Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Fireweed 288 Roadhouse Drinking Water System, Nenana, Alaska PWSID # 390489

DRINKING WATER PROTECTION PROGRAM REPORT # 268
Alaska Department of Environmental Conservation

Source Water Assessment for Fireweed 288 Roadhouse Drinking Water System, Nenana, Alaska PWSID # 390489

By Ecology & Environment, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT # 390489

August 2002

The Drinking Water Protection Program 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. 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

TABLES

FIGURES

APPENDICES

Source Water Assessment for Fireweed 288 Roadhouse Source of Public Drinking Water, Nenana, Alaska

By Ecology & Environment, Inc.

Drinking Water Protection Program
Alaska Department of Environmental Conservation

Executive Summary

Fireweed 288 Roadhouse is a Class B (transient/non-community) water system consisting of one well in Nenana, Alaska. Identified potential and current sources of contaminants for Fireweed 288 Roadhouse public drinking water source include: a paved road, a septic tank and an aboveground gasoline tank. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water sources for Fireweed 288 Roadhouse received a vulnerability rating of **High** for bacteria, **Low** for nitrates, nitrites and volatile organic chemicals.

Introduction

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this assessment is to provide owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system. Ecology and Environment, Inc. has been contracted to perform these assessments under the supervision of ADEC.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE CLEAR/NENANA AREA

Location

For the purposes of this report, the Nenana area encompasses the communities of Nenana (pop. 486), Anderson (pop. 513), and Clear. Nenana and Clear are located along the George Parks Highway at Mile 304.5 and Mile 280, respectively. The junction of the Parks Highway and the access road to Anderson and Clear Air Force Station is located at Mile 283.5; Anderson is 6 miles from the highway (Figure 1).

Figure 1

Precipitation

The Nenana area averages nearly 10 inches of precipitation per year, with approximately 49 inches of annual snowfall (ACRC 2002).

Topography and Drainage

Nenana, Anderson, and Clear are characterized by fairly flat topography, with numerous small creeks that generally flow north to the Nenana and Tanana Rivers.

Groundwater Use

There is no municipal water supply in Anderson or Clear. Residences, businesses, and the school have their own water wells and septic systems. The majority of residents of Nenana are served by two municipal wells and by city sewage lines; approximately 24 homes are still on private wells, with approximately 15 using private septic systems (ADCED 2002).

Geology and Soils

The surficial geology of the Nenana area chiefly comprises alluvial deposits of the Nenana and Tanana Rivers. Nenana river alluvium consists of interfingering lenses of washed, clean gravel, sand and silt. The average size of gravel in the recent Nenana River alluvium decreases with increasing distance from the mountains. Near the town of Nenana, the deposits are composed predominantly of sand and silt, while near Clear they consists chiefly of coarse gravel with some cobbles and boulders. A large portion of the alluvium consists of reworked glacial debris. Tanana River alluvium consists chiefly of sand and silt (Kachadoorian 1960).

FIREWEED 288 ROADHOUSE
PUBLIC DRINKING WATER SYSTEM

Fireweed 288 Roadhouse is a Class B (transient/non-community) water system. The system consists of one well located near the Parks Highway milepost 288.

There is no well log on file for this well; if one could be located, it would help improve the accuracy of this report. According to the most recent Sanitary Survey (6/8/99) completed for the water system, installation of the well occurred in 1977 to a total depth of approximately 40 feet below ground surface. The sanitary seal has recently been repaired. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is also appropriately sloped away from the well providing adequate surface water drainage. The well apparently was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters. The aquifer is assumed to be unconfined based on the well depth and on lithologies encountered during drilling of a nearby well.

This system operates year-round and serves approximately 5 residents and more than 50 non-residents.

FIREWEED 288 ROADHOUSE 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. Some areas are more likely to allow contamination to reach the well than others. 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 a release of contaminants within the DWPA 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. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick et al. 1989*). Additional methods were also used to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class B Water Systems for additional information).

The DWPAs established for wells by the ADEC are separated into four zones. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. 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 DWPA zones and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance to the 2-year TOT
B	Less than the 2-year TOT
C	Less than the 5-year TOT
D	Less than the 10 year TOT

As an example, water moving through the aquifer in Zone B will most likely reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

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 Fireweed 288 Roadhouse 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 B water system assessments, three categories of drinking water contaminants were inventoried. They include:

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

Inventoried potential sources of contamination within Zones A through Zone D were associated with residential and light industrial type activities. The sources are summarized in the tables in Appendix B of the Guidance Manual.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are sorted and ranked 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. Further, contaminant risks are a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the well.

VULNERABILITY OF FIREWEED 288 ROADHOUSE DRINKING WATER SOURCE

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

- Natural susceptibility; and
- Contaminant risks.

Each of the three categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

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 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. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

Table 2 shows the Overall Susceptibility score and rating for Fireweed 288 Roadhouse (see Charts 1 and 2).

Table 2. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	17	High
Natural Susceptibility	17	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing or historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants (see Charts 3, 5, and 7).

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	14	Low
Volatile Organic Chemicals	25	Medium

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five (see Charts 4, 6, and 8).

Table 4. Overall Vulnerability of Fireweed 288 Roadhouse to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	65	High
Nitrates and Nitrites	30	Low
Volatile Organic Chemicals	40	Low

Tables 2 through 4 in Appendix B contain a list of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

Only a small amount of bacteria and viruses are required to endanger public health. If bacteria and viruses have been detected during recent water sampling of the system at Fireweed 288 Roadhouse, the result is a maximum score on Chart 3.

The sampling history for Fireweed 288 Roadhouse well indicates that nitrates and/or nitrites are found in natural background concentration at this site, as elsewhere throughout Alaska. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000]. Existing nitrate concentration in the Fireweed 288 Roadhouse well is approximately 0.4 mg/L or 4% of the Maximum Contaminant Level (MCL) of 10mg/L. The MCL is the maximum level of contaminant that is allowed to exist

in drinking water and still be consumed by humans without harmful health effects. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Though existing nitrate contamination was detected at the site, concentrations remain at safe levels with respect to human health (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Class B Public Water systems are not required to test for volatile organic chemicals (VOCs); therefore, no score for pre-existing contamination has been assigned. The vulnerability score for VOCs reflects the potential for contamination from the sources indicated on Table 4 in Appendix B.

Summary

A *Source Water Assessment* has been completed for the sources of public drinking water serving Fireweed 288 Roadhouse. The overall vulnerability of this source to contamination is **High** for bacteria and viruses, **Low** for nitrates, nitrites, and volatile organic chemicals. 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 Fireweed 288 Roadhouse 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 Fireweed 288 Roadhouse public drinking water source.

REFERENCES CITED

Alaska Climate Research Center (ACRC), 2002 [WWW document]. URL http://climate.gi.alaska.edu/climatology/data.html.

Alaska Department of Community and Economic Development (ADCED), 2002 [WWW document]. URL http://www.dced.state.ak.us/cbd/commdb/CF_BLOCK.cfm

Kachadoorian, R., 1960, *Engineering and Surficial Geology of the Nenana-Rex area, Alaska*, Department of the Interior, United States Geological Survey, Miscellaneous Geologic Investigations series, Map I-307, Washington DC.

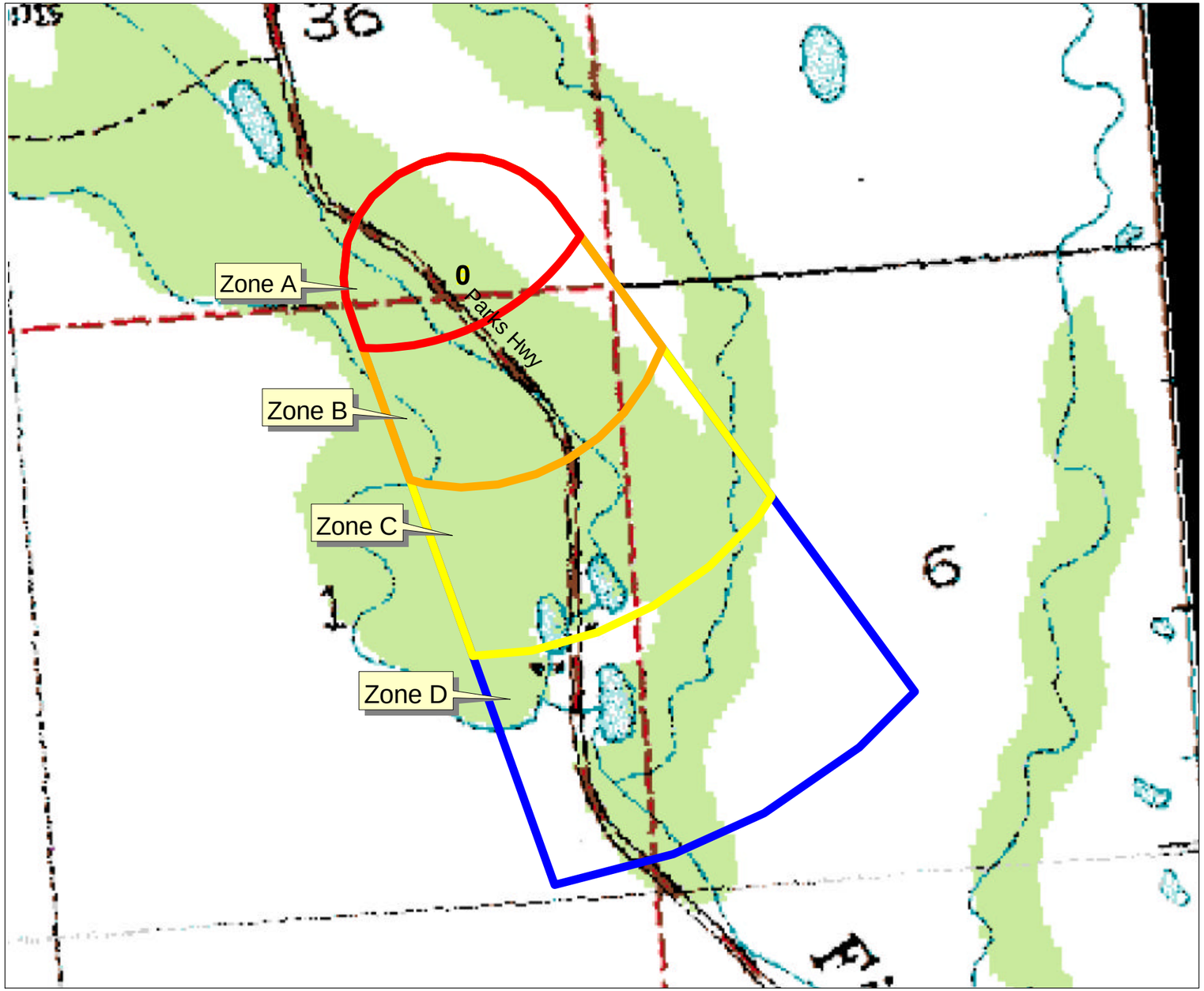
Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.

Wang, B., Strelakos, P.M., and Jokela, B., 2000, Nitrate Source Indicators In Groundwater of the Scimitar Subdivision, Peters Creek Area, Anchorage Alaska: U.S. Geological Survey Water-Resources Investigations Report 00-4137, 25p.

APPENDIX A

Fireweed 288 Roadhouse
Drinking Water Protection Area
(Map 1)

Drinking Water Protection Area for Fireweed 288 Roadhouse



0 Fireweed 288 Roadhouse Well
Zone A (Few Months Travel Time)
Zone B (Less Than 2 Years Travel Time)
Zone C (Less Than 5 Years Time)
Zone D (Less Than 10 Years Travel Time)

N
W E
S

0.6 0 0.6 Miles

PWSID 390489.001

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Fireweed 288 Roadhouse (Tables 1-4)

Table 1

Contaminant Source Inventory for ***Fireweed 288 Roadhouse***

PWSID 390489.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Septic systems (serves one single-family home)	R02	R2-1	A	FIREWEED 288 ROADHOUSE	2	
Tanks, gasoline (above ground)	T10	T10-1	A	FIREWEED 288 ROADHOUSE	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	PARK'S HWY	2	

Table 2

Contaminant Source Inventory and Risk Ranking for Fireweed 288 Roadhouse Sources of Bacteria and Viruses

PWSID 390489.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Septic systems (serves one single-family home)	R02	R2-1	A	Low	FIREWEED 288 ROADHOUSE	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Fireweed 288 Roadhouse Sources of Nitrates/Nitrites

PWSID 390489.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Septic systems (serves one single-family home)	R02	R2-1	A	Low	FIREWEED 288 ROADHOUSE	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	

Table 4

Contaminant Source Inventory and Risk Ranking for Fireweed 288 Roadhouse Sources of Volatile Organic Chemicals

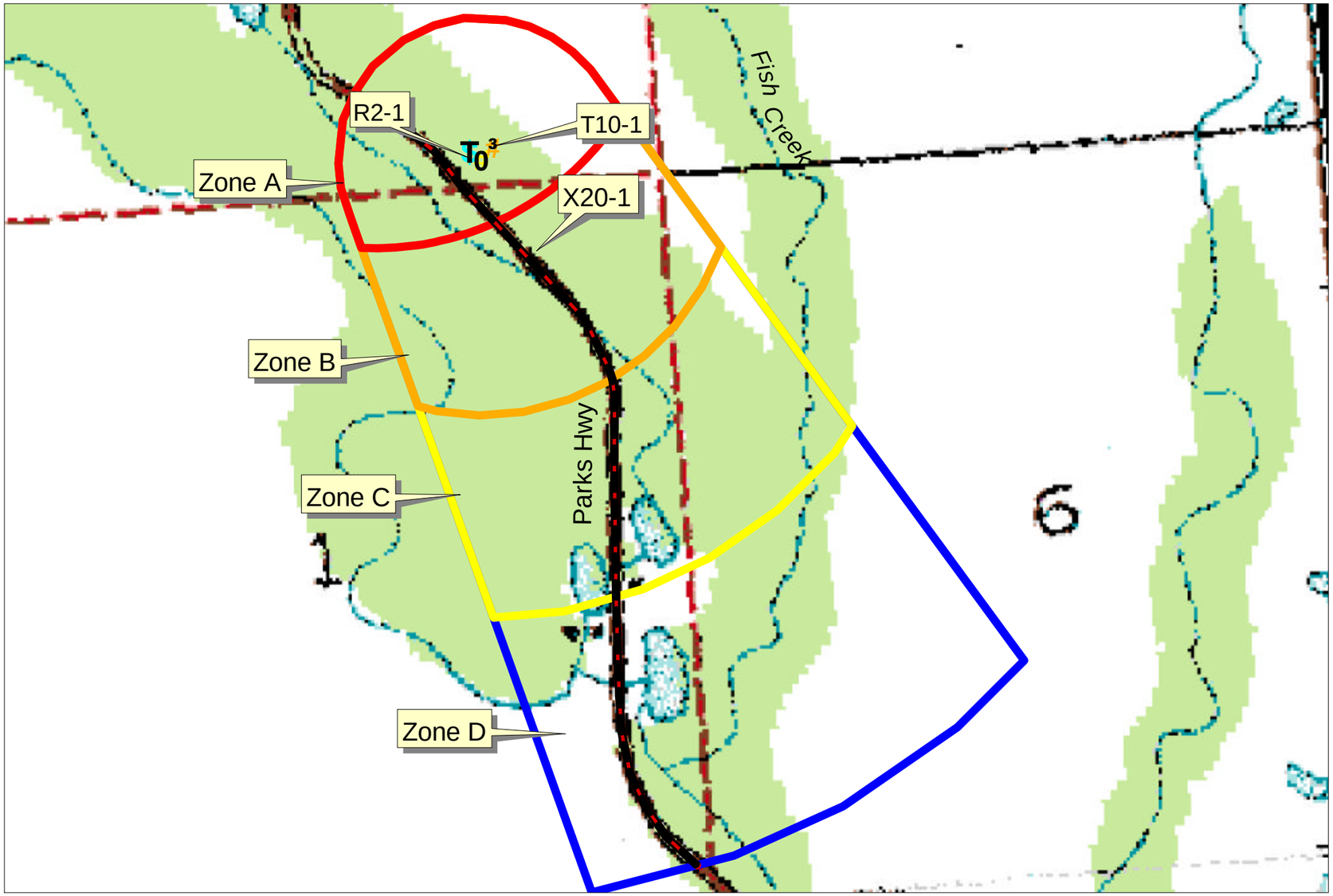
PWSID 390489.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Septic systems (serves one single-family home)	R02	R2-1	A	Low	FIREWEED 288 ROADHOUSE	2	
Tanks, gasoline (above ground)	T10	T10-1	A	Medium	FIREWEED 288 ROADHOUSE	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	

APPENDIX C

Fireweed 288 Roadhouse
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Drinking Water Protection Area for Fireweed 288 Roadhouse and Potential and Existing Sources of Contamination



0 Fireweed 288 Roadhouse Well

Contaminants

T Septic System-R2

3 # Tank, gasoline (above ground)-T10

Roads-X20

Zone A (Few Months Travel Time)

Zone B (Less Than 2 Years Travel Time)

Zone C (Less Than 5 Years Time)

Zone D (Less Than 10 Years Travel Time)

N

W E

S

0.5 0 0.5 1 Miles

PWSID 390489.001

Map 2

APPENDIX D

Vulnerability Analysis for Fireweed 288 Roadhouse Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - Fireweed 288 Roadhouse

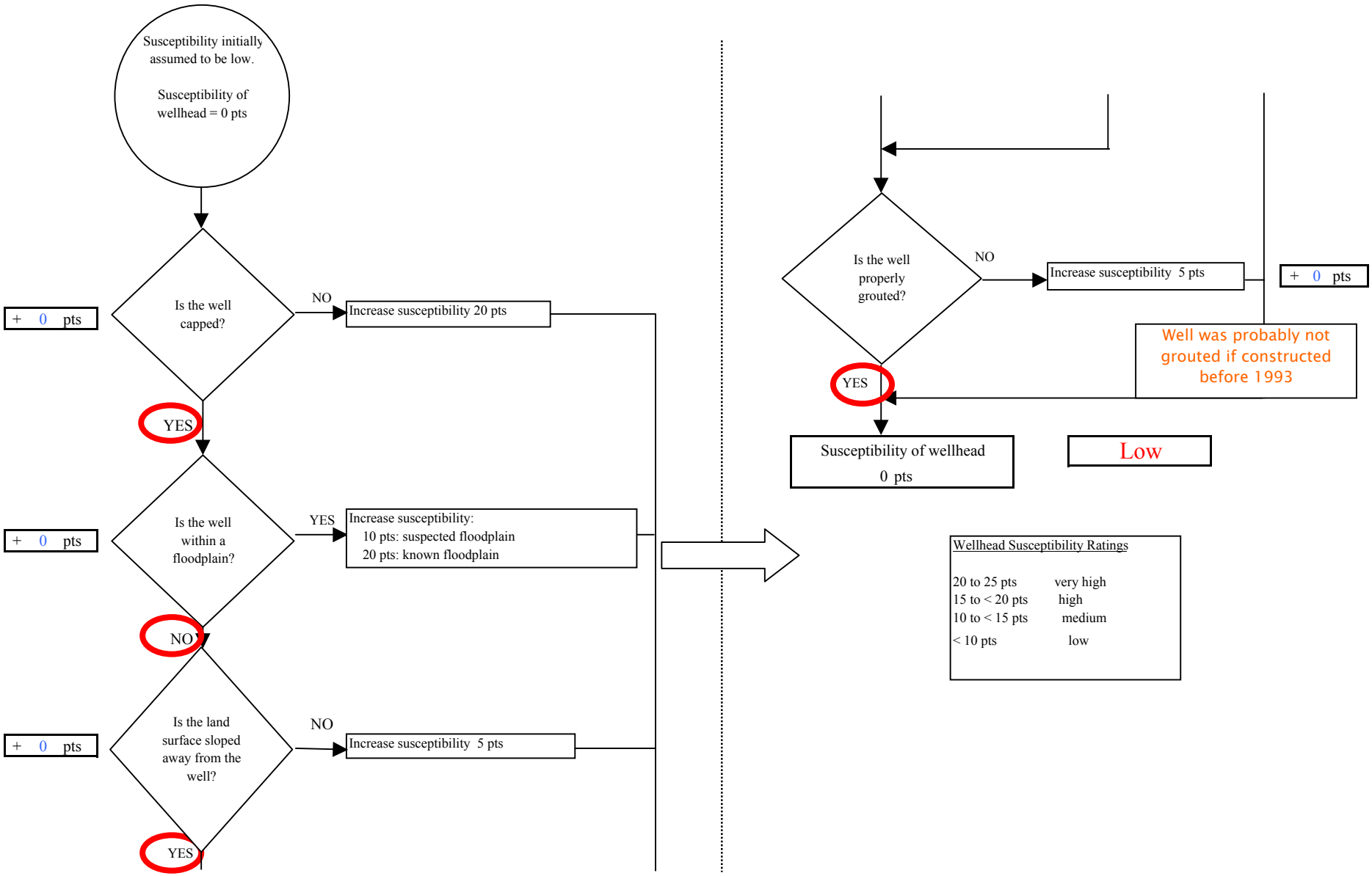


Chart 2. Susceptibility of the aquifer - Fireweed 288 Roadhouse

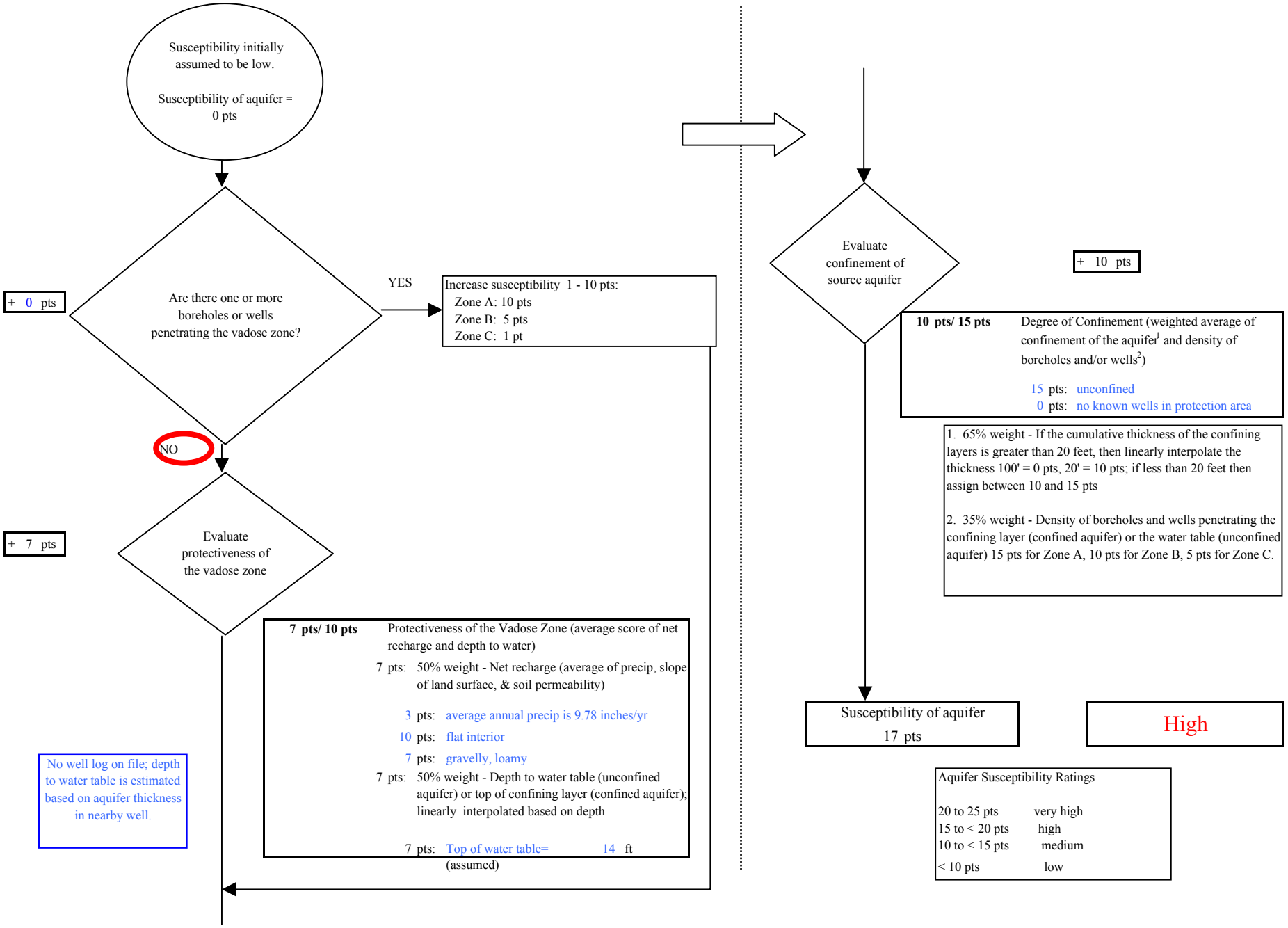
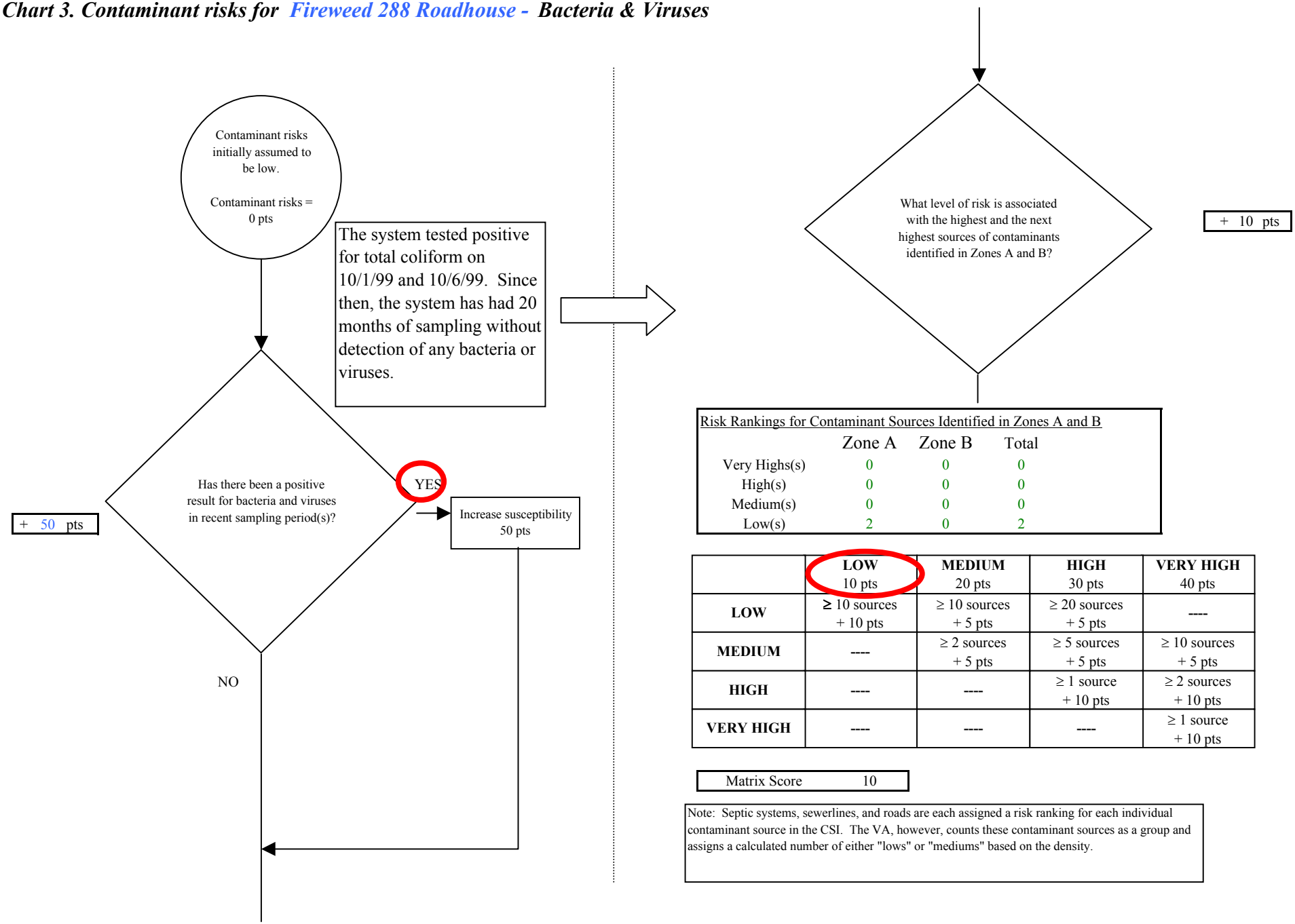


Chart 3. Contaminant risks for Fireweed 288 Roadhouse - Bacteria & Viruses



Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
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 10

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 Fireweed 288 Roadhouse - Bacteria & Viruses

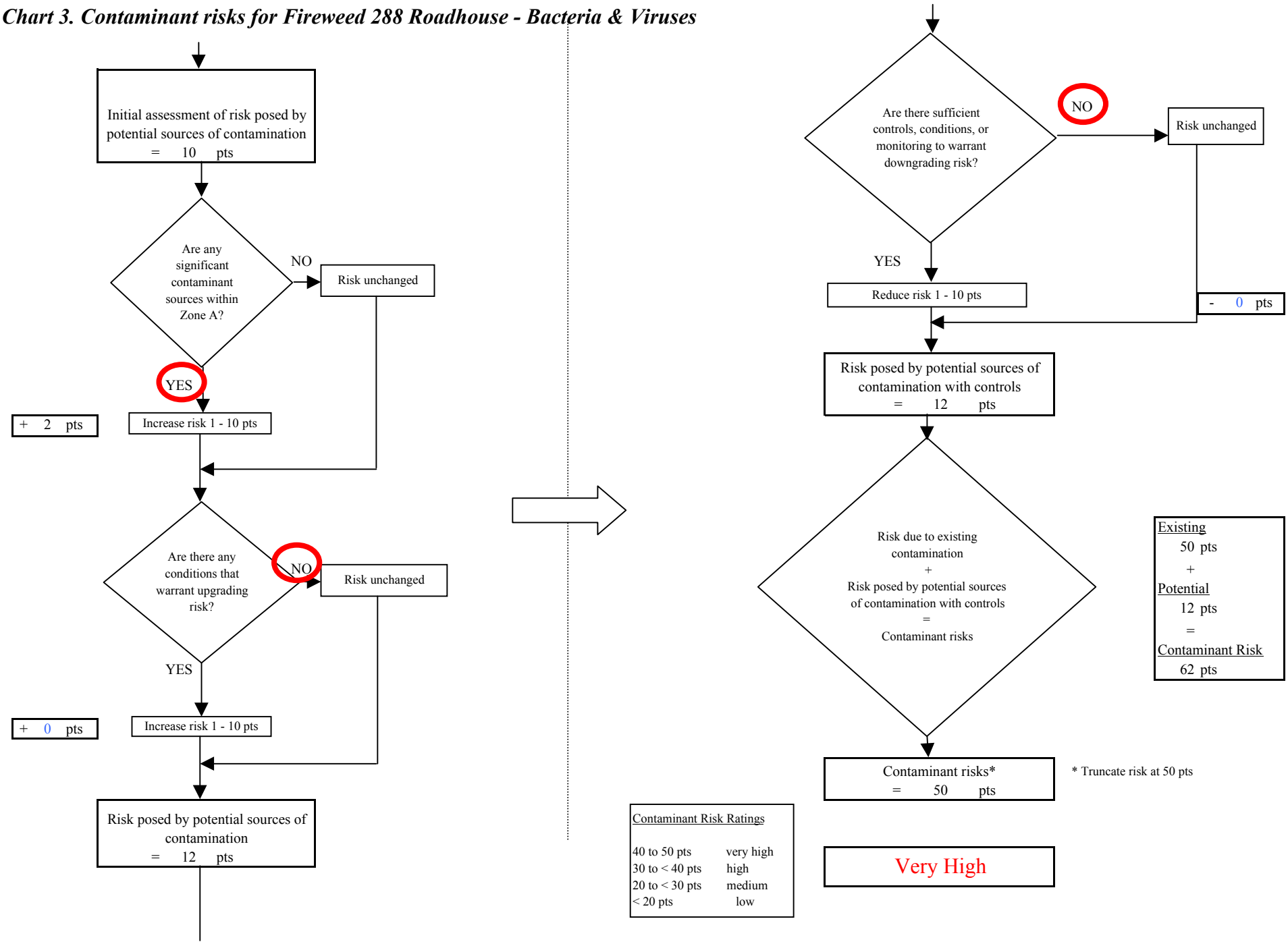


Chart 4. Vulnerability analysis for Fireweed 288 Roadhouse - Bacteria & Viruses

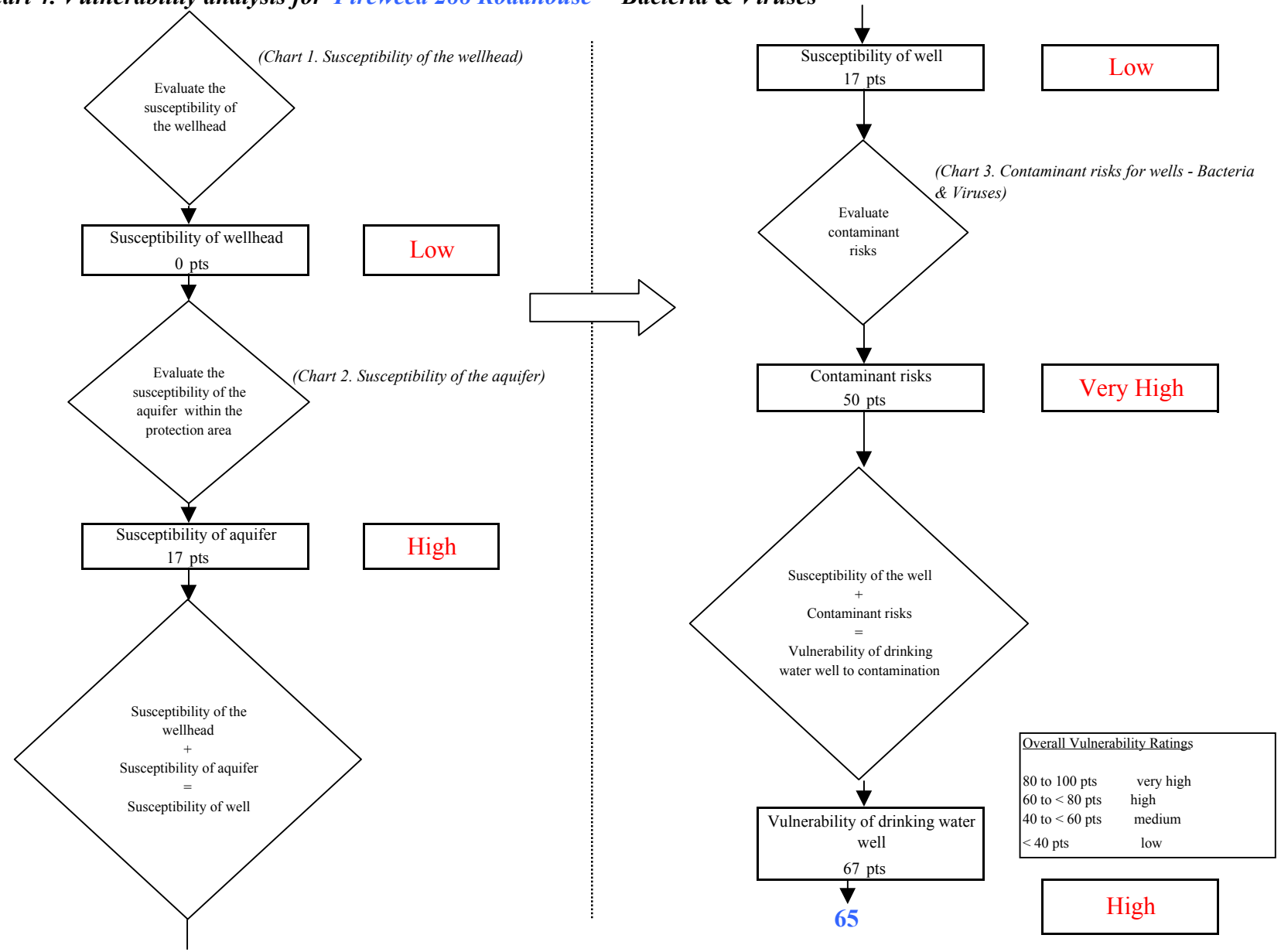


Chart 5. Contaminant risks for Fireweed 288 Roadhouse - Nitrates and Nitrites

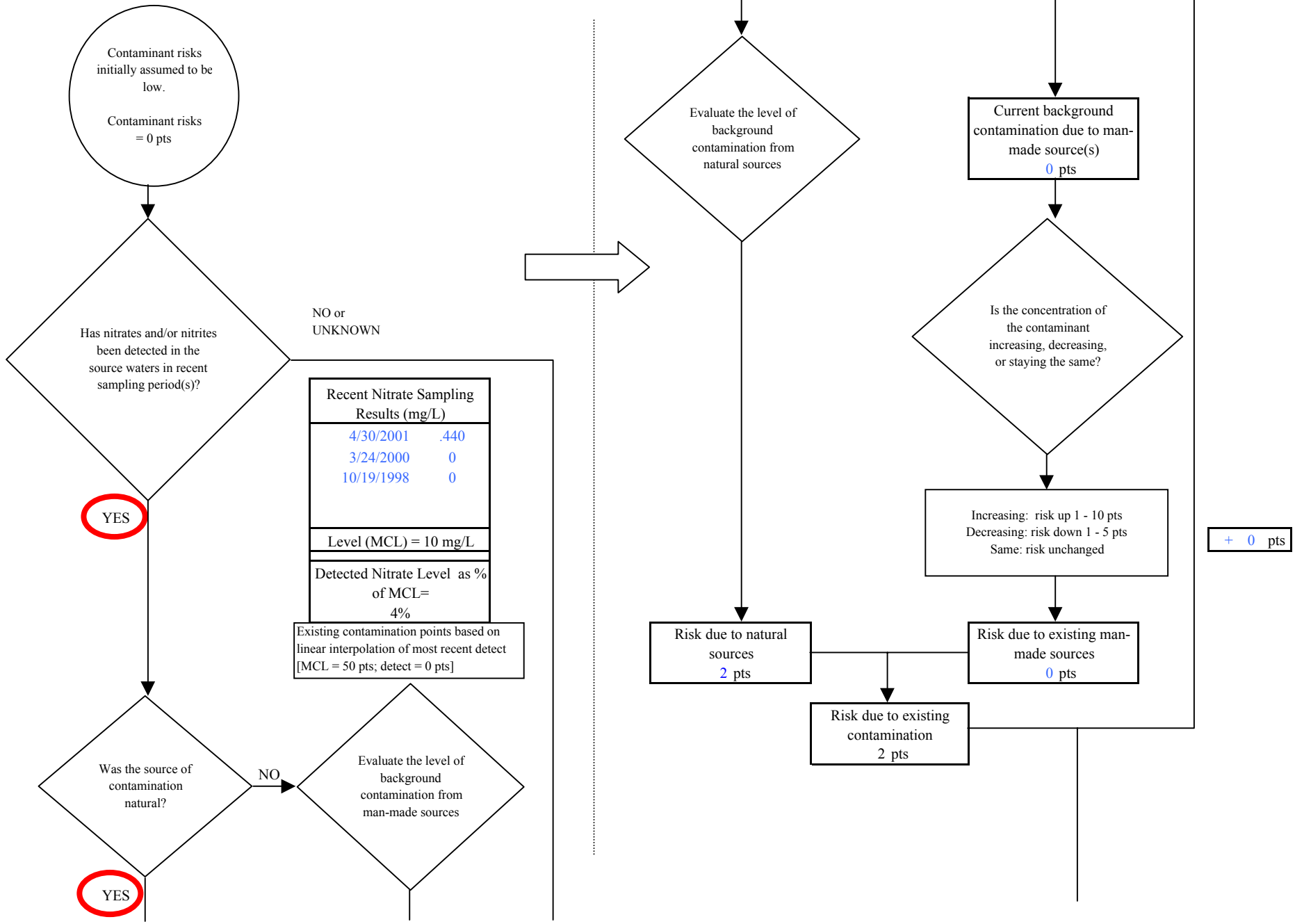
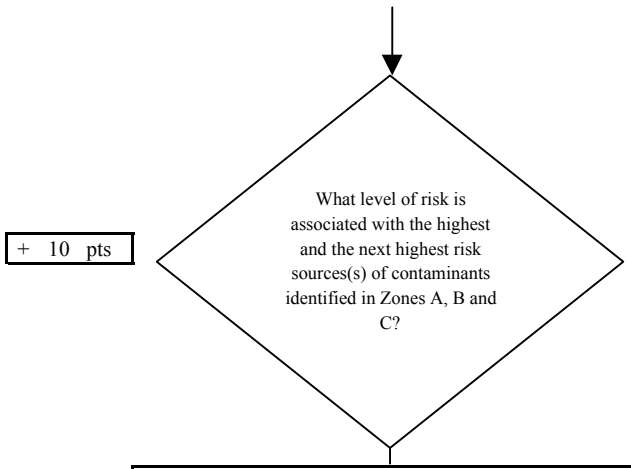


Chart 5. Contaminant risks for Fireweed 288 Roadhouse - Nitrates and Nitrites



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)	0	0	0
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 10

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.

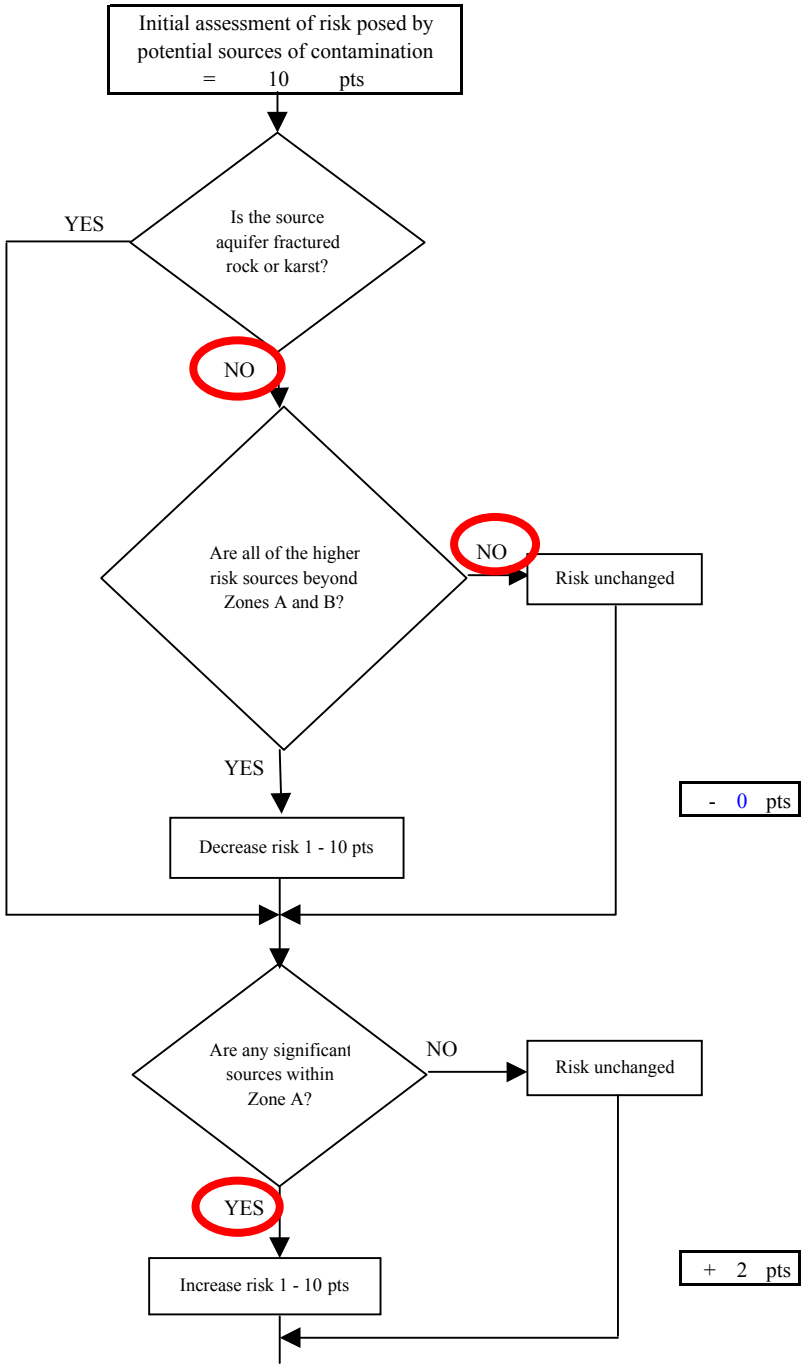
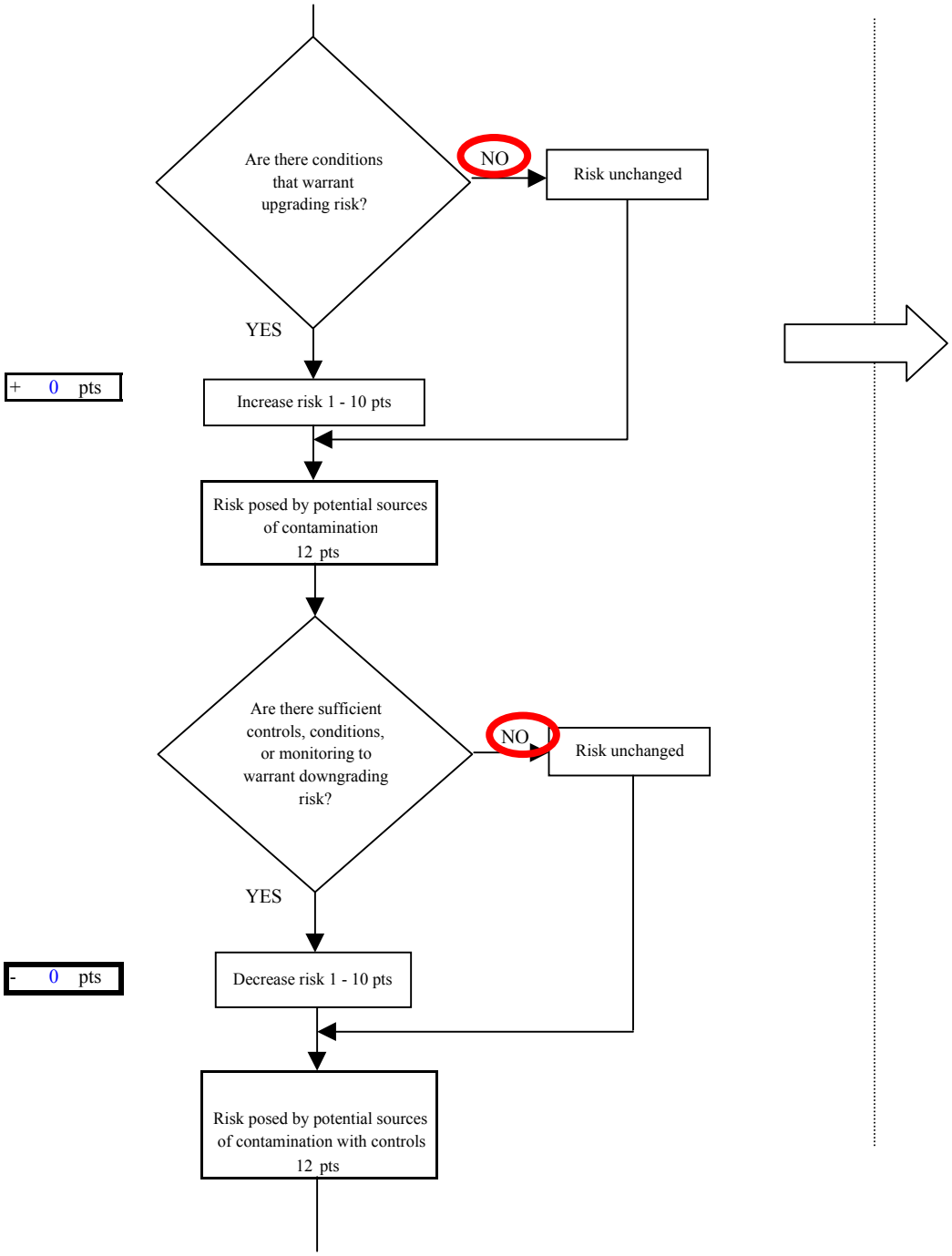
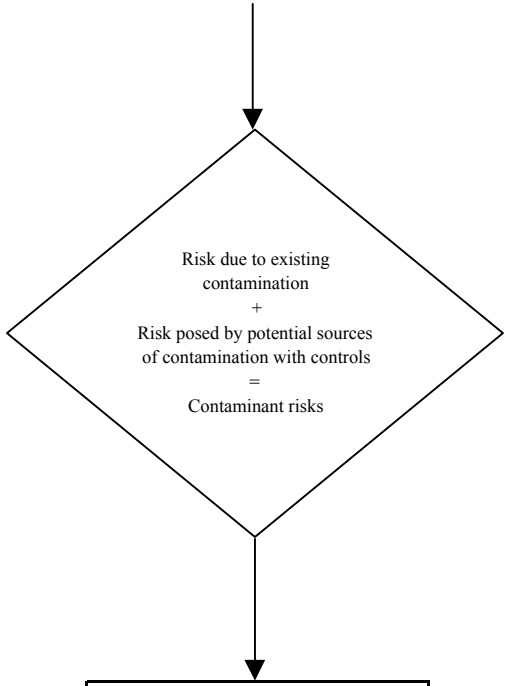


Chart 5. Contaminant risks for Fireweed 288 Roadhouse - Nitrates and Nitrites





Existing
2 pts
+
Potential
12 pts
=
Contaminant Risk
14 pts

Contaminant risks*
= 14 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

Chart 6. Vulnerability analysis for Fireweed 288 Roadhouse - Nitrates and Nitrites

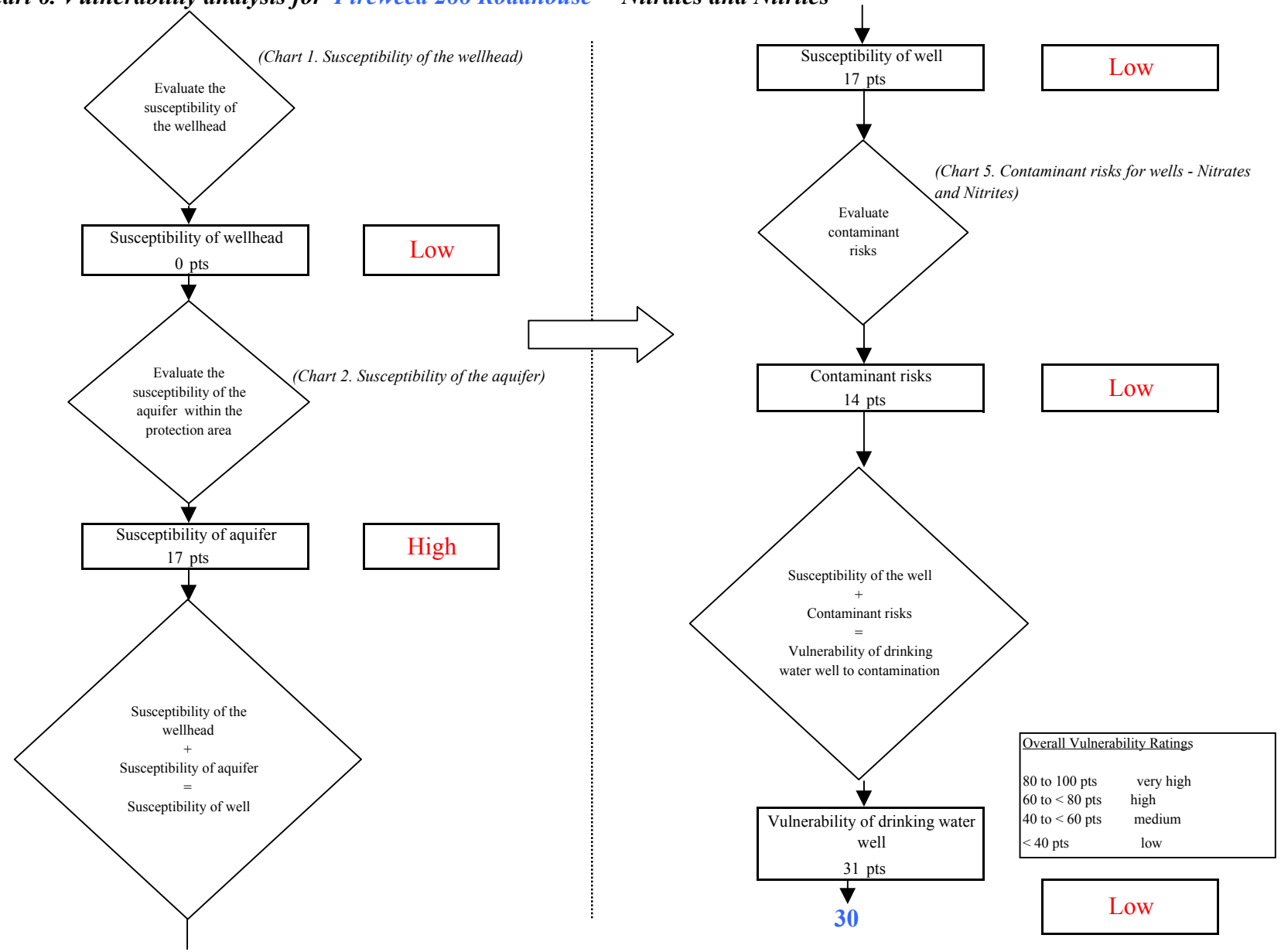


Chart 7. Contaminant risks for Fireweed 288 Roadhouse - Volatile Organic Chemicals

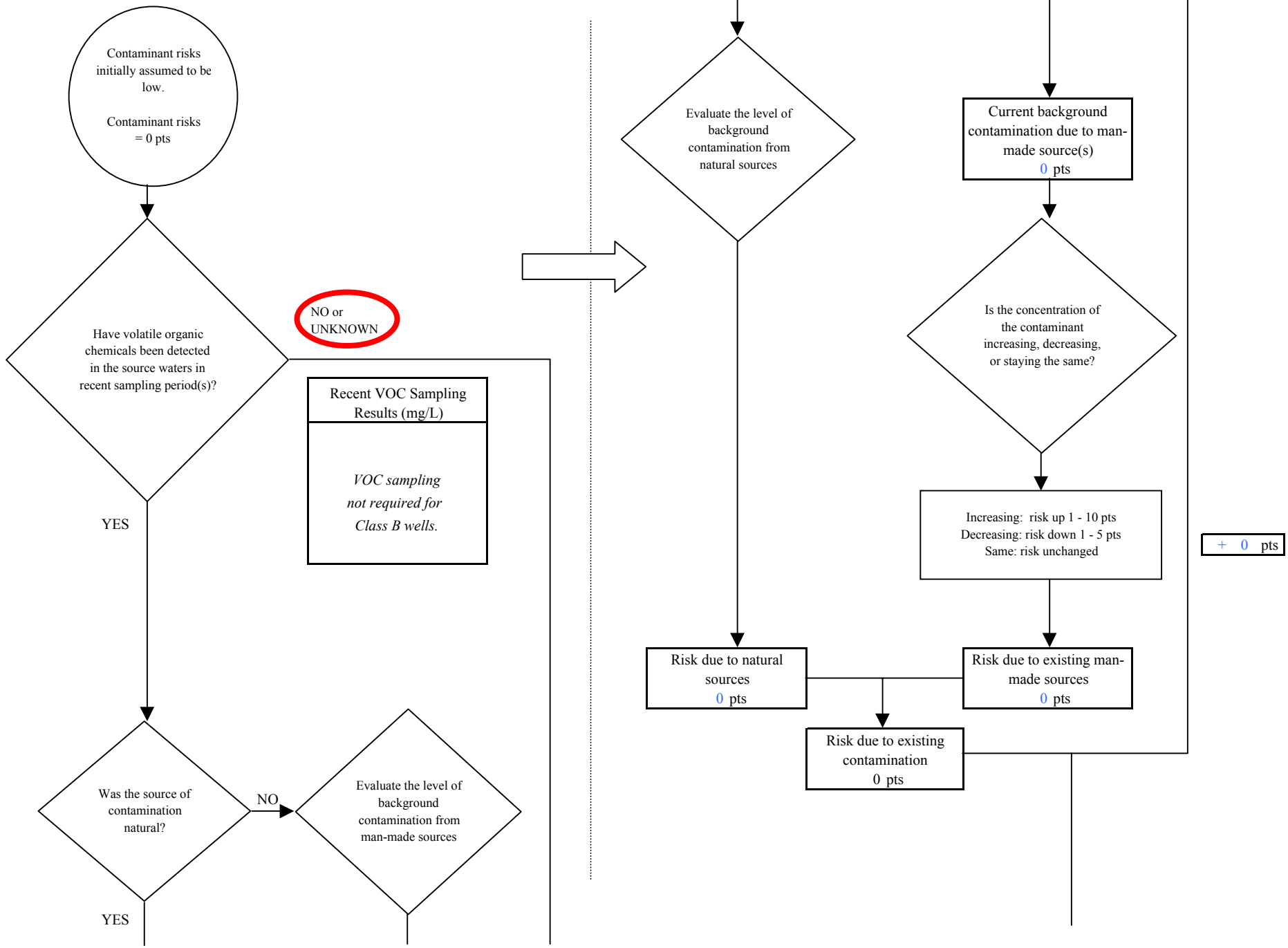


Chart 7. Contaminant risks for Fireweed 288 Roadhouse - Volatile Organic Chemicals

+ 20 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)	0	0	0
Medium(s)	1	0	1
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 20

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 = 20 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

+ 5 pts

Chart 7. Contaminant risks for Fireweed 288 Roadhouse - Volatile Organic Chemicals

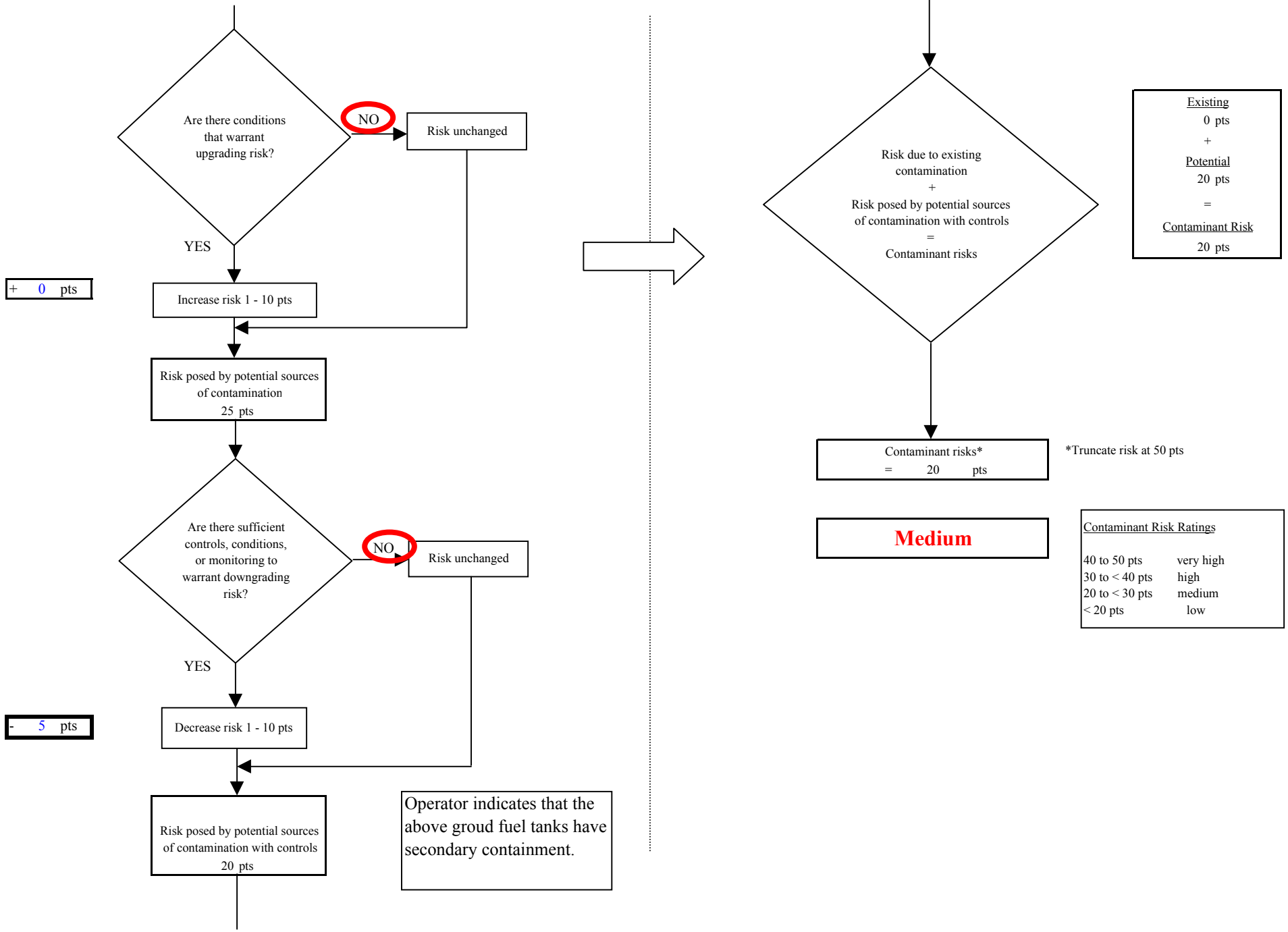


Chart 8. Vulnerability analysis for Fireweed 288 Roadhouse - Volatile Organic Chemicals