Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for FNSB Birch Hill Drinking Water System, Fairbanks area, Alaska PWSID # 312164

January 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 787
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 FNSB Birch Hill Source of Public Drinking Water, Fairbanks Area, Alaska

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 FNSB Birch Hill to potential contamination. The public water system for FNSB Birch Hill is a Class B (transient/non-community) water system consisting of one well near Birch Hill Road approximately 2 miles northeast of Fairbanks, Alaska. The well received a natural susceptibility rating of **Medium**. This rating is a combination of a susceptibility rating of **Low** for the actual wellhead and a **Very High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the FNSB Birch Hill public drinking water source include: foot trails, heating oil tanks, septic systems, and residential area. 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 sources for FNSB Birch Hill received an overall vulnerability rating of **High** for bacteria and viruses, and nitrates and/or nitrites; and a **Medium** for volatile organic chemicals.

FNSB BIRCH HILL PUBLIC DRINKING WATER SYSTEM

FNSB Birch Hill public water system is a Class B (transient/non-community) water system. The system consists of one well near Birch Hill Road approximately 2 miles northeast of Fairbanks, Alaska (T1N, R1W, Section 36) (See Map 1 of Appendix A). Fairbanks and its surrounding communities are located in the Fairbanks North Star Borough which is 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.

The majority of residents the Fairbanks area use individual water wells or hauled water, and septic systems (ADCED, 2002). Heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) is used for heating homes and buildings. Refuse is transported to the Fairbanks North Star Borough landfill.

The Fairbanks area includes two distinct topographic areas: the floodplain of the Tanana River and the Chena River, and the uplands north of this floodplain. This water system is located in the uplands at an elevation of approximately 900 feet above sea level.

According to the well log for this water system, the depth of the well is 460 feet below the ground surface, and is screened in bedrock (schist). 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).

The Sanitary Survey (8/5/99) for the water system indicates there is a sanitary seal on the well. The well has not been grouted. The well pad area is sloped away from the well providing adequate drainage. Proper drainage on the surface as well as grouting the well help to prevent potential contaminants from travelling down the well casing. The well is not located in a known floodplain.

This system operates year-round serving approximately 300+ non-residents through two service connections.

FNSB BIRCH HILL 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 recharge area. This area is designated as the drinking water protection area. Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate watershed was used to determine the size and shape of the protection area for FNSB Birch Hill. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. The DWPA for FNSB Birch Hill is limited by its immediate watershed and includes only Zone A (See Map 1 of Appendix A). The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four protection area zones for wells and the calculated time-of-travel for each:

Table 1. Definition of Zones

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

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 FNSB Birch Hill 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;
- 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 time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well.

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

VULNERABILITY OF FNSB BIRCH HILL 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 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.

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 well for the FNSB Birch Hill is completed in a semi-confined fractured bedrock aquifer. The silt layer above the aquifer creates a thin barrier to contaminants traveling downward from the surface with the precipitation and surface water runoff. Although the aquifer is relatively protected in the area of the well, the private wells within the protection area offer an easy pathway for contaminants to travel down into the confined aquifer and towards the well. Table 2 shows the Susceptibility scores and ratings for FNSB Birch Hill.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	20	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 score has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	40	Very High
Nitrates and/or Nitrites	45	High
Volatile Organic Chemicals	29	Mediu

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

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

Again, rankings are assigned according to a point score:

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

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the 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	65	High
Nitrates and Nitrites	70	High
Volatile Organic Chemicals	55	Medium

Bacteria and Viruses

The contaminant risk for bacteria and viruses is very high with the large capacity septic systems upgradient of the well representing the greatest risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent sampling of 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 high.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is high with the large capacity septic systems upgradient of the well representing the greatest risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Nitrates are very mobile, moving at approximately the same rate as water. Sampling history for the FNSB Birch Hill well indicates that low concentrations of nitrate have been detected in the drinking water. Recent nitrate concentration ranged from 1.296 mg/L to 1.530 mg/L or about 13 to 15% of the Maximum Contaminant Level (MCL) of 10 mg/L. The MCL is the maximum level of contaminant that is allowed by the Environmental Protection Agency (EPA) to exist in drinking water. 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 high.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is high with the density of heating oil storage tanks creating the greatest risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). The small quantities of fuel stored in and near the garage as noted in the Sanitary Survey (6/28/99) also increase the risk.

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 the FNSB Birch Hill public 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 medium.

REFERENCES

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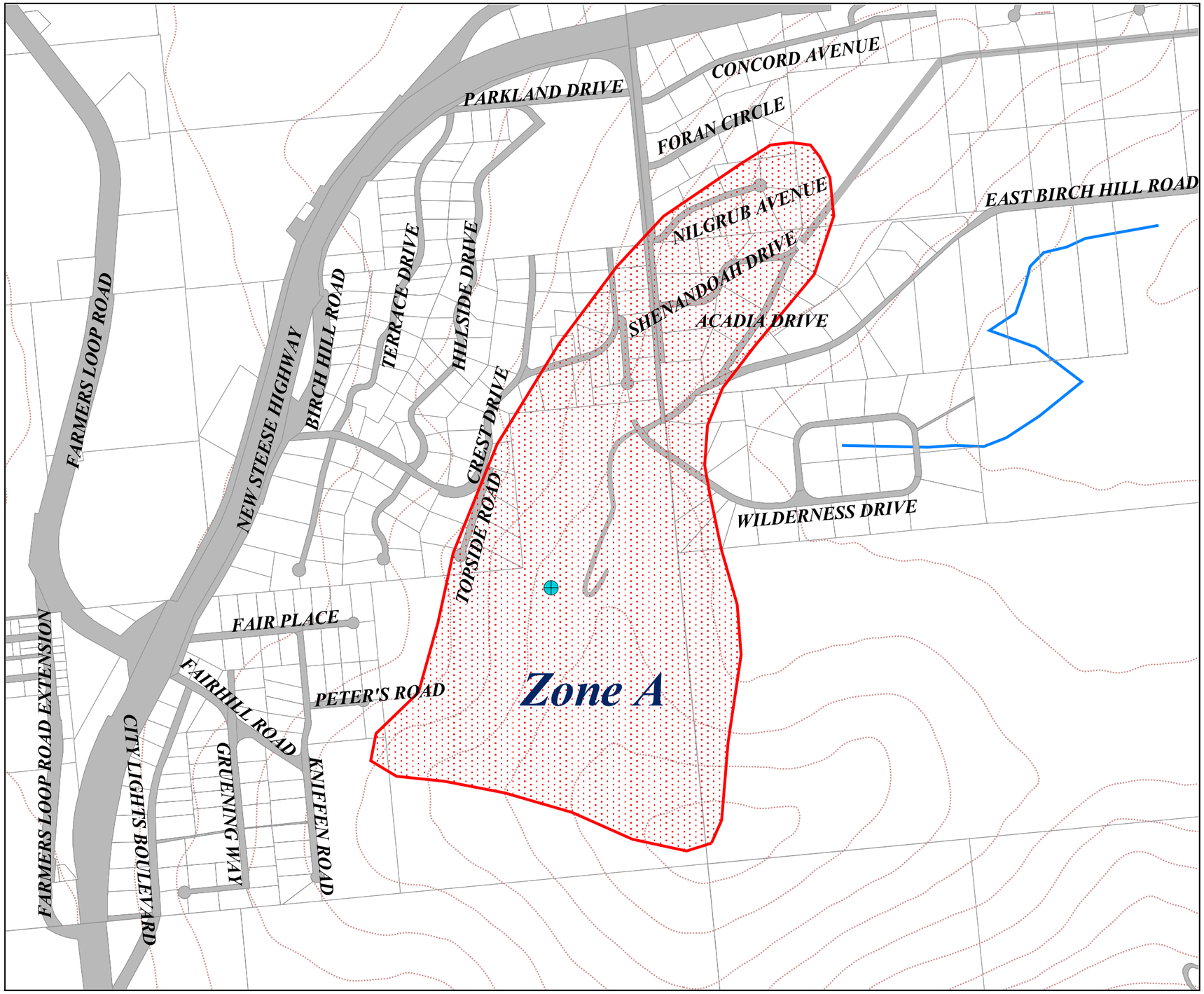
United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL http://www.epa.gov/safewater/mcl.html.

APPENDIX A

FNSB Birch Hill
Drinking Water Protection Area Location Map
(Map 1)

FNSB - Birch Hill Drinking Water Protection Area



0.5 0 0.5 Miles

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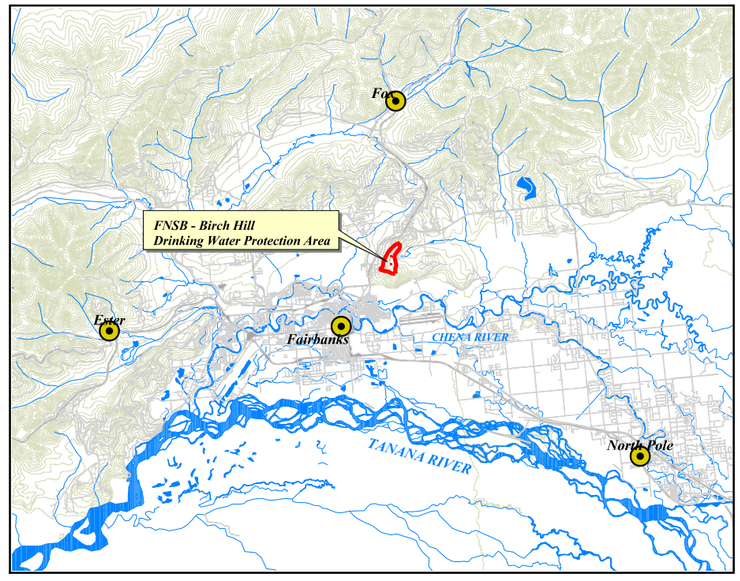
Legend

- FNSB - Birch Hill Well
- Zone A Protection Area
- Parcels
- Roads
- Rivers and streams
- Elevation Contours (20 m)



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for FNSB Birch Hill (Tables 1-4)

Table 1

Contaminant Source Inventory for ***FNSB / Birch Hill***

PWSID 312164.001

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	Septic system for FNSB Birch Hill
Residential Areas	R01		A	2	Approximately 50 acres of residential area
Septic systems (serves one single-family home)	R02		A	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Tanks, heating oil, residential (above ground)	R08		A	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Tanks, heating oil, nonresidential (aboveground)	T14	T14-1	A	2	Fuel tank for FNSB Birch Hill
Tanks, heating oil, nonresidential (aboveground)	T14	T14-2	A	2	Fuel tank next to Timing Building for FNSB Birch Hill
Highways and roads, dirt/gravel	X24		A	2	6 roads located within the protection area
Dog walking areas/foot trails	X46	X46-1	A	2	Birch Hill Recreation Area trails

Table 2

Contaminant Source Inventory and Risk Ranking for FNSB / Birch Hill Sources of Bacteria and Viruses

PWSID 312164.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Highways and roads, dirt/gravel	X24		A	Low	2	6 roads located within the protection area
Residential Areas	R01		A	Low	2	Approximately 50 acres of residential area
Septic systems (serves one single-family home)	R02		A	Low	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	2	Septic system for FNSB Birch Hill
Dog walking areas/foot trails	X46	X46-1	A	Low	2	Birch Hill Recreation Area trails

Table 3

Contaminant Source Inventory and Risk Ranking for FNSB / Birch Hill Sources of Nitrates/Nitrites

PWSID 312164.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01		A	Low	2	Approximately 50 acres of residential area
Highways and roads, dirt/gravel	X24		A	Low	2	6 roads located within the protection area
Septic systems (serves one single-family home)	R02		A	Low	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	2	Septic system for FNSB Birch Hill
Dog walking areas/foot trails	X46	X46-1	A	Low	2	Birch Hill Recreation Area trails

Table 4

Contaminant Source Inventory and Risk Ranking for FNSB / Birch Hill

Sources of Volatile Organic Chemicals

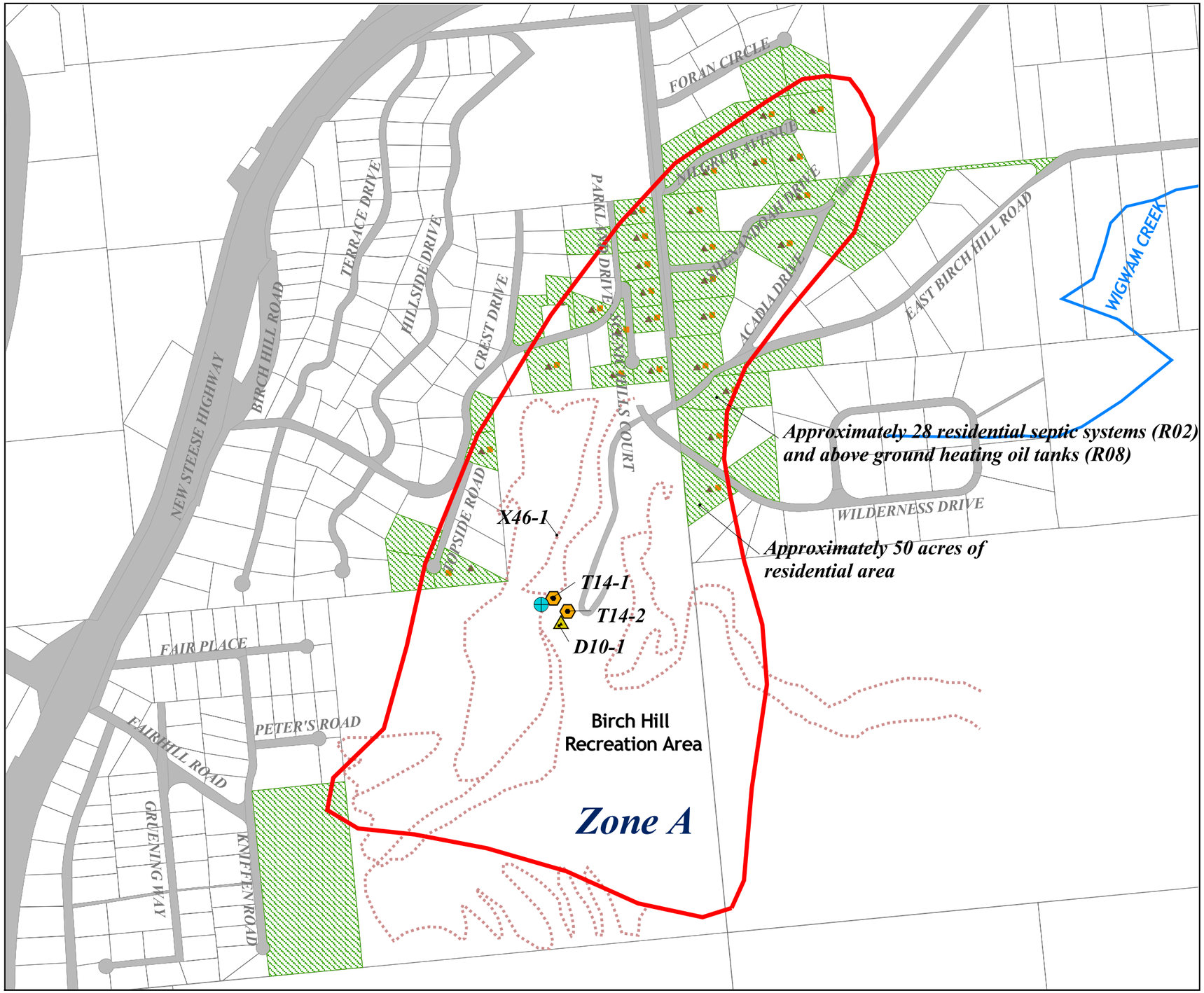
PWSID 312164.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Tanks, heating oil, residential (above ground)	R08		A	Medium	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Highways and roads, dirt/gravel	X24		A	Low	2	6 roads located within the protection area
Residential Areas	R01		A	Low	2	Approximately 50 acres of residential area
Septic systems (serves one single-family home)	R02		A	Low	2	Approximately 28 (number approximated based on number of parcels designated as residential)
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	2	Septic system for FNSB Birch Hill
Tanks, heating oil, nonresidential (aboveground)	T14	T14-1	A	Low	2	Fuel tank for FNSB Birch Hill
Tanks, heating oil, nonresidential (aboveground)	T14	T14-2	A	Low	2	Fuel tank next to Timing Building for FNSB Birch Hill

APPENDIX C

FNSB Birch Hill
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

FNSB Birch Hill Drinking Water Protection Area with Potential and Existing Contaminant Sources

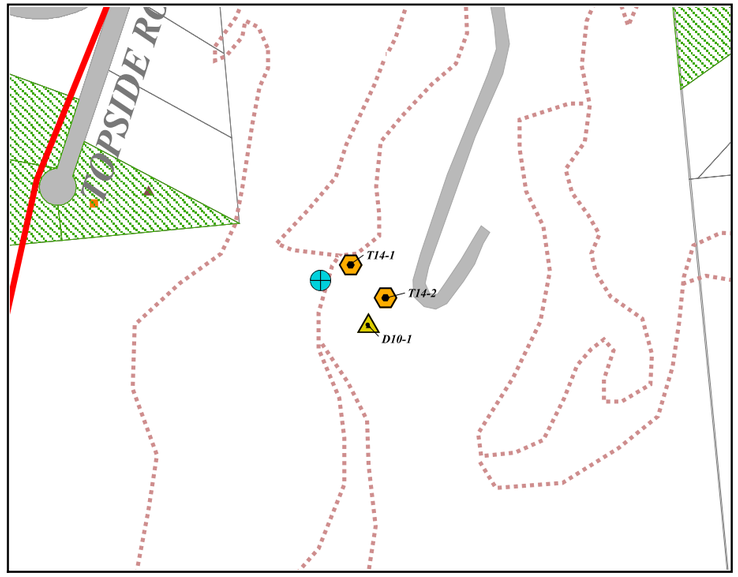


Legend

- FNSB - Birch Hill Well
- Zone A Protection Area

Contaminant Sources

- Large capacity septic system (D10)
- Above ground heating oil tanks (T14)
- Residential Area (R01)
- Residential septic systems (R02)
- Residential above ground heating oil tanks (R08)
- Foot trails (X46)
- Roads
- Parcels
- Rivers and streams



0.5 0 0.5 Miles

PWSID 312164

N W E S

Map 2

APPENDIX D

Vulnerability Analysis for FNSB Birch Hill Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - FNSB/Birch Hill Park

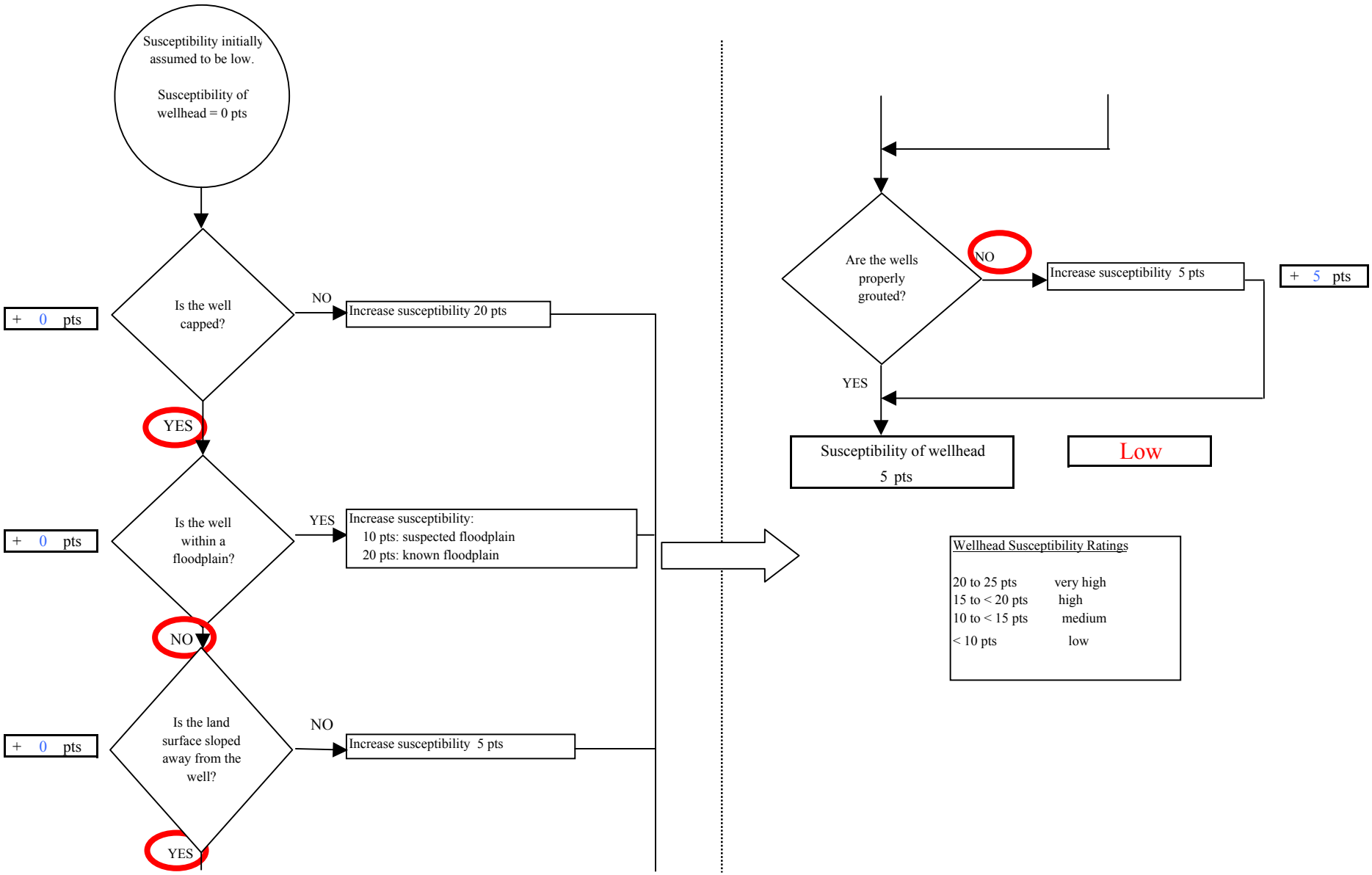


Chart 2. Susceptibility of the aquifer - FNSB/Birch Hill Park

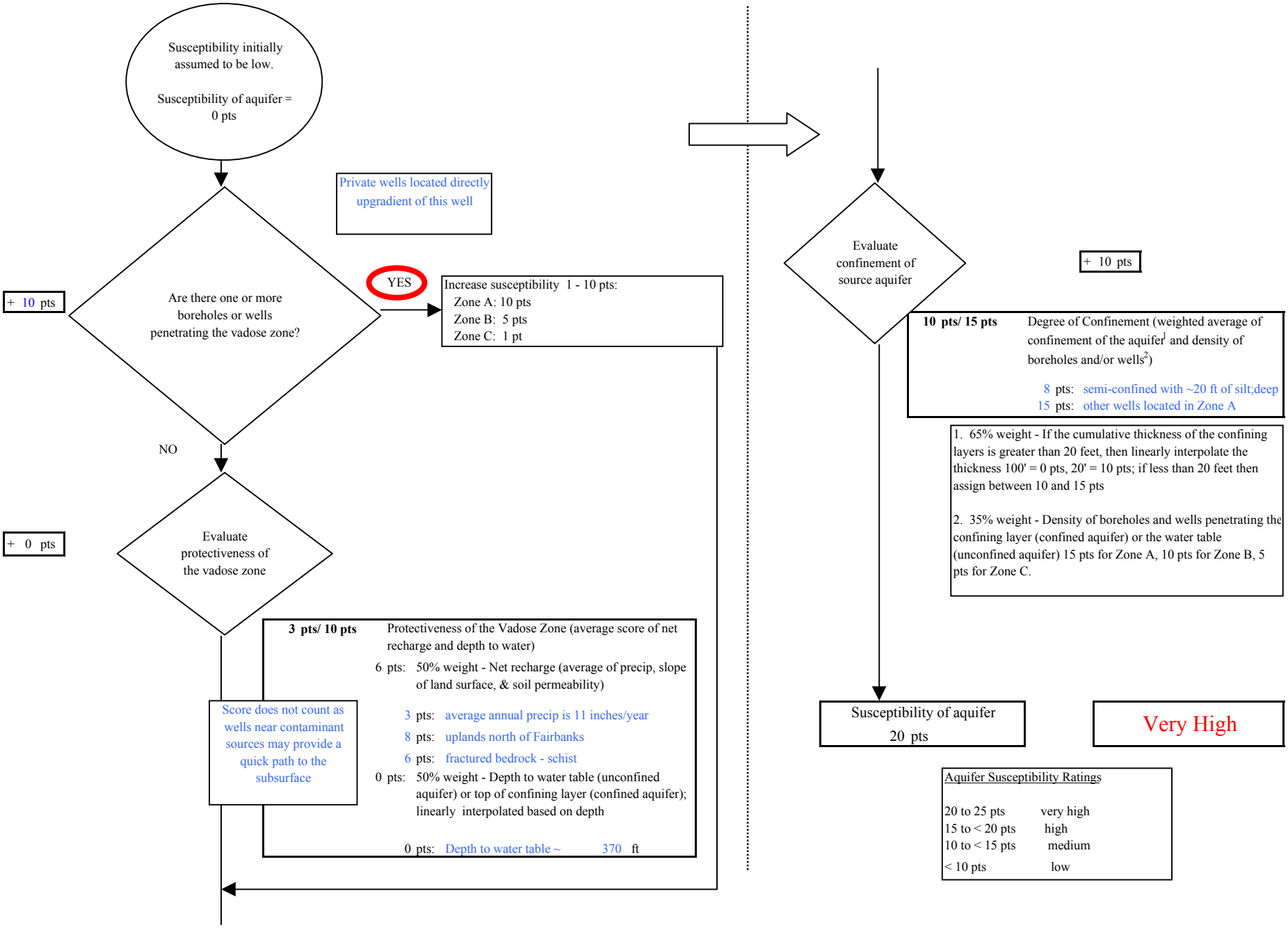
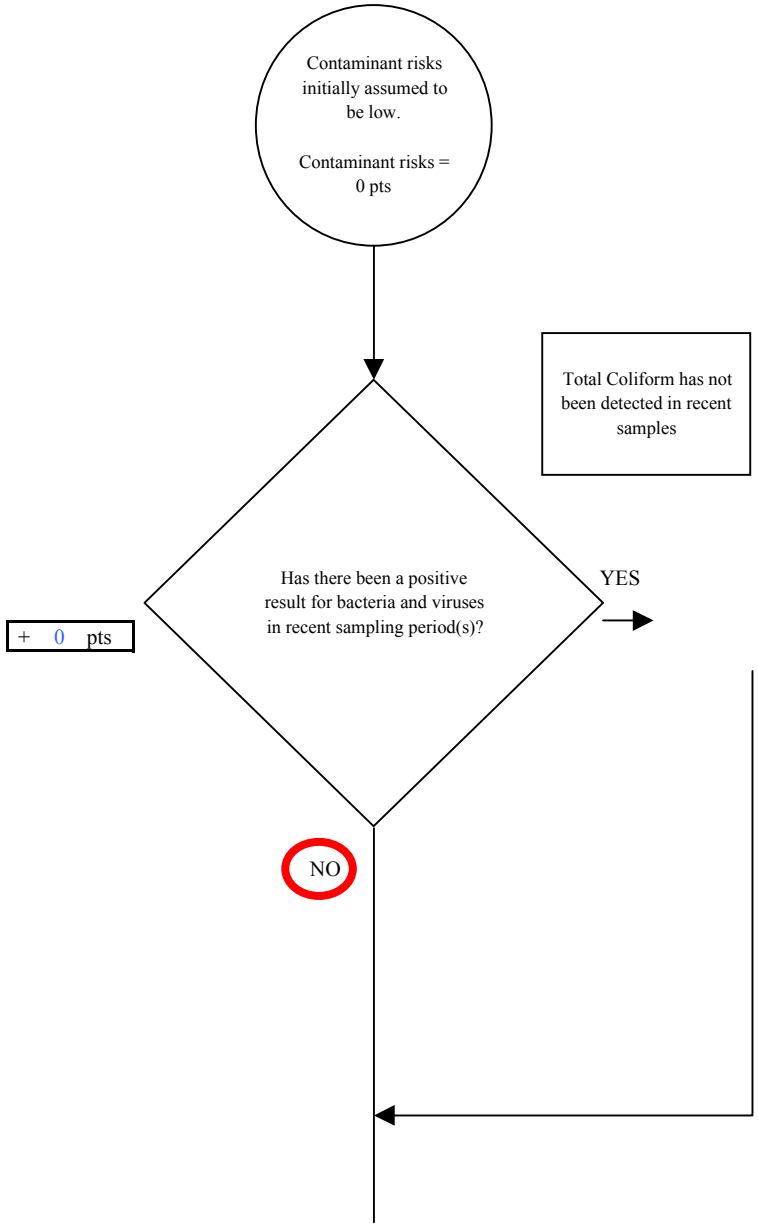
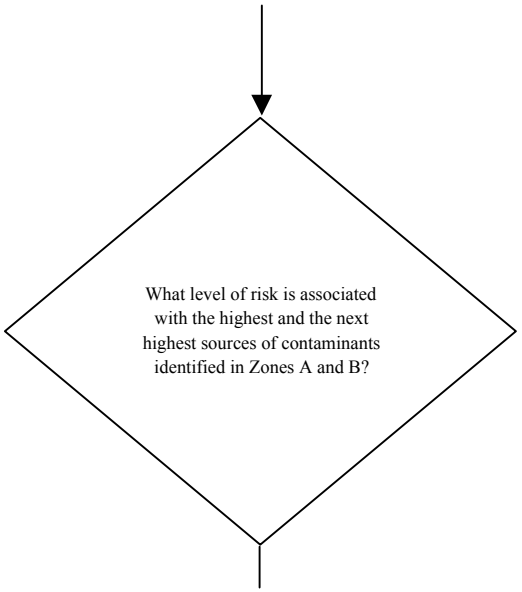


Chart 3. Contaminant risks for FNSB/Birch Hill Park - Bacteria & Viruses





+ 35 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)	31	0	31

	LOW 10 pts	**MEDIUM** 20 pts	**HIGH** 30 pts	**VERY HIGH** 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source + 10 pts

Matrix Score 35

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in 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 FNSB/Birch Hill Park - Bacteria & Viruses

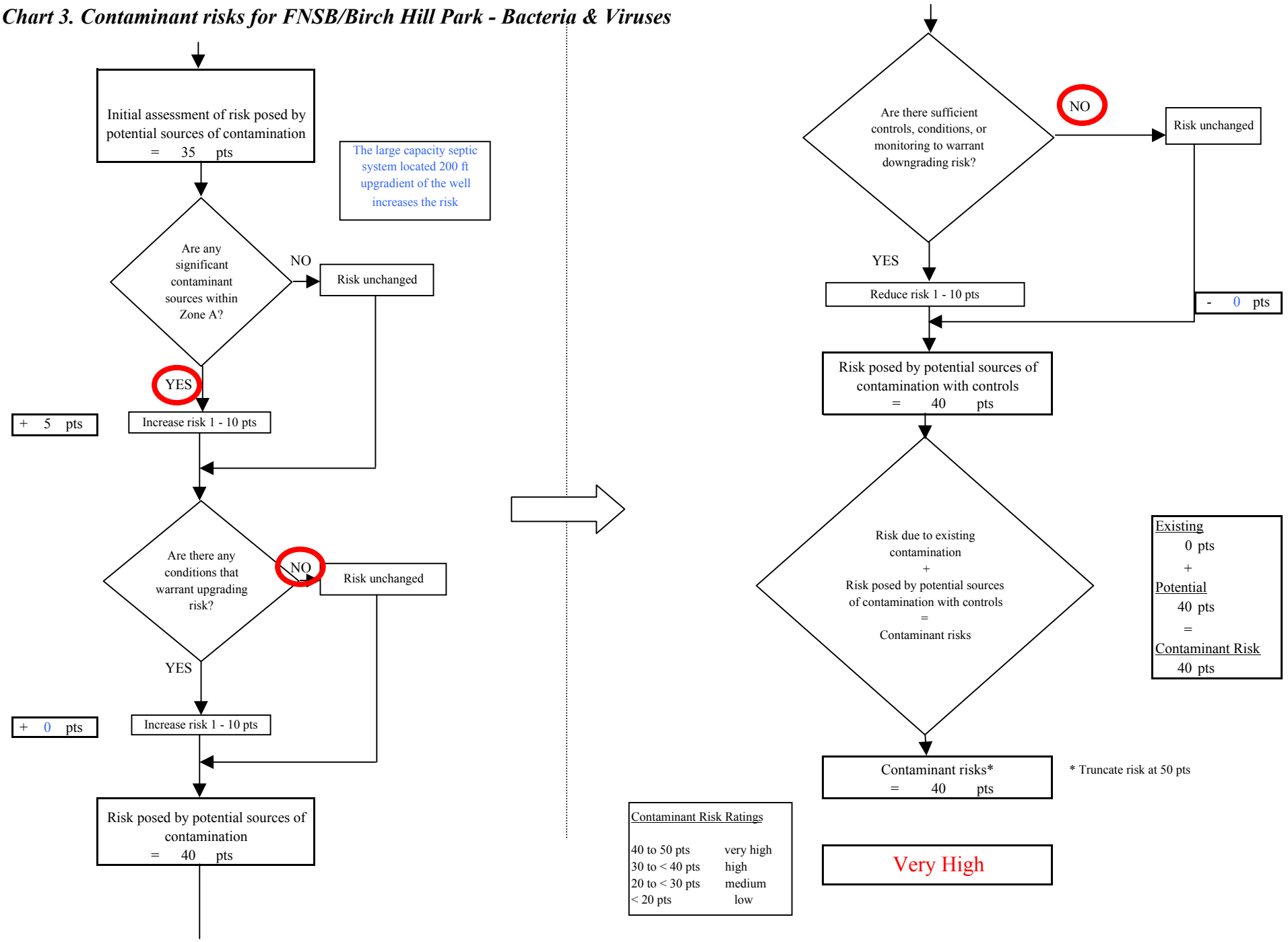


Chart 4. Vulnerability analysis for FNSB/Birch Hill Park - Bacteria & Viruses

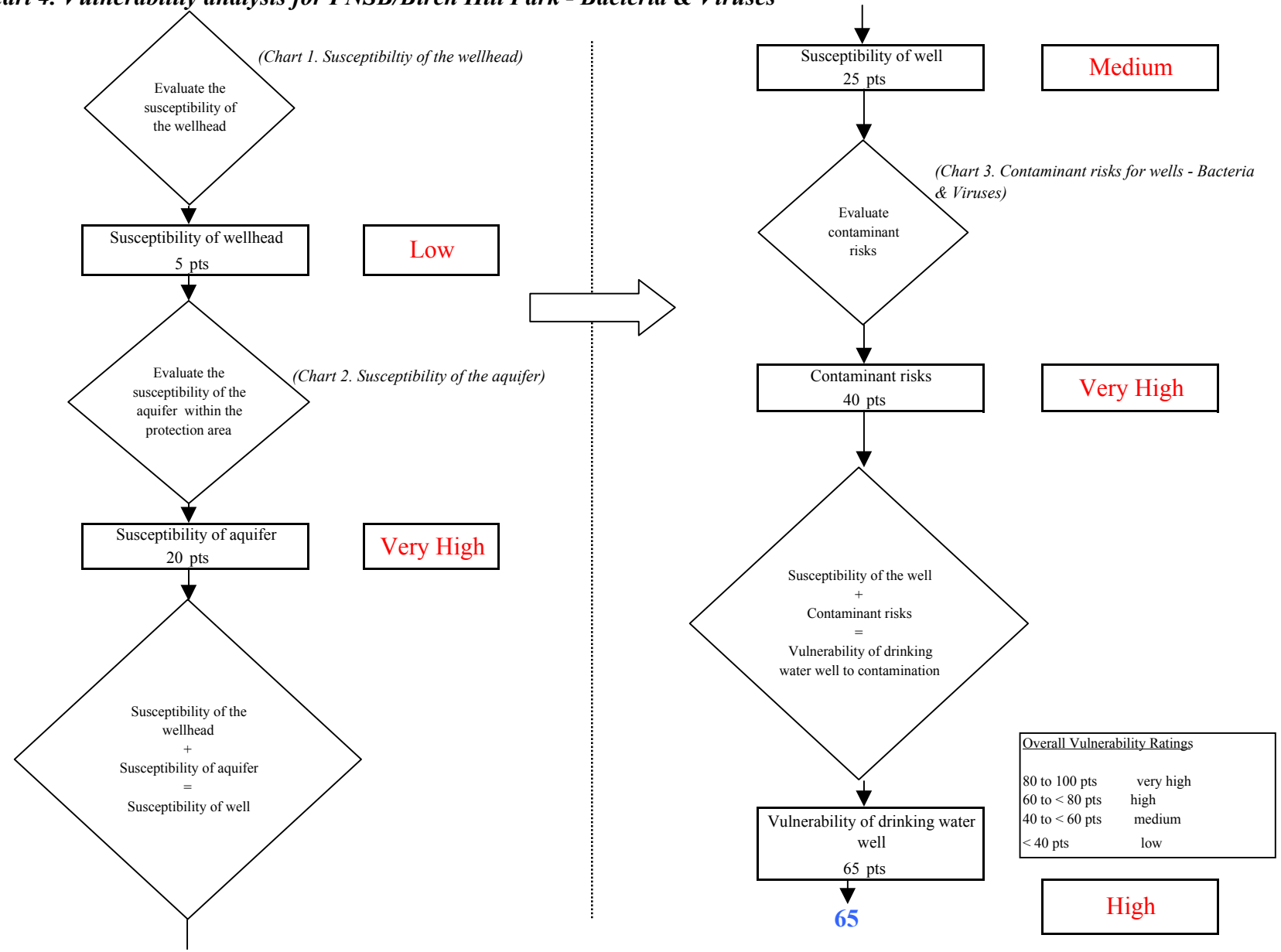


Chart 5. Contaminant risks for FNSB/Birch Hill Park - Nitrates and Nitrites

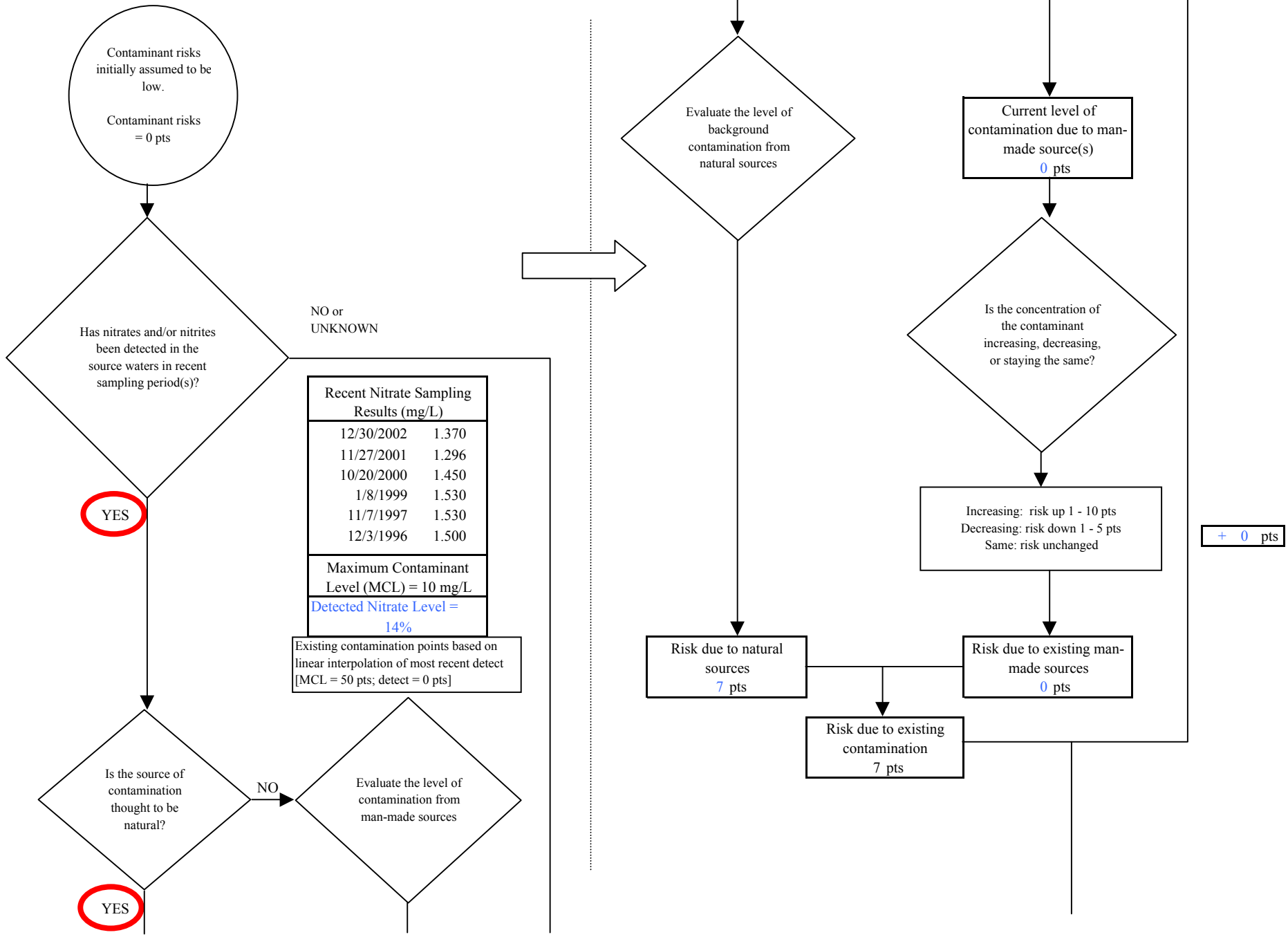
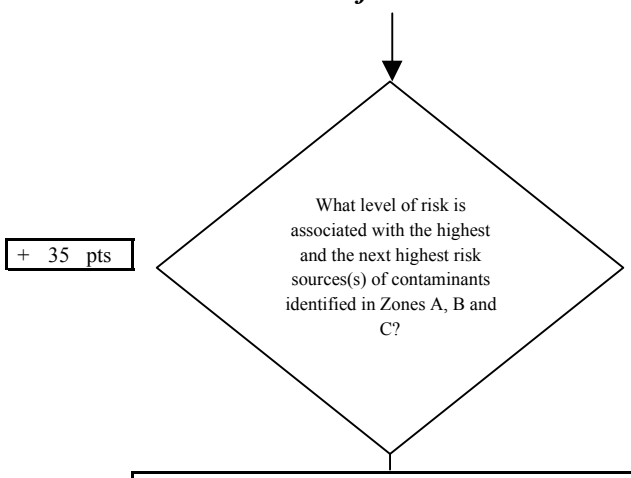


Chart 5. Contaminant risks for FNSB/Birch Hill Park - Nitrates and Nitrites



+ 35 pts

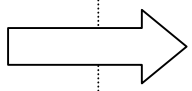
Risk Levels for Contaminant Sources identified in Zones A, B and C

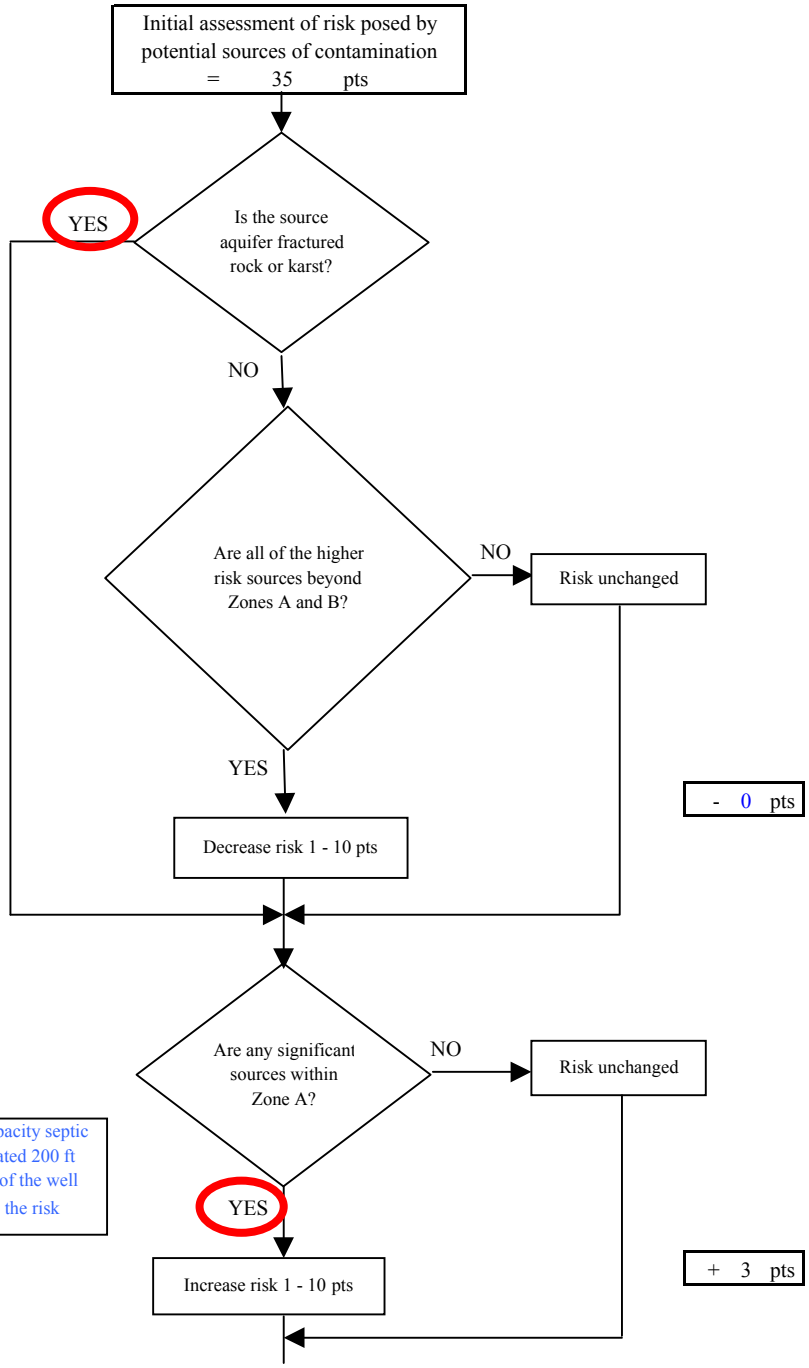
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	1	0	1
Medium(s)	0	0	0
Low(s)	31	0	31

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source + 10 pts

Matrix Score 35

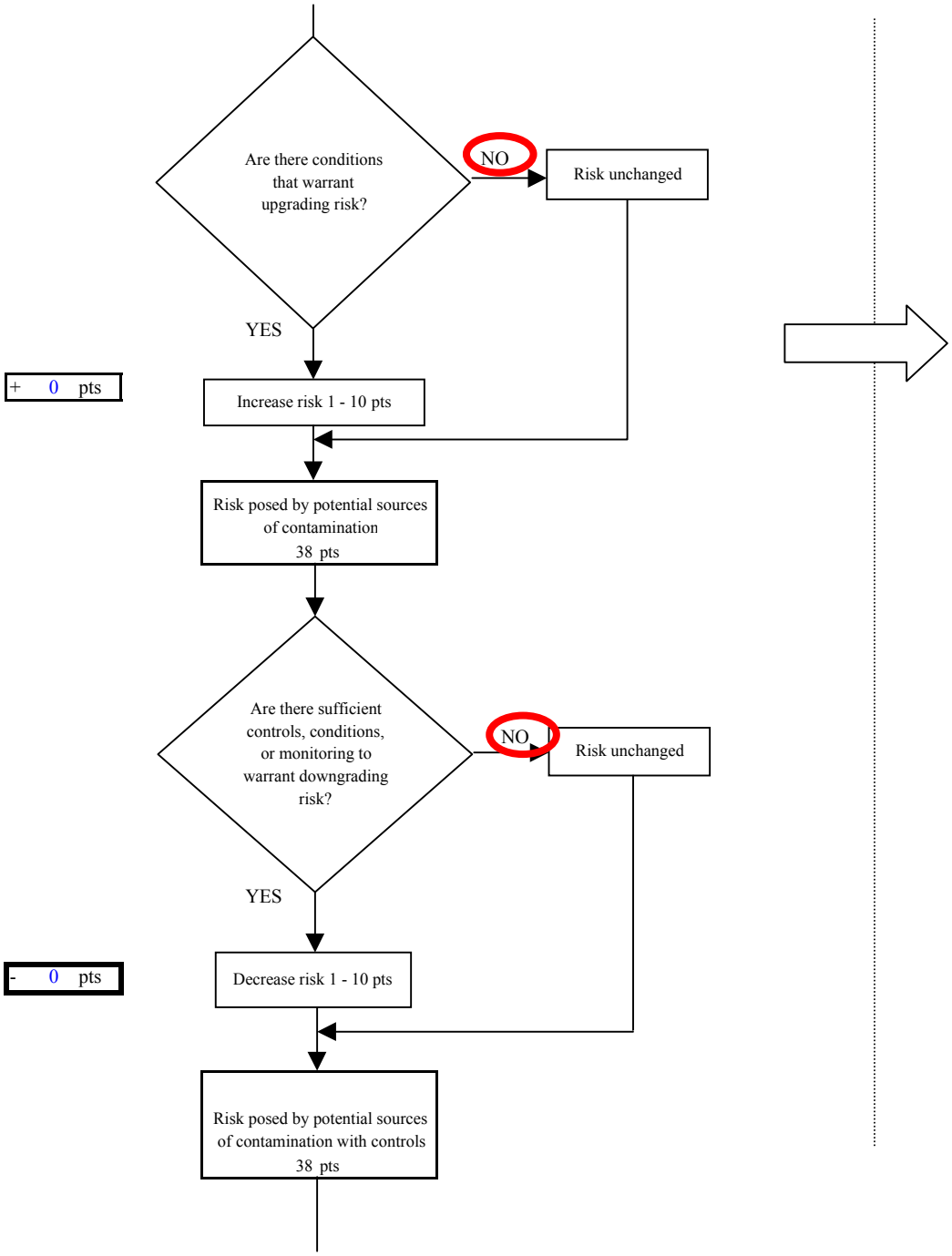
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

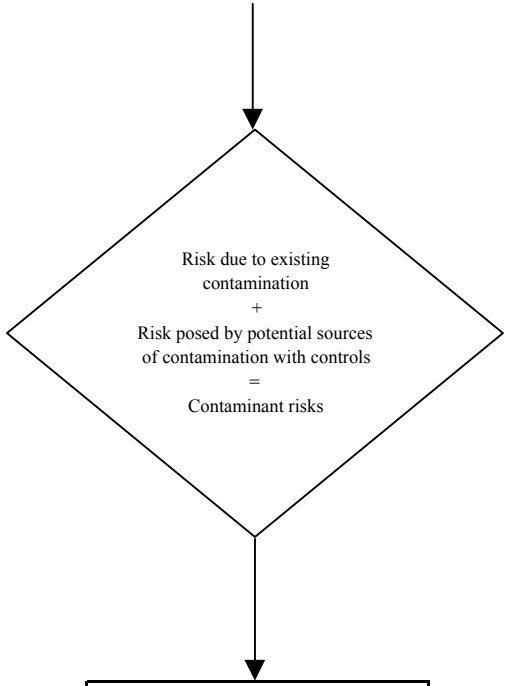




The large capacity septic system located 200 ft upgradient of the well increases the risk

Chart 5. Contaminant risks for FNSB/Birch Hill Park - Nitrates and Nitrites





Existing
7 pts
+
Potential
38 pts
=
Contaminant Risk
45 pts

Contaminant risks*
= 45 pts

*Truncate risk at 50 pts

Very High

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 FNSB/Birch Hill Park - Nitrates and Nitrites

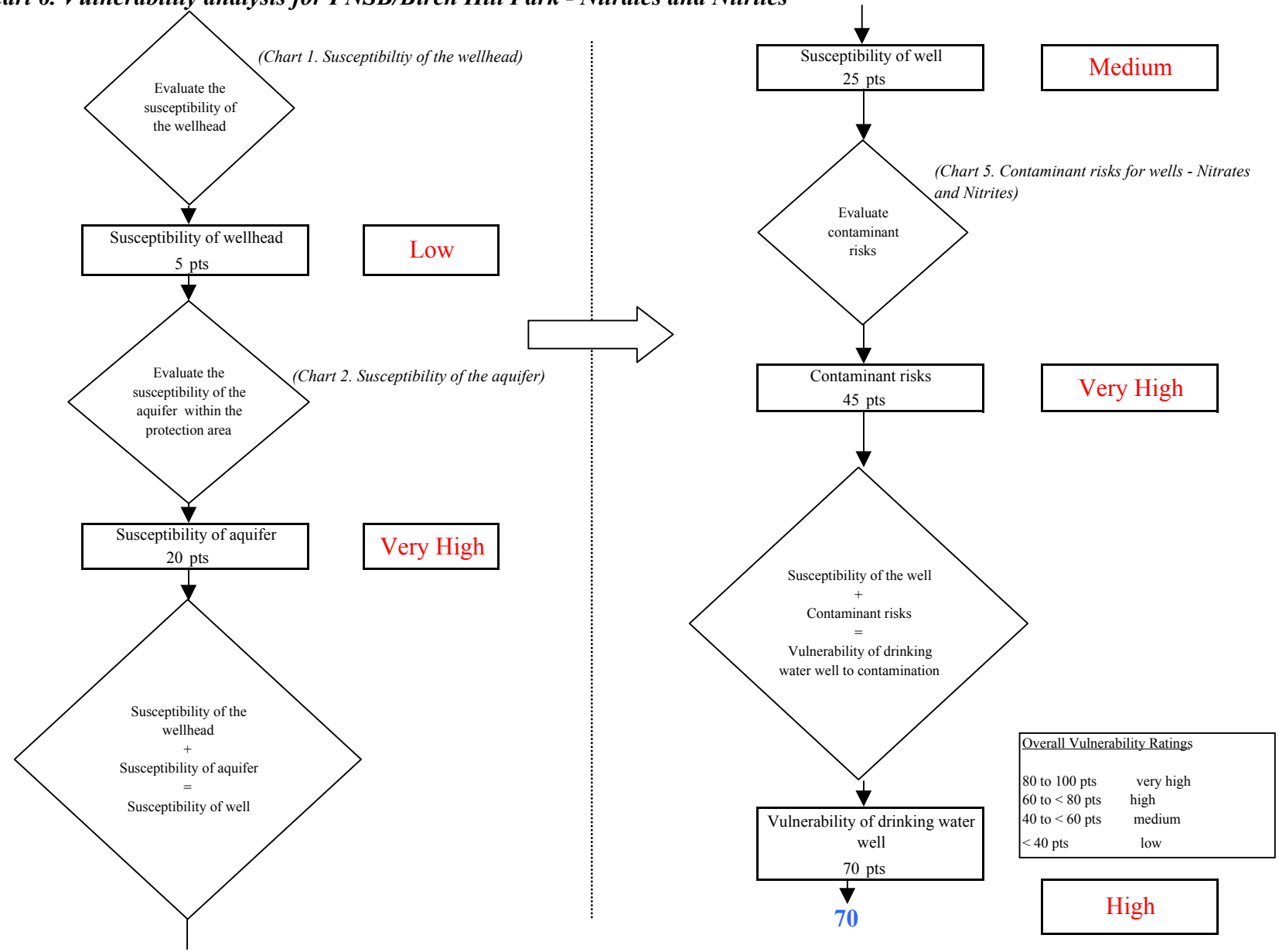


Chart 7. Contaminant risks for FNSB/Birch Hill Park - Volatile Organic Chemicals

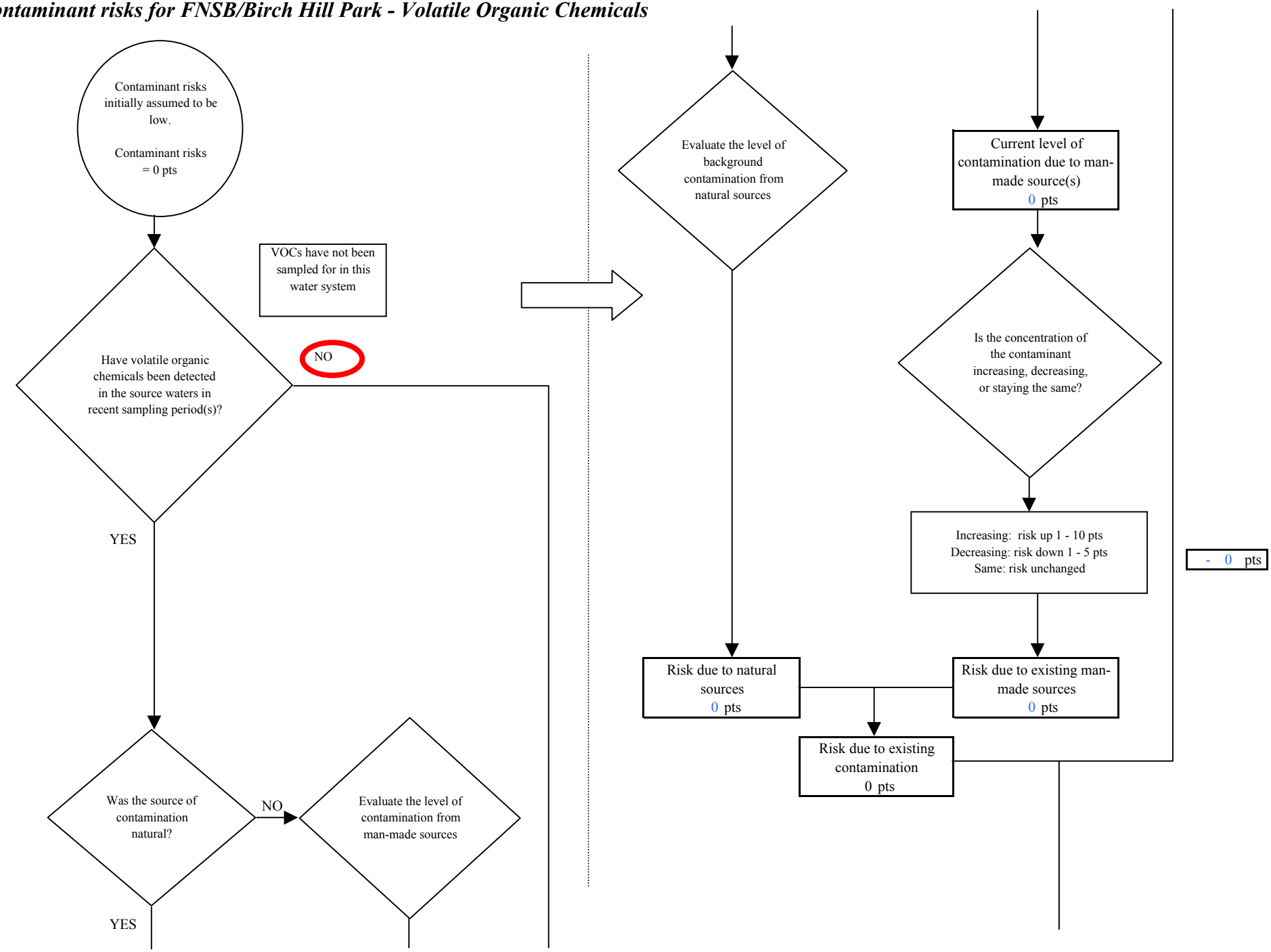
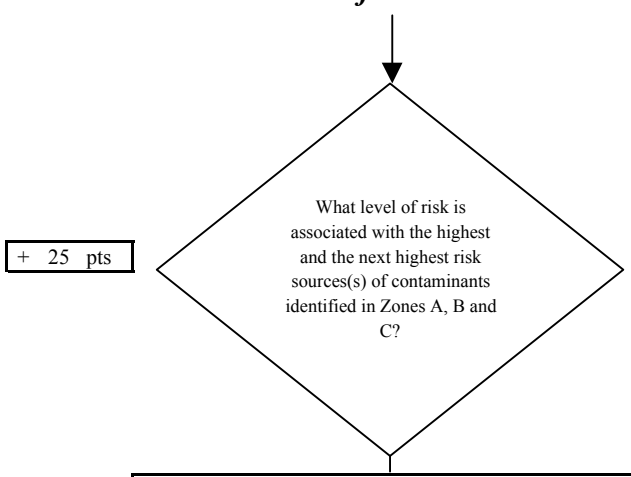


Chart 7. Contaminant risks for FNSB/Birch Hill Park - Volatile Organic Chemicals



+ 25 pts

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	29	0	29
Low(s)	7	0	7

	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 25

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.

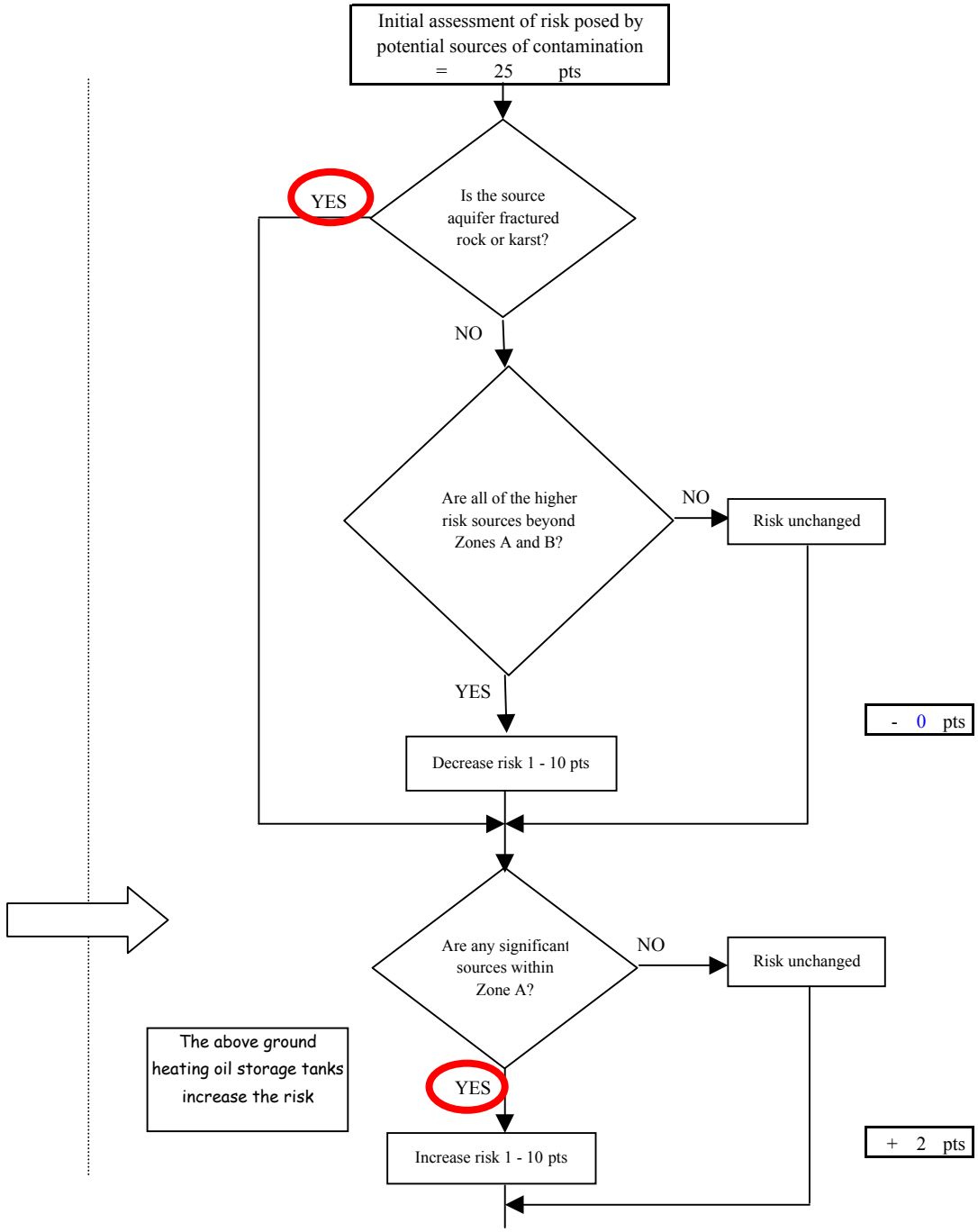


Chart 7. Contaminant risks for FNSB/Birch Hill Park - Volatile Organic Chemicals

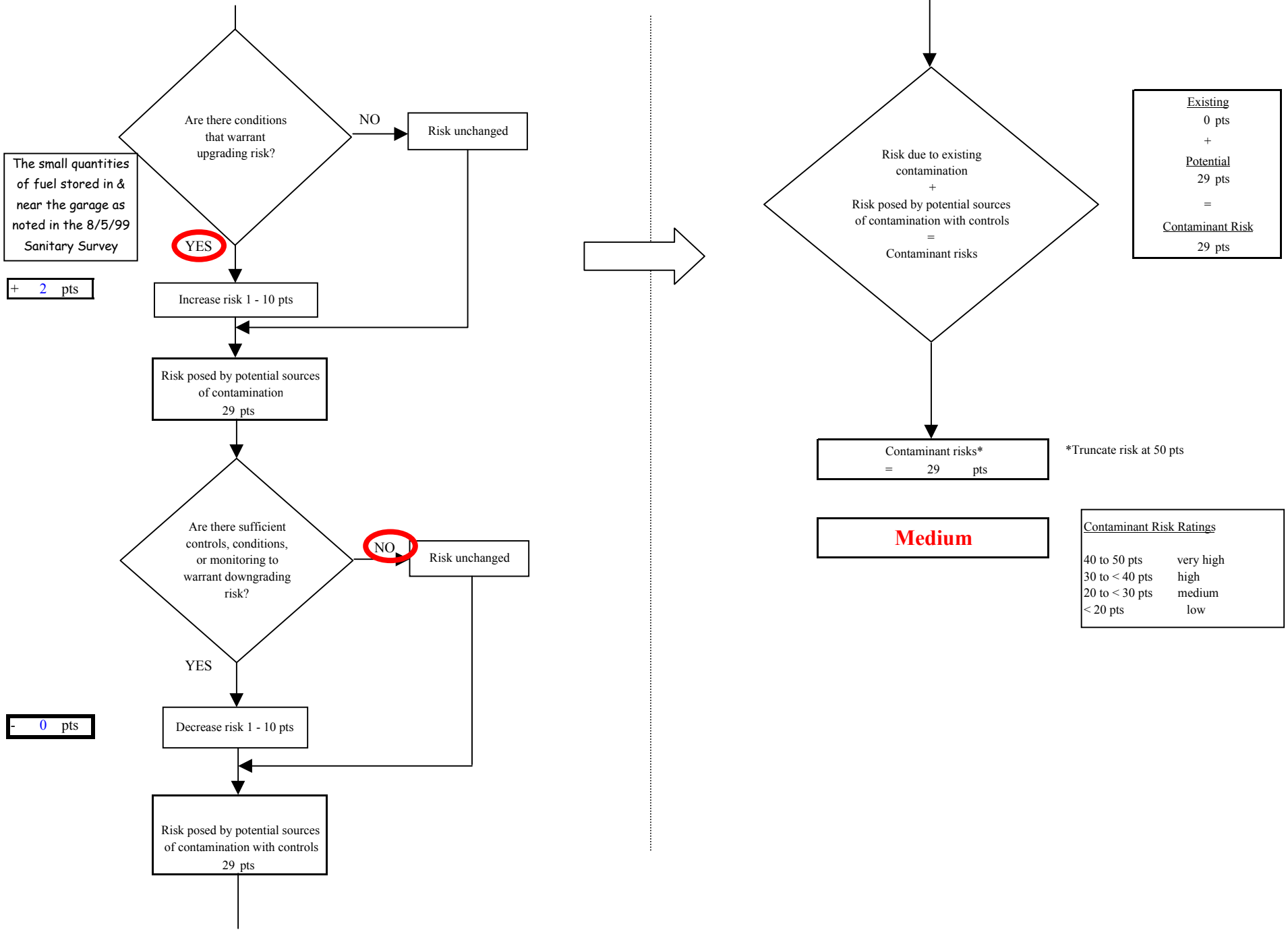


Chart 8. Vulnerability analysis for FNSB/Birch Hill Park - Volatile Organic Chemicals