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# Source Water Assessment

## A Hydrogeologic Susceptibility and Vulnerability Assessment for Two Rivers Lodge Drinking Water System, Two Rivers, Alaska PWSID 310756

January 2004

DRINKING WATER PROTECTION PROGRAM REPORT Report 1412  
Alaska Department of Environmental Conservation

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

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

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# Source Water Assessment for Two Rivers Lodge Source of Public Drinking Water, Two Rivers, Alaska

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## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

This source water assessment provides an evaluation of the vulnerability of the public water system serving the Two Rivers Lodge to potential contamination. This Class B (non-community) water system consists of one well at 4968 Chena Hot Springs Road near Two Rivers, Alaska. The well received a natural susceptibility rating of **Low**. This rating is a combination of a susceptibility rating of **Low** for the actual wellhead and a **High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Two Rivers Lodge public water system include: residential areas, septic systems, fuel storage tanks, roads, and a kennel. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water system for Two Rivers Lodge received an overall vulnerability rating of **Medium** for all three contaminant categories: bacteria and viruses, nitrates and nitrites and volatile organic chemicals.

### TWO RIVERS LODGE PUBLIC DRINKING WATER SYSTEM

Two Rivers Lodge public water system is a Class B (community) water system. The system consists of one well at 4968 Chena Hot Springs Road near Two Rivers, Alaska (T1N, R3E, Section 34). (See Map 1 of Appendix A). Two Rivers is located northeast of the town of Fairbanks which is located in the Fairbanks North Star Borough near the center of Alaska (Please see the inset of Map 1 in Appendix A for location). The Borough's current population is 82,840 making it the second-largest population center in the state (ADCED, 2002). Communities located within the Borough include : College, Eielson Air Force Base, Ester, Fairbanks, Fox, Harding Lake, Moose Creek, North Pole, Pleasant Valley, Salcha, and Two Rivers.

Residents of Moose Creek use individual wells or have water delivered, and septic systems or outhouses. Electricity for the city is provided by Golden Valley Electric Association. The majority of residents use heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) to heat homes and buildings. Refuse is collected in dumpsters and

transported to the Fairbanks North Star Borough Class I Landfill on South Cushman Street in Fairbanks.

This general area includes two distinct topographic areas: the alluvial plain between the Tanana River and the Chena River, and the uplands north of this alluvial plain. The Two Rivers Lodge water system is located in uplands at an elevation of approximately 650 feet above sea level.

According to the well log for this well, the depth of the well is 300 feet below the ground surface and is screened in water bearing rock. Bedrock in this area is predominantly a metamorphosed marine mud deposit, called a pelitic schist. The schist is locally intruded by granitic rocks – granite and quartz diorite. Groundwater in the bedrock is principally contained in fractures. The water wells in this area with the greatest well recharge appear to be in quartz veins, quartzite, and siliceous schist (Nelson, 1978).

Groundwater in the uplands is recharged by local precipitation. Outflow of ground water in the uplands primarily occurs two ways. In areas under artesian pressure (pressure caused by overlying permafrost), water can flow to the surface through thawed conduits within the permafrost. Otherwise groundwater will flow under the permafrost (if present) and out to the groundwater beneath the adjacent flood plain or creek valley (Nelson, 1978). Areas with discontinuous permafrost may locally affect the ground water flow directions.

The Two Rivers Lodge public drinking water system serves approximately 50 non-residents through one service connection.

### TWO RIVERS LODGE DRINKING WATER PROTECTION AREA

The pathways most likely for surface contamination to reach the groundwater are identified as the first step in determining a drinking water system's risk. 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 capture zone. The groundwater capture zone is located in the area circling the well (the area influenced by pumping) and also the

area of the water table upgradient of the well, usually forming a parabola shape.

An outline of the immediate watershed was used to determine the size and shape of the protection area for the Pumphouse Restaurant. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

Because of uncertainties and changing site conditions, a factor of safety is added to the groundwater capture zone to form the drinking water protection area for the well.

The protection areas established for wells are usually separated into four zones, limited by the watershed. These zones correspond to times-of-travel (TOT) of the water moving through the aquifer to the well (plus the factor of safety). Because the rate at which water travels through fractured bedrock is unknown but usually relatively fast, the protection area for the Pumphouse Restaurant consists only of Zone A.

The following is a summary of the four zones for wells and the calculated time-of-travel of the groundwater for each:

**Table 1. Definition of Zones**

Zone	Definition
A	¼ the distance for the 2-yr. time-of-travel
B	Less than 2 years time-of-travel
C	Less than 5 years time-of-travel
D	Less than 10 years time-of-travel

The time of travel for contaminants within the water varies with their unique physical and chemical characteristics.

The drinking water protection area outlined for the Two Rivers Lodge on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

## INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program (DWPP) has completed an inventory of potential and existing sources of contamination within the Two Rivers Lodge protection area. This inventory was completed through a search of agency records and other publicly available information. 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 B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites; and
- Volatile organic chemicals;

The sources are displayed on Map 2 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 each 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 combination of toxicity and volume associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

Tables 2 through 4 in Appendix B contain the ranking of inventoried potential and existing sources of contamination with respect to the six contaminant categories.

## VULNERABILITY OF TWO RIVERS LODGE 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 eight 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 properties of the aquifer and the presence of other wells or boreholes in the area. 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 the water system’s contaminant sample results. Lastly, Chart 4 combines the results of the first three charts to produce the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 7 contain the Contaminant

Risks and Vulnerability Analyses for nitrates and nitrites, and volatile 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 wellhead for the Two Rivers Lodge received a Low Susceptibility rating. The 10/21/99 Sanitary Survey indicates the well is capped with a sanitary seal, the land surface is sloped away from the well and the well is grouted. A sanitary seal prevents potential contaminants from entering the well from the inside while sloping the land surface away from the well and grouting help to prevent potential contaminants from traveling down the outside of the well casing.

The aquifer in the area the Two Rivers Lodge well is completed in received a High Susceptibility rating. Although the 250 feet of silt above the bedrock aquifer is very protective, other wells in the area can provide a quick pathway for contaminants to reach the aquifer. Table 2 summarizes the Susceptibility scores and ratings for Two Rivers Lodge.

**Table 2. Susceptibility**

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

The Contaminant Risk has been derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources. 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	27	Medium
Nitrates and/or Nitrites	27	Medium
Volatile Organic Chemicals	30	High

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

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

Again, rankings are assigned according to a point score:

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

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

**Table 4. Overall Vulnerability**

Category	Score	Rating
Bacteria and Viruses	40	Medium
Nitrates and/or Nitrites	40	Medium
Volatile Organic Chemicals	45	Medium

#### **Bacteria and Viruses**

The kennel and the residential septic systems represent the greatest risk of Bacteria and Viruses to this water system.

Only a small amount of bacteria and viruses are required to endanger public health. Coliforms 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 (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002). Routine sampling has not detected coliforms in this water system.

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 medium.

#### **Nitrates and Nitrites**

The kennel and the residential septic systems also represent the greatest risk to nitrates and nitrites for this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have not been detected in recent sampling history for the Two Rivers Lodge well.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

#### **Volatile Organic Chemicals**

The residential heating oil tanks represent the greatest risk of volatile organic chemical contamination to the well.

Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the area surrounding Fairbanks. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

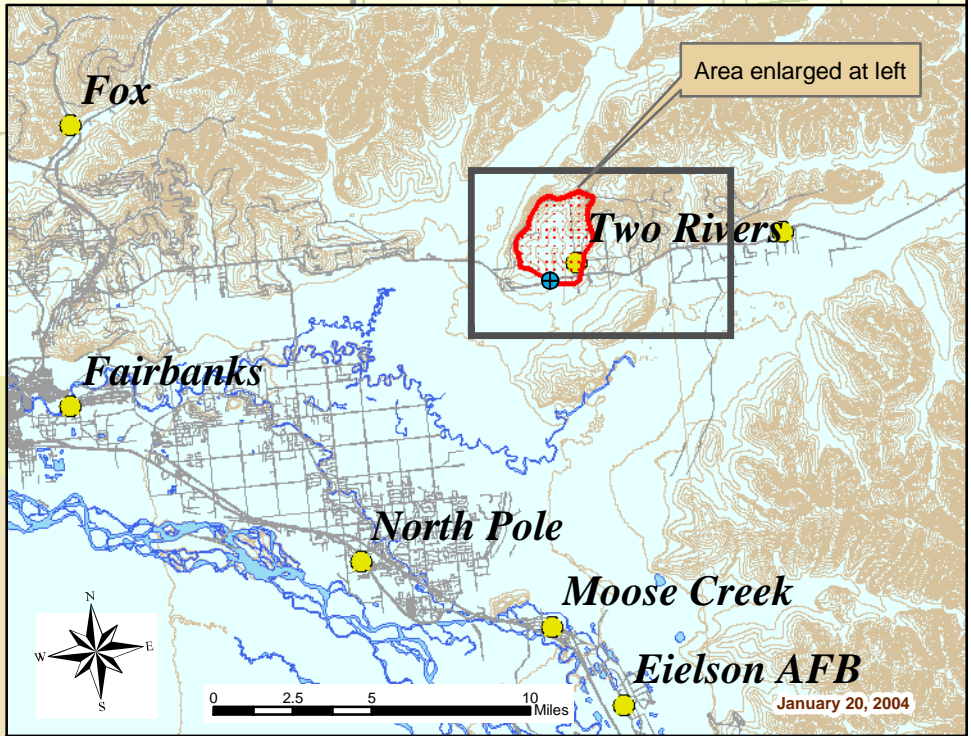
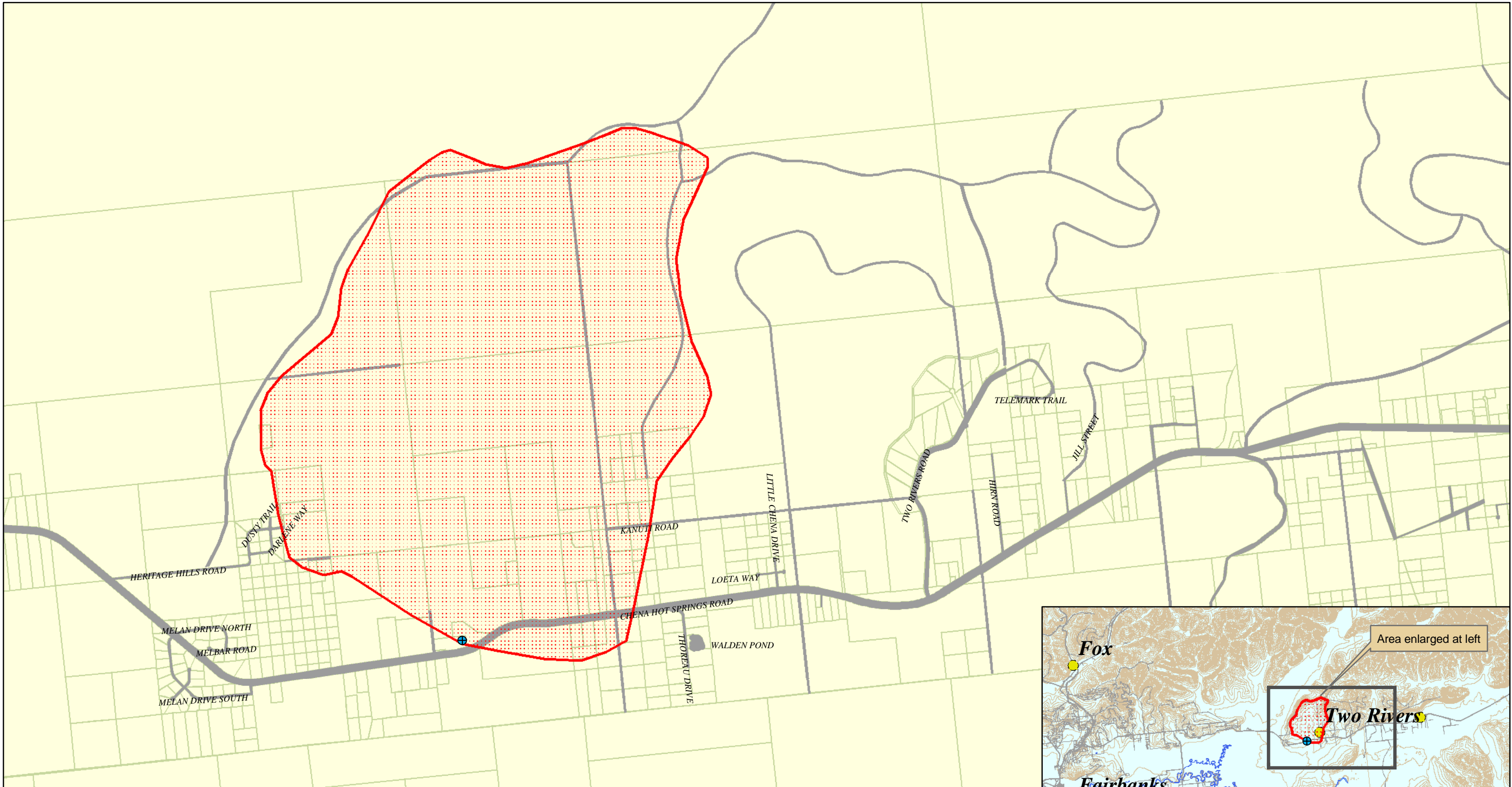
Volatile Organic Chemicals have not been sampled for in this water system. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

## REFERENCES

- Alaska Department of Community and Economic Development (ADCED), 2002 [WWW document]. URL [http://www.dced.state.ak.us/mra/CF\\_BLOCK.cfm](http://www.dced.state.ak.us/mra/CF_BLOCK.cfm).
- Anderson, G.S., 1970, Hydrologic reconnaissance of the Tanana basin, central Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-319.
- Forbes, R.B. and Weber, F.R., 1981. Bedrock Geologic Map of the Fairbanks Mining District, Alaska. Funded by the State of Alaska, US Geological Survey, and The National Science Foundation.
- Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Englewood Cliffs, NJ.
- Glass, Roy L., Lilly, Micheal R., and Meyer, David F., 1996. Ground-Water Levels in an Alluvial Plain Between the Tanana and Chena Rivers Near Fairbanks, Alaska 1986-93. US Geological Survey Water Resources Investigations Report 96-4060, 39p.
- Nakanishi, Allan S. and Lilly, Micheal R., 1998. Estimate of Aquifer Properties by Numerically Simulating Ground-Water/Surface-Water Interactions, Fort Wainwright, Alaska. US Geological Survey Water Resources Investigations Report 98-4088, 27p.
- Nelson, Gordon L., 1978, Hydrologic Information for Land-Use Planning, Fairbanks Vicinity, Alaska. US Department of the Interior Geological Survey Open File Report 78-959, 47p.
- Pewe, T. L., 1958, Geologic map of the Fairbanks D-2 quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ-110, scale 1:63,360.
- United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL <http://www.epa.gov/safewater/mcl.html>.

## **APPENDIX A**

### **Two Rivers Lodge Drinking Water Protection Area Location Map (Map 1)**



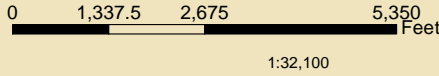
Map 1: Two Rivers Lodge Drinking Water Protection Area

PWSID: 310756



**Data Sources:**

Parcel, roads - Fairbanks North Star Borough  
Water bodies, railroad - Geographic Data Technology  
Elevation contours - USGS digital elevation models (DEMs)



**Legend**

- Two Rivers Lodge well
- Zone A
- Towns
- Roads
- Parcels

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Two Rivers Lodge (Tables 1-4)**

**Table 1**

***Contaminant Source Inventory for  
Two Rivers Lodge***

***PWSID 310756.001***

<b><i>Contaminant Source Type</i></b>	<b><i>Contaminant Source ID</i></b>	<b><i>CS ID tag</i></b>	<b><i>Zone</i></b>	<b><i>Map Number</i></b>	<b><i>Comments</i></b>
Residential Areas	R01		A	2	Estimated 200 acres of residential area
Septic systems (serves one single-family home)	R02		A	2	Assumed 29 septics based on number of parcels designated as residential
Tanks, heating oil, residential (above ground)	R08		A	2	Assumed 29 tanks based on number of parcels designated as residential
Highways and roads, paved (cement or asphalt)	X20		A	2	4 roads
Kennels	X49	X49-1	A	2	388 Reynolds Lane

**Table 2**

*Contaminant Source Inventory and Risk Ranking for  
Two Rivers Lodge  
Sources of Bacteria and Viruses*

**PWSID 310756.001**

<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>
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	4 roads
Residential Areas	R01		A	Low	2	Estimated 200 acres of residential area
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 29 septs based on number of parcels designated as residential
Kennels	X49	X49-1	A	Medium	2	388 Reynolds Lane

**Table 3**

*Contaminant Source Inventory and Risk Ranking for  
Two Rivers Lodge  
Sources of Nitrates/Nitrites*

**PWSID 310756.001**

<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>
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 29 septic systems based on number of parcels designated as residential
Residential Areas	R01		A	Low	2	Estimated 200 acres of residential area
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	4 roads
Kennels	X49	X49-1	A	Medium	2	388 Reynolds Lane

**Table 4**

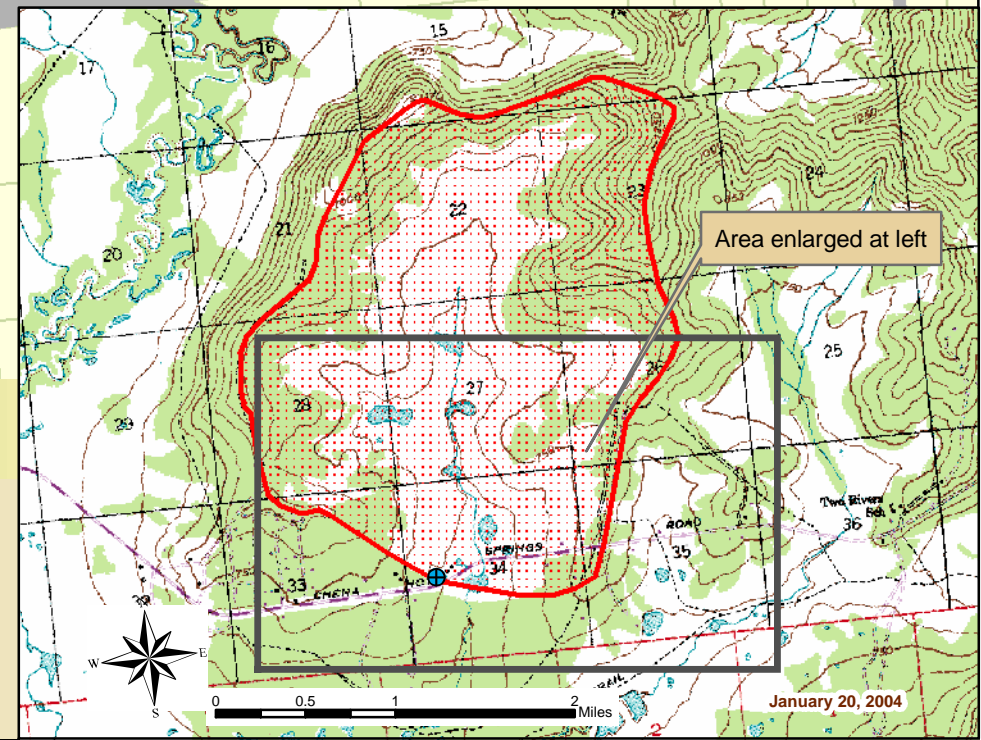
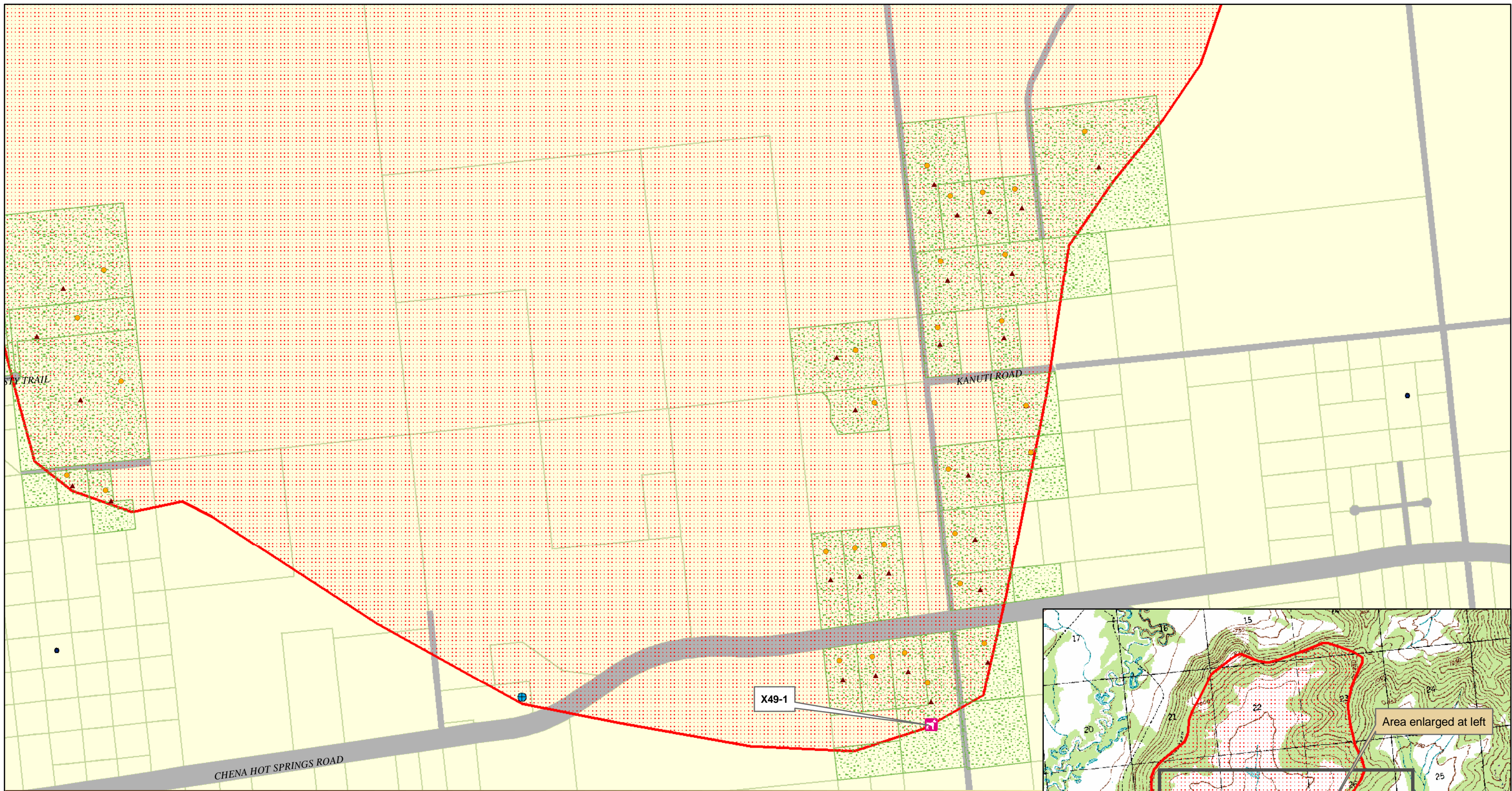
*Contaminant Source Inventory and Risk Ranking for  
Two Rivers Lodge  
Sources of Volatile Organic Chemicals*

**PWSID 310756.001**

<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>
Tanks, heating oil, residential (above ground)	R08		A	Medium	2	Assumed 29 tanks based on number of parcels designated as residential
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 29 septic systems based on number of parcels designated as residential
Residential Areas	R01		A	Low	2	Estimated 200 acres of residential area
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	4 roads

## **APPENDIX C**

### **Two Rivers Lodge Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)**



Map 2: Two Rivers Lodge Drinking Water Protection Area

PWSID: 310756



**Data Sources:**  
 Parcel, roads - Fairbanks North Star Borough  
 Water bodies, railroad - Geographic Data Technology  
 Elevation contours - USGS digital elevation models (DEMs)

- Legend**
- R08, Residential heating oil tanks
  - ▲ R02, Residential septic systems
  - R01, Residential area
  - ⊕ Two Rivers Lodge well
  - Zone A
  - Surface water
  - Roads
  - Parcels

0 475 950 Feet  
 1:11,400

## **APPENDIX D**

### **Vulnerability Analysis for Two Rivers Lodge Public Drinking Water Source (Charts 1-8)**

**Chart 1. Susceptibility of the wellhead - Two Rivers Lodge**

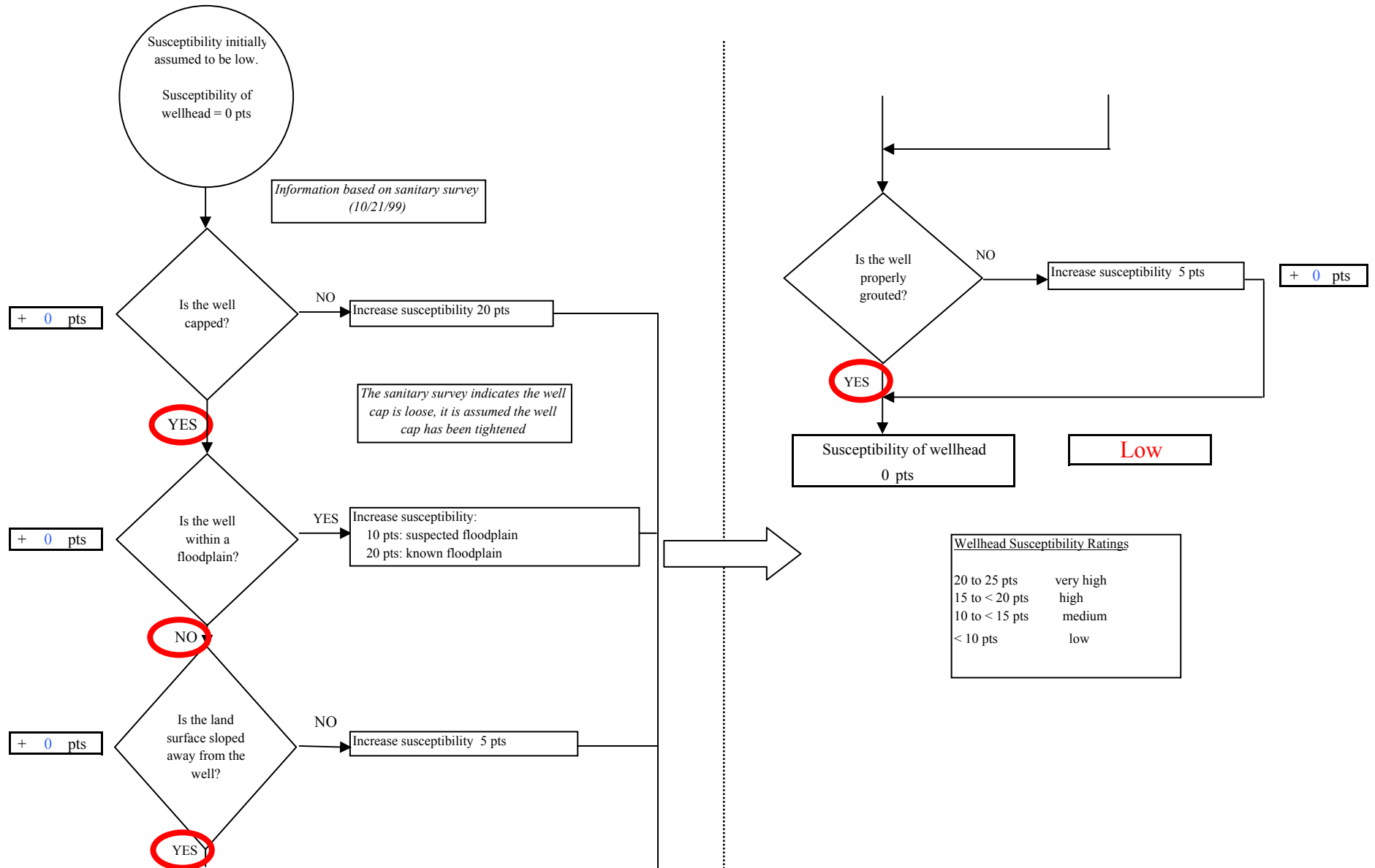


Chart 2. Susceptibility of the aquifer - Two Rivers Lodge

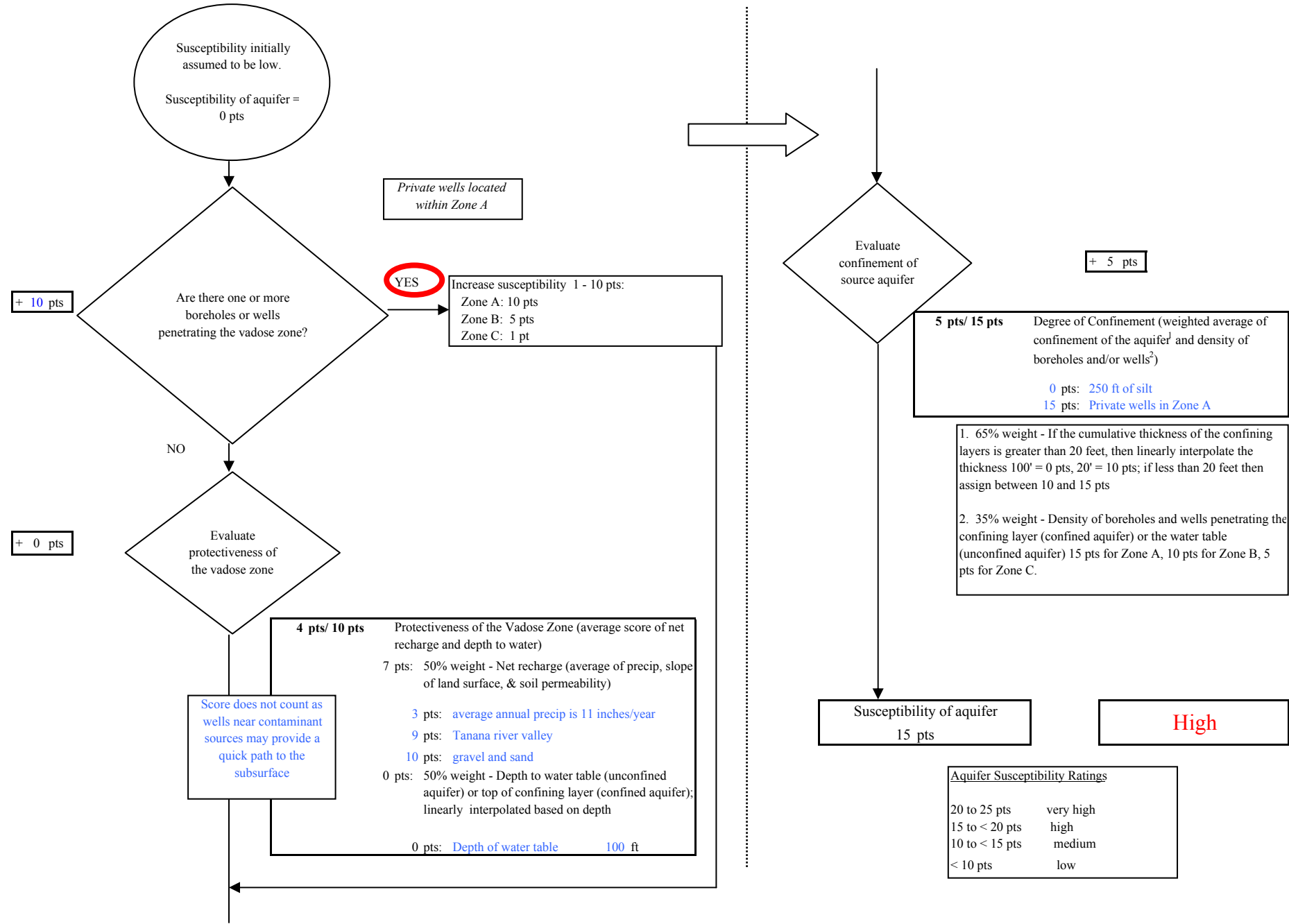


Chart 3. Contaminant risks for Two Rivers Lodge - Bacteria & Viruses

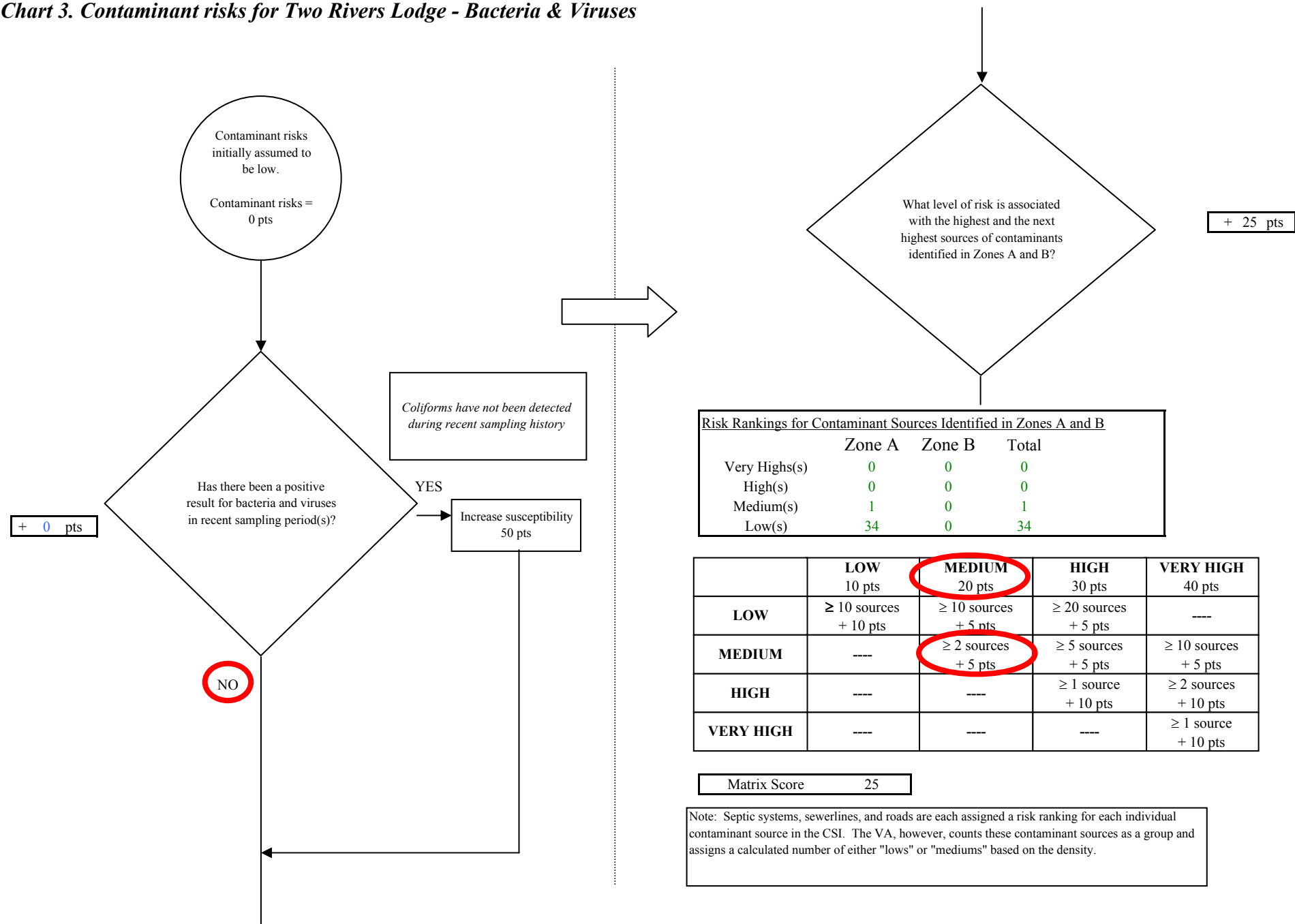
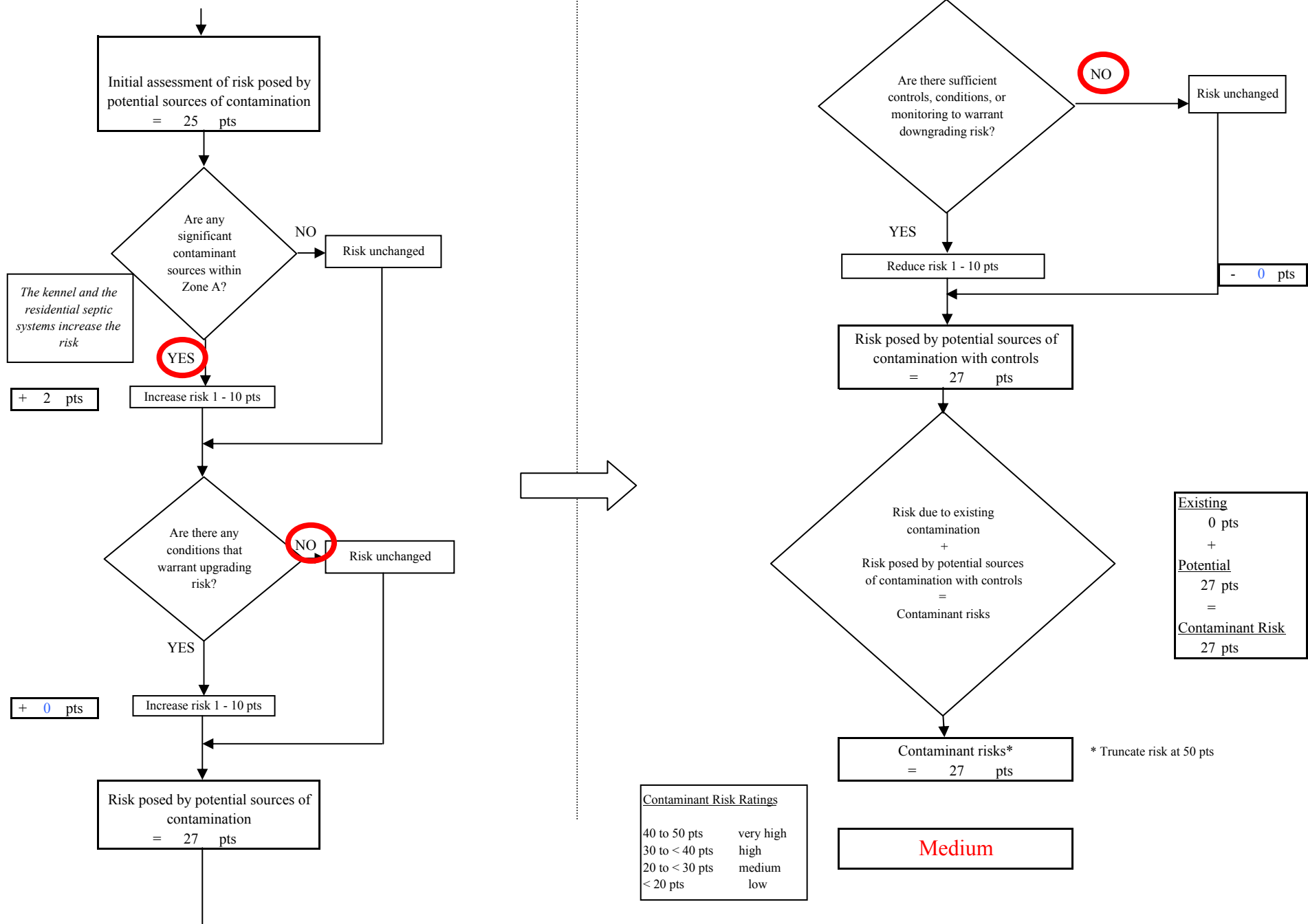
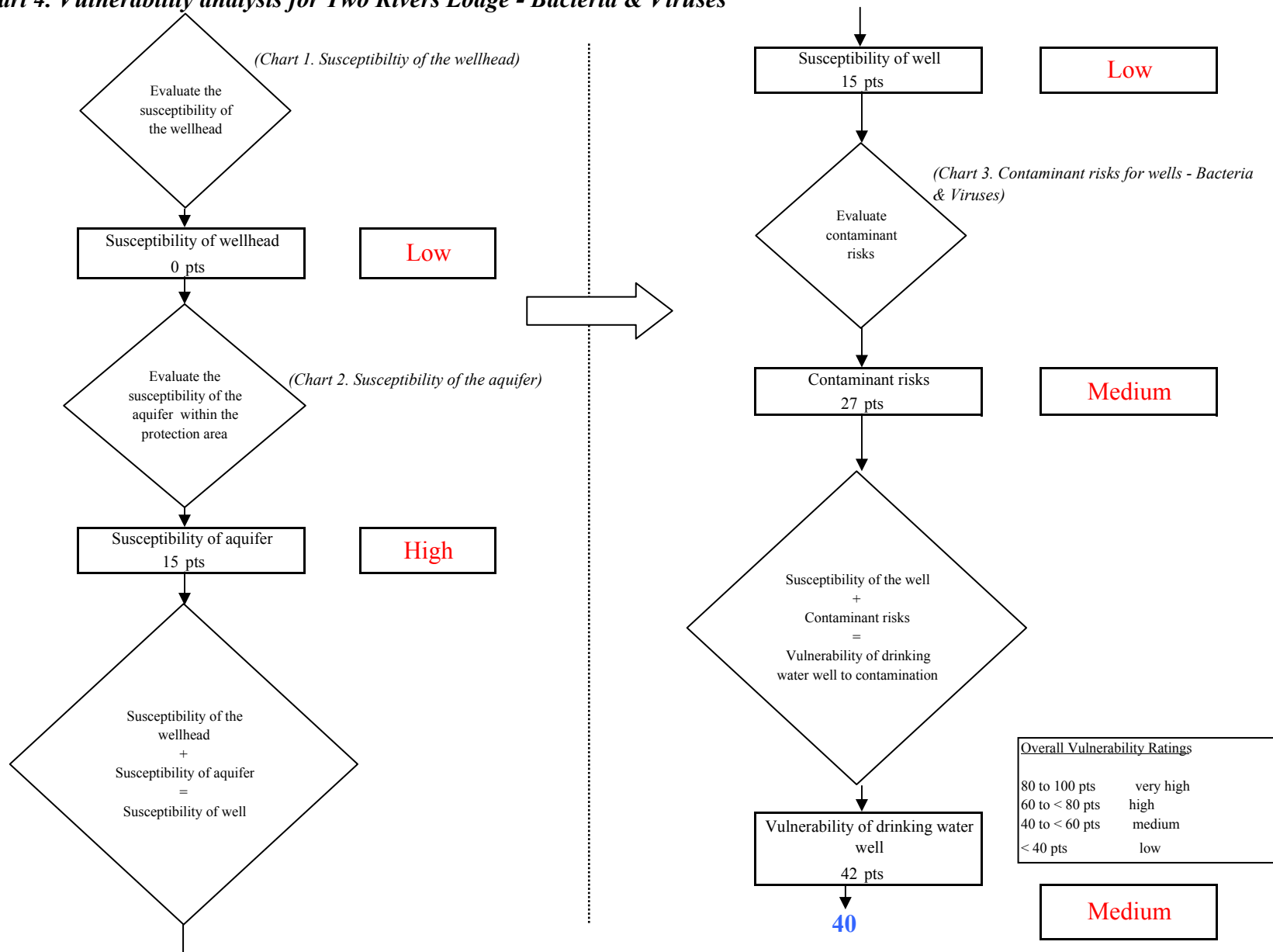


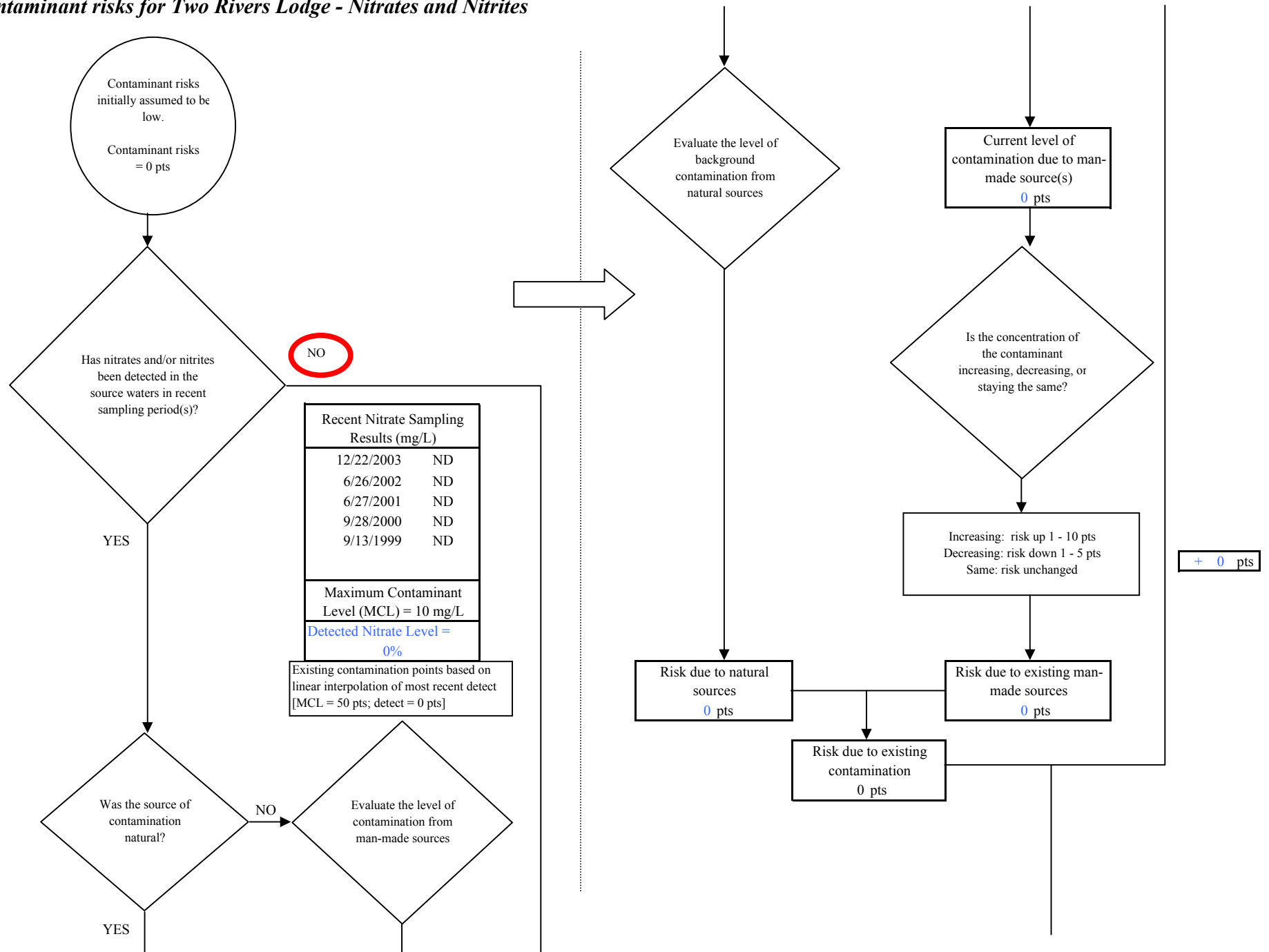
Chart 3. Contaminant risks for Two Rivers Lodge - Bacteria & Viruses



**Chart 4. Vulnerability analysis for Two Rivers Lodge - Bacteria & Viruses**



**Chart 5. Contaminant risks for Two Rivers Lodge - Nitrates and Nitrites**



**Chart 5. Contaminant risks for Two Rivers Lodge - Nitrates and Nitrites**

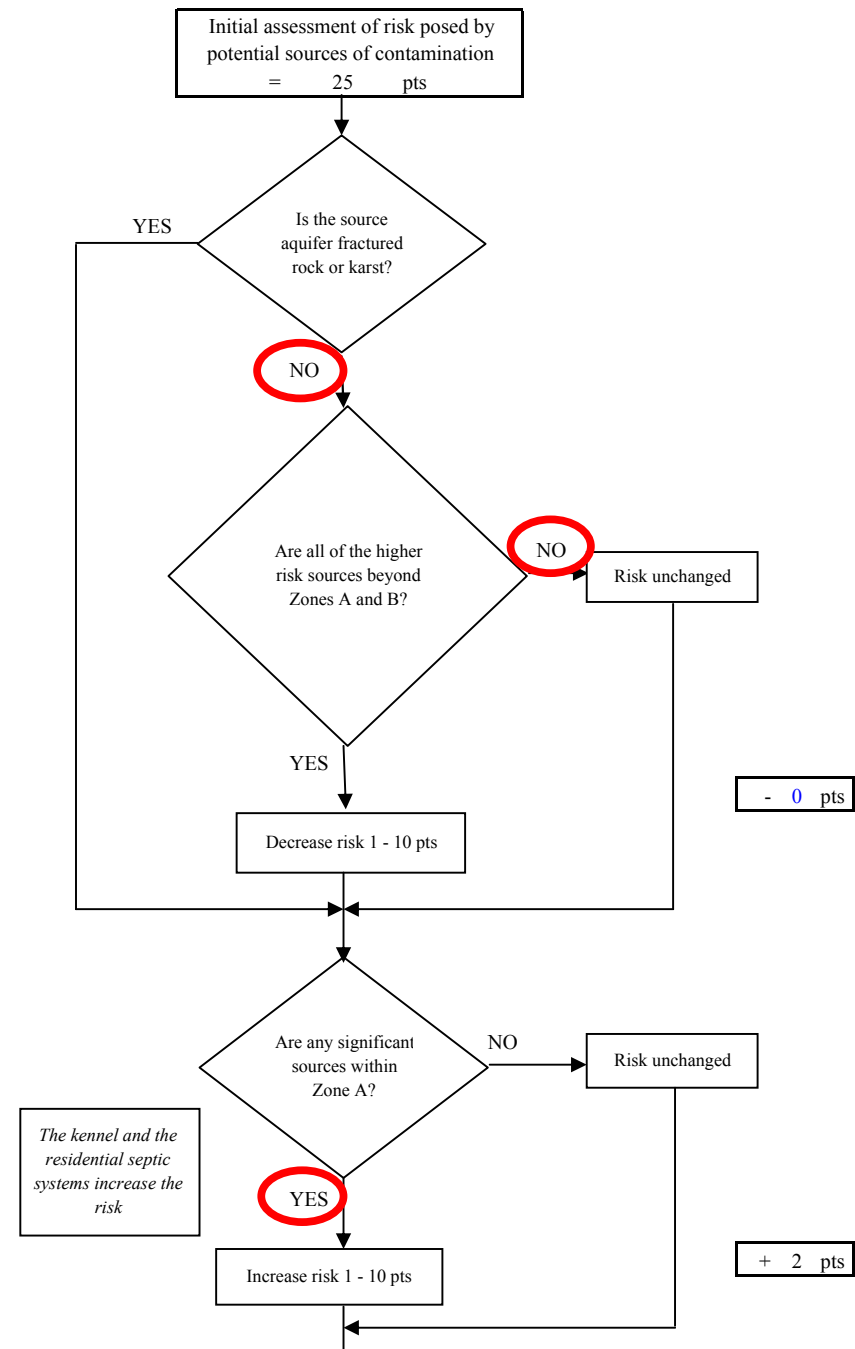
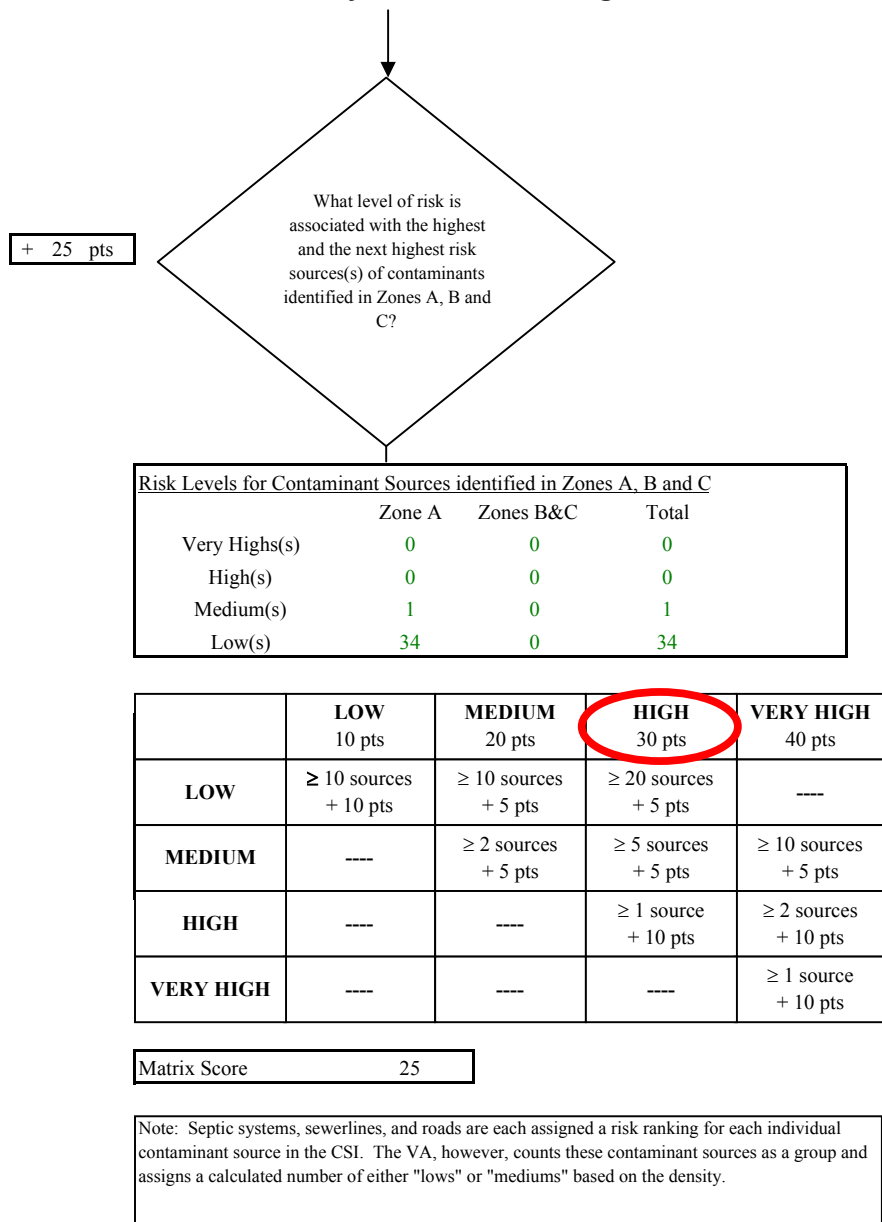
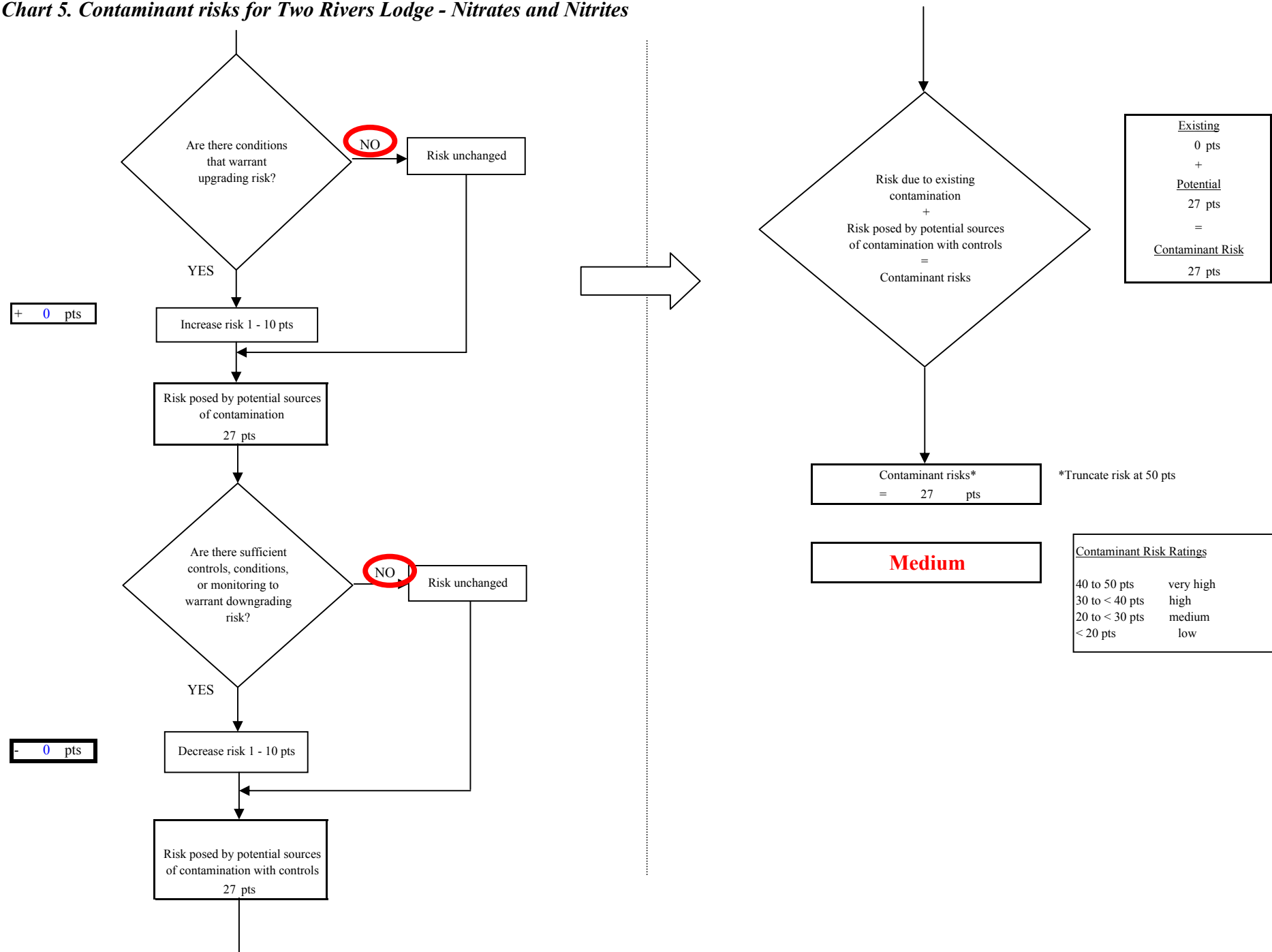
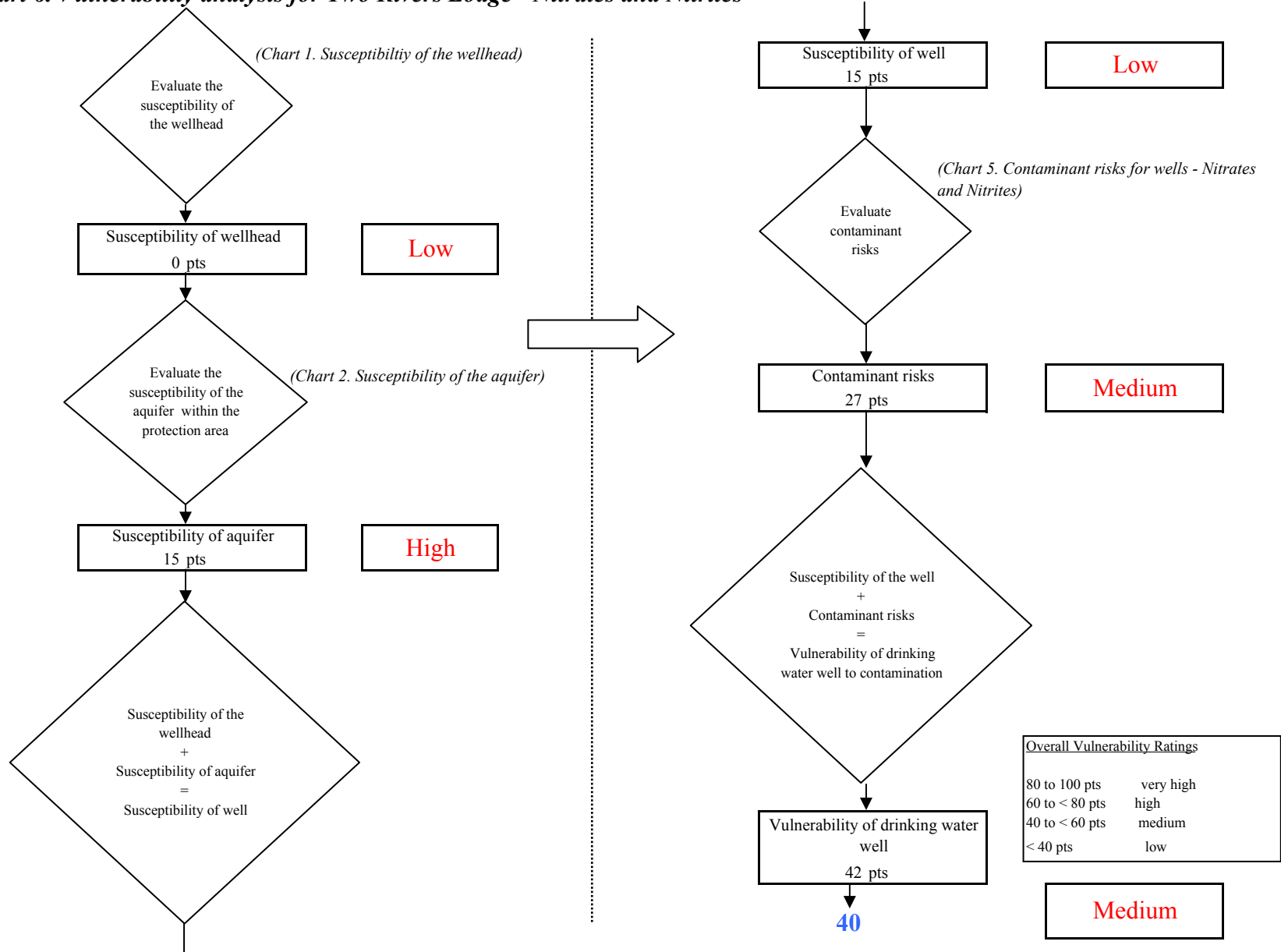


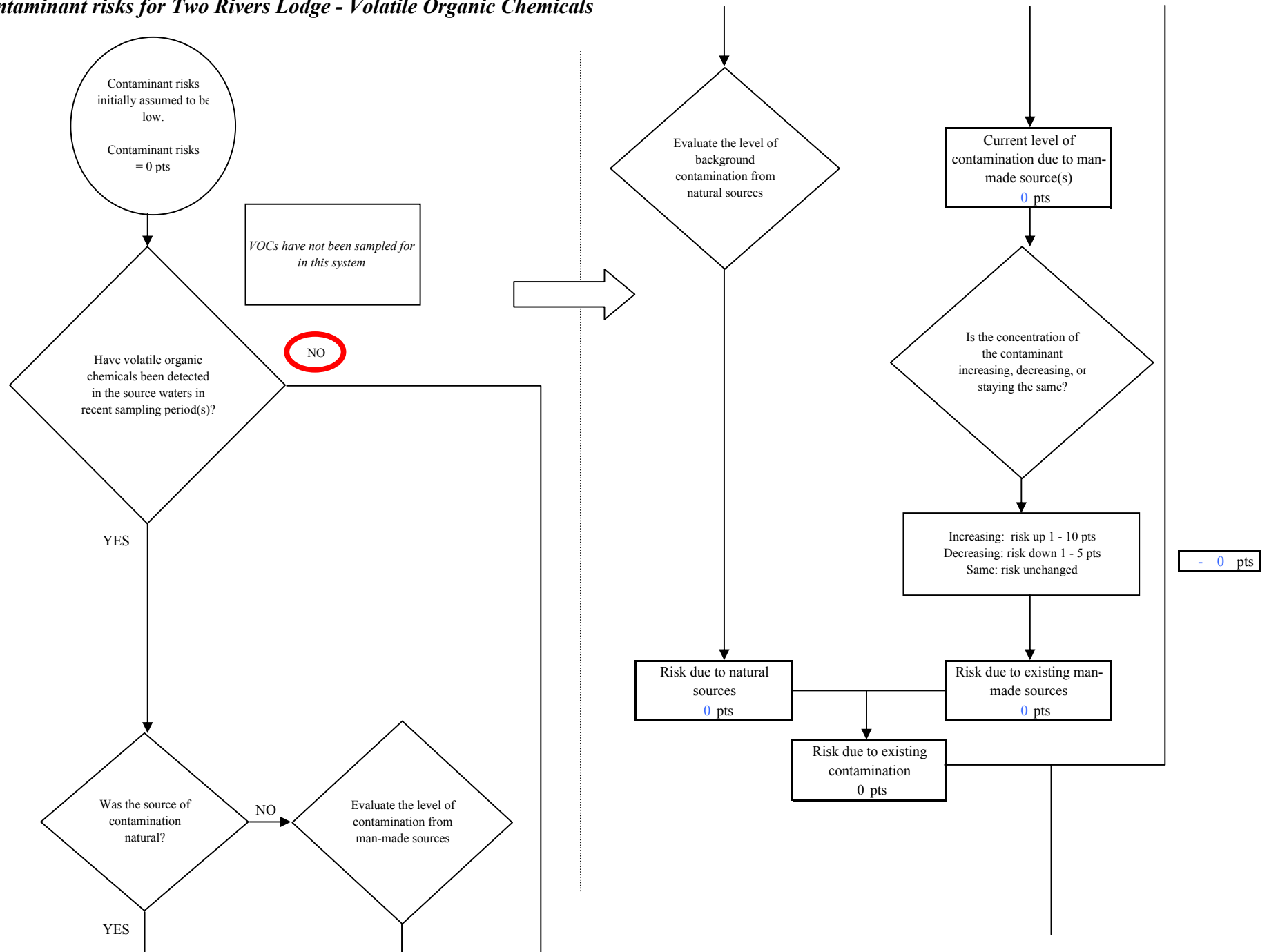
Chart 5. Contaminant risks for Two Rivers Lodge - Nitrates and Nitrites



**Chart 6. Vulnerability analysis for Two Rivers Lodge - Nitrates and Nitrites**



**Chart 7. Contaminant risks for Two Rivers Lodge - Volatile Organic Chemicals**



**Chart 7. Contaminant risks for Two Rivers Lodge - Volatile Organic Chemicals**

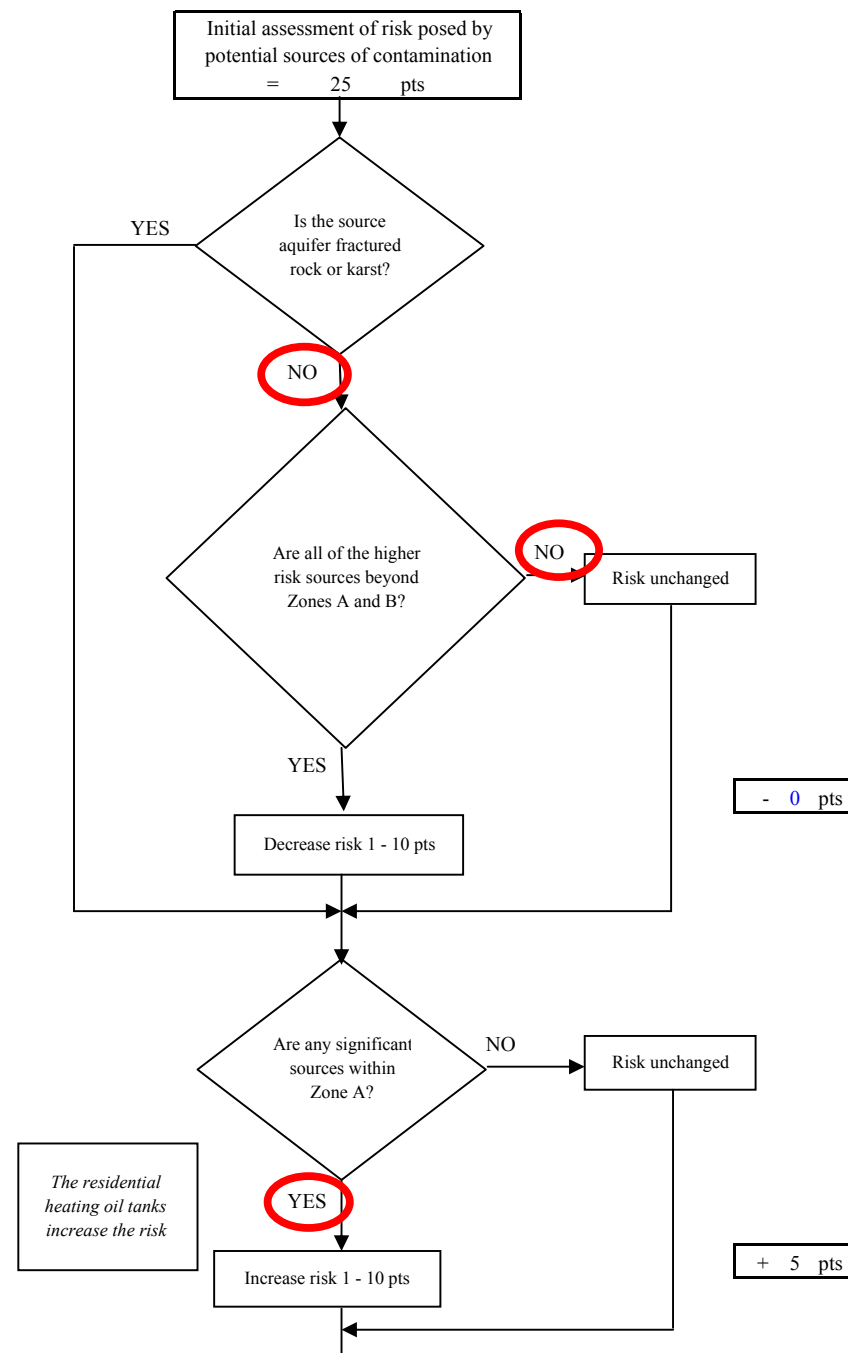
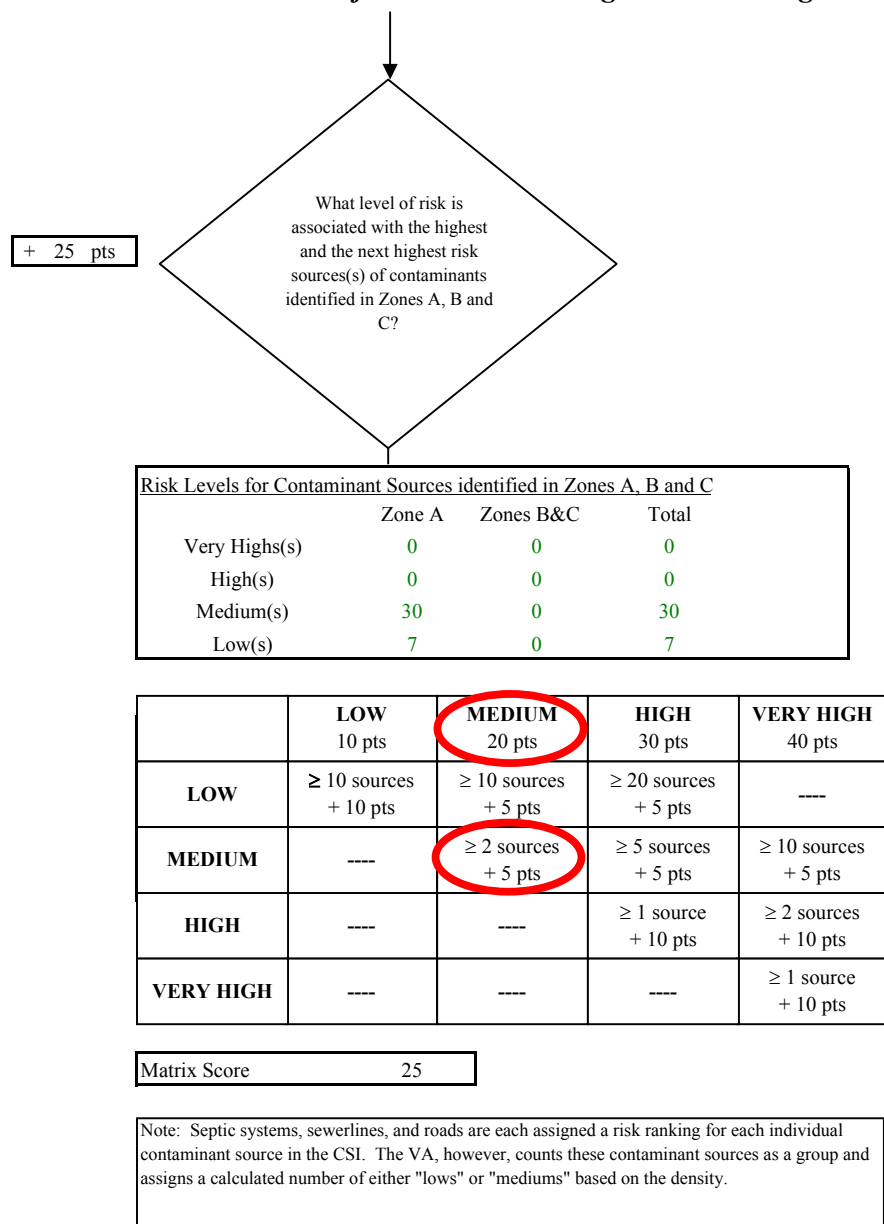
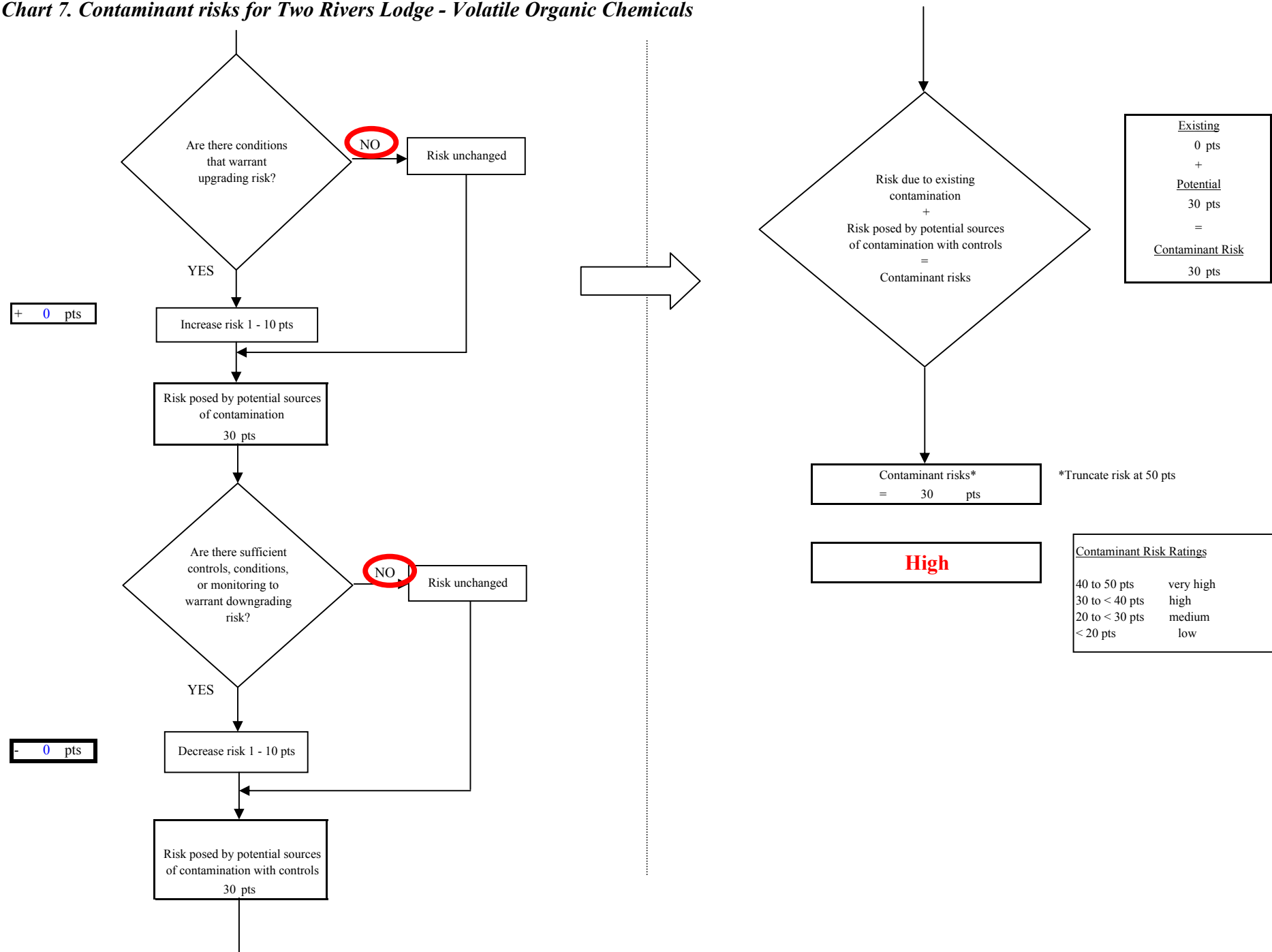


Chart 7. Contaminant risks for Two Rivers Lodge - Volatile Organic Chemicals



**Chart 8. Vulnerability analysis for Two Rivers Lodge - Volatile Organic Chemicals**

