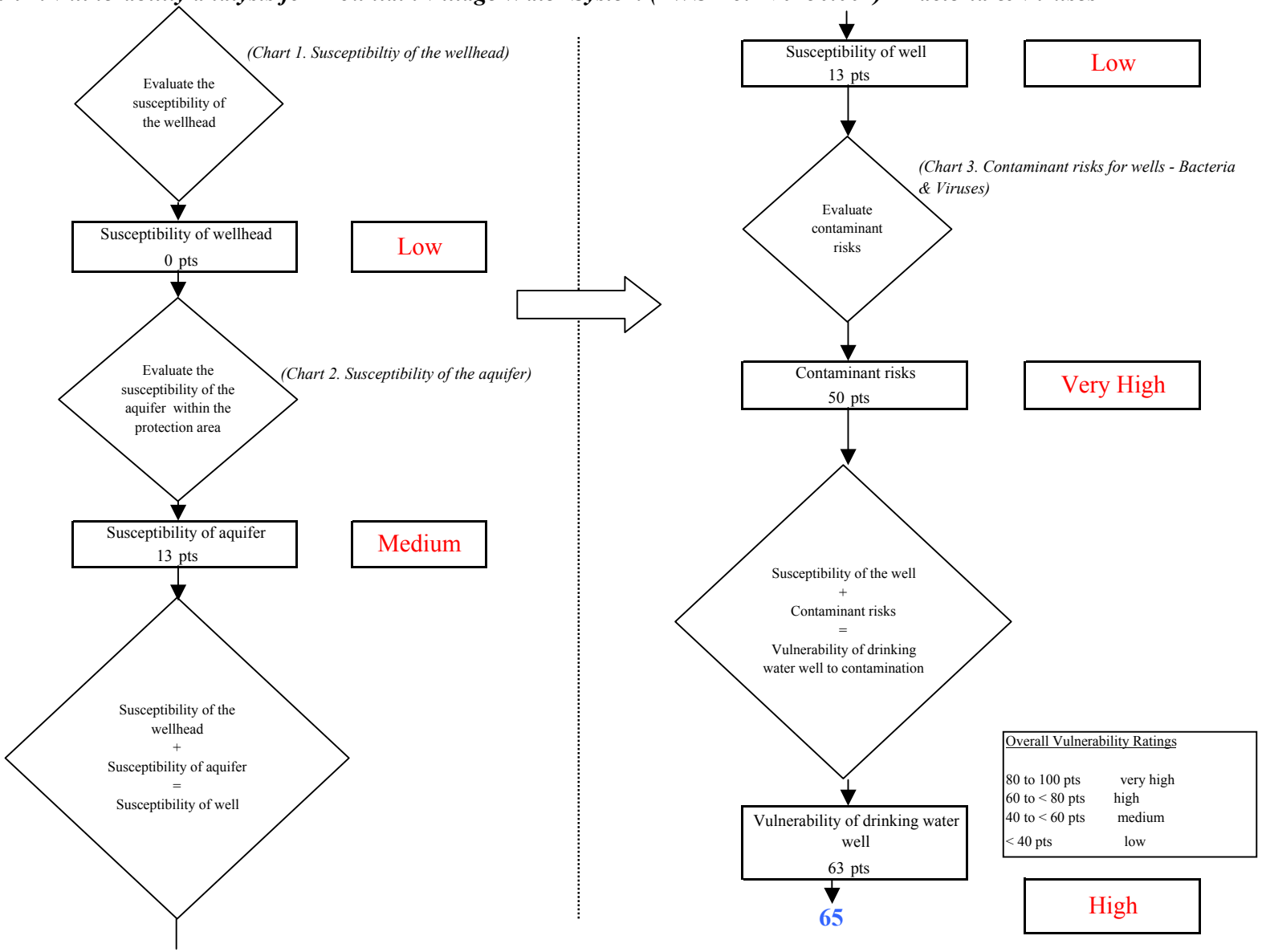
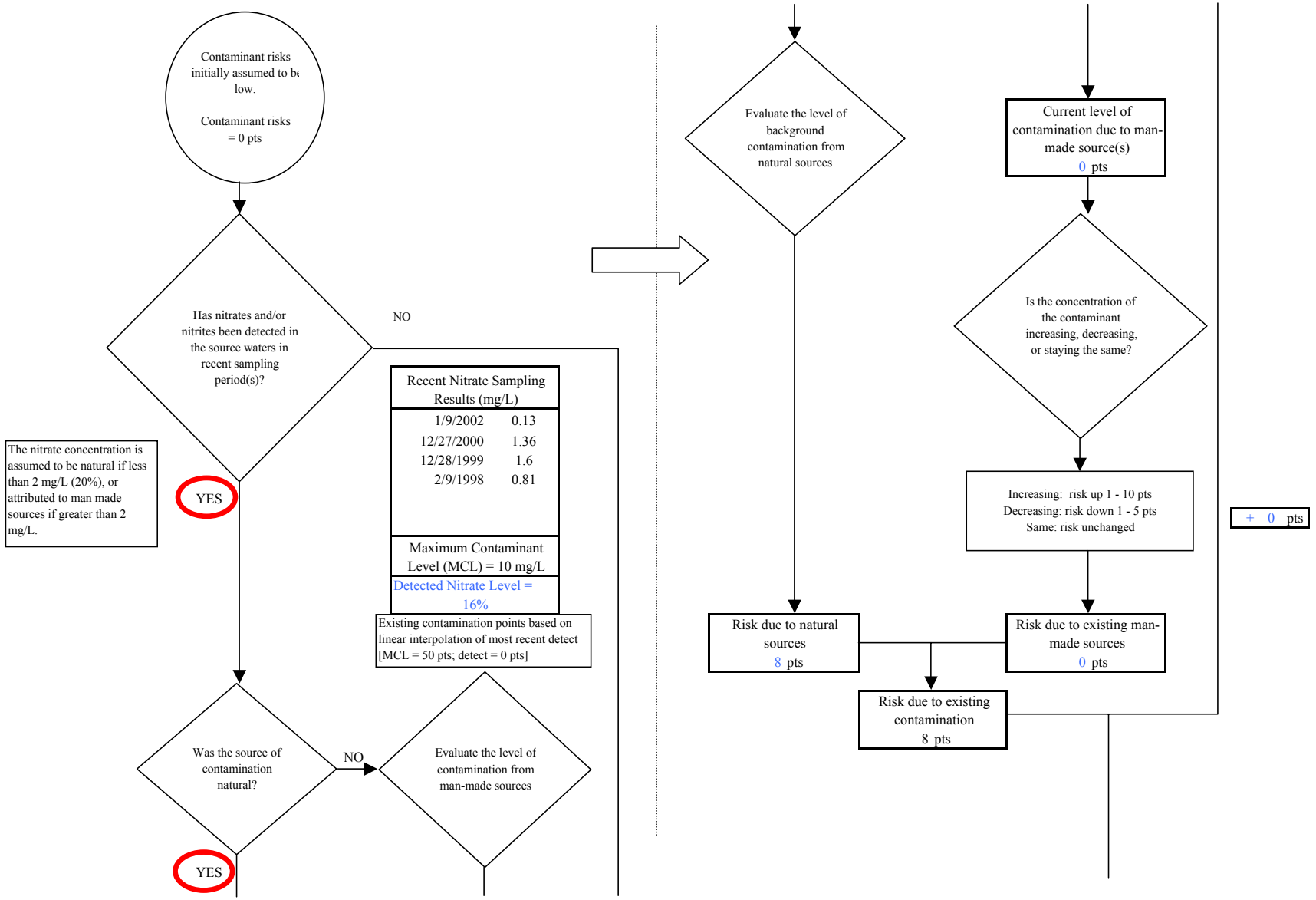
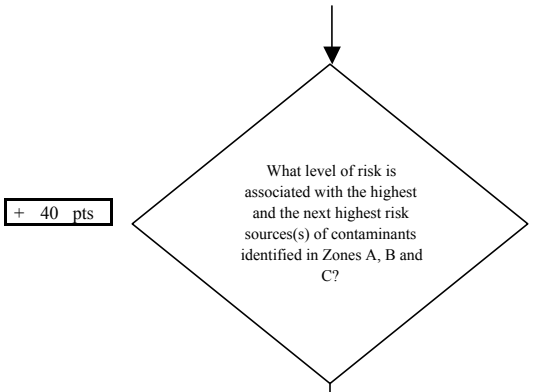


***Chart 5. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Nitrates and Nitrites***



## *Chart 5. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Nitrates and Nitrites*




+ 40 pts

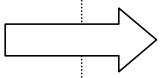
Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 1 | 0 | 1 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 1 | 0 | 1 |
| Low(s) | 1 | 0 | 1 |

| | **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 individua 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.



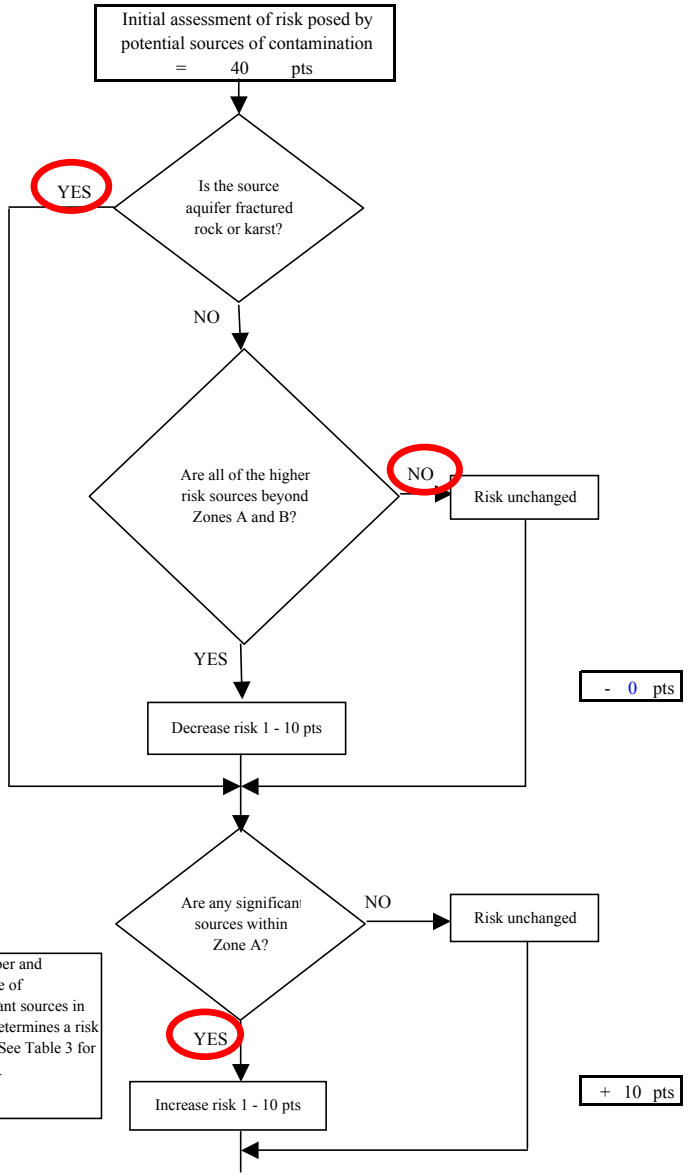
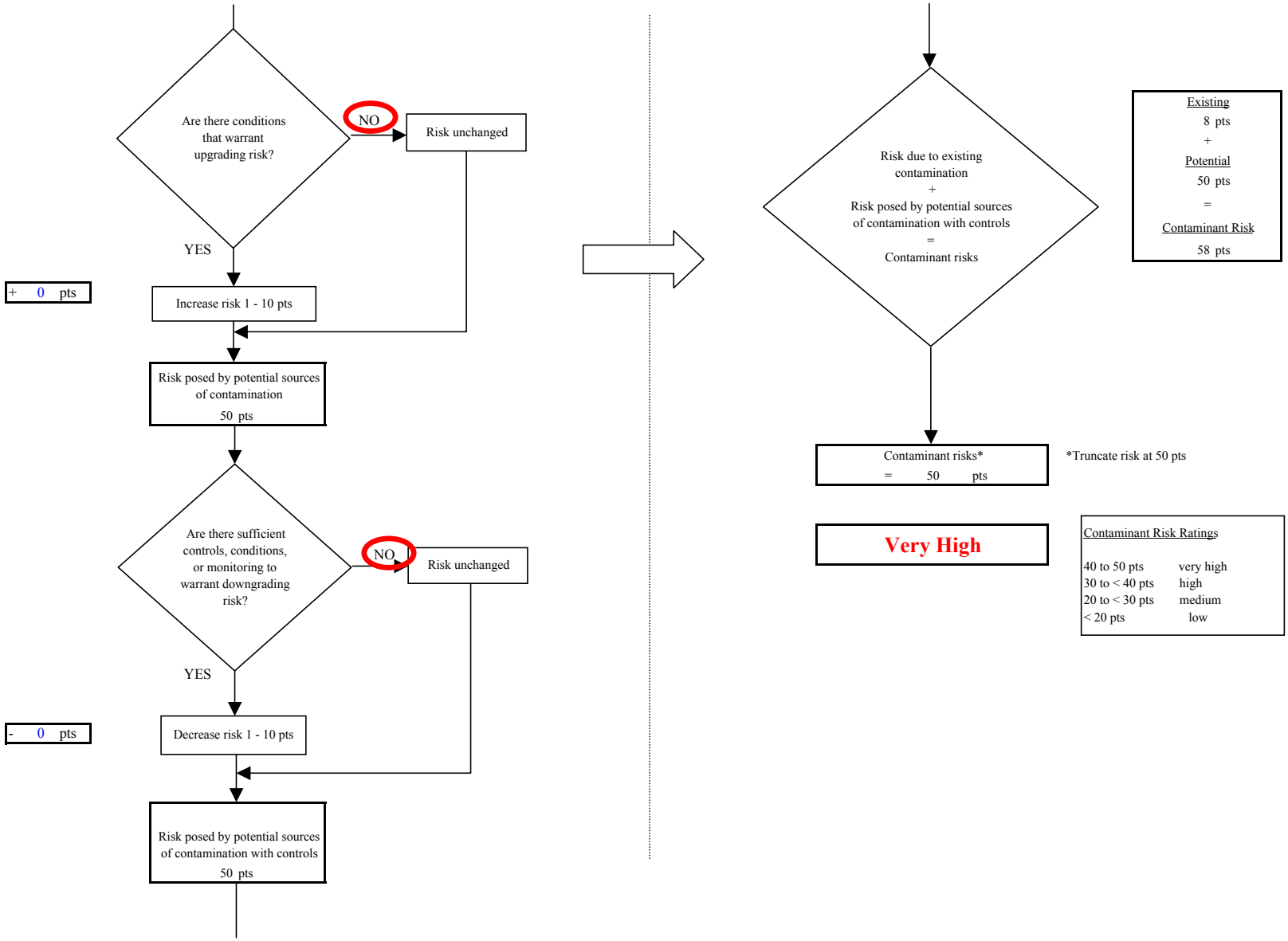


***Chart 5. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Nitrates and Nitrites***



## *Chart 6. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Nitrates and Nitrites*

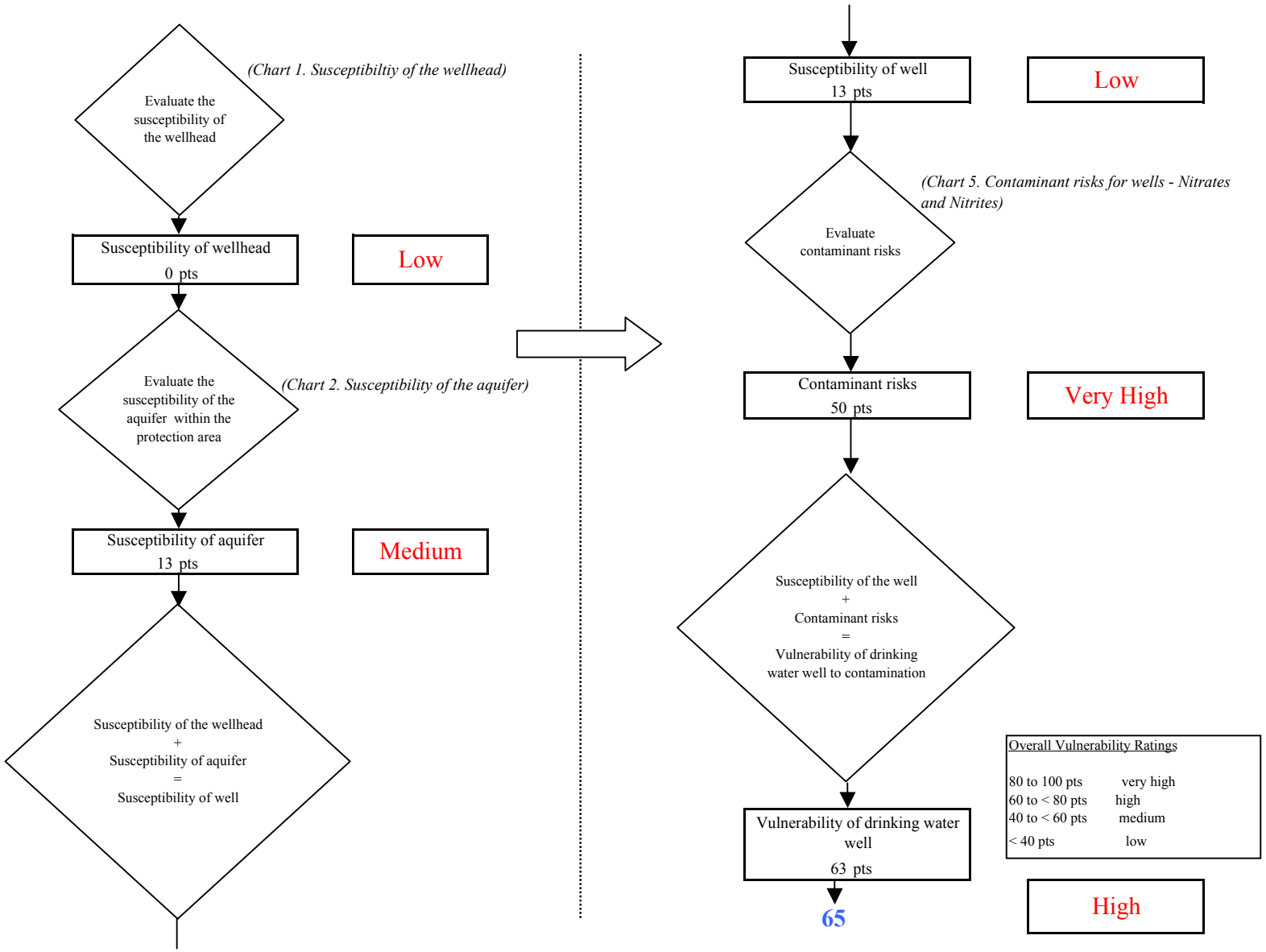


***Chart 7. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Volatile Organic Chemicals***

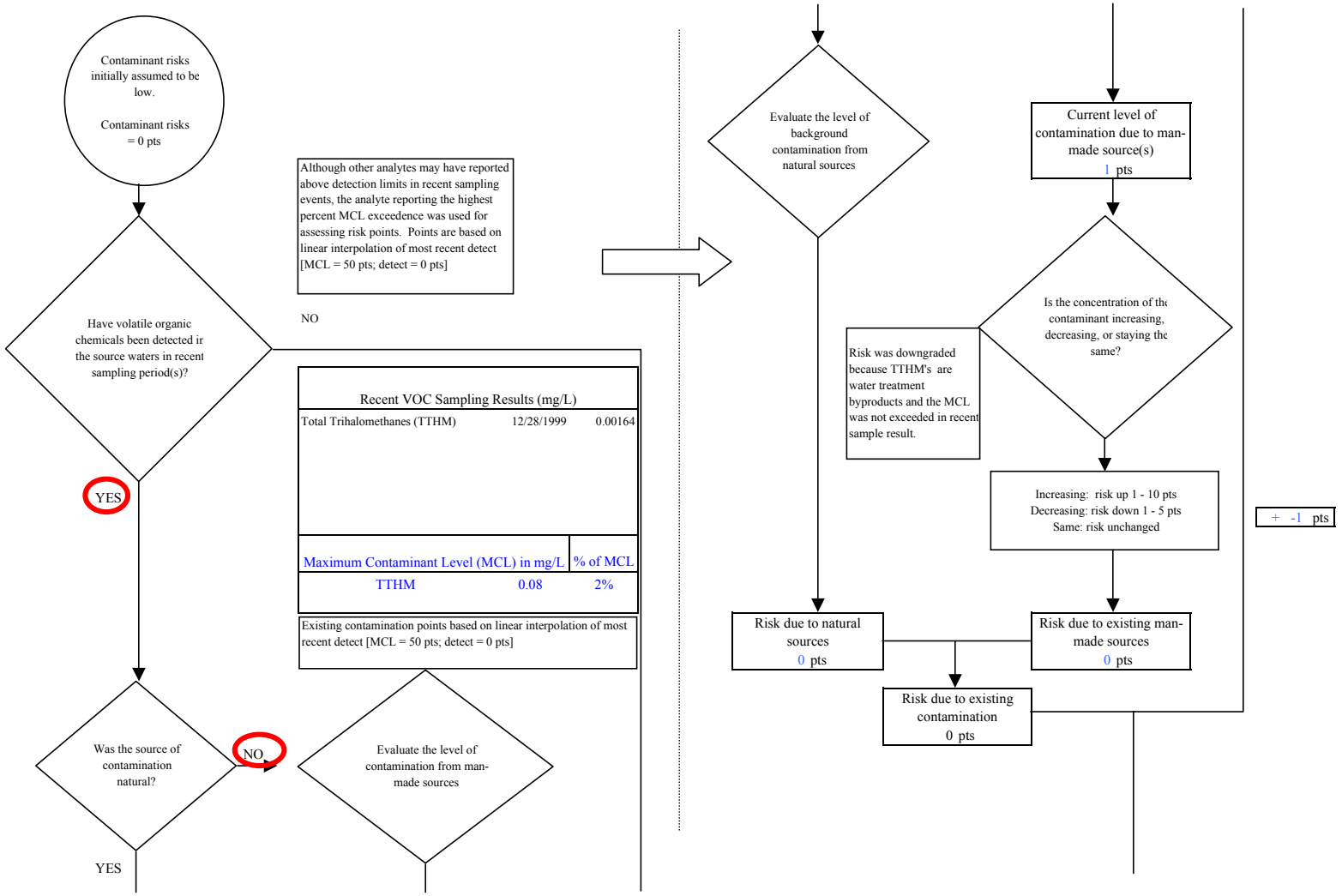
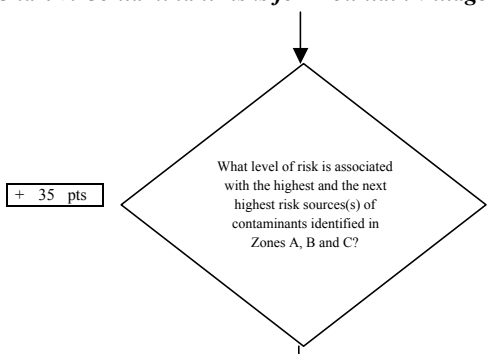


***Chart 7. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Volatile Organic Chemicals***




+ 35 pts

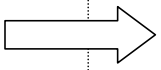
Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 1 | 0 | 1 |
| Medium(s) | 21 | 0 | 21 |
| Low(s) | 2 | 0 | 2 |

| | **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 35

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in tl 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.



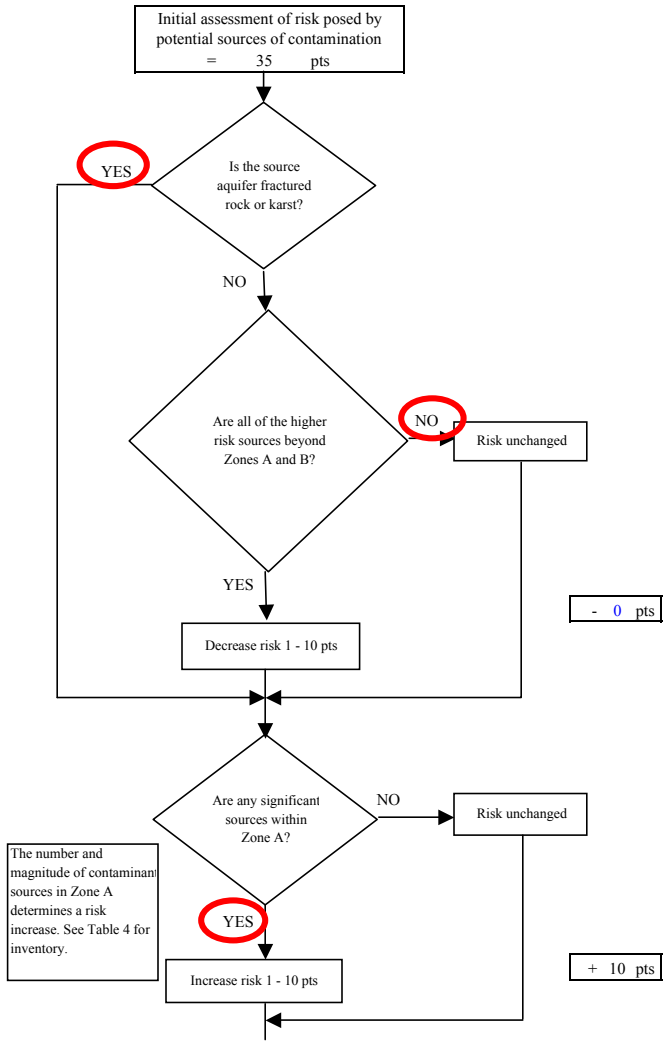
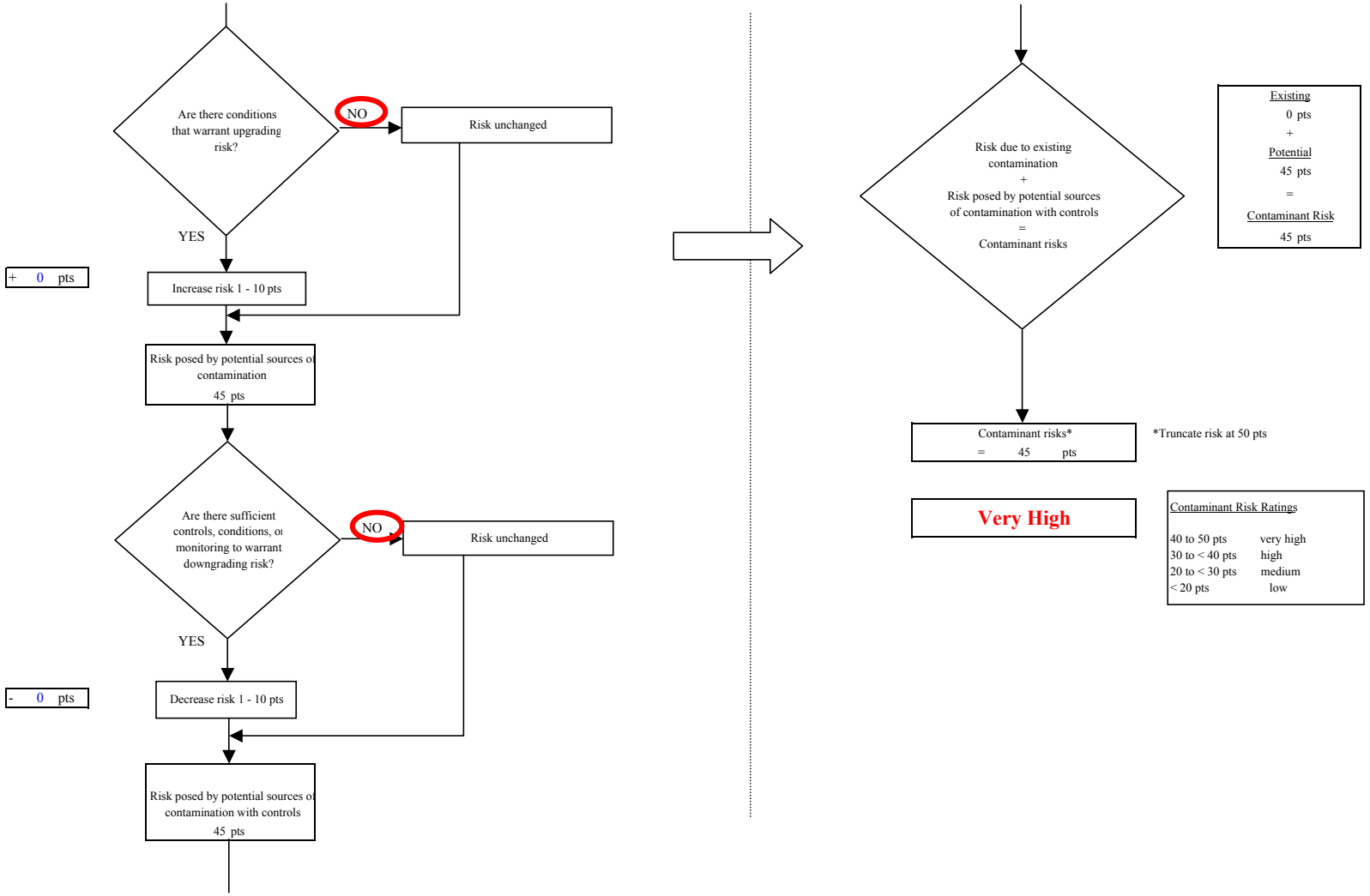
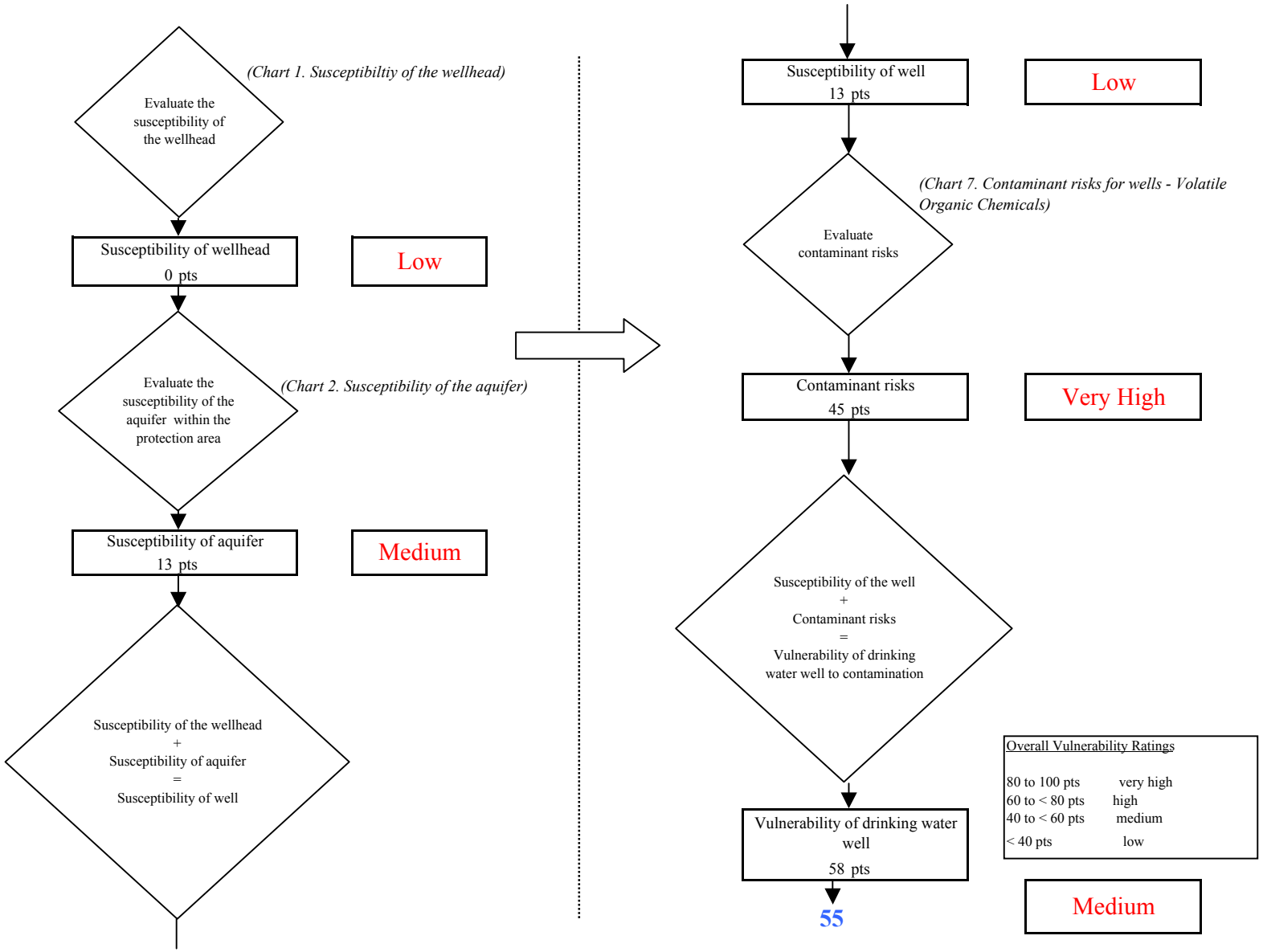


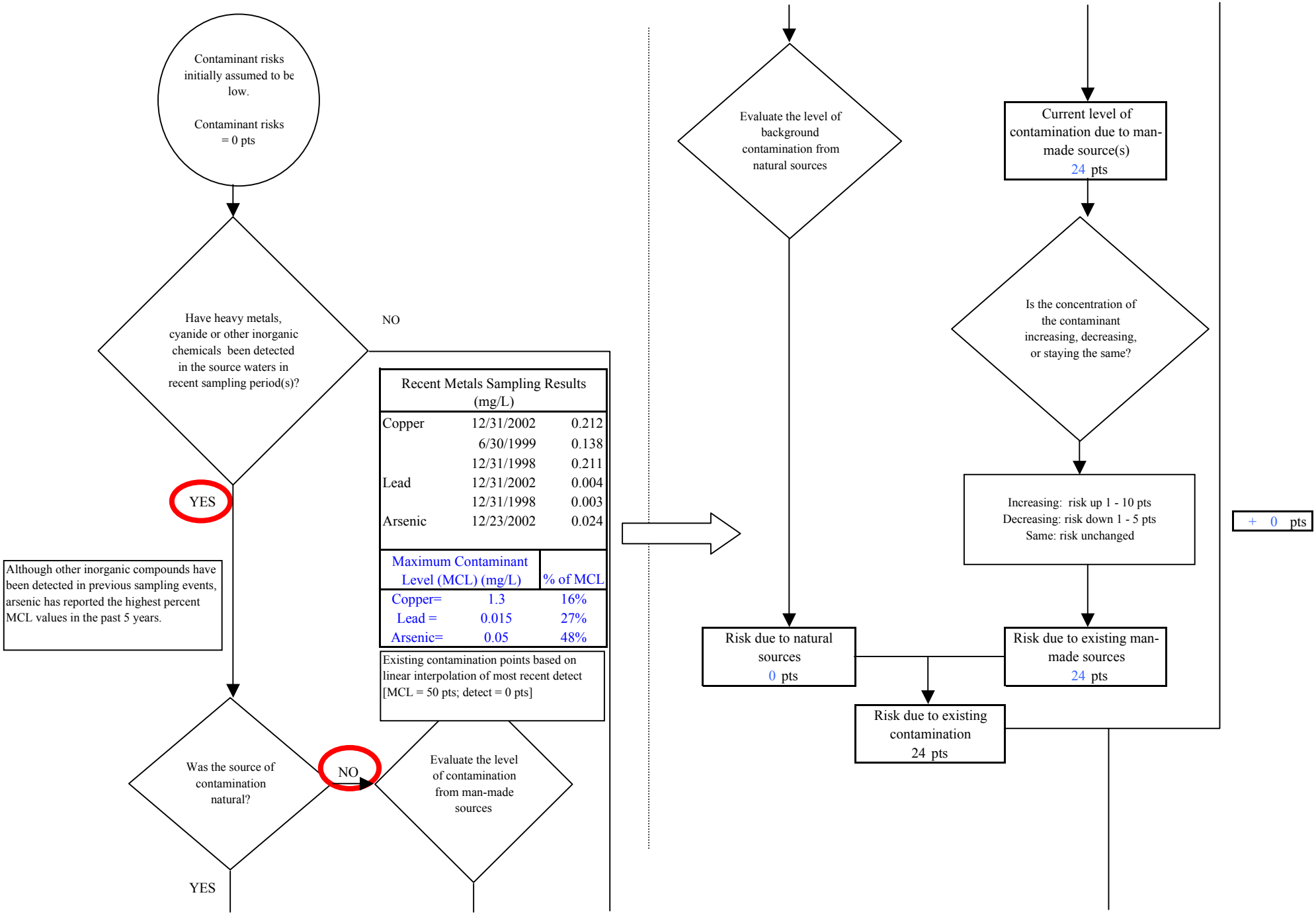
***Chart 7. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Volatile Organic Chemicals***



## *Chart 8. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Volatile Organic Chemicals*



## *Chart 9. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Heavy Metals, Cyanide and Other Inorganic Chemicals*



## *Chart 9. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Heavy Metals, Cyanide and Other Inorganic Chemicals*

+ 30 pts

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?

Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 1 | 0 | 1 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 2 | 0 | 2 |

| | **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 30

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.

Initial assessment of risk posed by potential sources of contamination = 30 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 5 for inventory.

YES

Increase risk 1 - 10 pts

+ 10 pts

## *Chart 9. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Heavy Metals, Cyanide and Other Inorganic Chemicals*

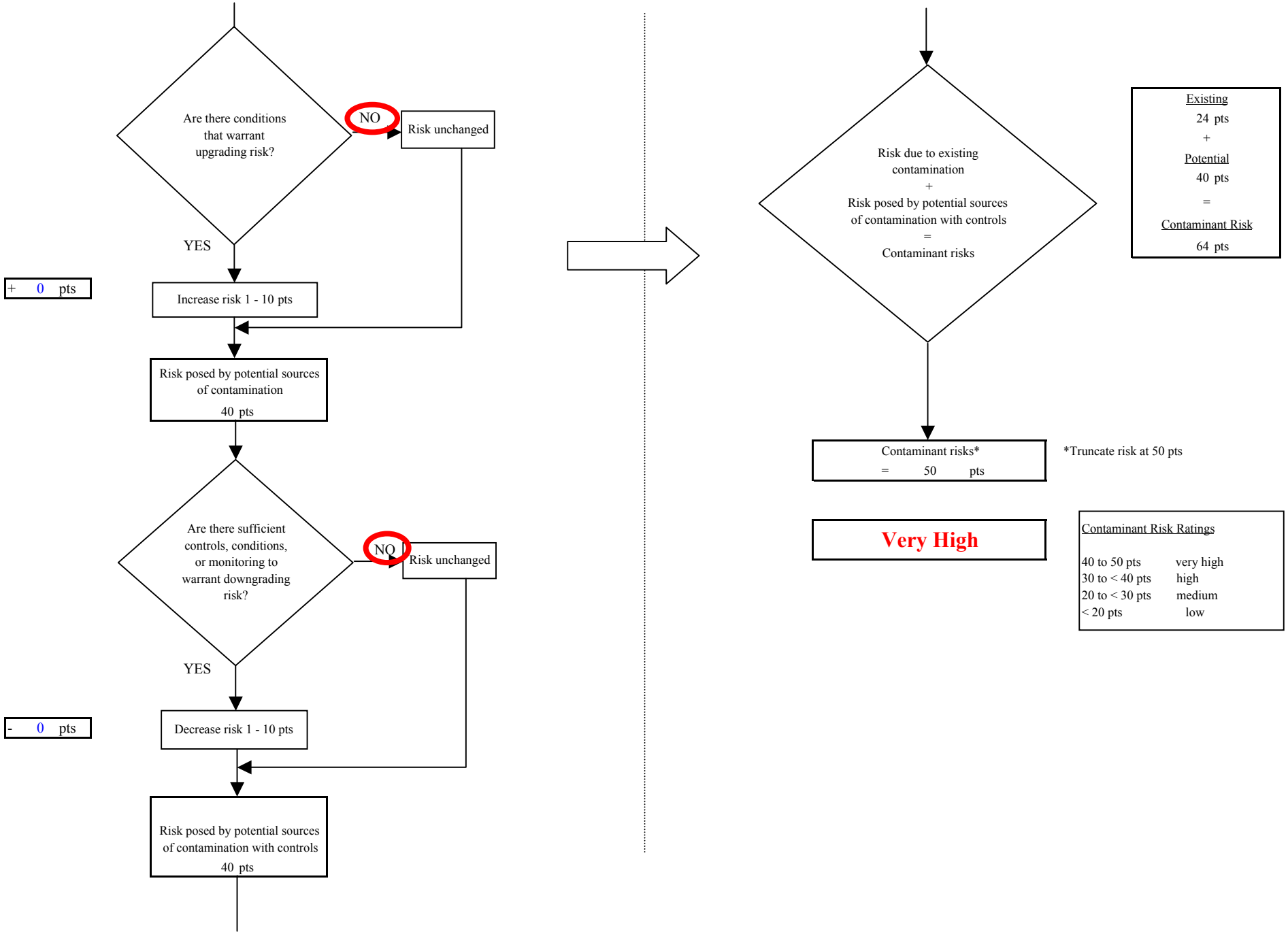
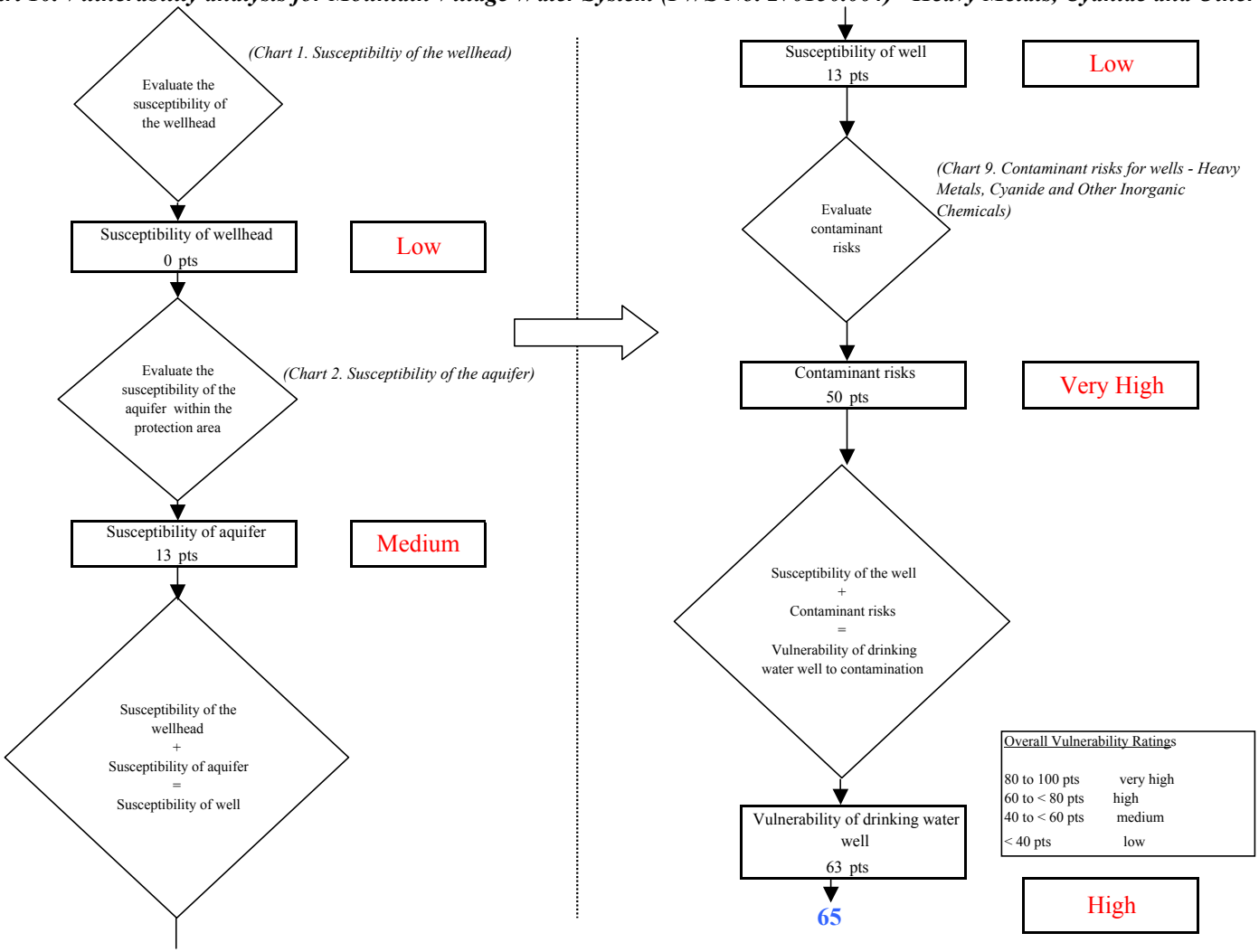
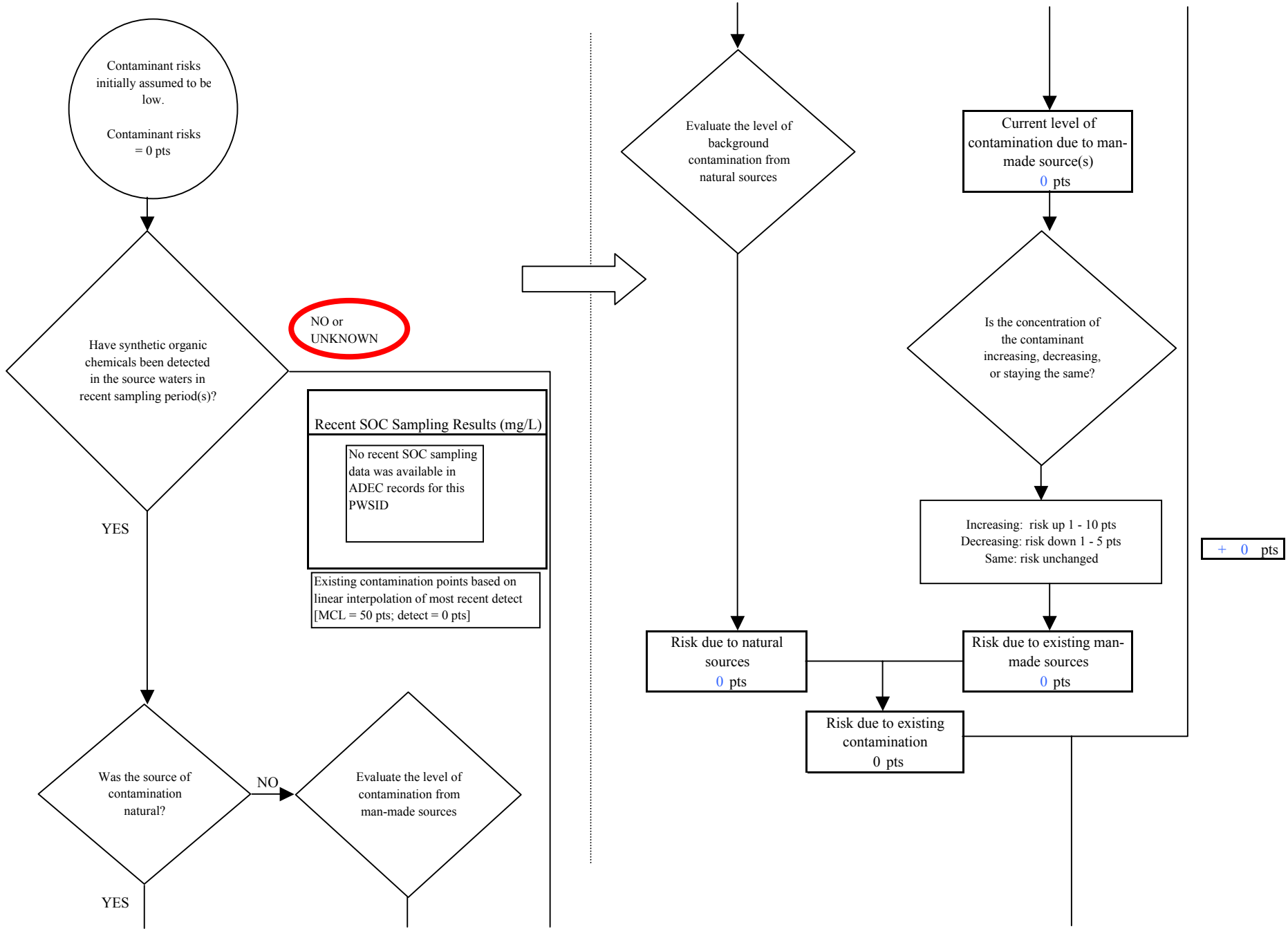


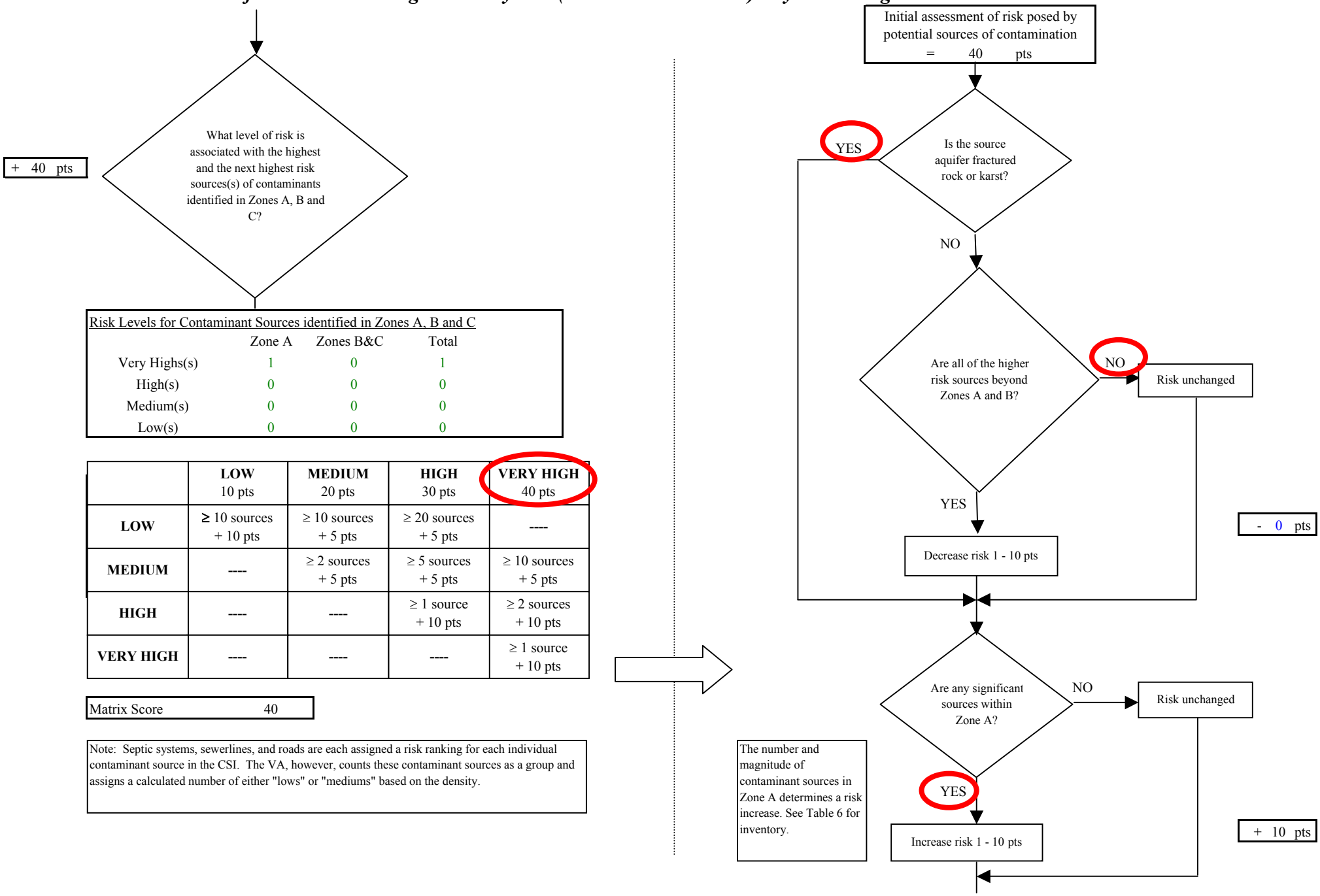
***Chart 10. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Heavy Metals, Cyanide and Other Inorganic Chemicals***



## *Chart 11. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Synthetic Organic Chemicals*



## *Chart 11. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Synthetic Organic Chemicals*




Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 1 | 0 | 1 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 0 | 0 | 0 |

| | **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 11. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Synthetic Organic Chemicals***

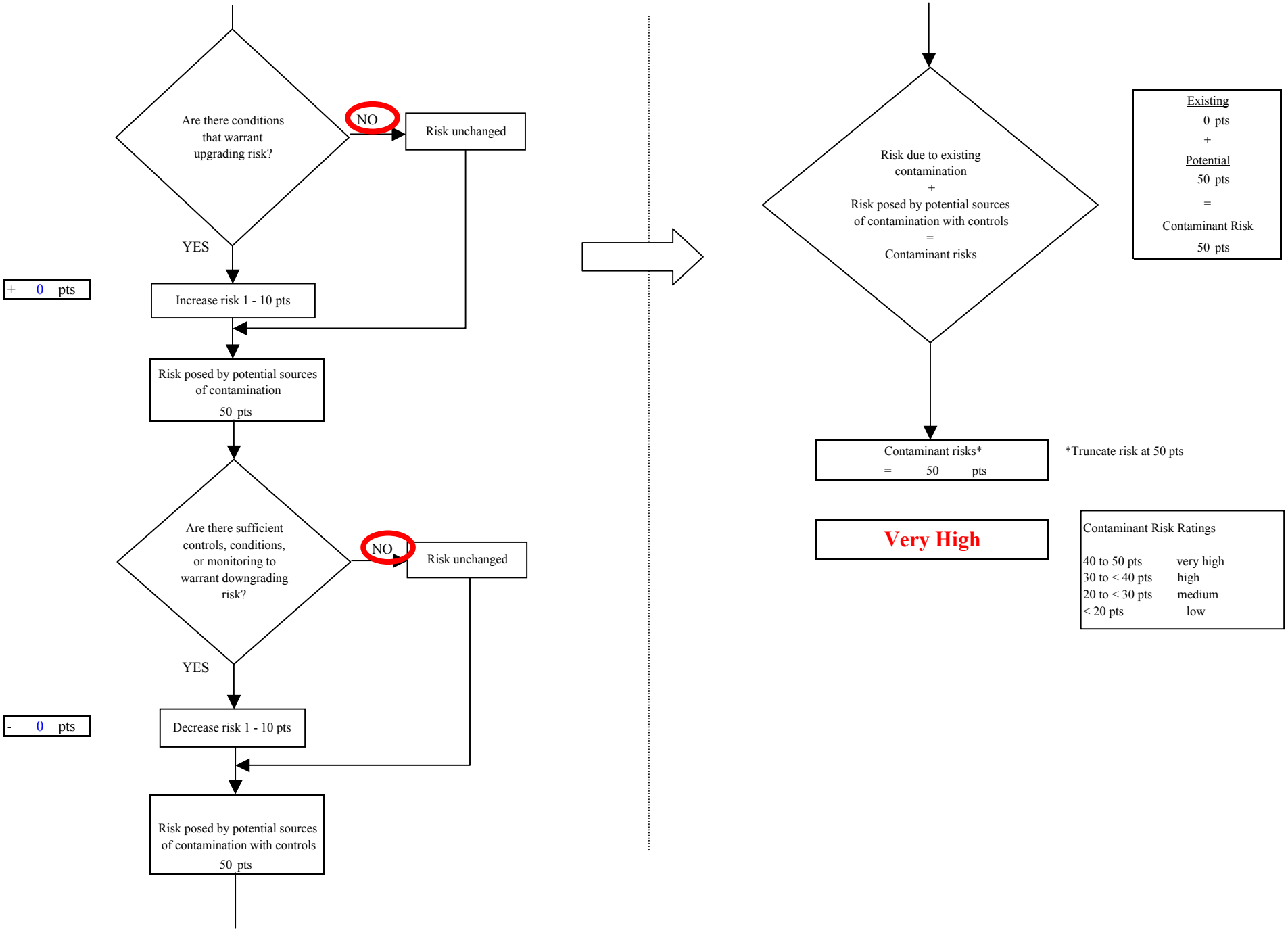
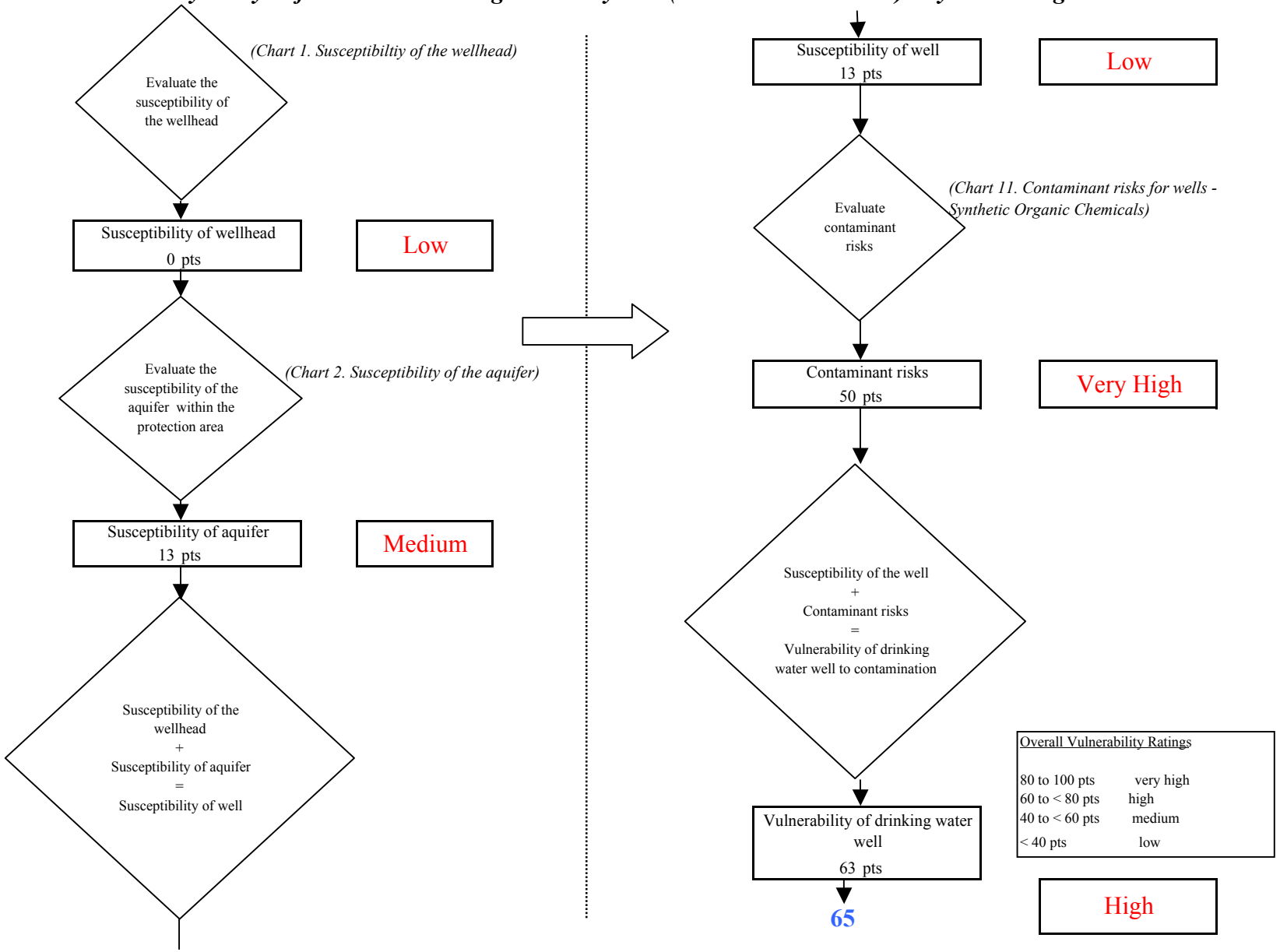
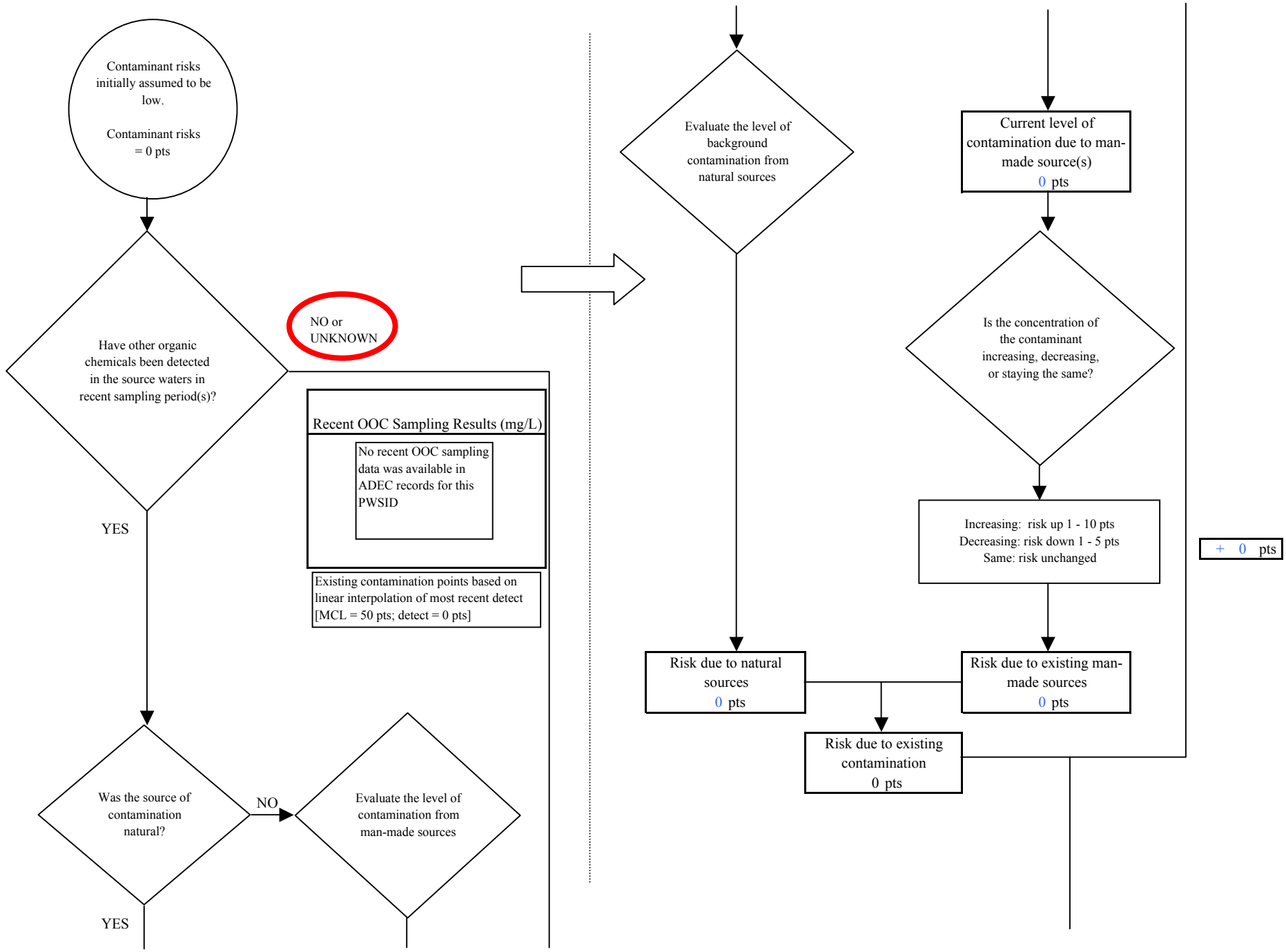


***Chart 12. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Synthetic Organic Chemicals***



## *Chart 13. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Other Organic Chemicals*



## *Chart 13. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Other Organic Chemicals*

+ 40 pts

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?

Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 1 | 0 | 1 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 1 | 0 | 1 |

| | **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.

Initial assessment of risk posed by potential sources of contamination = 40 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

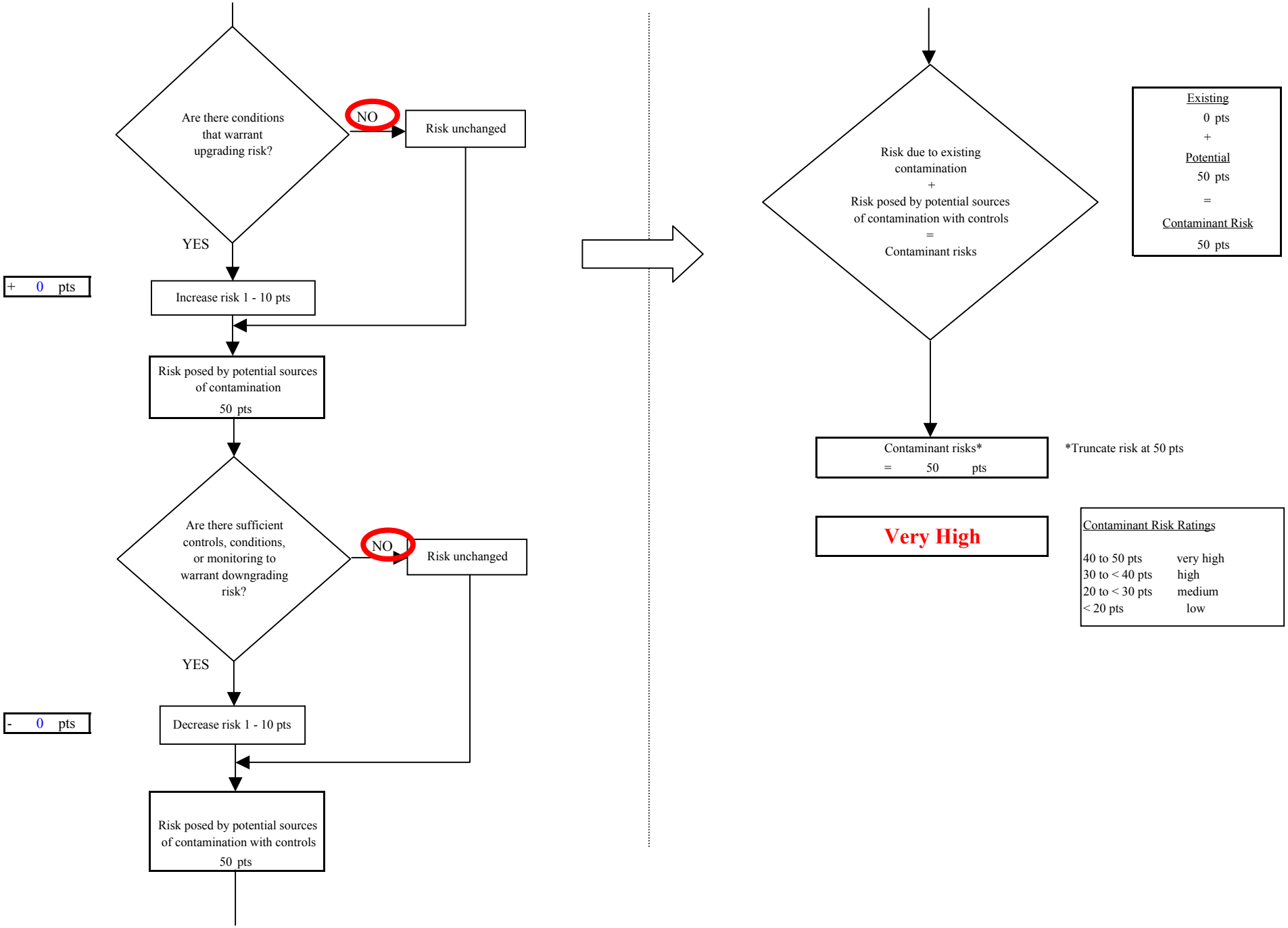
YES

Increase risk 1 - 10 pts

+ 10 pts

The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 7 for inventory.

## *Chart 13. Contaminant risks for Mountain Village Water System (PWS No. 270150.004) - Other Organic Chemicals*



## *Chart 14. Vulnerability analysis for Mountain Village Water System (PWS No. 270150.004) - Other Organic Chemicals*