

Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Wally's Healy Service
Drinking Water System,
Healy, Alaska
PWSID # 390667

DRINKING WATER PROTECTION PROGRAM REPORT # 270
Alaska Department of Environmental Conservation

Source Water Assessment for Wally's Healy Service Drinking Water System, Healy, Alaska PWSID # 390667

By Ecology & Environment, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT # 270

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

	Page		Page
Executive Summary	1	Inventory of Potential and Existing	
Introduction	1	Contaminant Sources	2
Description of the Healy Area, Alaska	1	Ranking of Contaminant Risks	3
Wally's Healy Service		Vulnerability of Wally's Healy Service	
Public Drinking Water System	2	Drinking Water Source	3
Wally's Healy Service		Summary	4
Drinking Water Protection Area	2	References Cited	5

TABLES

TABLE	1. Definition of Zones	2
	2. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination	3
	3. Contaminant Risks	3
	4. Overall Vulnerability of Wally's Healy Service to Contamination	4

FIGURES

FIGURE	1. Index map showing the location of the Healy area	1
--------	---	---

APPENDICES

APPENDIX	A. Wally's Healy Service Drinking Water Protection Area (Map 1)	
	B. Contaminant Source Inventory for Wally's Healy Service (Table 1) Contaminant Source Inventory and Risk Ranking for Wally's Healy Service– Bacteria and Viruses (Table 2) Contaminant Source Inventory and Risk Ranking for Wally's Healy Service– Nitrates/Nitrites (Table 3) Contaminant Source Inventory and Risk Ranking for Wally's Healy Service– Volatile Organic Chemicals (Table 4)	
	C. Wally's Healy Service Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)	
	D. Vulnerability Analysis for Contaminant Source Inventory and Risk Ranking for Wally's Healy Service Public Drinking Water Source (Charts 1 – 8)	

Source Water Assessment for Wally's Healy Service Source of Public Drinking Water, Healy, Alaska

By Ecology & Environment, Inc.

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Wally's Healy Service is a Class B (transient/non-community) water system consisting of one well in Healy, Alaska. Identified potential and current sources of contaminants for Wally's Healy Service public drinking water source include: paved and gravel roads, a septic system and an underground fuel 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 Wally's Healy Service received a vulnerability rating of **Low** for bacteria and viruses, **Medium** for nitrates and nitrites, and **Medium** for 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 HEALY AREA

Location

The community of Healy (pop. 1,000) is located at approximately 78 miles southwest of Fairbanks, on the George Parks Highway, a few miles north of the entrance to Denali National Park (Figure 1).



Figure 1

Precipitation

The Healy area averages over 15 inches of precipitation per year, with approximately 73 inches of annual snowfall (ACRC 2002).

Topography and Drainage

Healy is located near the confluence of Healy Creek and the Nenana River. The area is dominated by several steep peaks to the south, including Mount Healy, with somewhat gentler terrain to the north. The town itself has relatively flat topography. Drainage is typically towards the Nenana River or one of its tributaries.

Groundwater Use

The majority of residents in Healy have private water wells and septic systems; others haul water from a

community well source. There are no municipal water or sewage facilities (ADCED 2002).

Geology and Soils

The surficial geology of the Healy area consists mainly of glacial outwash gravel of various ages, together with some recent river terrace gravels. Nenana Gravel, a poorly-consolidated conglomerate and coarse sandstone with interbedded mudflow deposits and thin claystone and lignite, is found in the mountainous terrain northeast of Healy (Wahrhaftig 1970).

WALLY'S HEALY SERVICE PUBLIC DRINKING WATER SYSTEM

Wally's Healy Service is a Class B (transient/non-community) water system. The system consists of one well located at Mile 249.2 of the Parks Highway.

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 (8/8/01), installation of the well occurred in August 1978 to a total depth of approximately 98 feet below ground surface. The well has a sanitary seal. 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 static water level and lithologies encountered during drilling of a nearby well.

This system operates year-round and serves approximately 60 non-residents.

WALLY'S HEALY SERVICE 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 DWPA's 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 Wally's Healy Service 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 WALLY'S HEALY SERVICE 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:

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

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

$$\begin{array}{r}
 \text{Susceptibility of the Wellhead (0 – 25 Points)} \\
 + \\
 \text{Susceptibility of the Aquifer (0 – 25 Points)}
 \end{array}$$

=

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 Wally's Healy Service (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	25	Very High
Natural Susceptibility	25	Medium

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	12	Low
Nitrates and/or Nitrites	16	Low
Volatile Organic Chemicals	30	High

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 Wally's Healy Service to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	40	Medium
Volatile Organic Chemicals	55	Medium

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 Wally's Healy Service, the result is a maximum score on Chart 3.

The sampling history for the Wally's Healy Service 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 Wally's Healy Service well is approximately 0.8 mg/L or 8% 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 Wally's Healy Service. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, **Medium** for nitrates and nitrites, and **Medium** for 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 Wally's Healy Service 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 Wally's Healy Service public drinking water source.

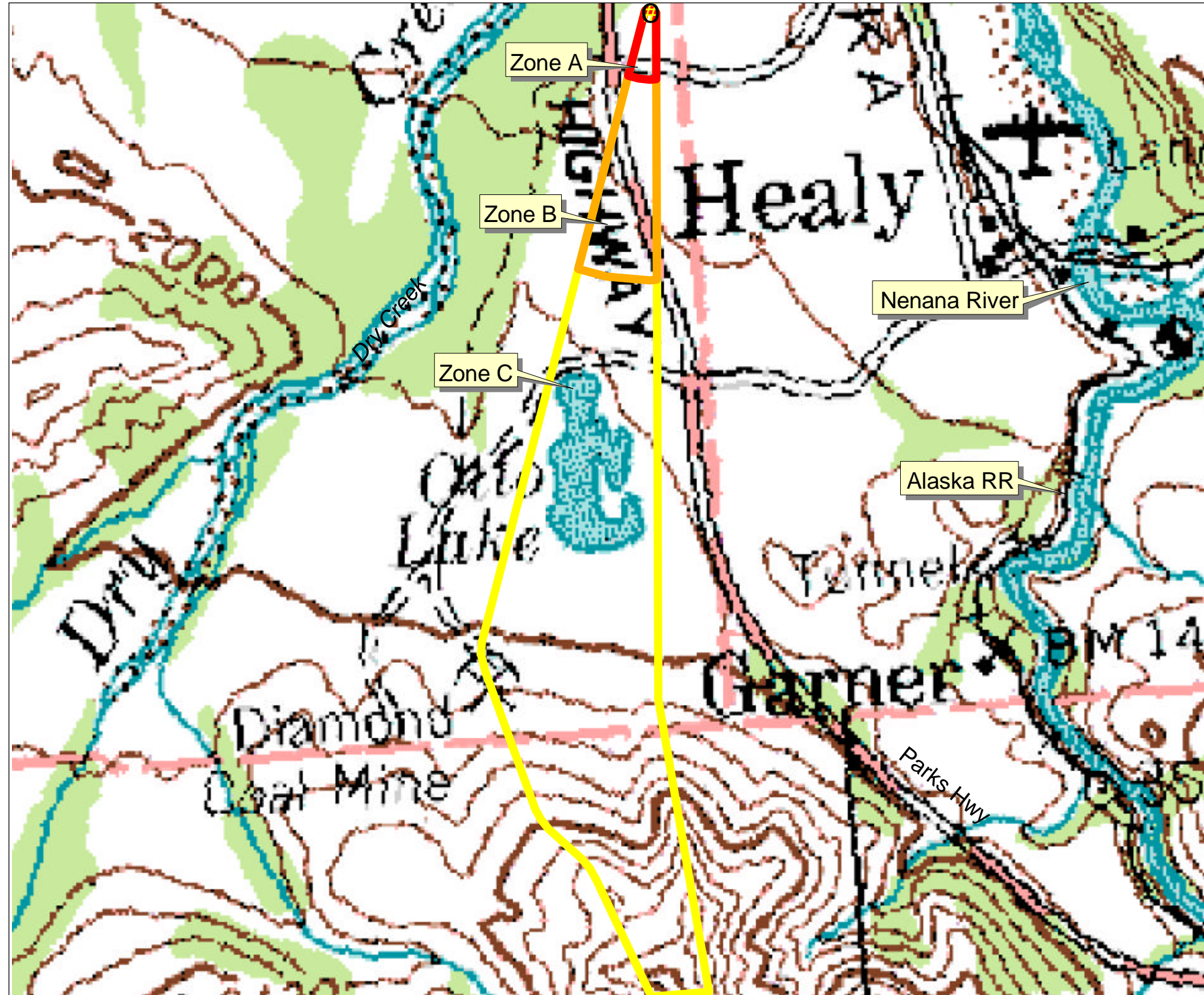
REFERENCES CITED

- 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
- 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.
- Wahrhaftig, C., 1970, *Geologic Map of the Healy D-4 Quadrangle, Alaska*, Department of the Interior, United States Geological Survey, Geologic Quadrangle Maps of the United States series, Map GQ-806, Washington, DC.
- 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.

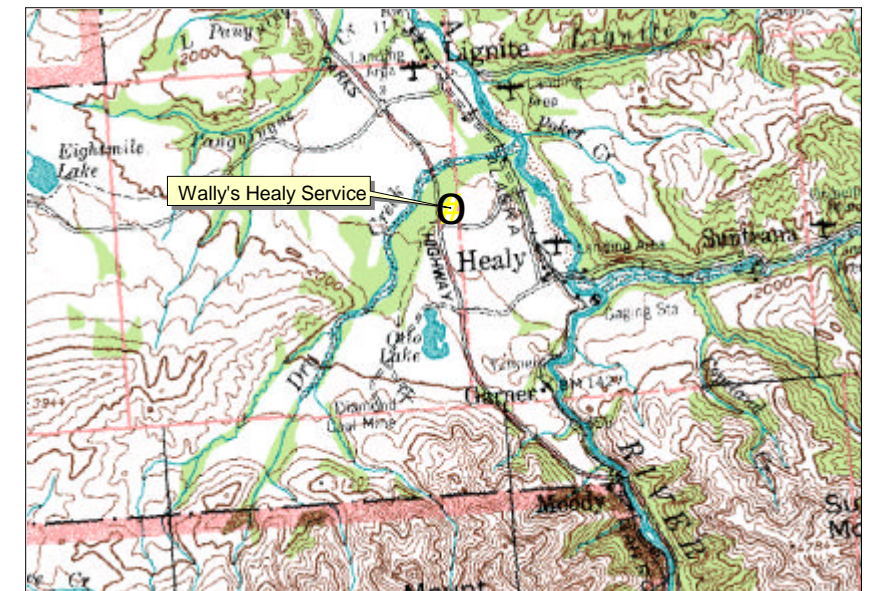
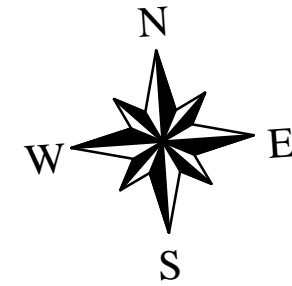
APPENDIX A

Wally's Healy Service Drinking Water Protection Area (Map 1)

Drinking Water Protection Area for Wally's Healy Service



- Wally's Healy Service Well
- Zone A (Few Months Travel Time)
- Zone B (Less Than 2 Years Travel Time)
- Zone C (Less Than 5 Years Travel Time)



0.6 0 0.6 1.2 1.8 2.4 3.0 Miles

PWSID 390667.001

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Wally's Healy Service (Tables 1-4)

Table 1

**Contaminant Source Inventory for
Wally's Healy Service**

PWSID 390667.001

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	Wally's Healy Service	2	
Tanks, gasoline (underground)	T12	T12-1	A	Wally's Healy Service	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Local Healy road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Local Healy Road	2	

Table 2

*Contaminant Source Inventory and Risk Ranking for
Wally's Healy Service
Sources of Bacteria and Viruses*

PWSID 390667.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	Wally's Healy Service	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	Local Healy road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Low	Local Healy Road	2	

Table 3

*Contaminant Source Inventory and Risk Ranking for
Wally's Healy Service
Sources of Nitrates/Nitrites*

PWSID 390667.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	Wally's Healy Service	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	Local Healy road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Low	Local Healy Road	2	

Table 4

*Contaminant Source Inventory and Risk Ranking for
Wally's Healy Service
Sources of Volatile Organic Chemicals*

PWSID 390667.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	Wally's Healy Service	2	
Tanks, gasoline (underground)	T12	T12-1	A	High	Wally's Healy Service	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	Local Healy road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Low	Local Healy Road	2	

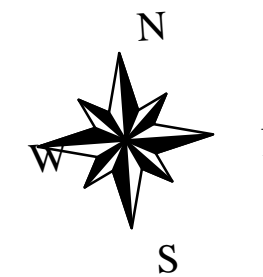
APPENDIX C

Wally's Healy Service Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)

Drinking Water Protection Area for Wally's Healy Service and Potential and Existing Sources of Contamination



- Water Sources**
- Wally's Healy Service Well
 - Public Water Wells
- Contaminant Sources**
- Septic System-R2
 - Underground Fuel Tank-T12
- Roads**
- Unpaved-X20
 - Paved-X24
- Zones**
- Zone A (Few Months Travel Time)
 - Zone B (Less Than 2 Years Travel Time)
 - Zone C (Less Than 5 Years Travel Time)



1 0 1 2 Miles

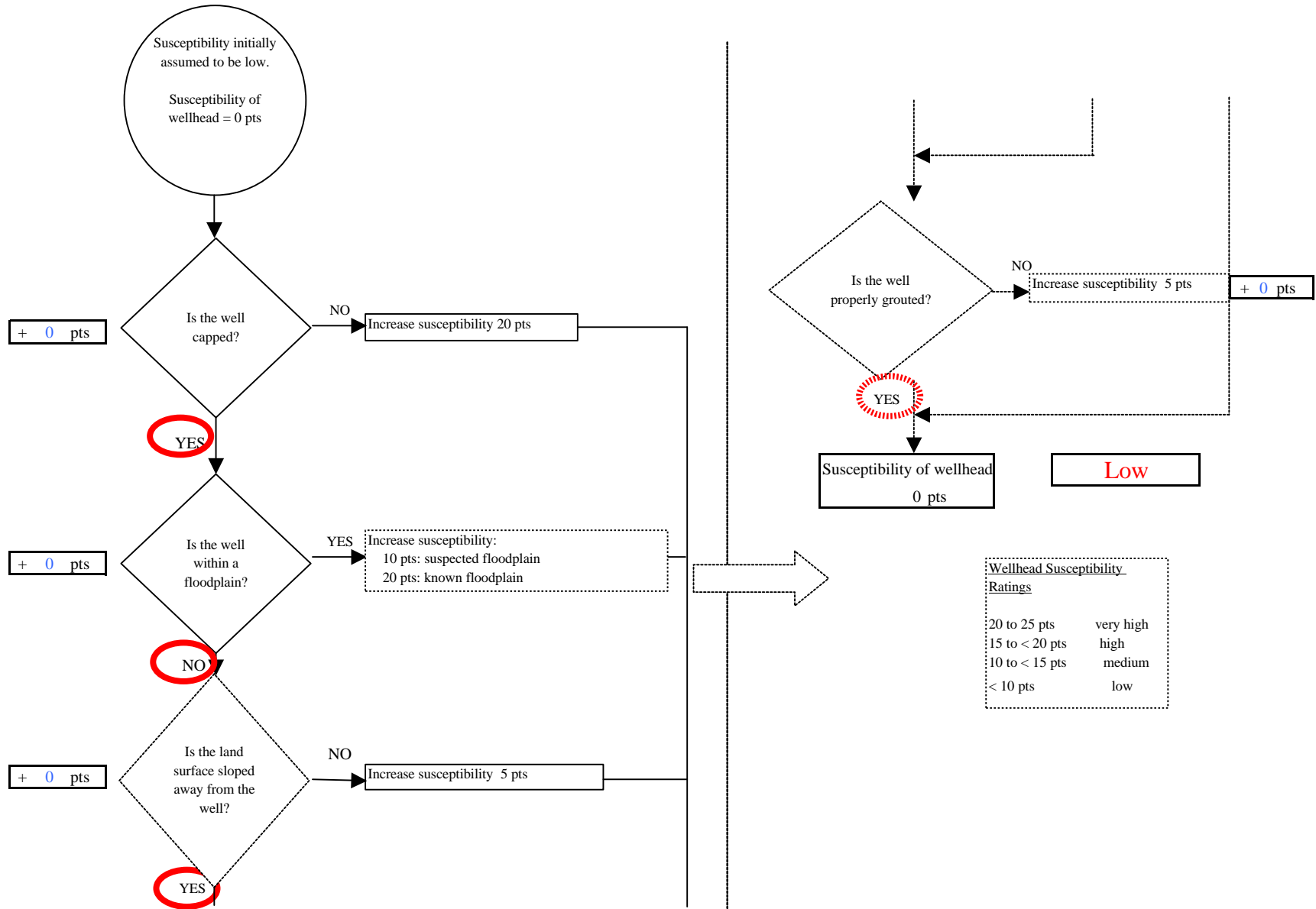
PWSID 390667.001

Map 2

APPENDIX D

Vulnerability Analysis for Wally's Healy Service Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - Wally's Healy Service



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

Chart 2. Susceptibility of the aquifer - Wally's Healy Service

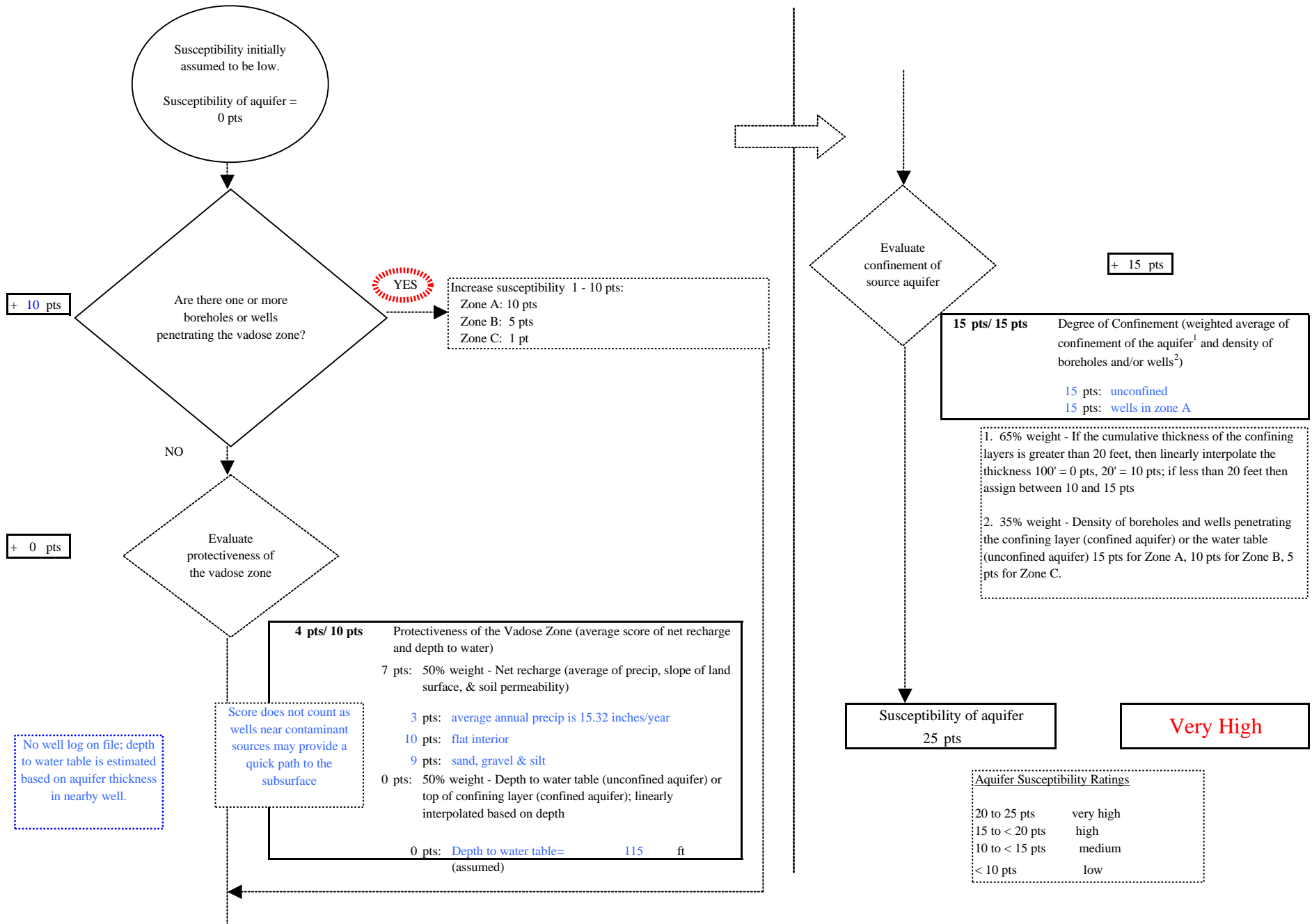
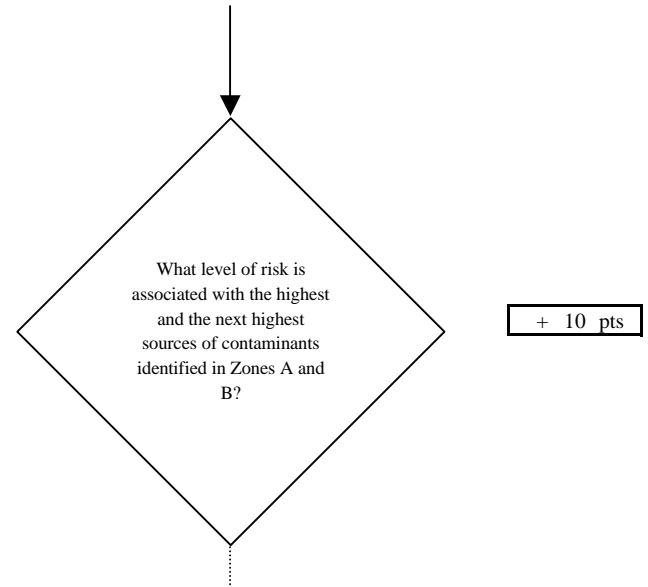
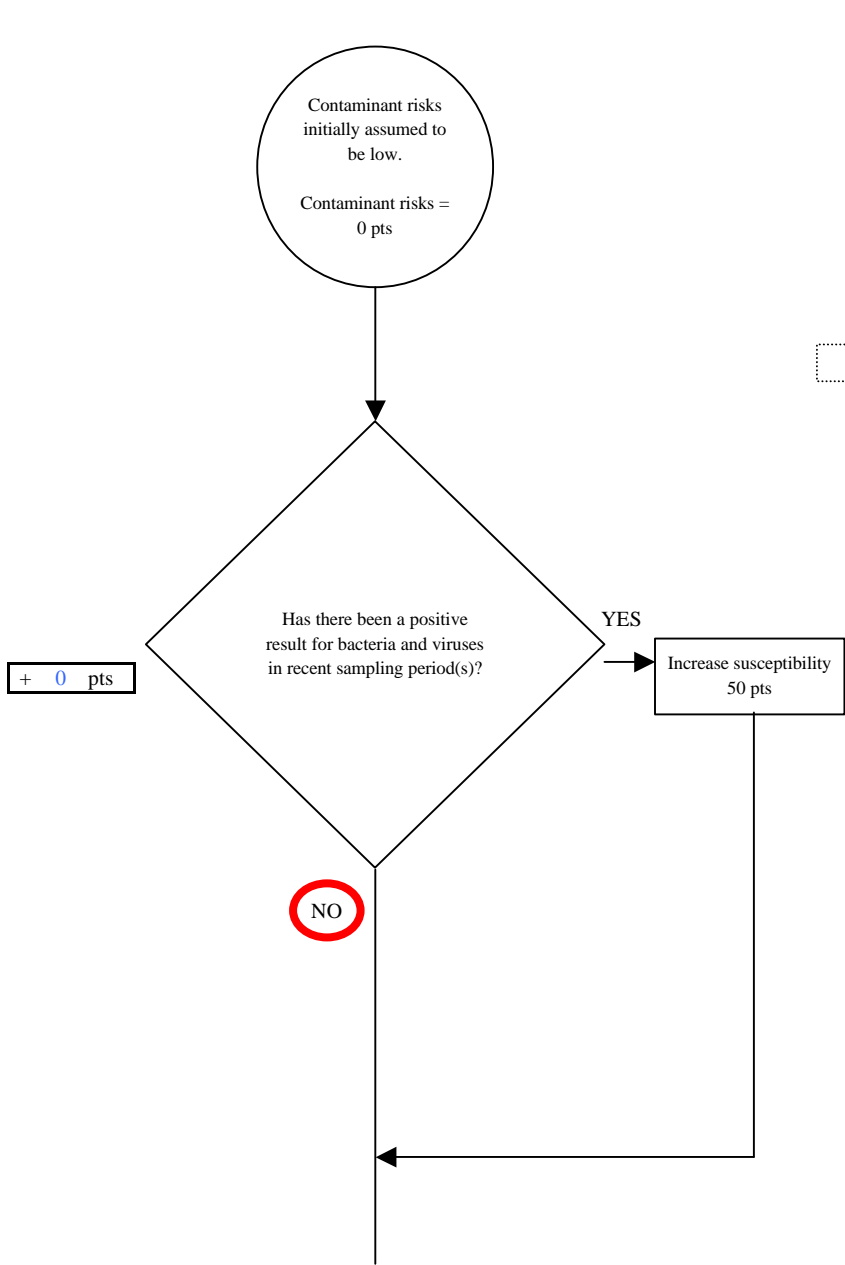


Chart 3. Contaminant risks for Wally's Healy Service - Bacteria & Viruses



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	1	3

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	³ 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 Wally's Healy Service - Bacteria & Viruses

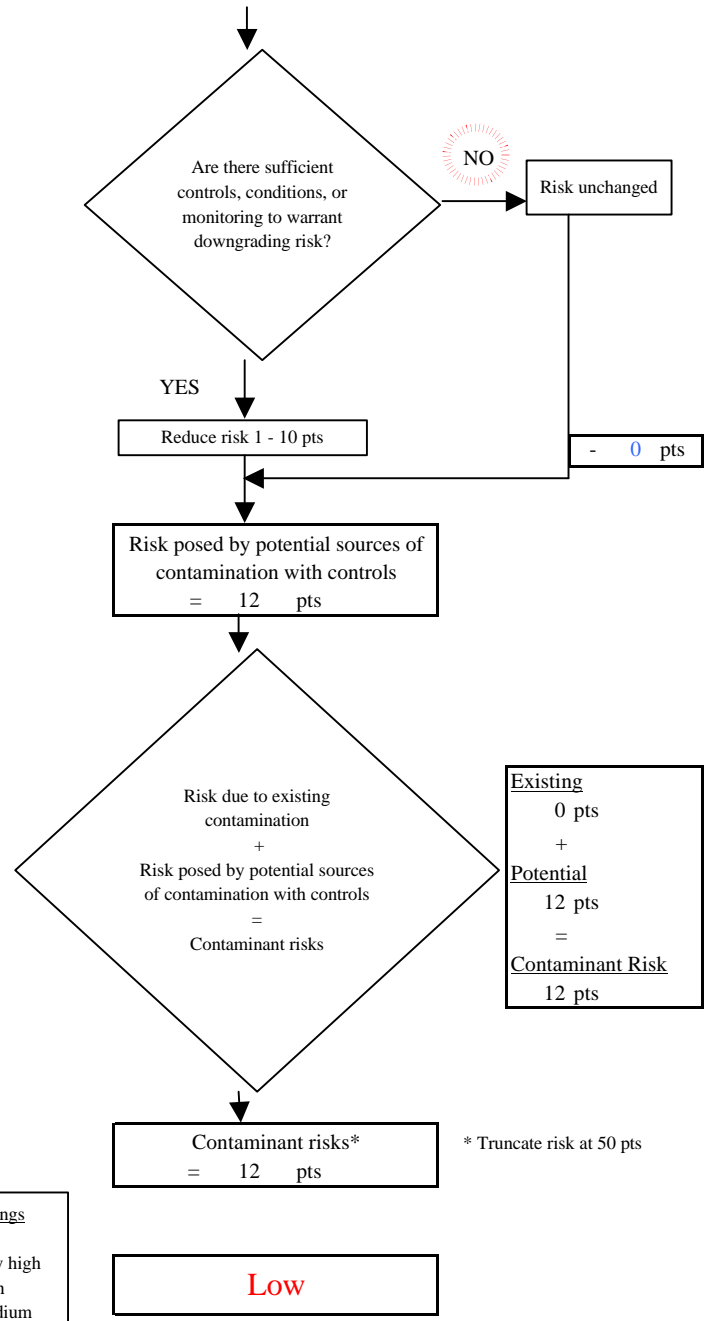
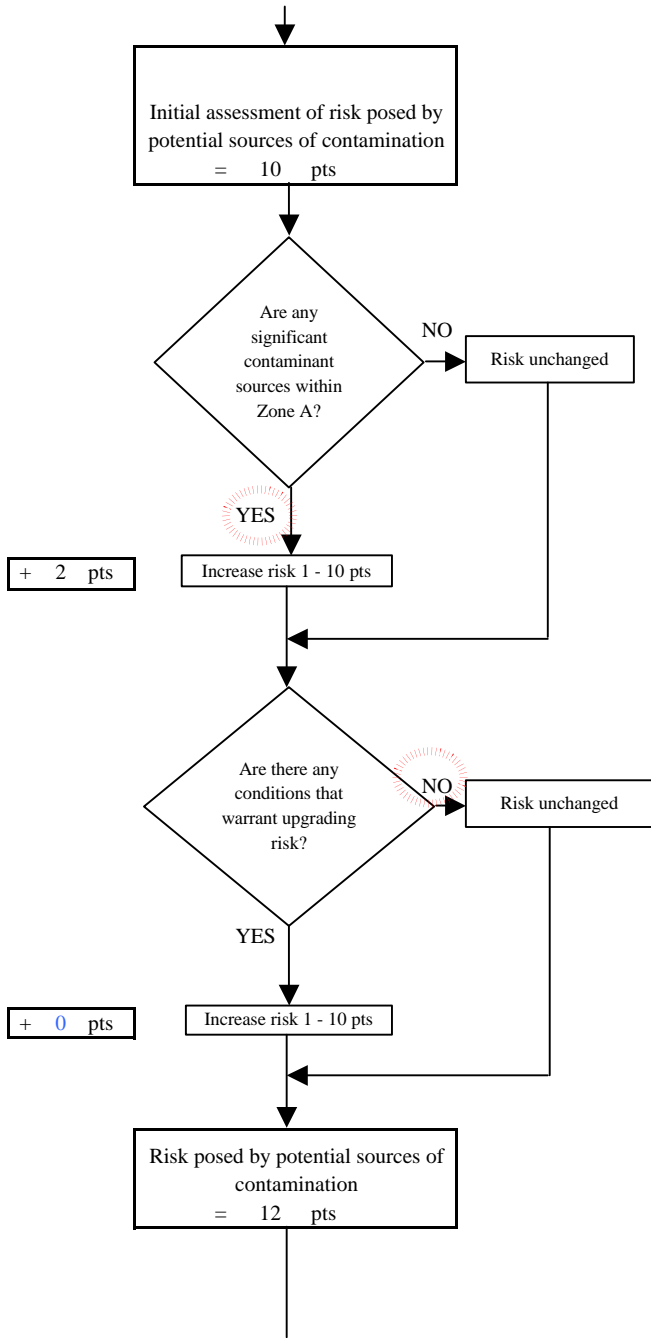


Chart 4. Vulnerability analysis for Wally's Healy Service - Bacteria & Viruses

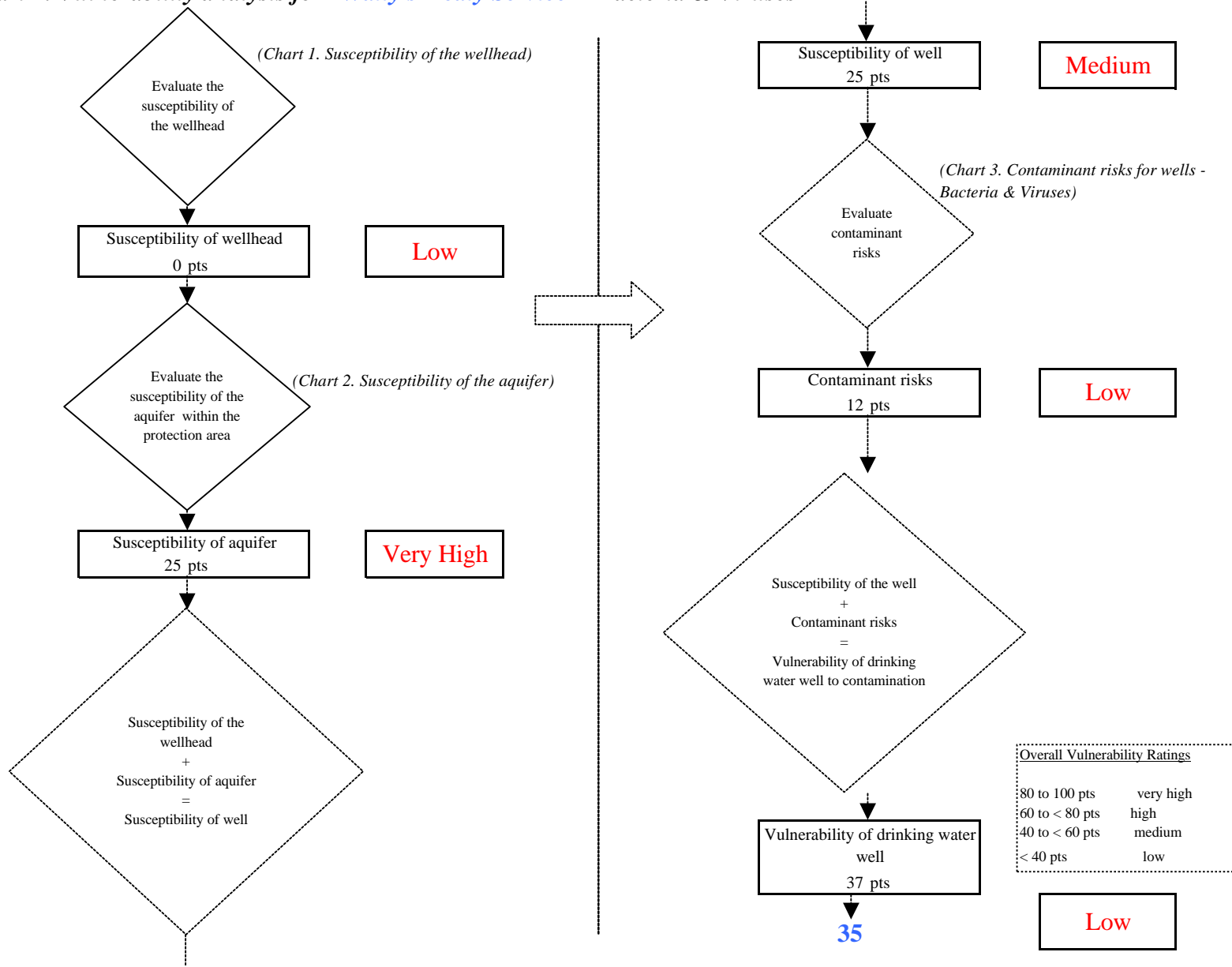


Chart 5. Contaminant risks for *Wally's Healy Service* - Nitrates and Nitrites

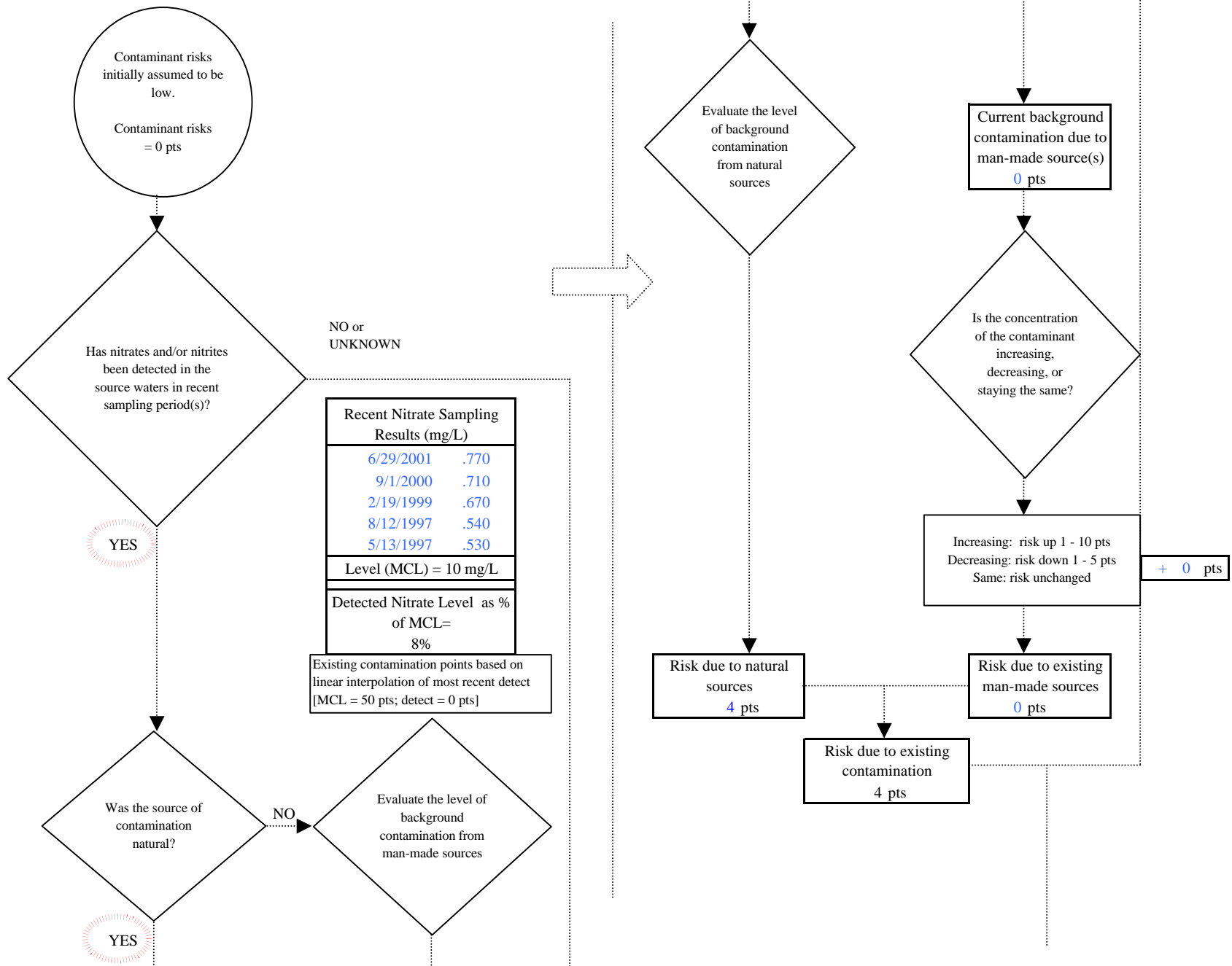
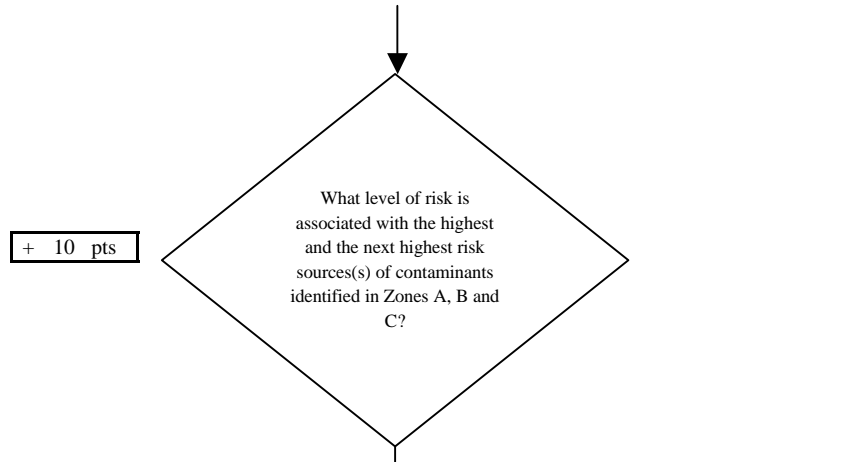


Chart 5. Contaminant risks for Wally's Healy Service - Nitrates and Nitrites



	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	1	3

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	³ 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.

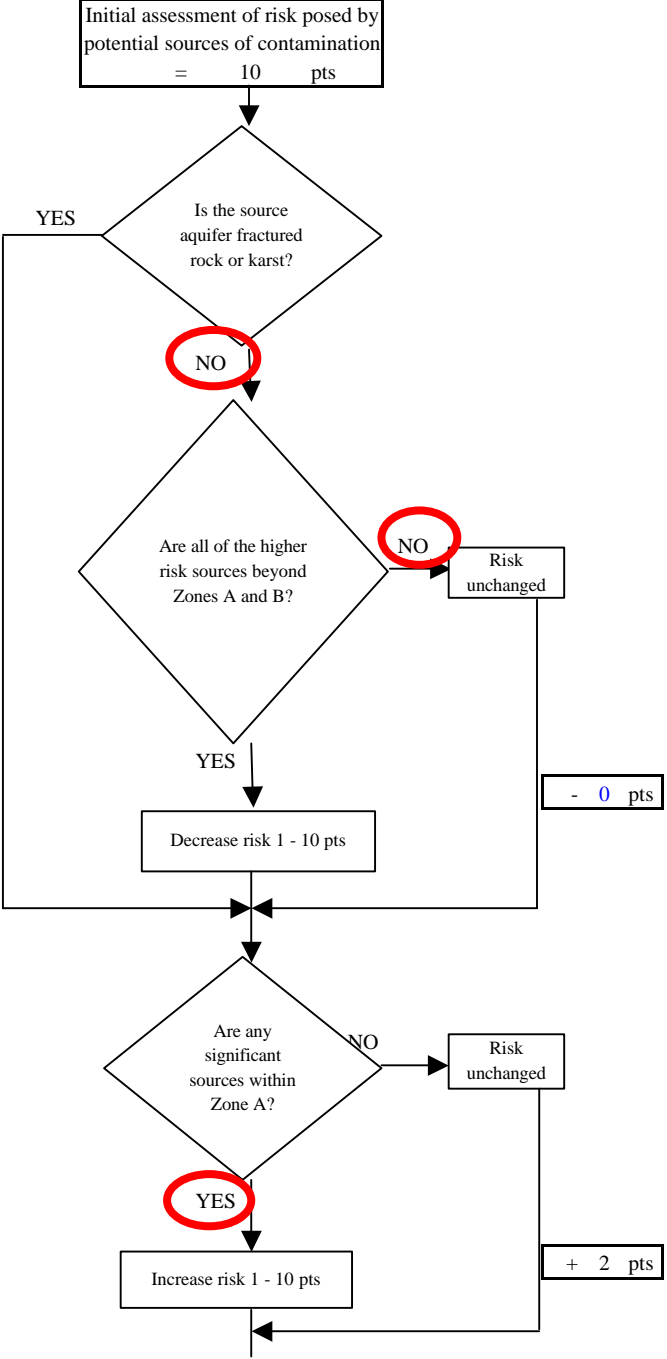


Chart 5. Contaminant risks for Wally's Healy Service - Nitrates and Nitrites

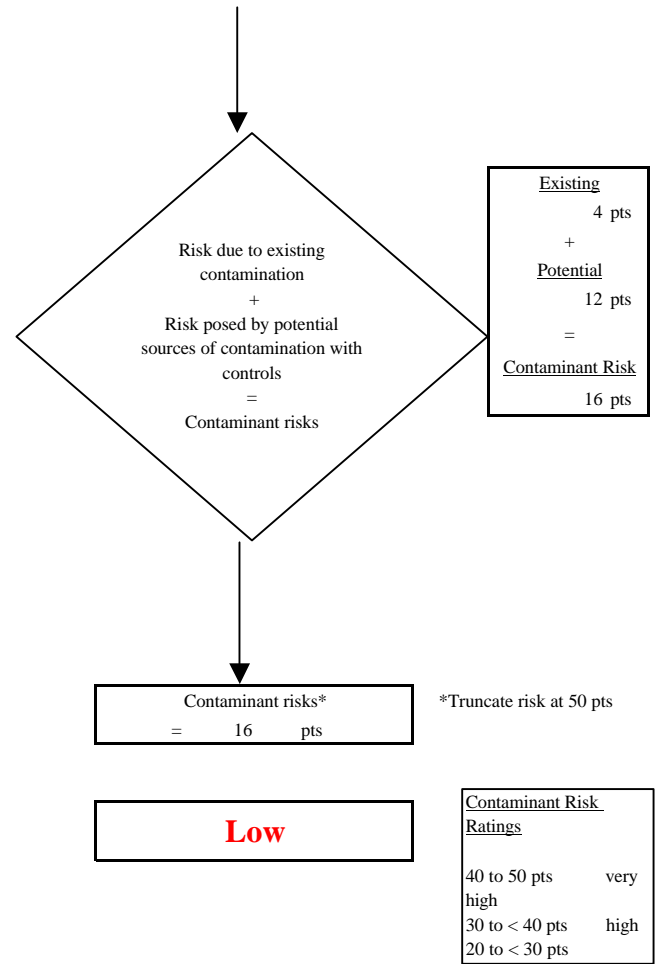
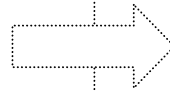
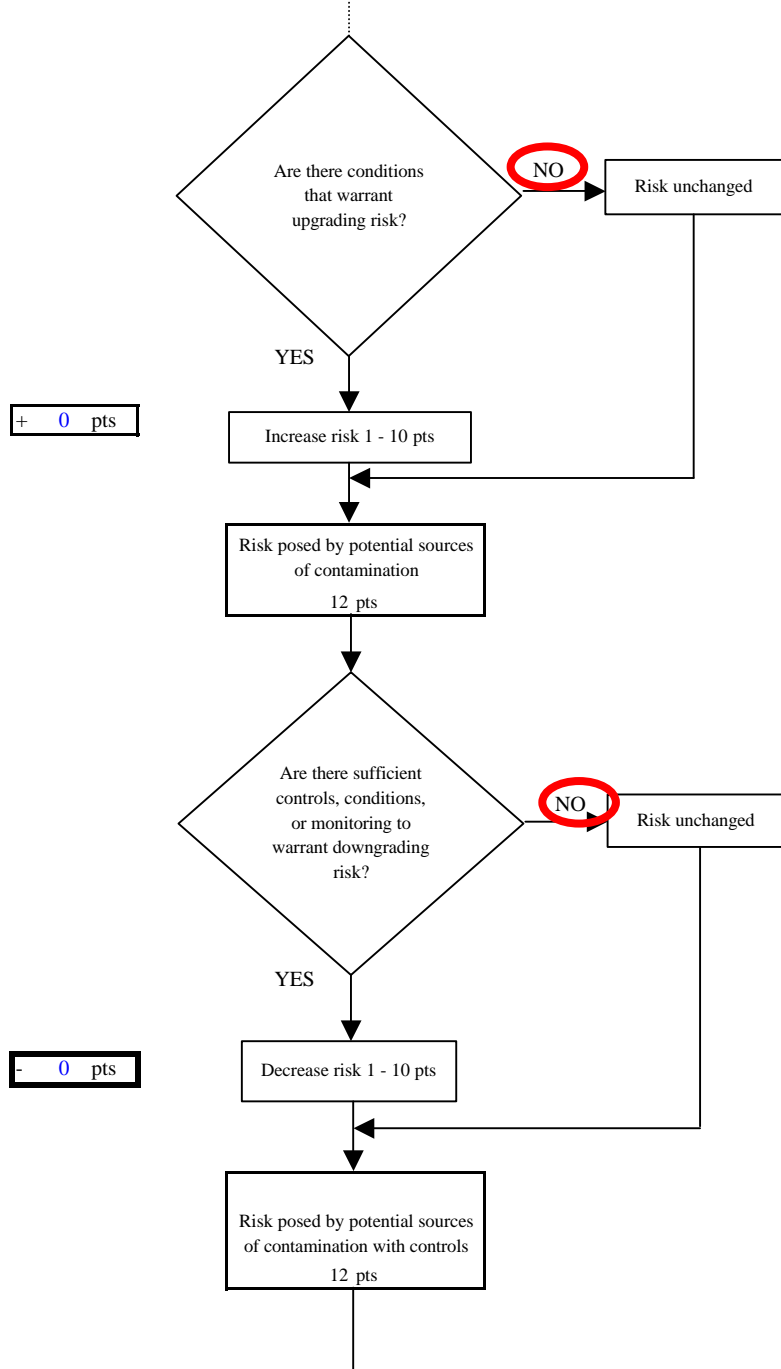


Chart 6. Vulnerability analysis for Wally's Healy Service - Nitrates and Nitrites

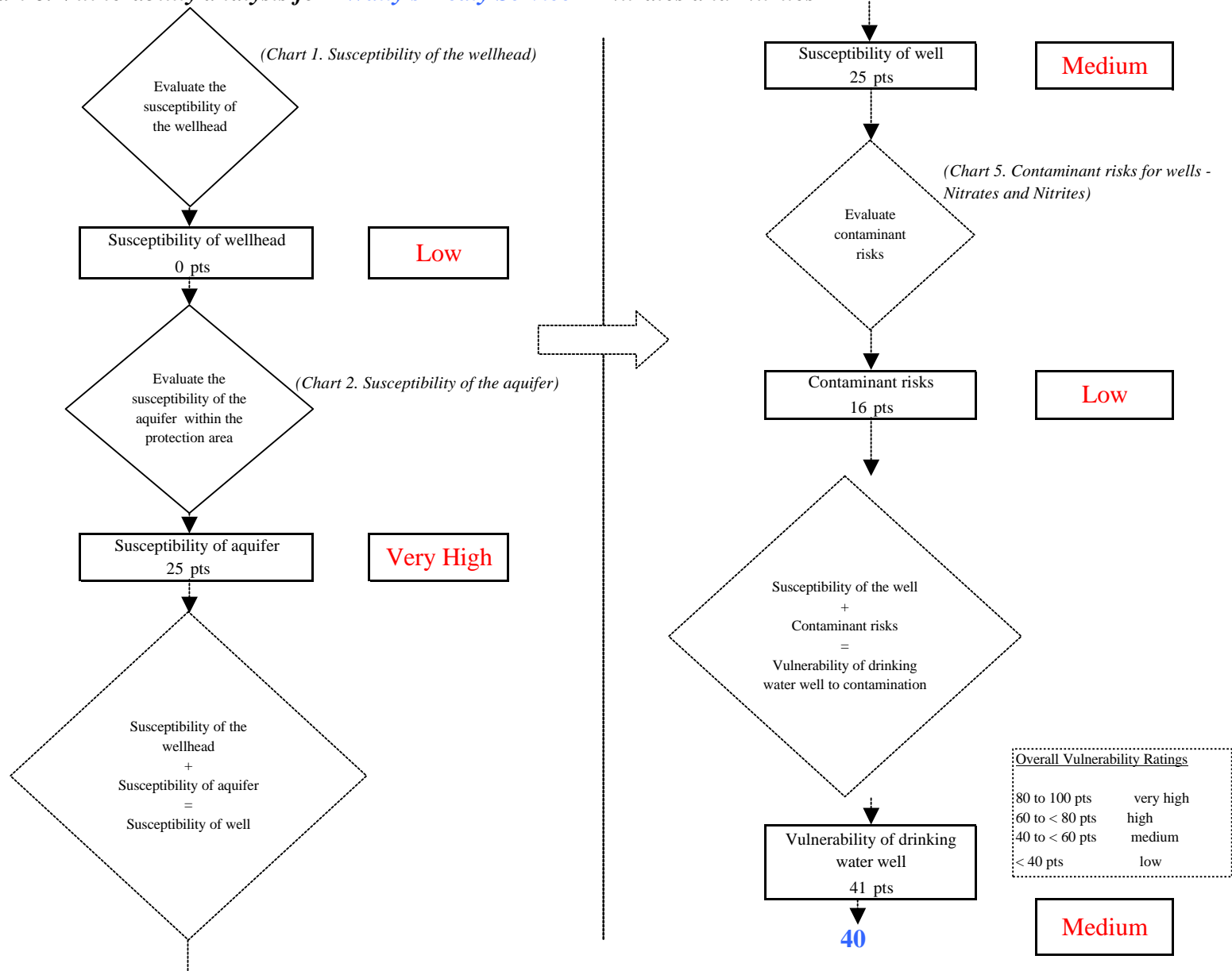


Chart 7. Contaminant risks for *Wally's Healy Service* - Volatile Organic Chemicals

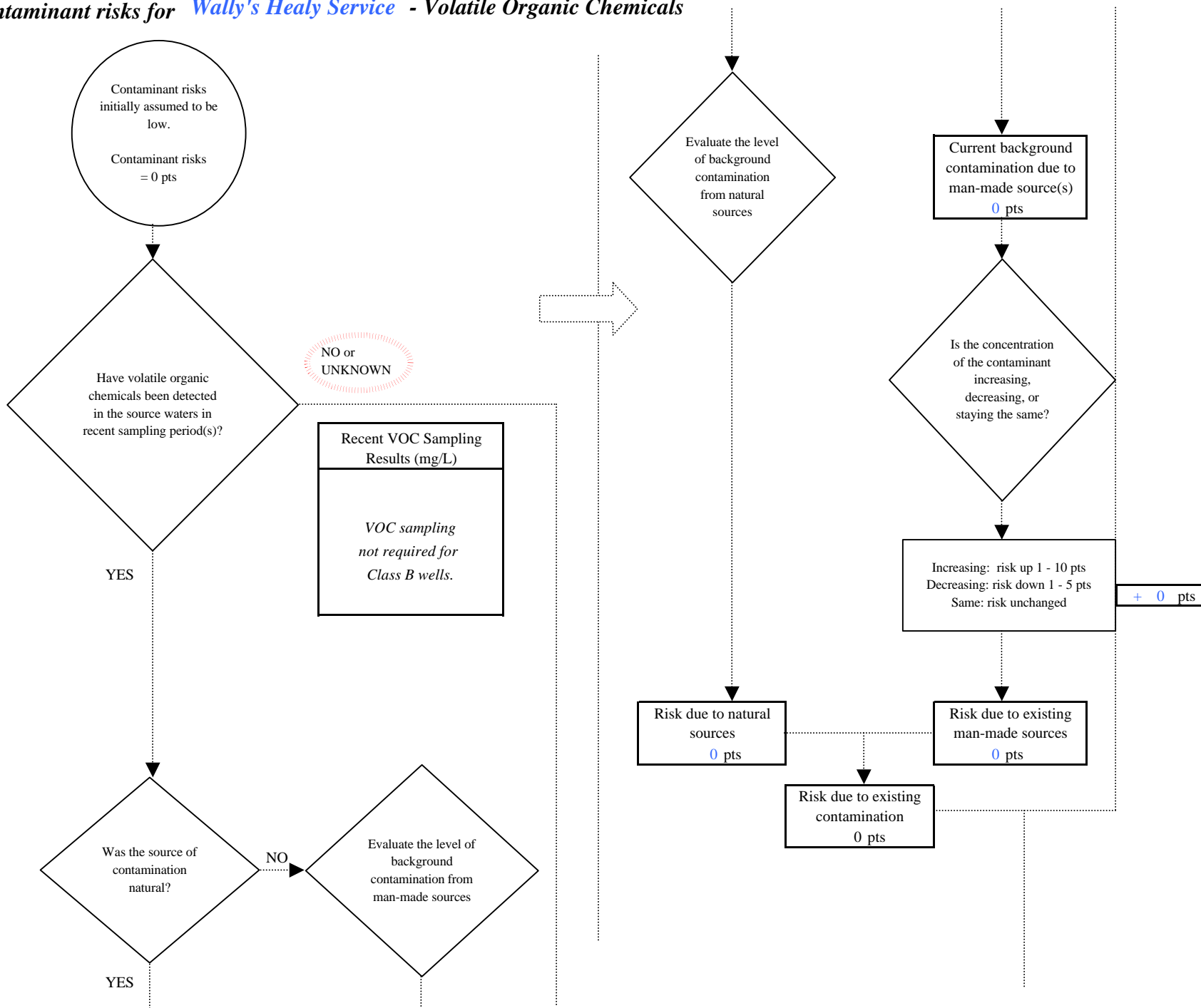
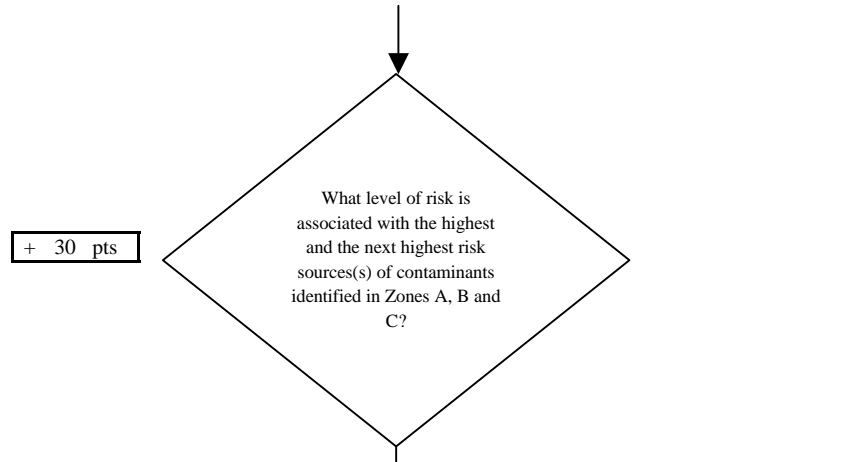


Chart 7. Contaminant risks for Wally's Healy Service - Volatile Organic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	1	0	1
Medium(s)	0	0	0
Low(s)	2	1	3

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	³ 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.

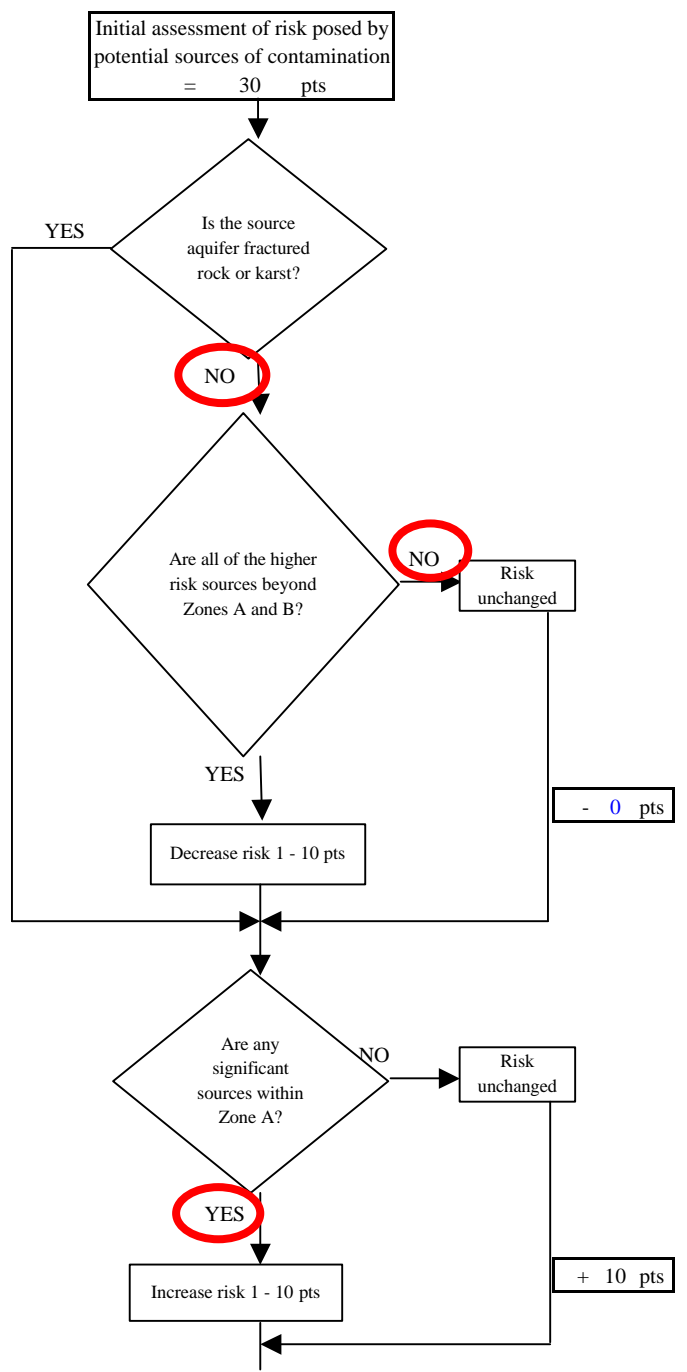


Chart 7. Contaminant risks for Wally's Healy Service - Volatile Organic Chemicals

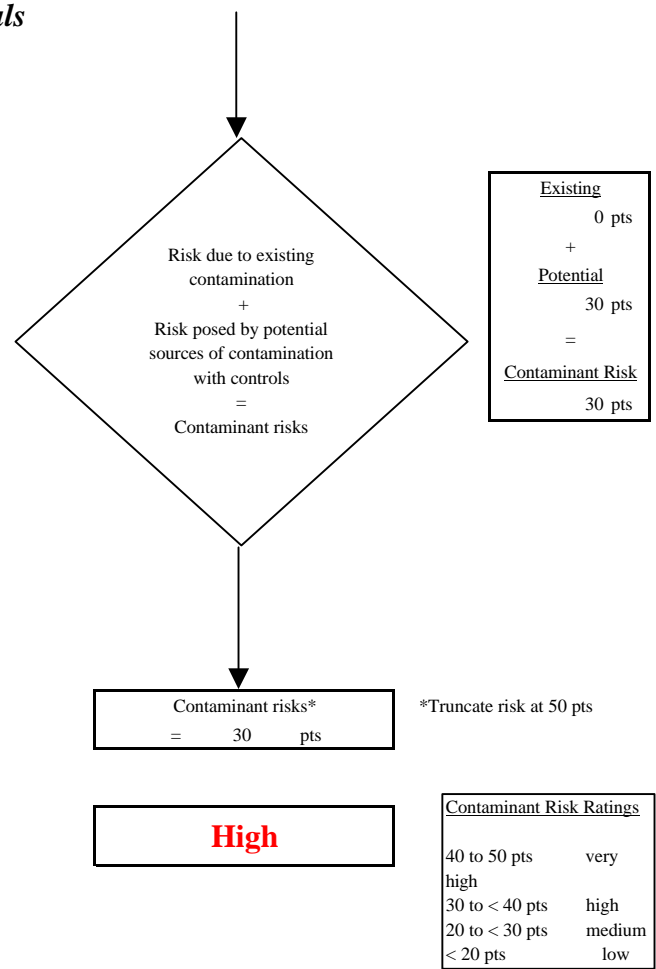
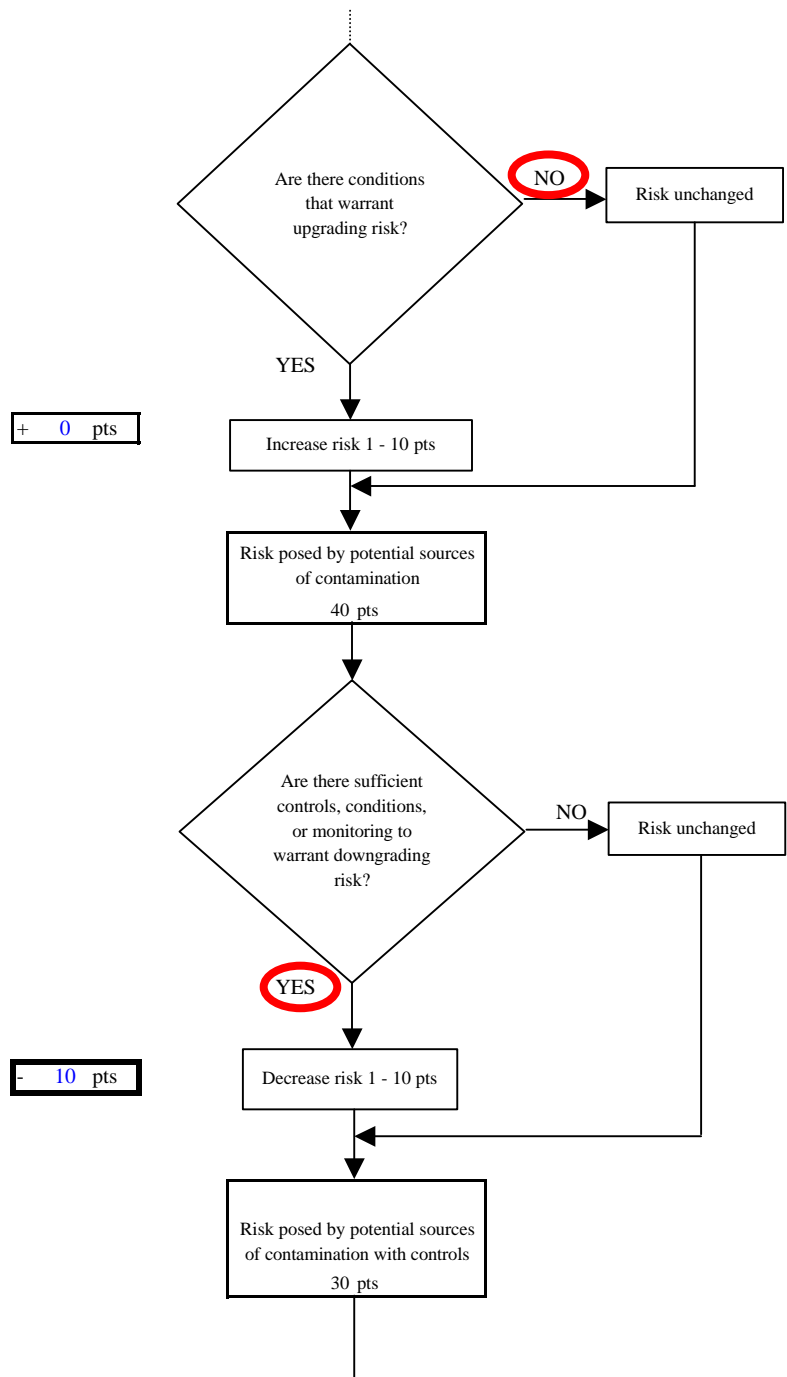


Chart 8. Vulnerability analysis for *Wally's Healy Service* - Volatile Organic Chemicals

