Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Bethel Baptist Church Drinking Water System,
Fairbanks area, Alaska
PWSID # 314001

March 2004

DRINKING WATER PROTECTION PROGRAM REPORT Report 1487
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 Bethel Baptist Church Source of Public Drinking Water, Fairbanks Area, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Bethel Baptist Church is a Class B (transient non-community) water system consisting of one well at Mile 5.5 of Farmer's Loop Road approximately 4 miles northwest of Fairbanks, Alaska. The well received a natural susceptibility rating of **High**. 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 contaminants for Bethel Baptist Church public drinking water source include: residential septic systems, residential heating oil tanks, roads, and residential area. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water source for Bethel Baptist Church received a vulnerability rating of **High** for bacteria and viruses, and nitrates and/or nitrites, and a **Medium** for volatile organic chemicals.

BETHEL BAPTIST CHURCH PUBLIC DRINKING WATER SYSTEM

Bethel Baptist Church public water system is a Class B (transient non-community) water system consisting of one well at Mile 5.5 of Farmer's Loop Road approximately 4 miles northwest of Fairbanks, Alaska (T1N, R1W, Section 28) (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 in the Fairbanks area use individual wells or hauled water, and septic systems (ADCED, 2002). Heating oil (commonly stored in both above and below ground 275 to 500-gallon tanks) is most commonly used for heating homes and buildings (ADCED, 2002). 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. The well for Bethel Baptist Church is located in the uplands at an elevation of approximately 500 feet above sea level.

This well was drilled on 4/2/98 to a depth of 80 feet below ground surface (ft bgs). Most wells in this area are screened in bedrock and it is assumed this one is also. 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).

This system operates year-round and serves approximately 500 non-residents through 1 service connection.

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, and 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 Bethel Baptist Church. 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 protection area for Bethel Baptist Church 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

An inventory of the potential sources of contamination was completed through a search of agency records and other publicly available information for this water system. 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 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 all three contaminant categories.

VULNERABILITY OF BETHEL BAPTIST CHURCH DRINKING WATER SYSTEM

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

- Natural susceptibility; and
- Contaminant risks.

Appendix D contains eight charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the properties of the aquifer and the presence of other wells or boreholes in the area. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to Bacteria and Viruses. The

'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of the water system's contaminant sample results. Lastly, Chart 4 combines the results of the first three charts to produce the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 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 wellhead for the Bethel Baptist Church received a Low Susceptibility rating. The well is capped with a sanitary seal and the land surface is correctly sloped away from the well according to ADEC regulations. The well is also grouted. A sanitary seal prevents potential contaminant from entering the well from the inside while sloping the land surface away from the well and grouting help to prevent potential contaminants from traveling down the outside of the well casing.

The aquifer in the area of the Bethel Baptist Church well is completed in received a High Susceptibility rating. The thickness of the bedrock above the screened area provides some protection from contaminants traveling downward from the surface with the precipitation and surface water runoff. However, ground water can move extremely quickly through fractures within the bedrock, depending on their width, density, connectivity, and direction in the area. Water supply wells upgradient of the well offer an easy pathway for contaminants to travel down into the aquifer and potentially towards the well. Table 2 shows the Susceptibility scores and ratings for Bethel Baptist Church.

Table 2. Susceptibility

	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 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	50	Very High
Nitrates and/or Nitrites	47	Very High
Volatile Organic Chemicals	32	High

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

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	75	High
Nitrates and Nitrites	70	High
Volatile Organic Chemicals	55	Medium

Bacteria and Viruses

The density of septic systems nearest to the well represents the greatest risk of Bacteria and Viruses to the drinking water well.

Only a small amount of bacteria and viruses are required to endanger public health. Total coliforms have not been detected in recent sampling history. Coliforms are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. Coli which only come from human and animal fecal waste (EPA, 2002). Routine sampling detected total coliforms most recently of 11/5/99, 11/17/99, 11/30/99, and 12/10/99. Fecal coliforms and E. Coli have not been detected.

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 septic systems nearest the well also represent the greatest risk of nitrate and nitrites to this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Sampling history for the Bethel Baptist Church well indicates that concentrations of nitrate have consistently been detected in the drinking water. Recent nitrate concentrations have ranged from 2.5 to 4.5 mg/L or about 25% to 45% of the Maximum Contaminant Level (MCL) of 10 mg/L. The MCL is the maximum level of contaminant that is allowed to exist in drinking water by the Environmental Protection Agency (EPA). Naturally occurring nitrate levels are typically less than 2 mg/l (Wang, Strelakos, Jokela, 2000).

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 density of heating oil storage tanks represents the greatest risk for volatile organic chemicals in the water.

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 within the past 5 years. 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.

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APPENDIX A

Bethel Baptist Church
Drinking Water Protection Area Location Map
(Map 1)

GRENAC ROAD
SPRING GLADE ROAD
GREENTREE DRIVE
FARMERS LOOP ROAD
CAPRICORN STREET
UNION DRIVE
MUSHER'S ROAD
NORDIN DRIVE
DARRELL DRIVE
FIREWEED DRIVE
CANDAMAR ROAD
PYROLA DRIVE
WALKER WAY
CONSTITUTION DR
ETON BOULEVARD
OVERHILL DRIVE
JOLIET DRIVE
VIEWPOINTE DRIVE
HOLY CROSS DRIVE
SHUROS DRIVE
FARMERS LOOP ROAD
ITHACA ROAD

Map 1: Bethel Baptist Church Drinking Water Protection Area

PWSID: 314001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 300 600 1,200 1,800 Feet

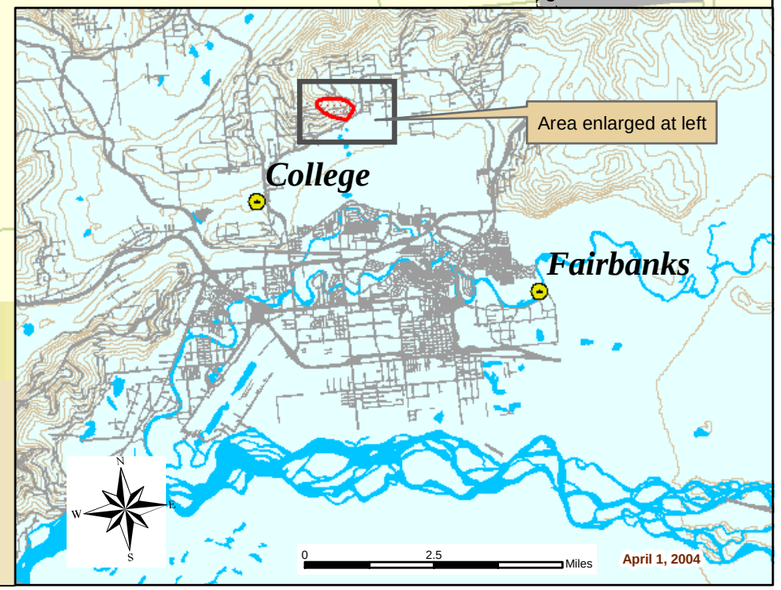
1:7,200

Data Sources:

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

Legend

- Zone A
- Towns
- Parcels
- Roads
- Surface water
- Elevation contours (20m)



APPENDIX B

Contaminant Source Inventory and Risk Ranking for Bethel Baptist Church (Tables 1-4)

Table 1

Contaminant Source Inventory for
Bethel Babtist Church

PWSID 314001.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Residential Areas	R01		A	2	Approximately 100 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02		A	2	Assumed 72 septic systems based on number of tax parcels labeled as residential
Tanks, heating oil, residential (above ground)	R08		A	2	Assumed 72 heating oil tanks based on number of tax parcels labeled as residential
Highways and roads, paved (cement or asphalt)	X20		A	2	5 roads in Zone A

Table 2

Contaminant Source Inventory and Risk Ranking for Bethel Babtist Church Sources of Bacteria and Viruses

PWSID 314001.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 72 septic systems based on number of tax parcels labeled as residential
Residential Areas	R01		A	Low	2	Approximately 100 acres of residential area in Zone A
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	5 roads in Zone A

Table 3

Contaminant Source Inventory and Risk Ranking for Bethel Babtist Church Sources of Nitrates/Nitrites

PWSID 314001.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	5 roads in Zone A
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 72 septic systems based on number of tax parcels labeled as residential
Residential Areas	R01		A	Low	2	Approximately 100 acres of residential area in Zone A

Table 4

Contaminant Source Inventory and Risk Ranking for Bethel Babtist Church Sources of Volatile Organic Chemicals

PWSID 314001.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	5 roads in Zone A
Residential Areas	R01		A	Low	2	Approximately 100 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02		A	Low	2	Assumed 72 septic systems based on number of tax parcels labeled as residential
Tanks, heating oil, residential (above ground)	R08		A	Medium	2	Assumed 72 heating oil tanks based on number of tax parcels labeled as residential

APPENDIX C

Bethel Baptist Church
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

NORDIN DRIVE

GRENAC ROAD

FIREWEED DRIVE

ETON BOULEVARD

OVERHILL DRIVE

DARRELL DRIVE

JOLIET DRIVE

VIEWPOINTE DRIVE

HOLY CROSS DRIVE

SHUROS DRIVE

FARMERS LOOP

Map 2: Bethel Baptist Church Potential Contaminant Sources

PWSID: 314001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 162.5 325 650 975 Feet

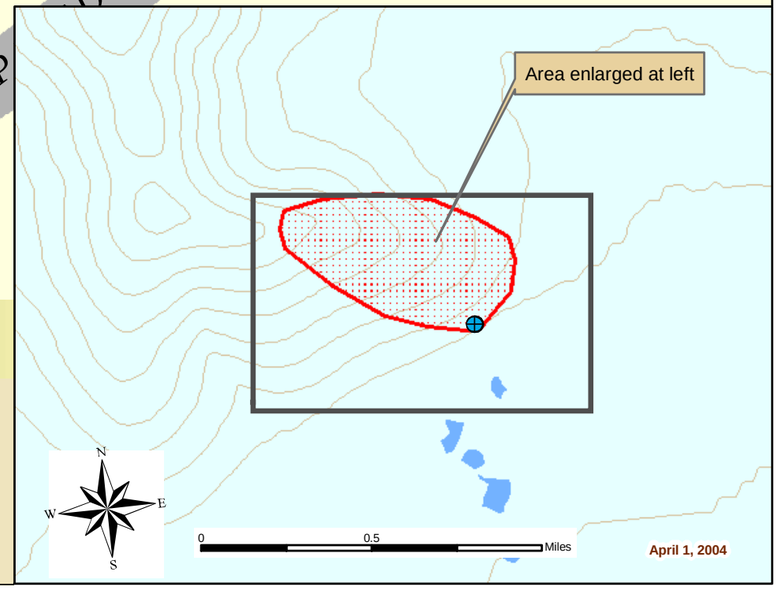
1:3,900

Data Sources:

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

Legend

- Zone A
- R01, Residential area
- R08, Residential heating oil tanks
- R02, Residential septics systems
- Roads
- Parcels



April 1, 2004

APPENDIX D

Vulnerability Analysis for Bethel Baptist Church Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - Bethel Baptist Church

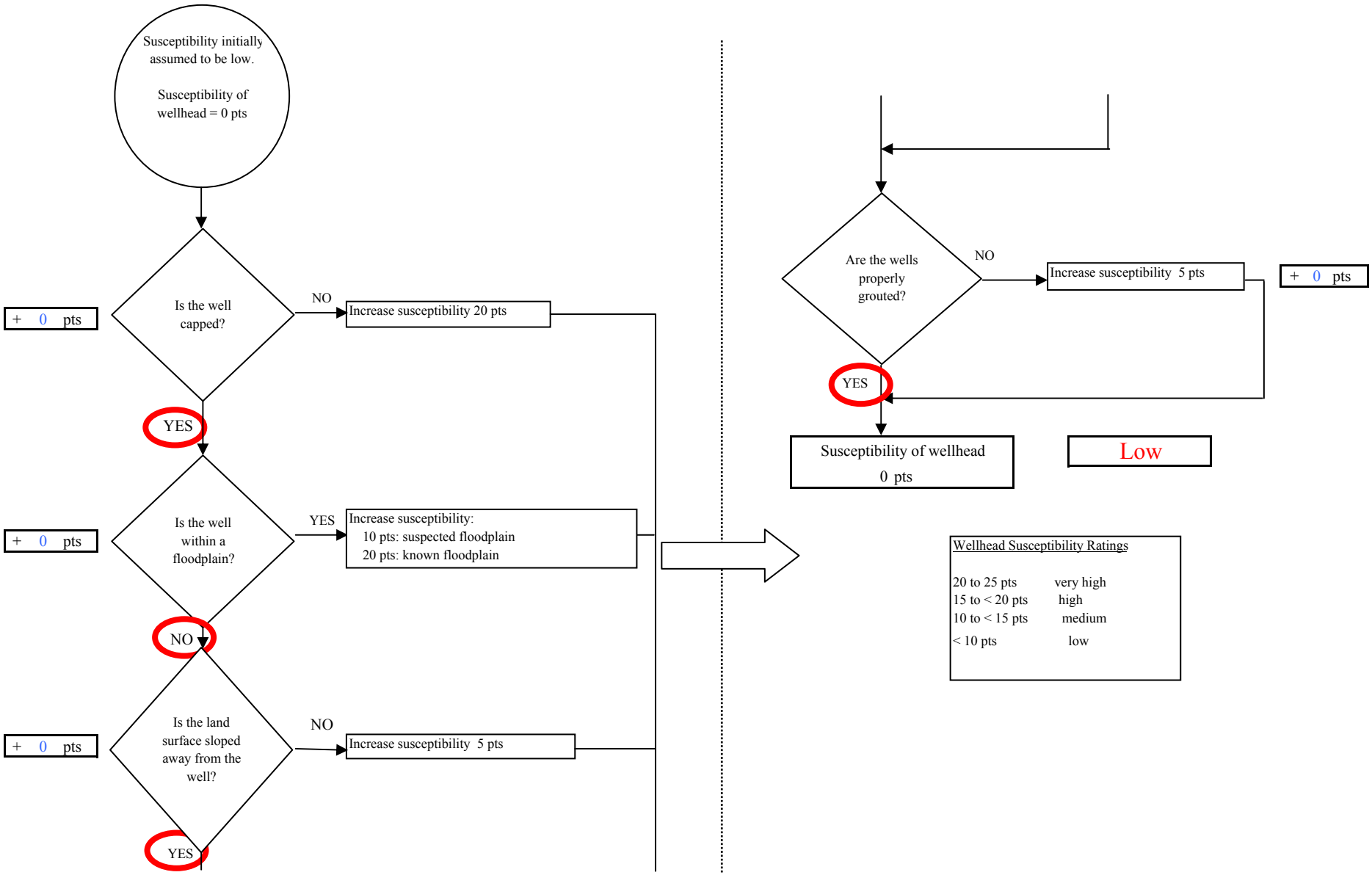


Chart 2. Susceptibility of the aquifer - Bethel Baptist Church

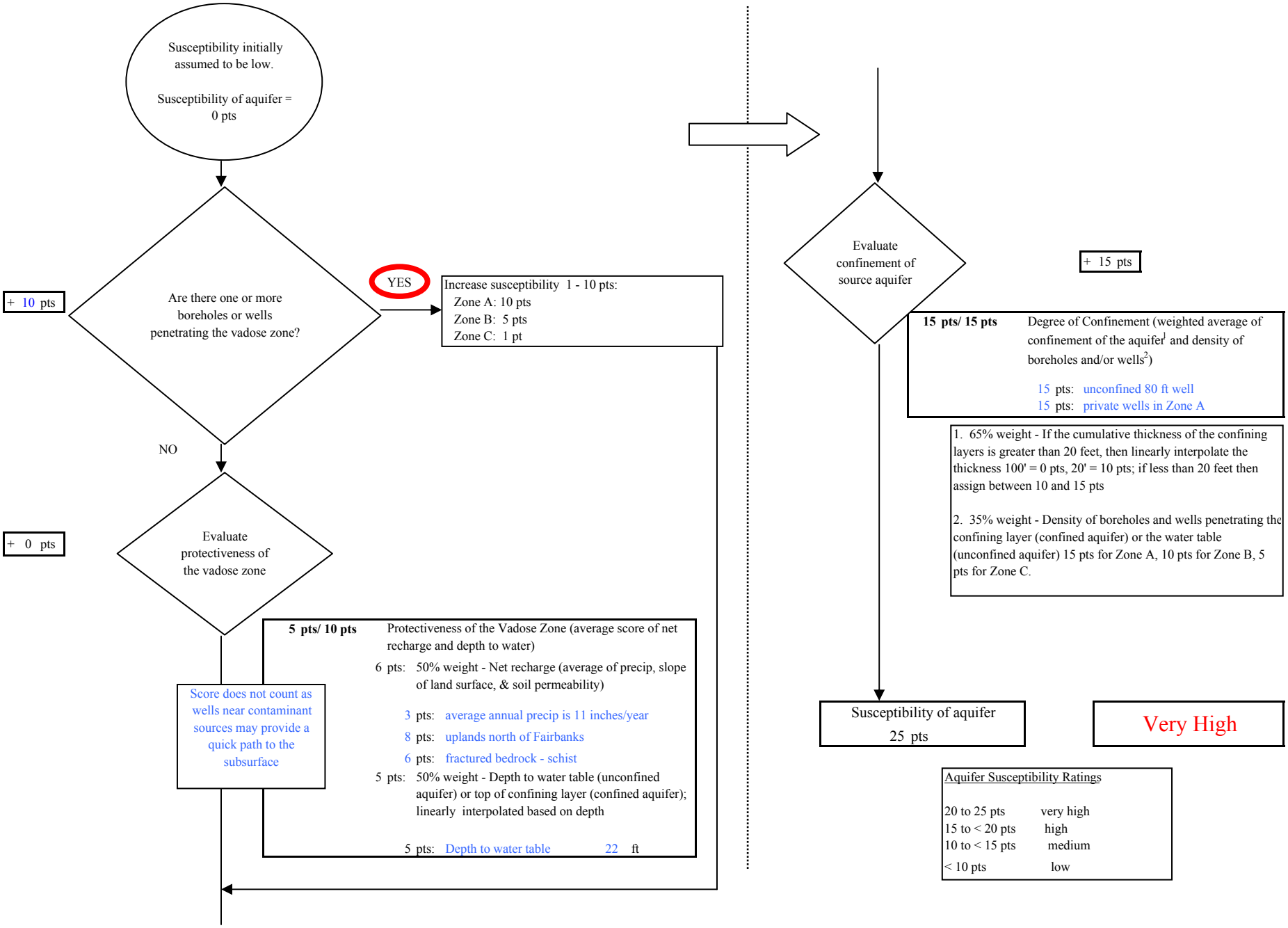
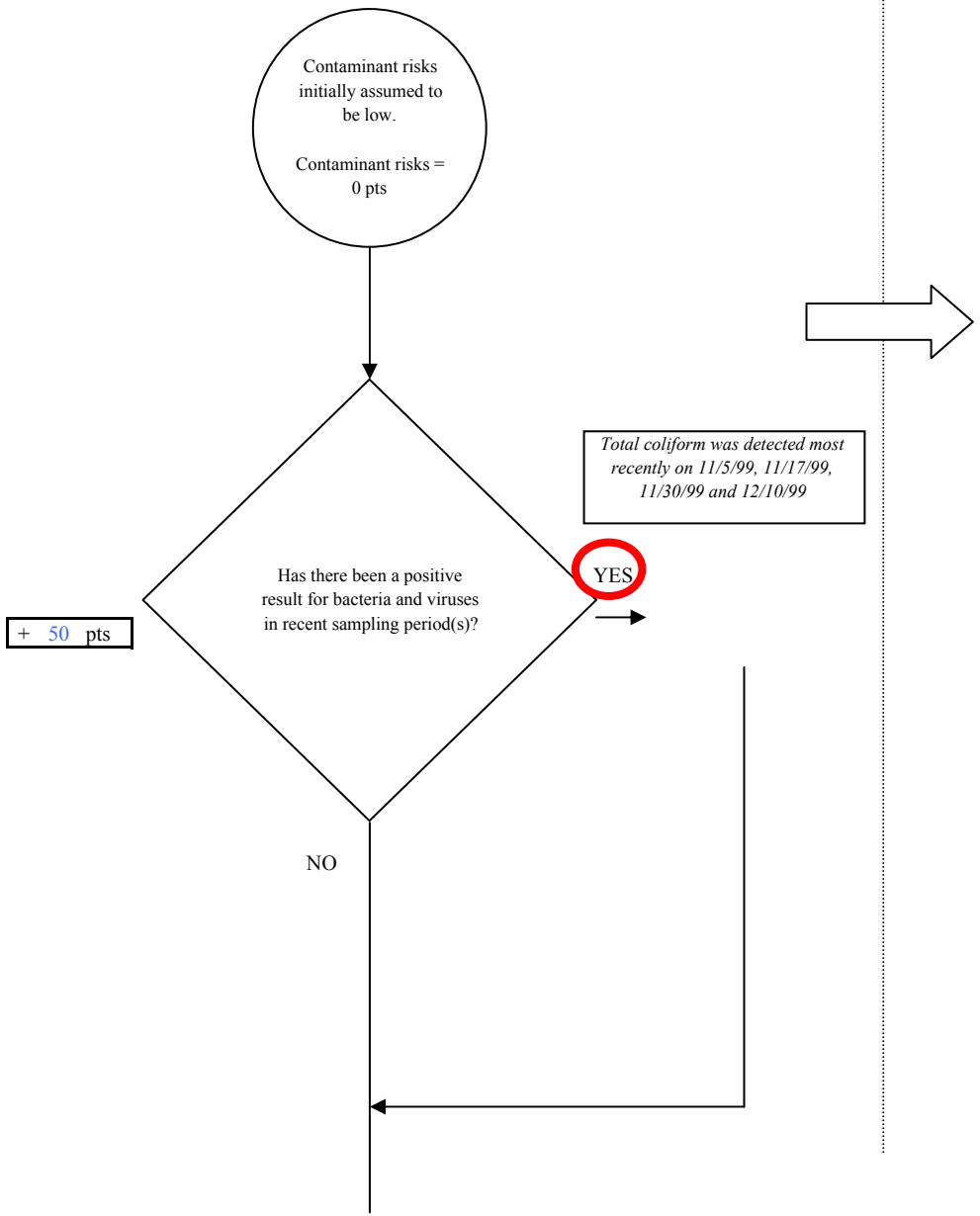
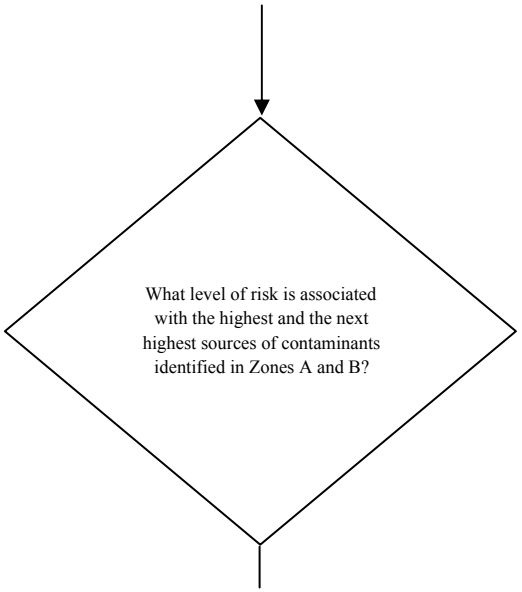


Chart 3. Contaminant risks for Bethel Baptist Church - Bacteria & Viruses





+ 20 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)	0	0	0
Medium(s)	0	0	0
Low(s)	75	0	75

	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.

Chart 3. Contaminant risks for Bethel Baptist Church - Bacteria & Viruses

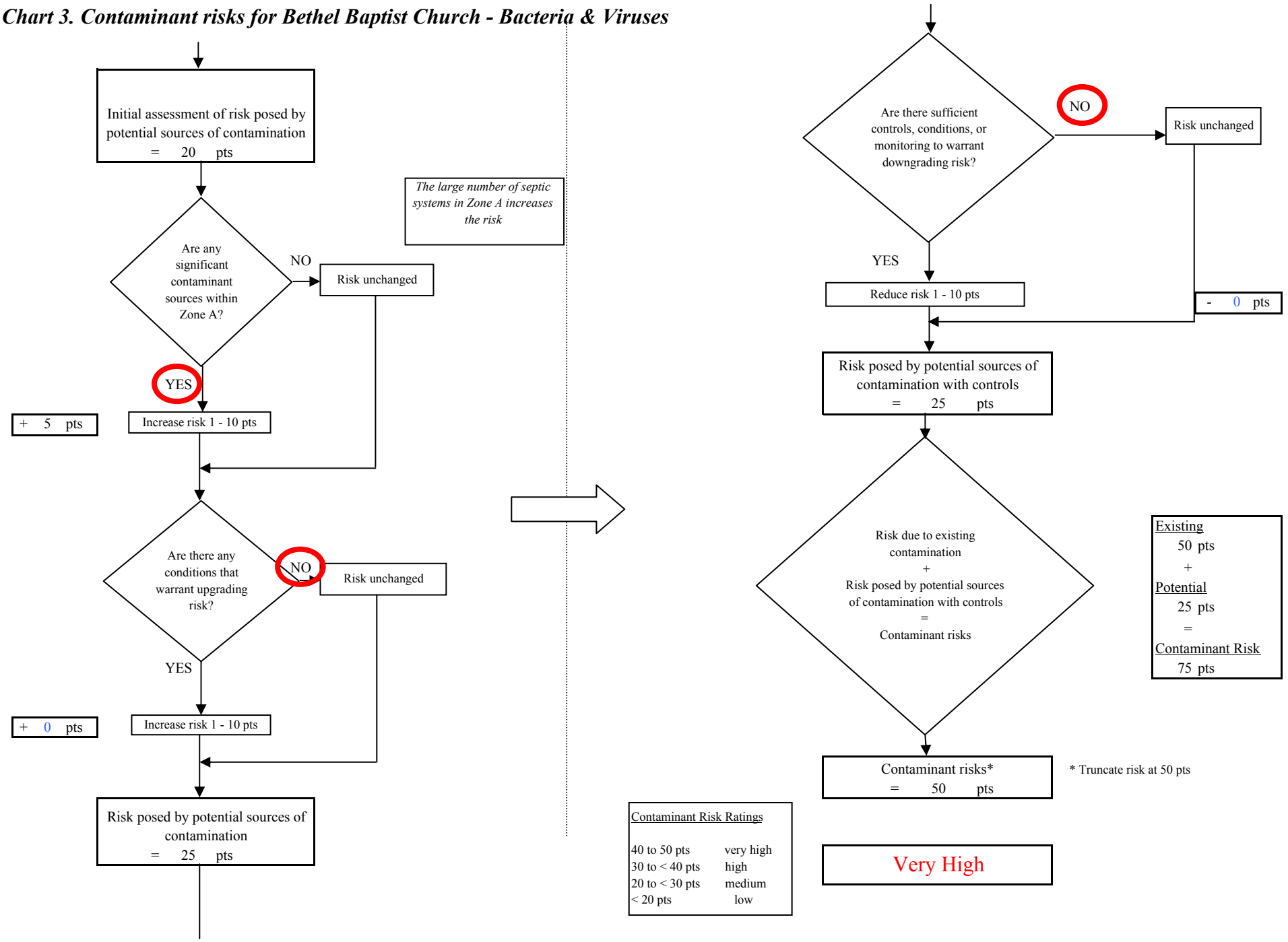


Chart 4. Vulnerability analysis for Bethel Baptist Church - Bacteria & Viruses

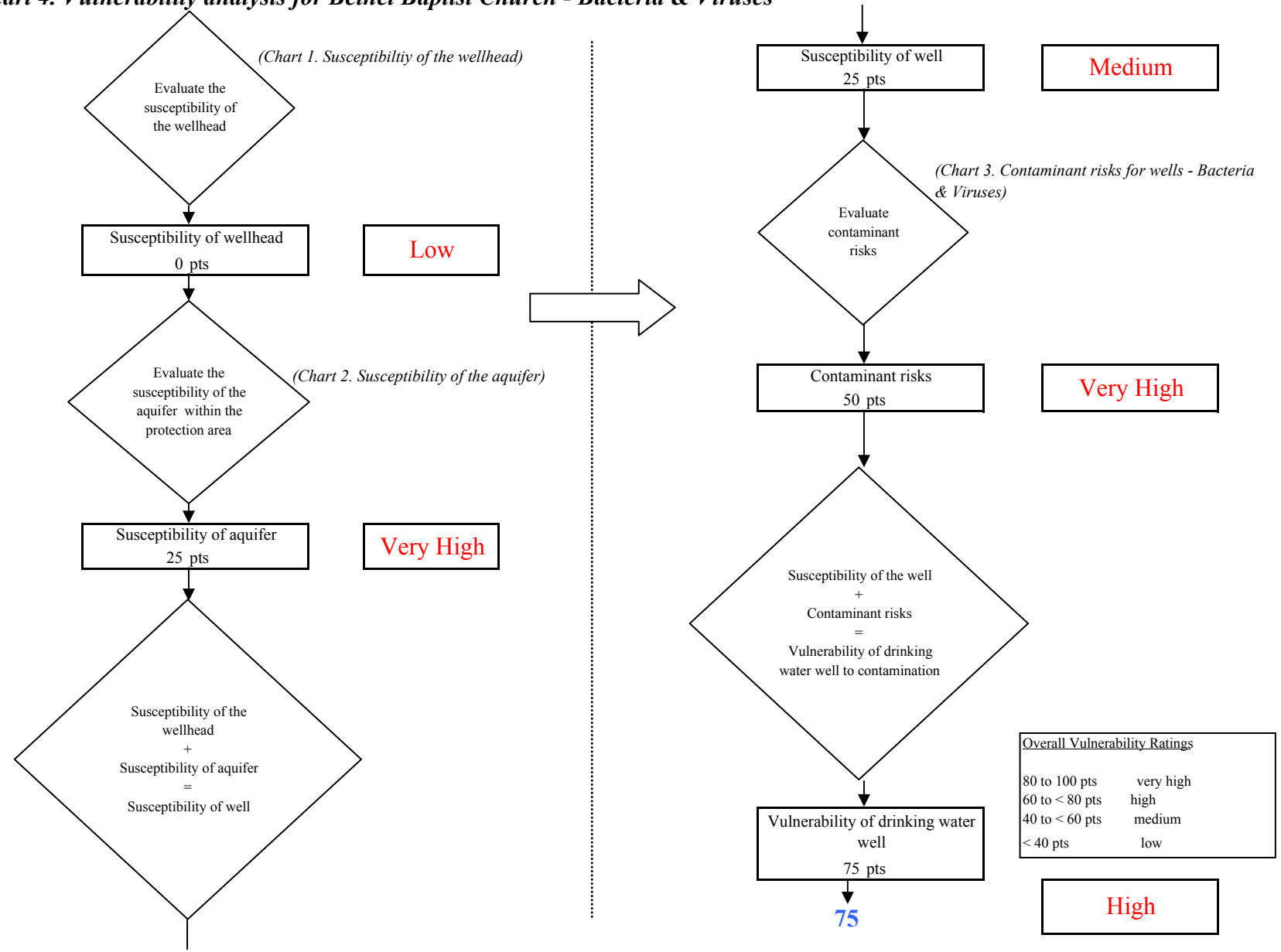


Chart 5. Contaminant risks for Bethel Baptist Church - Nitrates and Nitrites

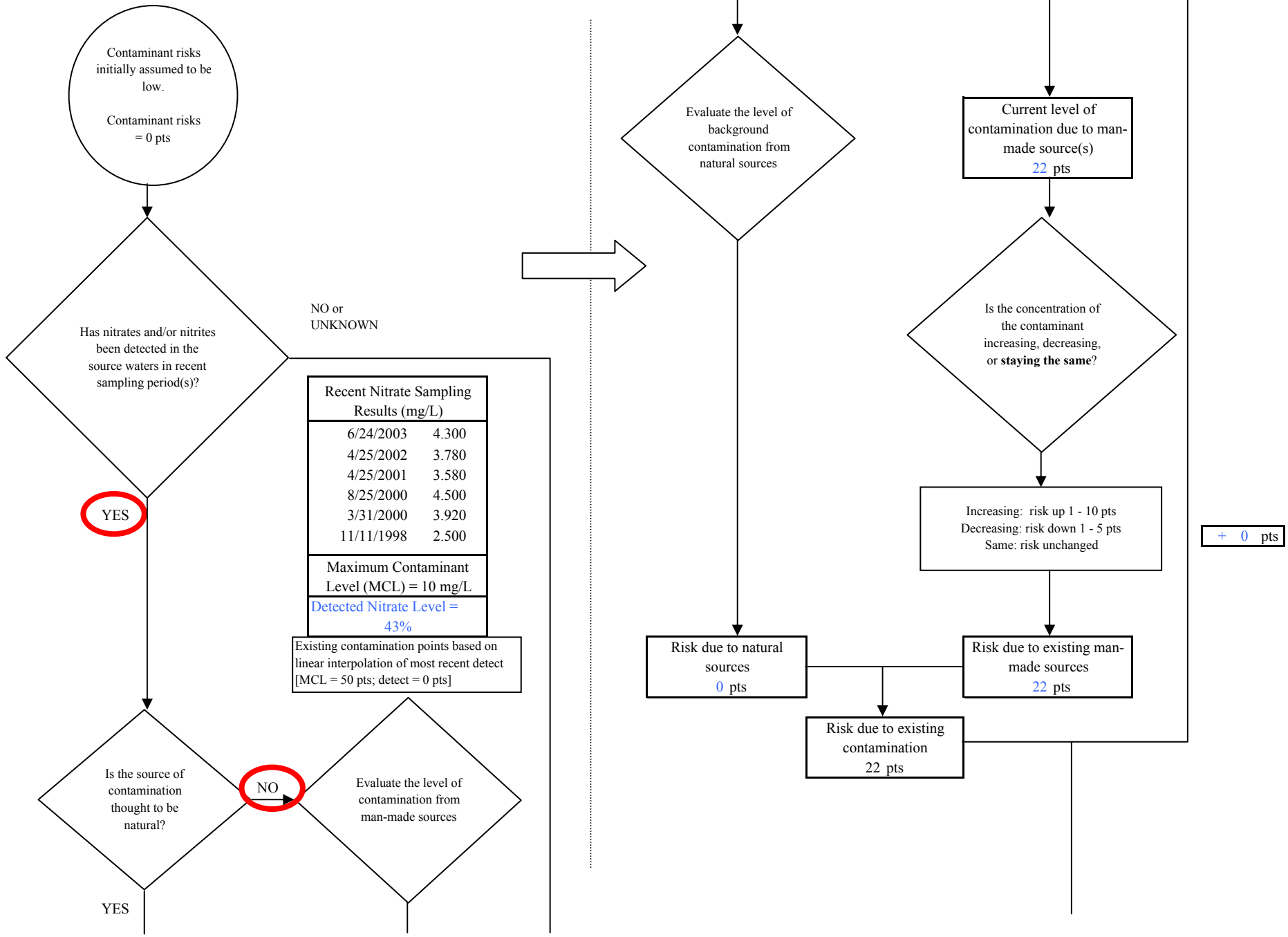


Chart 5. Contaminant risks for Bethel Baptist Church - Nitrates and Nitrites

+ 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)	0	0	0
Low(s)	75	0	75

	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

YES

Is the source aquifer fractured rock or karst?

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

The large number of septic systems in Zone A increases the risk

YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 5. Contaminant risks for Bethel Baptist Church - Nitrates and Nitrites

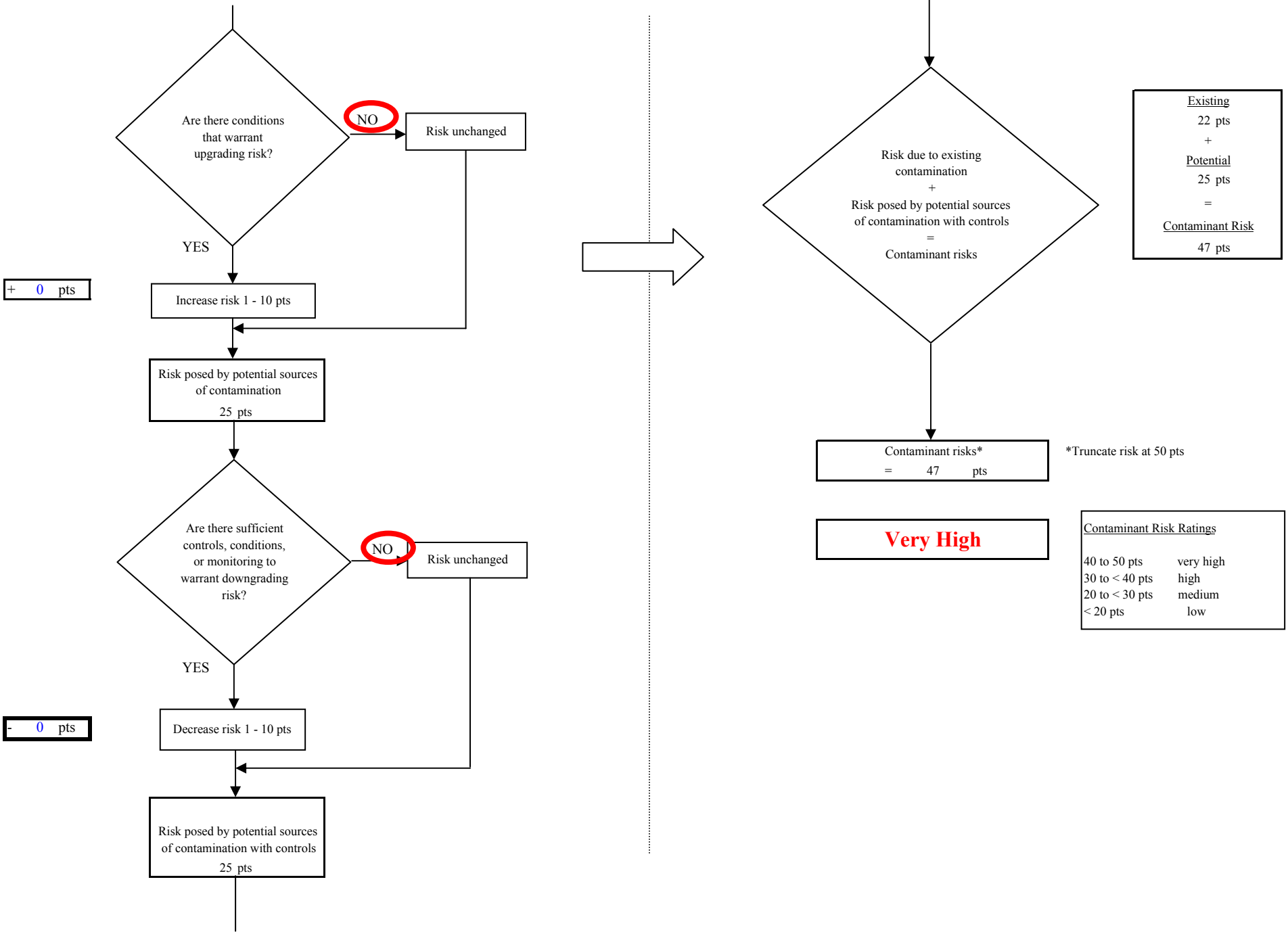


Chart 6. Vulnerability analysis for Bethel Baptist Church - Nitrates and Nitrites

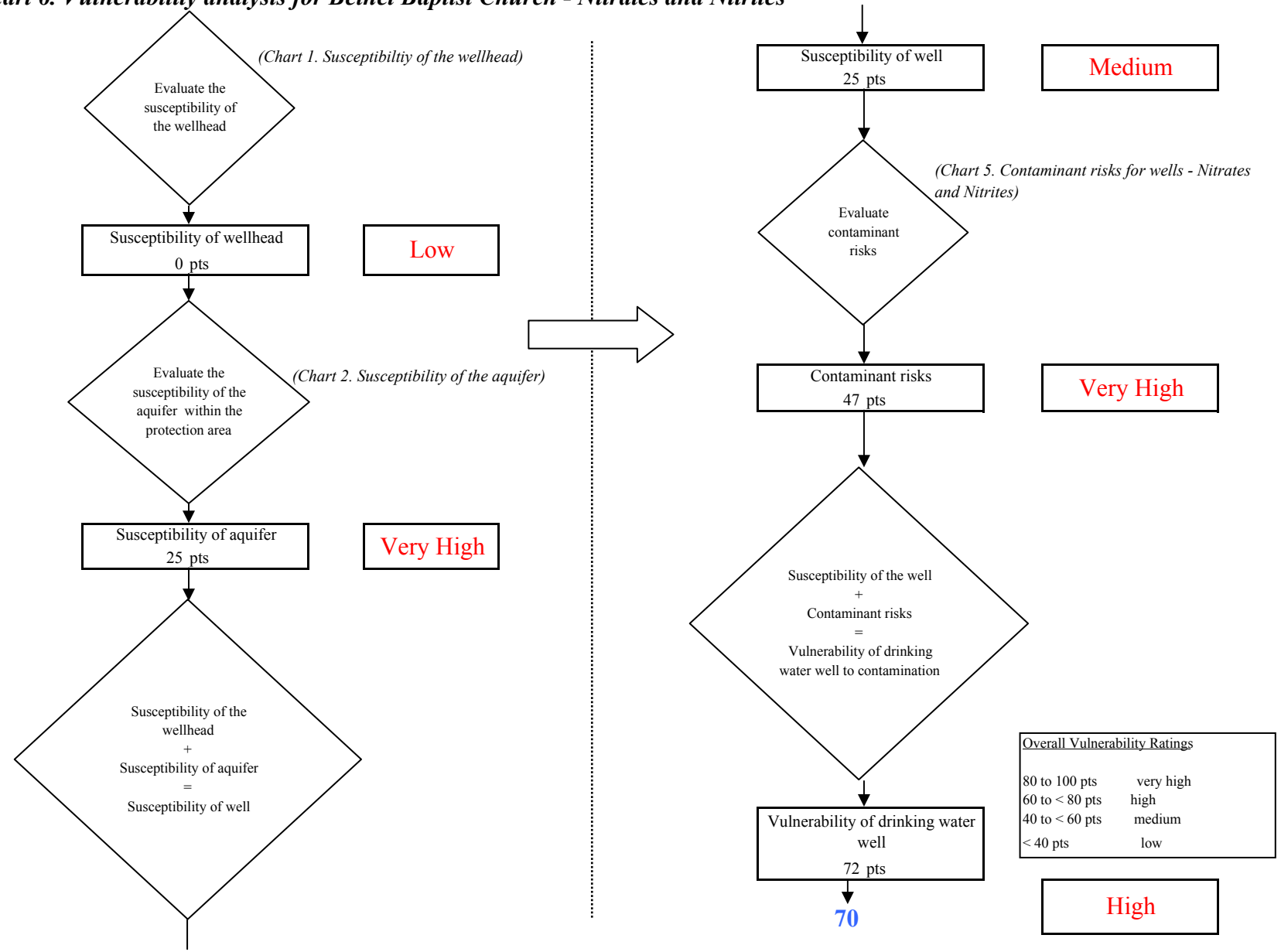


Chart 7. Contaminant risks for Bethel Baptist Church - Volatile Organic Chemicals

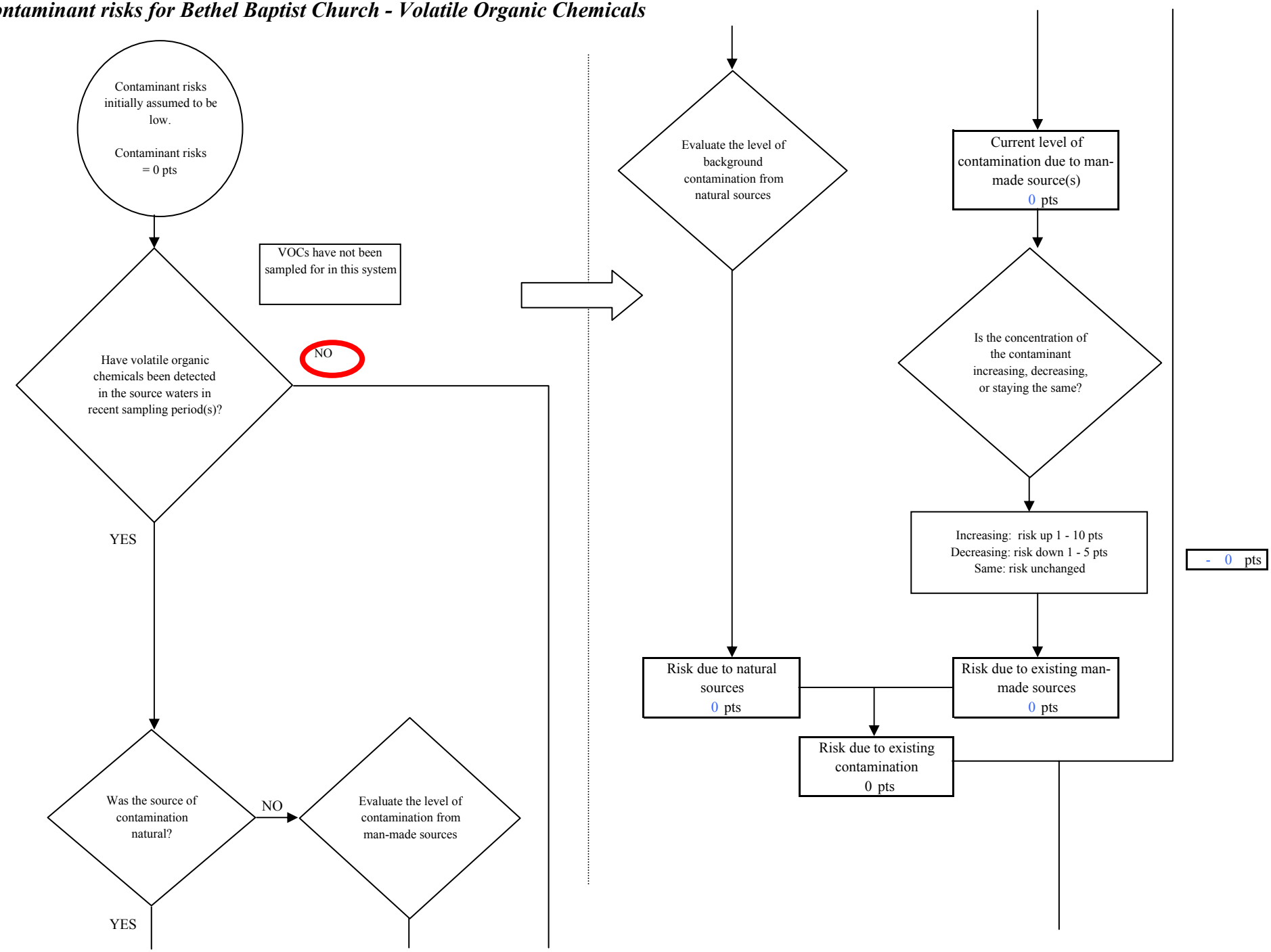
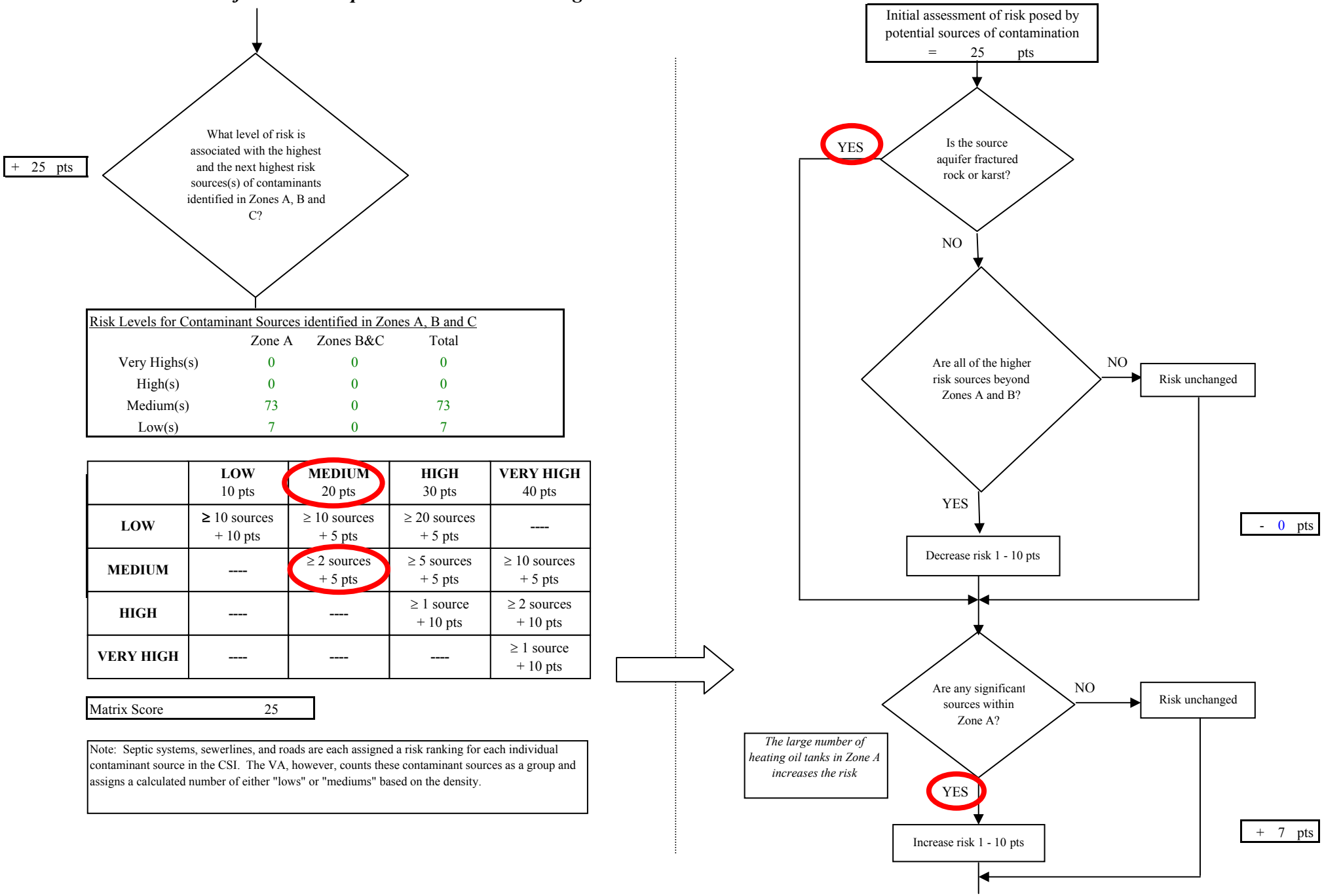


Chart 7. Contaminant risks for Bethel Baptist Church - Volatile Organic Chemicals



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

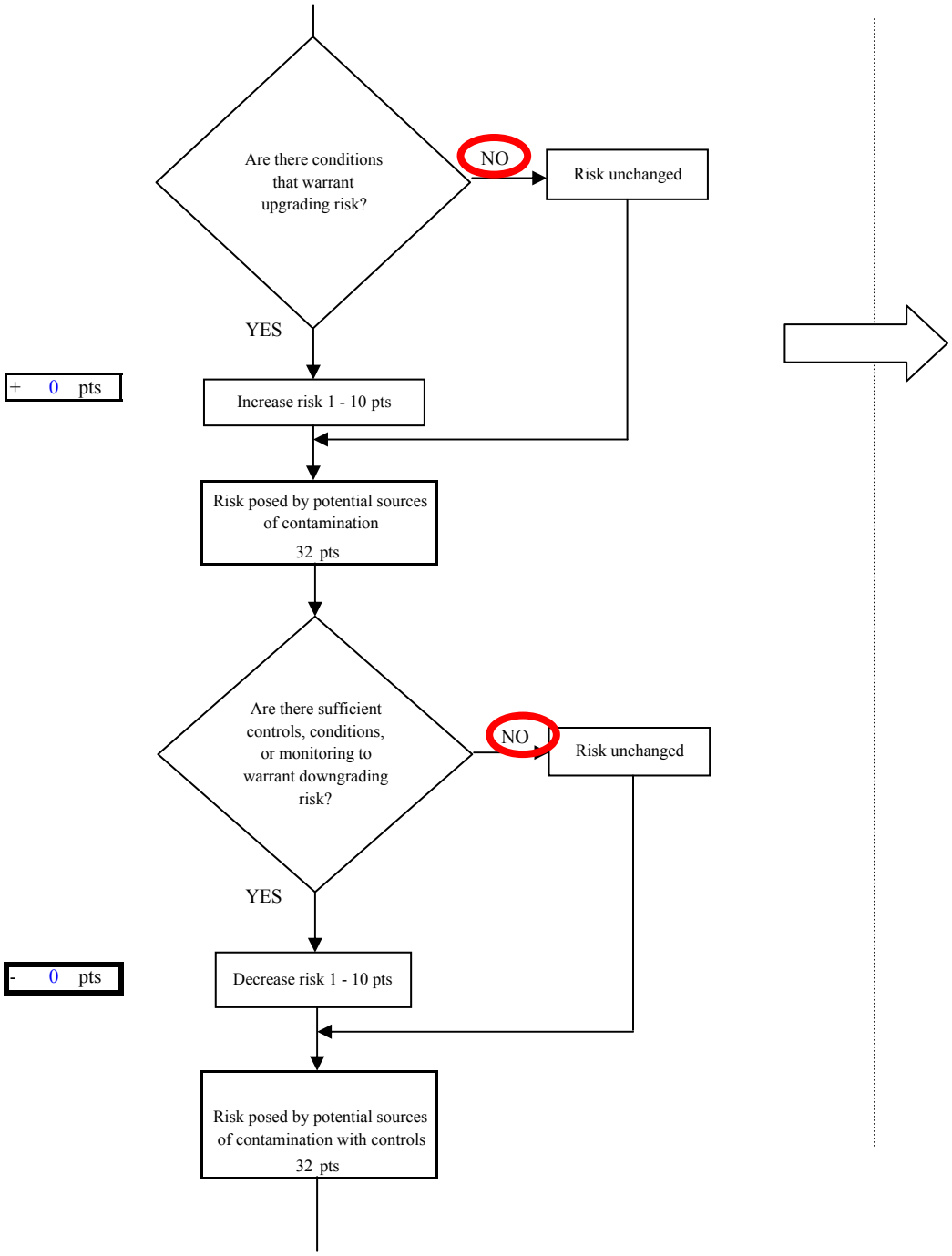
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	73	0	73
Low(s)	7	0	7

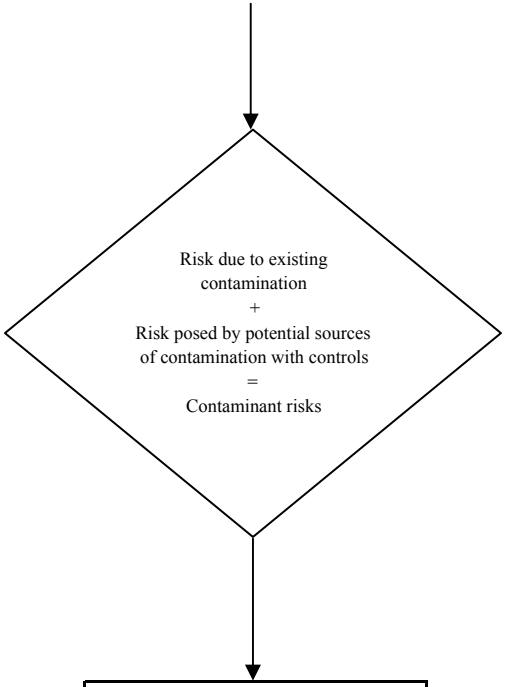
	LOW 10 pts	**MEDIUM** 20 pts	**HIGH** 30 pts	**VERY HIGH** 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source + 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 Bethel Baptist Church - Volatile Organic Chemicals





Existing
0 pts
+
Potential
32 pts
=
Contaminant Risk
32 pts

Contaminant risks*
= 32 pts

*Truncate risk at 50 pts

High

Contaminant Risk Ratings

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

Chart 8. Vulnerability analysis for Bethel Baptist Church - Volatile Organic Chemicals