Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Thane Ore House, Juneau, Alaska PWSID #110871

DRINKING WATER PROTECTION PROGRAM REPORT NO. 738

Alaska Department of Environmental Conservation

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Thane Ore House
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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 Thane Ore House, Juneau, Alaska

Drinking Water Protection Program
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EXECUTIVE SUMMARY

The public water system for Thane Ore House is a Class B (transient/non-community) water system consisting of one surface water intake from a spring located at 4400 Thane Road, Juneau, Alaska. The spring outlet/intake received a susceptibility rating of **Medium**. Identified potential and current sources of contaminants for Thane Ore House public drinking water source include septic systems; placer metals mining; DEC-recognized contaminated site; water supply wells; dirt/gravel highways and roads; electric substation; and fish hatcheries. These identified potential and existing sources of contamination include sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Contaminant sources could potentially contribute bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals into the source waters. Overall, the public water sources for Thane Ore House received a vulnerability rating of **High** for bacteria and viruses, and nitrates and nitrites; and **Medium** for volatile organic chemicals.

THANE ORE HOUSE PUBLIC DRINKING WATER SYSTEM

Thane Ore House public water system is a Class B (transient/non-community) water system. The system consists of one spring located at 4400 Thane Road, Juneau, Alaska (See Map 1 of Appendix A).

Downtown Juneau averages about 92 inches of precipitation per year and approximately 101 inches of snow. The groundwater sources underlying the area are recharged through the infiltration of precipitation and surface water. Groundwater sources in the region generally occur in the fractured bedrock and unconsolidated sediments deposited by glaciers and/or rivers.

Juneau's topography varies from near sea level along the Gastineau Channel to approximately 3,300 feet to the surrounding mountains.

According to the Sanitary Survey from July 14, 1998, the existing system began operation in 1981. This survey indicates that the intake is properly protected against ice building and siltation. The intake is underground in a gravel bed. An adequately constructed intake may provide protection against debris and contaminants from entering the system. The raw water was treated by filtration and chlorination. There is a potential for runoff within the area surrounding the surface water.

This system operates seasonally from May 1 through September 30 and serves approximately 300 non-residents through two connections.

THANE ORE HOUSE 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 spring. Some areas are more likely to allow contamination to reach the spring than others. These areas are determined by looking at the characteristics of the soil, groundwater, source, and intake.

The most probable area for contamination to reach the spring intake is the area that contributes water to the perched source areas. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water system, this area will serve as the focus for voluntary protection efforts. Please refer to the Guidance Manual for Class B Public Water Systems for additional information.

The DWPAs established for springs by the ADEC are separated into three zones. These zones correspond to differences in the aerial distances from the spring intake and the entire watershed boundary. Little is known about the time of travel for contaminants, thus conservative distances have been established to provide protection for the spring. The following is a summary of the three DWPA zones and the calculations for each.

Table 1. Definition of Zones

Zone	Definition
A	1,000 feet from the Spring Intake
B	1 mile from the Spring Intake
C	Entire Watershed

The DWPA for Thane Ore House extends over the entire Sheep Creek watershed. Development in the vicinity of the surface water intake is limited to only Zone A (See Map 1 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 Thane Ore House DWPA. This inventory was completed through a search of agency records and other publicly-available information. There is a wide range of contamination to the drinking water source. 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;
- 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 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 TOT 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.

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, and volatile organic chemicals.

VULNERABILITY OF THANE ORE HOUSE 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 Spring Outlet/Intake' to contamination by looking at the construction of the spring and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Spring Outlet/Intake' 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 spring. 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.

A score for the Natural Susceptibility is reached by considering the properties of the spring and the aquifer.

Susceptibility of the Spring (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 Spring)
(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 spring intake for Thane Ore House is in an unnamed Spring. Because the Spring is recharged by surface water runoff and precipitation, contaminants at or near the Spring have the potential to adversely impact the drinking water source. Table 2 shows the Susceptibility of the Aquifer score and rating for Thane Ore House.

Table 2. Natural Susceptibility

	Score	Rating
Natural Susceptibility	22	Very High

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score has been derived from an examination of existing or 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 was 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	30	High
Nitrates and/or Nitrites	42	Very High
Volatile Organic Chemicals	12	Low

Finally, an overall vulnerability score is assigned for each water system by combining each of the contaminant risk cores 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 (30 – 100) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	60	High
Nitrates and Nitrites	75	High
Volatile Organic Chemicals	45	Medium

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, and volatile organic chemicals.

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **High** with the septic systems and dirt/gravel highways and roads located within Zone A representing the risk to the drinking water (See Chart 2 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at the Thane Ore House. Combining the contaminant risks with the overall natural susceptibility of the surface water source, the vulnerability of the surface water source to contamination by bacteria and viruses is **High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High** with the septic systems and dirt/gravel highways and roads located within Zone A representing the risk to the drinking water (See Chart 4 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Sampling history for Thane Ore House indicates that nitrates have been detected in the water, but only in very low concentrations (most recently at 0.404 mg/L on 6/16/2002) or 4% of the Maximum Contaminant Level (MCL). 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.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the surface water source, the overall vulnerability of the surface water source to contamination by nitrates and nitrites is **High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Low** with the septic systems; dirt/gravel highways and roads; and electric substation located within Zone A representing the risk to the drinking water (See Chart 6 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Sampling history indicates that volatile organic chemicals have not been detected in the water. Combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the surface water source, the overall vulnerability of the surface water source to contamination by volatile organic chemicals is **Medium**.

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Gehrels, G.E., Berg, H.C., Geologic Map of Southeastern Alaska: U.S. Geological Survey Map (scale 1:600,000), Map I-1867, 1sheet.

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United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL: http://www.epa.gov/safewater/mcl.html.

APPENDIX A

Thane Ore House
Drinking Water Protection Area Location Map
(Map 1)

Map 1: Thane Ore House Drinking Water Protection Areas

PWSID: 110871.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 1,150 2,300 4,600 6,900 9,200 Feet

1:22,626

Data Sources:

Background image - USGS 1:63,000 mapping

Protection zones were delineated based upon streams noted on USGS 1:63,000 mapping.

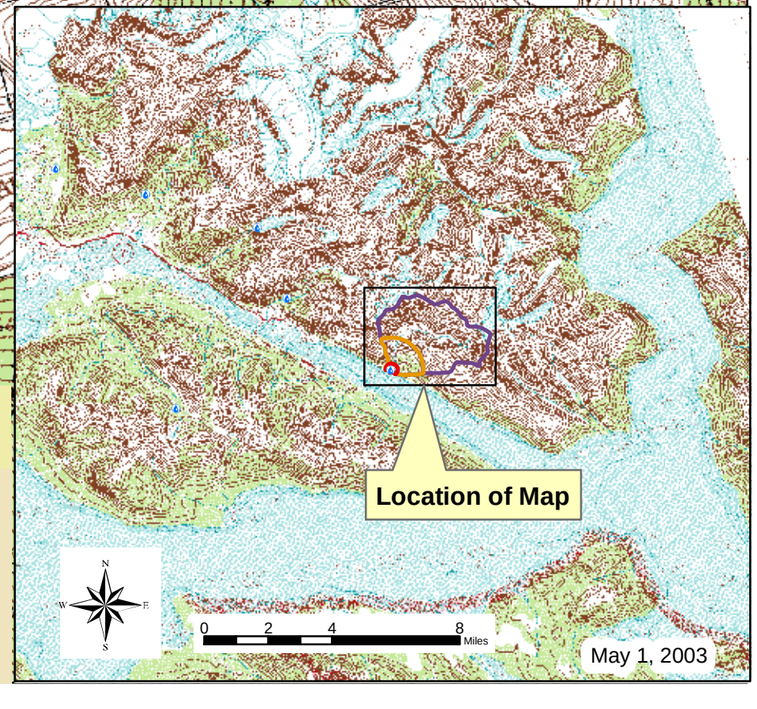
Legend

- Public Drinking Water Systems

Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less than 2 Years Travel Time

Zone C Protection Area
Entire Watershed



May 1, 2003

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Thane Ore House (Tables 1-4)

Table 1 *Contaminant Source Inventory for* ***PWSID 110871.001***

Thane Ore House

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	2	Thane Ore House
Metals mining, placer (active or inactive?)	E04	E04-1	A	2	Beach Mine
Septic systems (serves one single-family home)	R02	R02-1	A	2	Residence
Septic systems (serves one single-family home)	R02	R02-2	A	2	Residence
Septic systems (serves one single-family home)	R02	R02-3	A	2	Residence
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	A	2	Fuel Tanks
Water supply wells	W09	W09-1	A	2	Residence
Water supply wells	W09	W09-3	A	2	Residence
Water supply wells	W09	W9-2	A	2	Residence
Highways and roads, dirt/gravel	X24	X24-1	A	2	Thane Road
Highways and roads, dirt/gravel	X24	X24-2	A	2	South Franklin Street
Highways and roads, dirt/gravel	X24	X24-3	A	2	Road to Thane Ore House
Highways and roads, dirt/gravel	X24	X24-4	A	2	Parking Lot by Thane Ore House
Electric substation	X37	X37-1	A	2	Electric Substation
Septic systems (serves one single-family home)	R02	R02-4	B	2	Residence Northwest of Thane Ore House
Water supply wells	W09	W09-4	B	2	Residence Northwest of Thane Ore House
Highways and roads, dirt/gravel	X24	X24-5	B	2	Road North of Thane Ore House
Fish hatcheries	X47	X47-1	B	2	Fish Hatchery East of Thane Ore House
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	C	2	A-J Mine

Contaminant Source Inventory and Risk Ranking for

Table 2 ***PWSID 110871.001***

Thane Ore House

Sources of Bacteria and Viruses

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	2	Thane Ore House
Septic systems (serves one single-family home)	R02	R02-1	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-2	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-3	A	Low	2	Residence
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	Thane Road
Highways and roads, dirt/gravel	X24	X24-2	A	Low	2	South Franklin Street
Highways and roads, dirt/gravel	X24	X24-3	A	Low	2	Road to Thane Ore House
Highways and roads, dirt/gravel	X24	X24-4	A	Low	2	Parking Lot by Thane Ore House
Septic systems (serves one single-family home)	R02	R02-4	B	Low	2	Residence Northwest of Thane Ore House
Highways and roads, dirt/gravel	X24	X24-5	B	Low	2	Road North of Thane Ore House

Contaminant Source Inventory and Risk Ranking for

Table 3 ***PWSID 110871.001***

Thane Ore House

Sources of Nitrates/Nitrites

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	2	Thane Ore House
Septic systems (serves one single-family home)	R02	R02-1	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-2	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-3	A	Low	2	Residence
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	Thane Road
Highways and roads, dirt/gravel	X24	X24-2	A	Low	2	South Franklin Street
Highways and roads, dirt/gravel	X24	X24-3	A	Low	2	Road to Thane Ore House
Highways and roads, dirt/gravel	X24	X24-4	A	Low	2	Parking Lot by Thane Ore House
Septic systems (serves one single-family home)	R02	R02-4	B	Low	2	Residence Northwest of Thane Ore House
Highways and roads, dirt/gravel	X24	X24-5	B	Low	2	Road North of Thane Ore House

Contaminant Source Inventory and Risk Ranking for

Table 4 ***PWSID 110871.001***

Thane Ore House

Sources of Volatile Organic Chemicals

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	2	Thane Ore House
Septic systems (serves one single-family home)	R02	R02-1	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-2	A	Low	2	Residence
Septic systems (serves one single-family home)	R02	R02-3	A	Low	2	Residence
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	Thane Road
Highways and roads, dirt/gravel	X24	X24-2	A	Low	2	South Franklin Street
Highways and roads, dirt/gravel	X24	X24-3	A	Low	2	Road to Thane Ore House
Highways and roads, dirt/gravel	X24	X24-4	A	Low	2	Parking Lot by Thane Ore House
Electric substation	X37	X37-1	A	Low	2	Electric Substation
Septic systems (serves one single-family home)	R02	R02-4	B	Low	2	Residence Northwest of Thane Ore House
Highways and roads, dirt/gravel	X24	X24-5	B	Low	2	Road North of Thane Ore House

APPENDIX C

Thane Ore House
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Map 2: Drinking Water Protection Areas for Thane Ore House and Potential and Existing Sources of Contamination

PWSID: 110871.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 120 240 480 720 960 Feet

1:3,432

Data Sources:

Background image - USGS 1:25,000 mapping

Protection zones were delineated based upon streams noted on USGS 1:63,000 mapping.

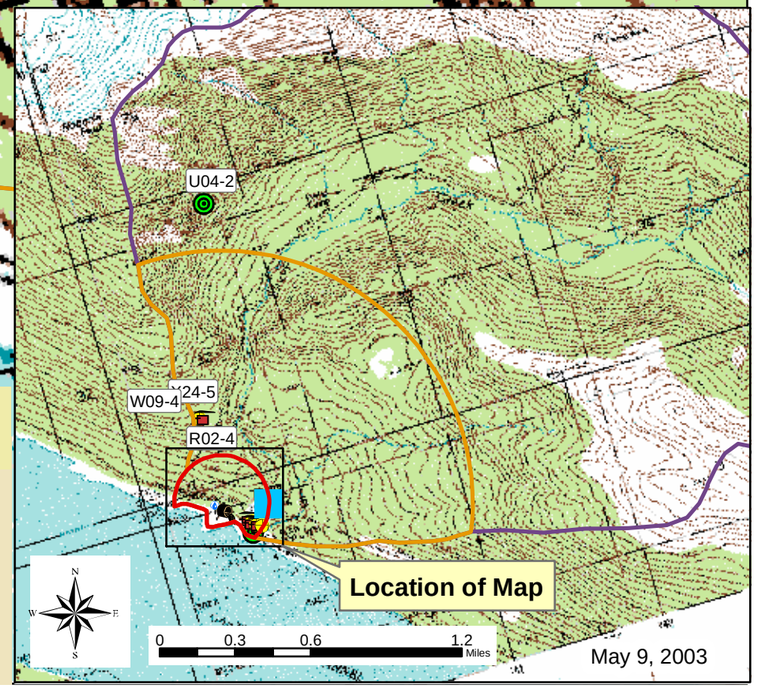
Legend

- Public Drinking Water Systems
- Large Capacity Septic System (D10)
- Single Family Septic System (R02)
- Contaminate Site, DEC Recognized (U04)
- Private Water Supply Well (W09)
- Electric Substation (X37)
- Placer Mining Claim

Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less than 2 Years Travel Time

Zone C Protection Area
Entire Watershed



APPENDIX D

Vulnerability Analysis for Thane Ore House Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the spring outlet/intake - Thane Ore House

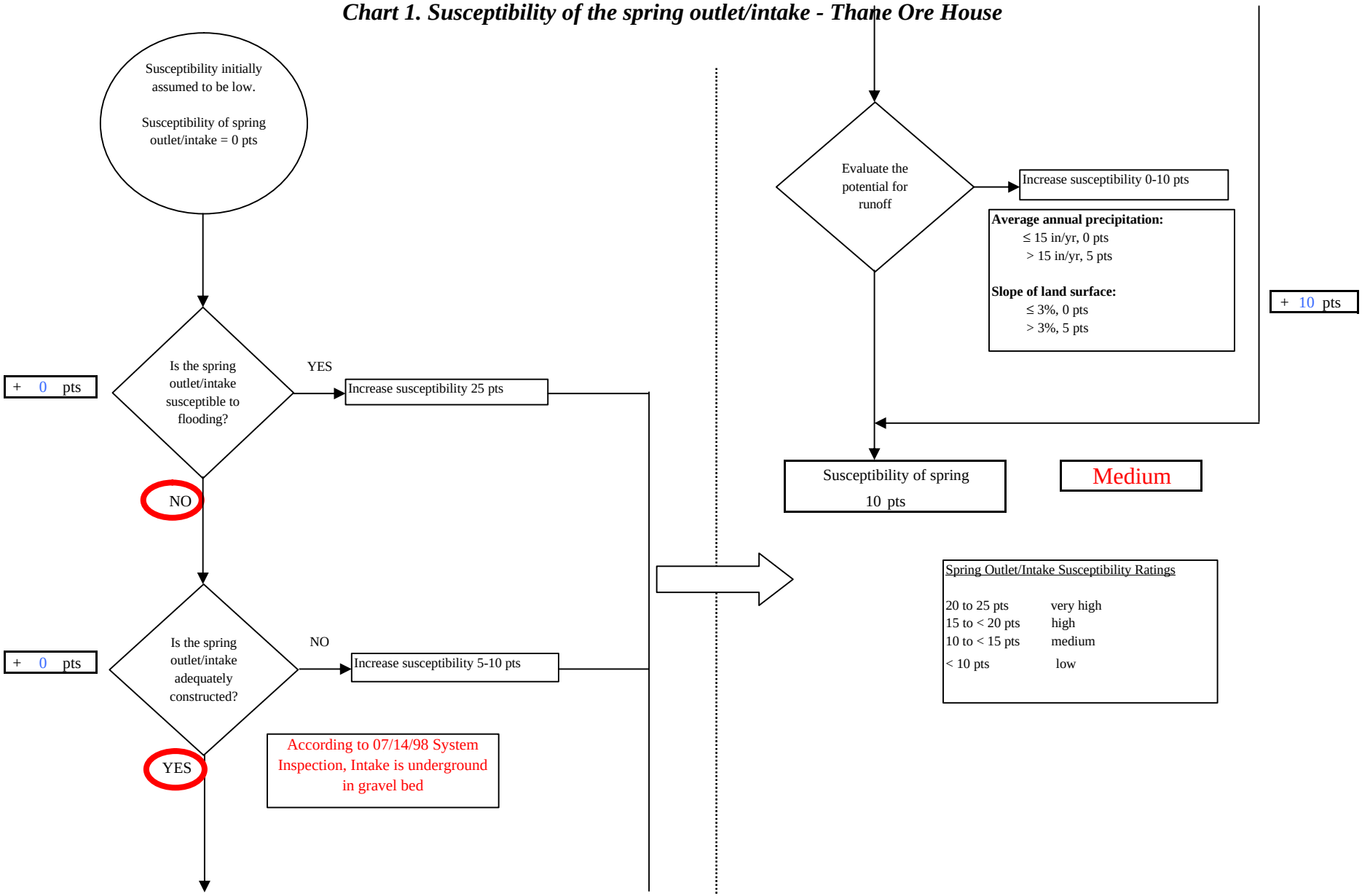


Chart 2. Susceptibility of the aquifer - Thane Ore House

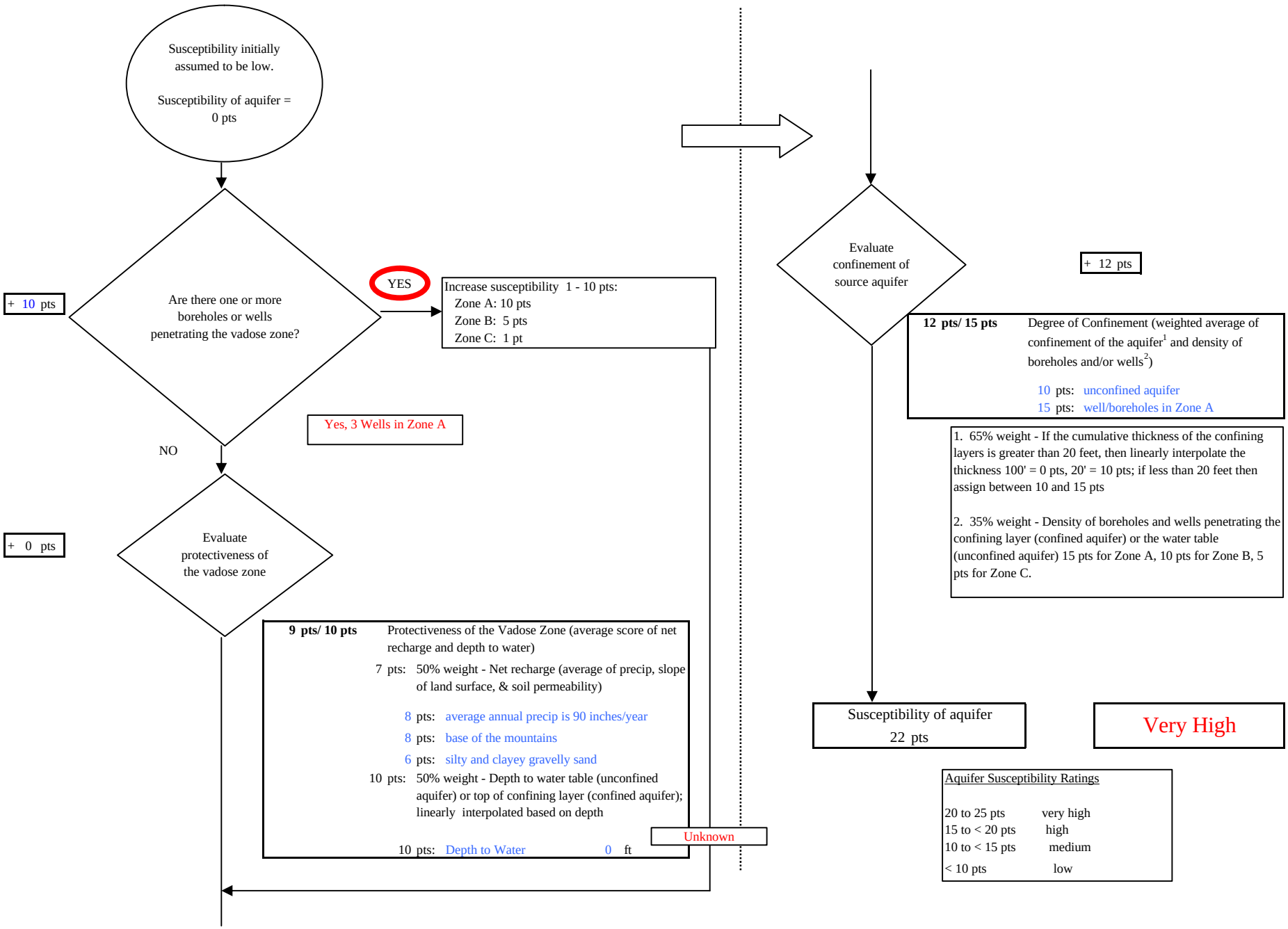
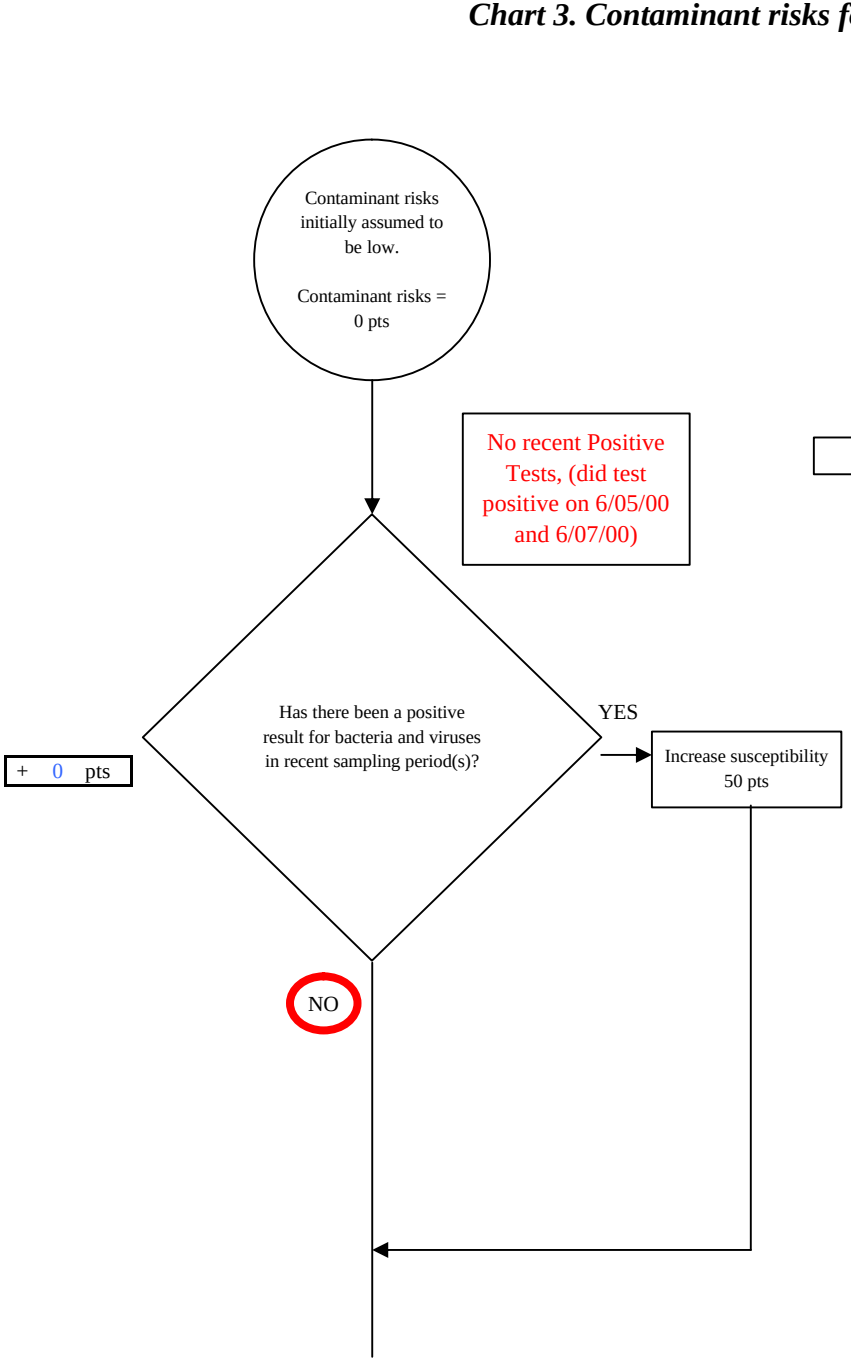
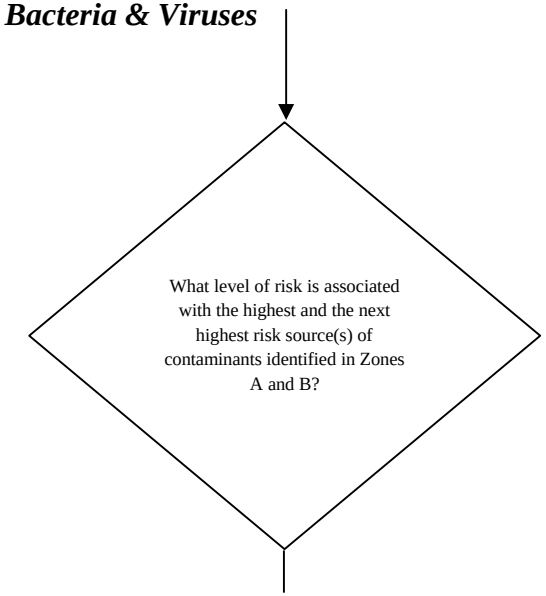


Chart 3. Contaminant risks for Thane Ore House - Bacteria & Viruses





+ 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)	0	0	0
Low(s)	4	2	6

	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 3. Contaminant risks for Thane Ore House - Bacteria & Viruses

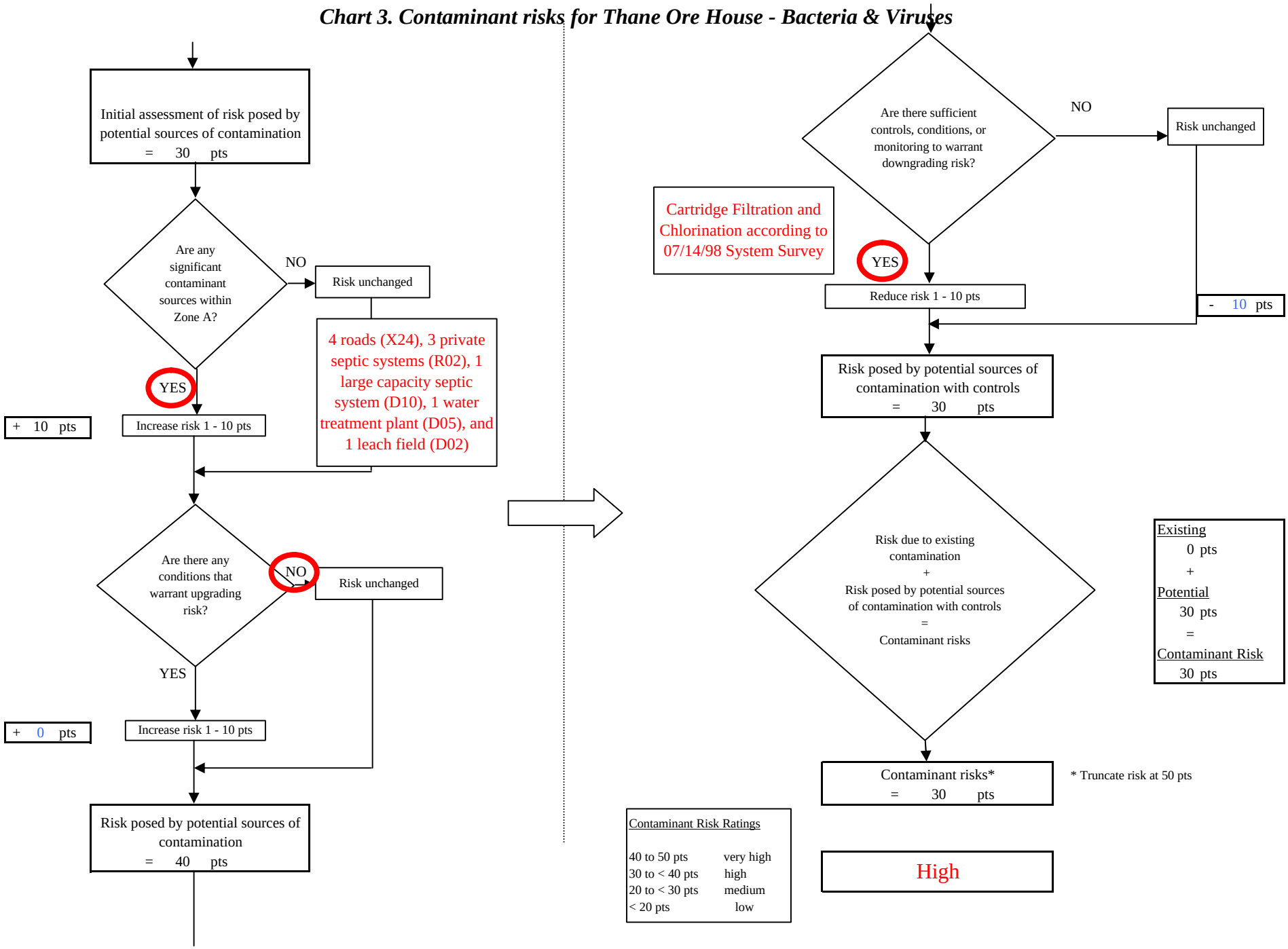


Chart 4. Vulnerability analysis for Thane Ore House - Bacteria & Viruses

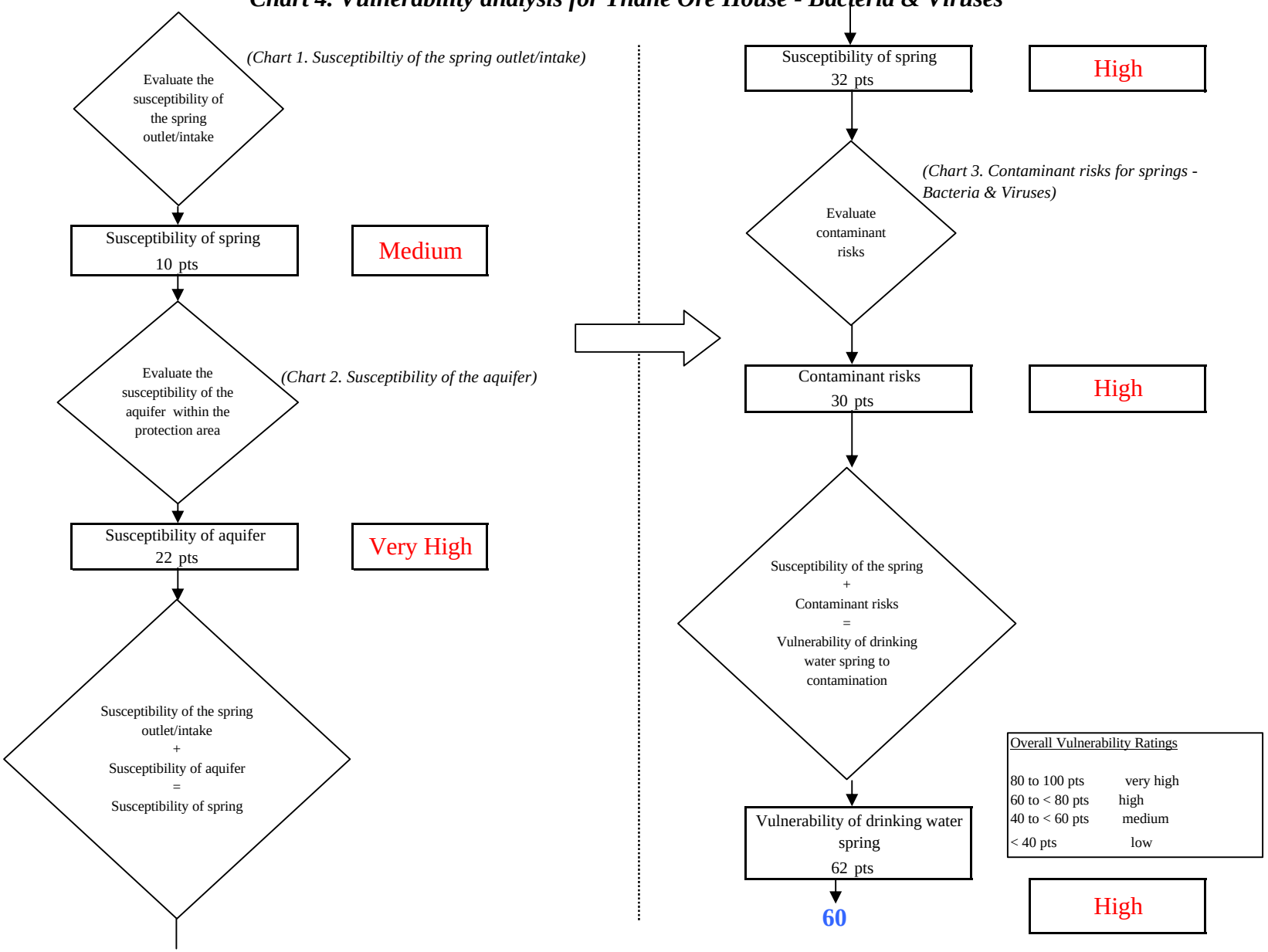


Chart 5. Contaminant risks for Thane Ore House - Nitrates and Nitrites

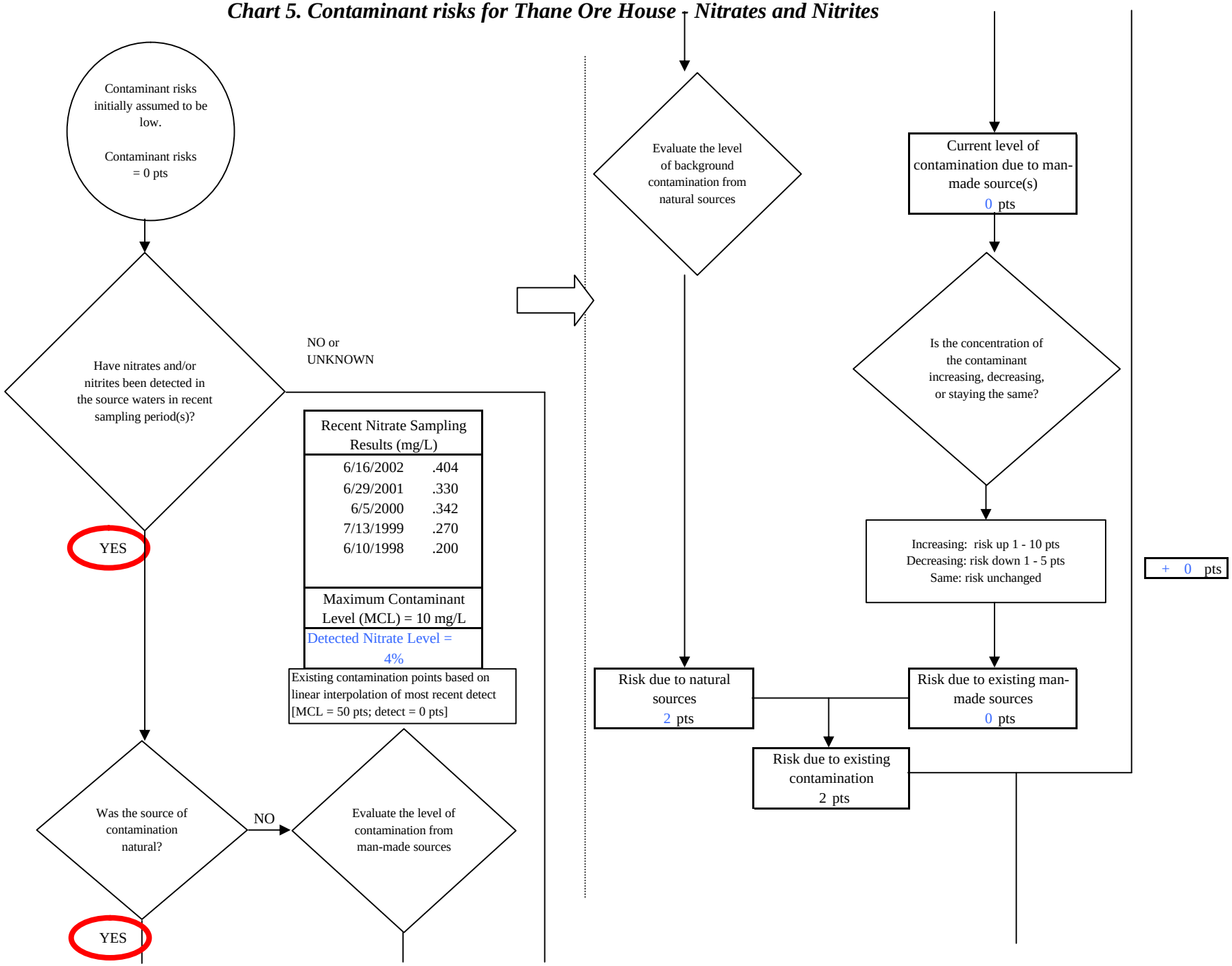


Chart 5. Contaminant risks for Thane Ore House - Nitrates and Nitrites

+ 30 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A and B? (see Risk Matrix below)

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

Are any significant sources in Zone A?

NO → Risk unchanged

YES → Increase risk 1 - 10 pts

4 roads (X24), 3 private septic systems (R02), 1 large capacity septic system (D10), 1 water treatment plant (D05), and 1 leach field (D02)

+ 10 pts

Risk Levels 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)	0	0	0
Low(s)	4	2	6

	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, sewerline, 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 Thane Ore House - Nitrates and Nitrites

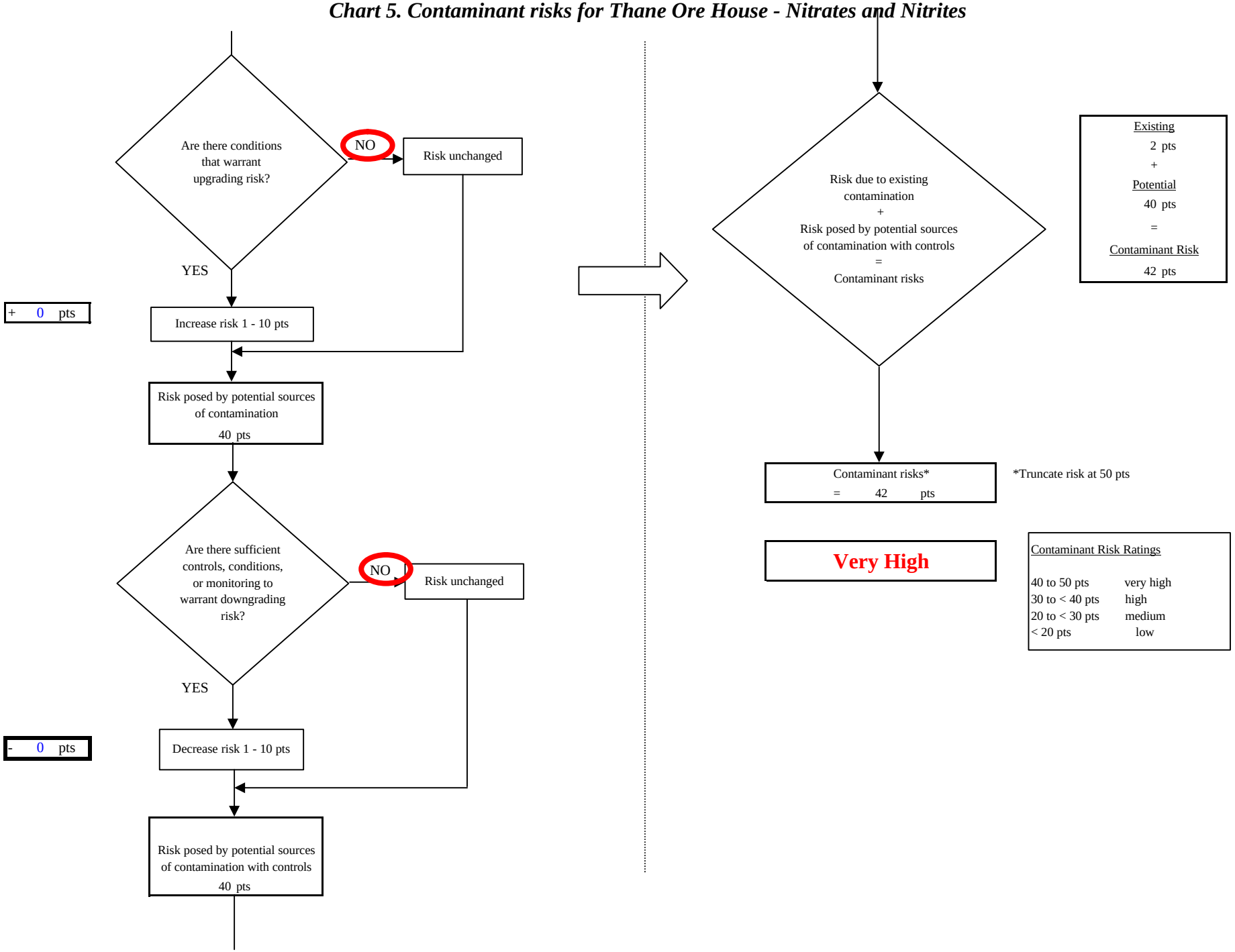


Chart 6. Vulnerability analysis for Thane Ore House - Nitrates and Nitrites

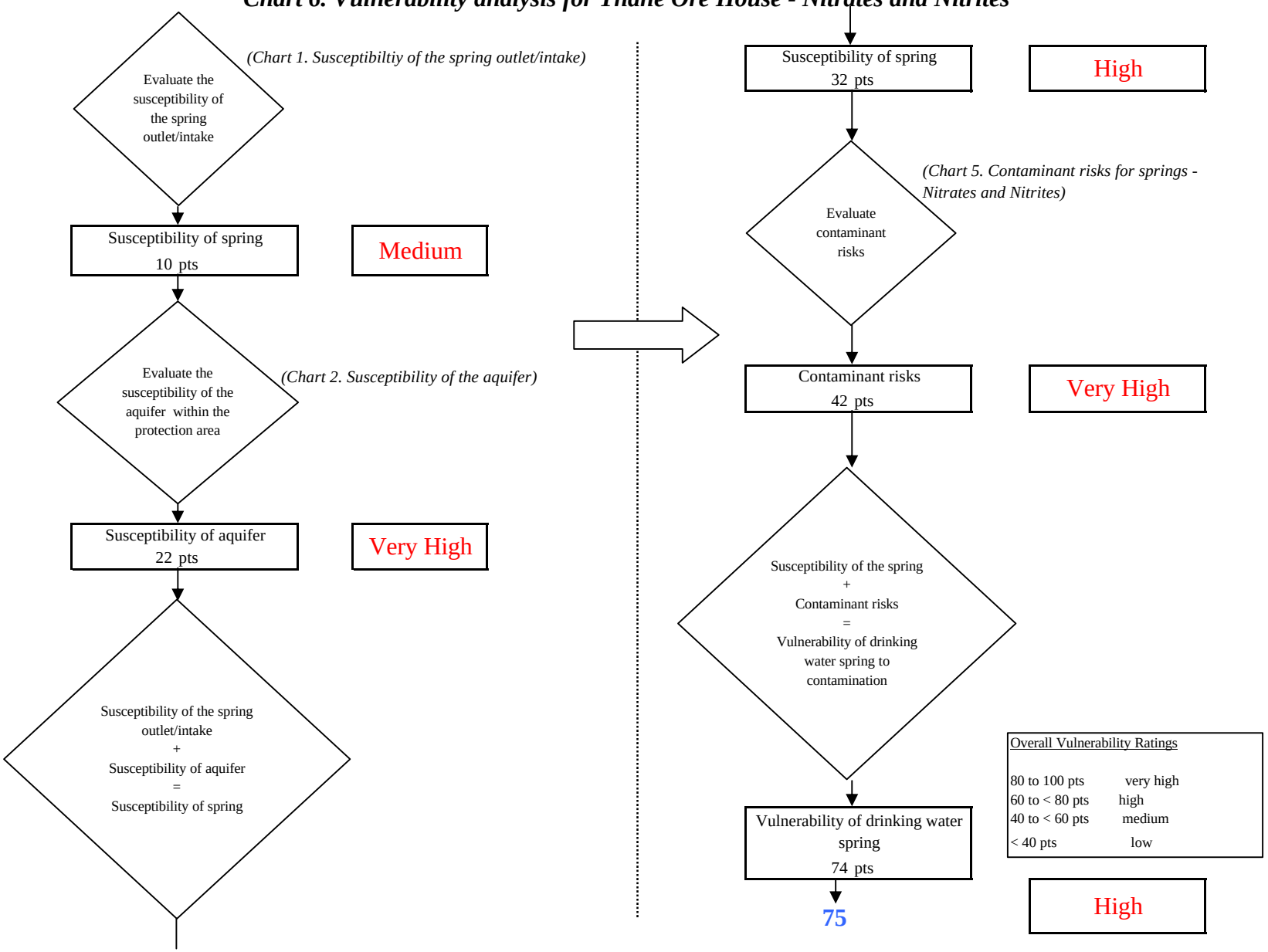


Chart 7. Contaminant risks for Thane Ore House - Volatile Organic Chemicals

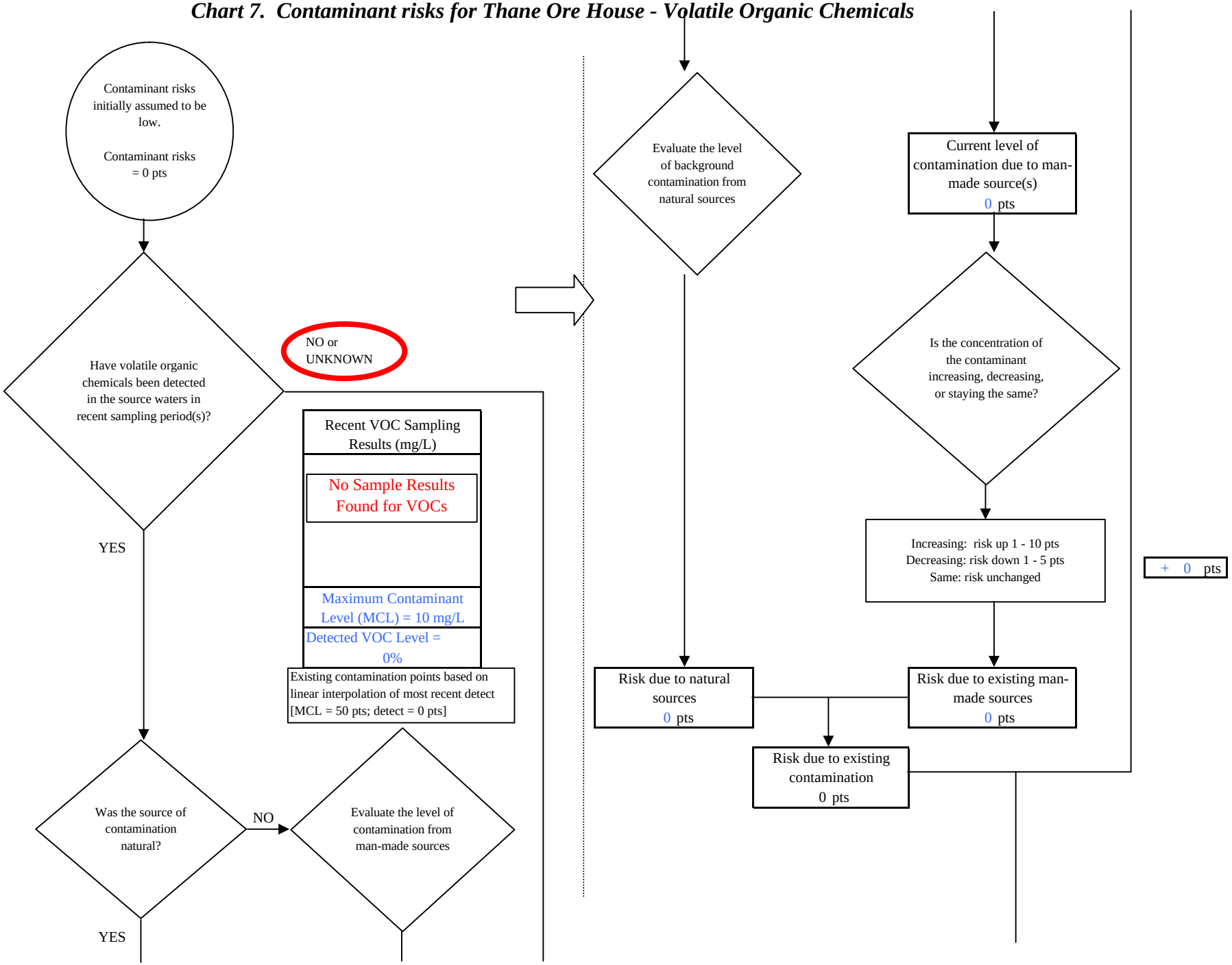


Chart 7. Contaminant risks for Thane Ore House - Volatile Organic Chemicals

+ 10 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zone A and B? (see Risk Matrix below)

Initial assessment of risk posed by potential sources of contamination = 10 pts

Are any significant sources in Zone A?

NO → Risk unchanged

YES → Increase risk 1 - 10 pts

4 roads (X24), 3 private septic systems (R02), 1 large capacity septic system (D10), 1 water treatment plant (D05), and 1 leach field (D02)

+ 2 pts

Risk Levels 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)	4	2	6

	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, sewerline, 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 Thane Ore House - Volatile Organic Chemicals

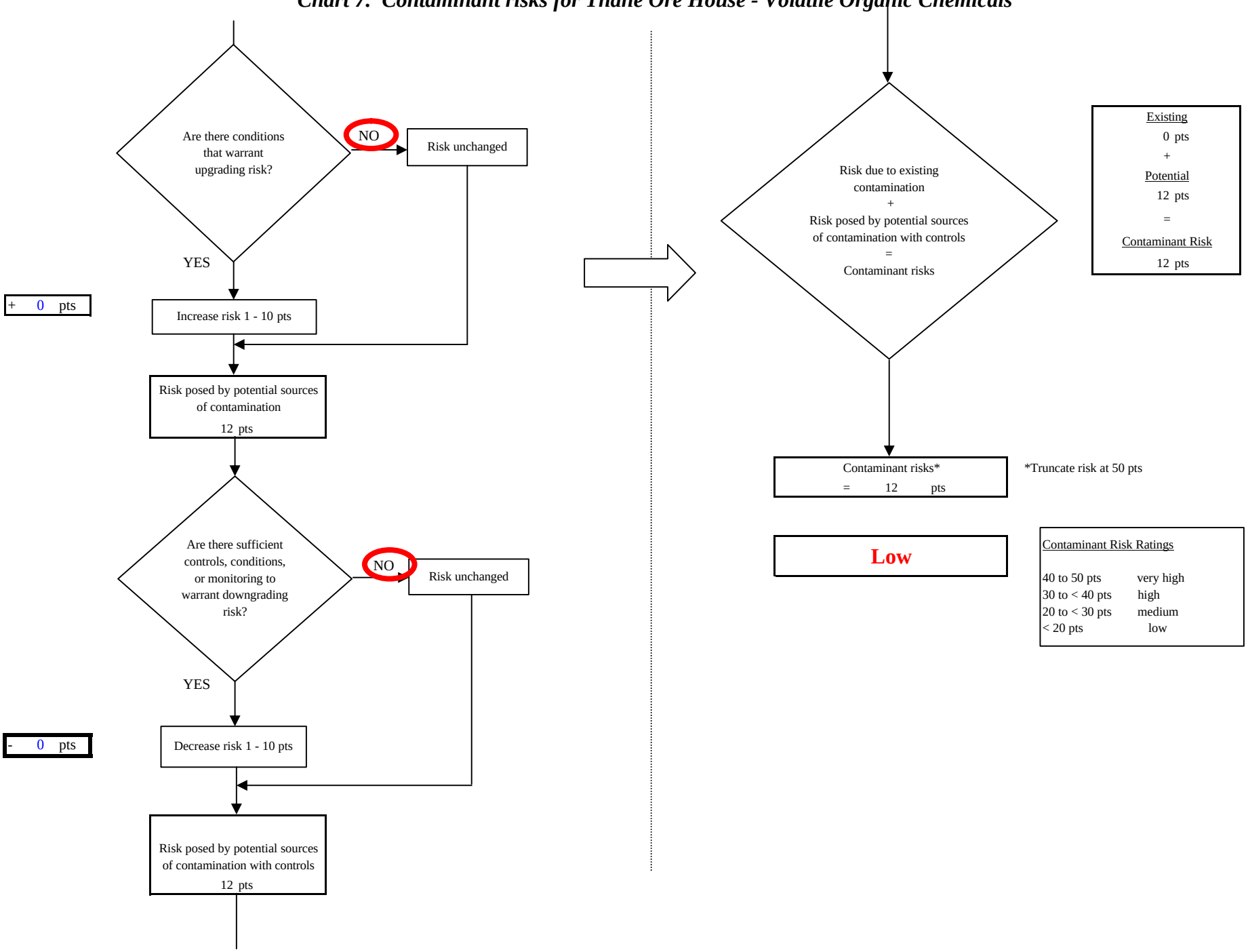


Chart 8. Vulnerability analysis for Thane Ore House - Volatile Organic Chemicals