Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for LDS Steese Chapel Drinking Water System,
Fairbanks area, Alaska
PWSID 312253

September 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 1235
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 LDS Steese Chapel 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 serving the LDS Steese Chapel to potential contamination. This Class B (non-community) water system consists of one well at the intersection of Lazelle Road and the Steese Highway north 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 **High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the LDS Steese Chapel public water system include: a petroleum product bulk station, a cemetery, and ADEC-recognized contaminated sites. 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 system for LDS Steese Chapel received an overall vulnerability rating of **Low** for bacteria and viruses, **Medium** nitrates and/or nitrites; and **High** for volatile organic chemicals.

LDS STEESE CHAPEL PUBLIC DRINKING WATER SYSTEM

LDS Steese Chapel public water system is a Class B (non-community) water system. The system consists one well at the intersection of Lazelle Road and the Steese Highway north of Fairbanks, Alaska (T1S, R1W, Section 1) (See Map 1 of Appendix A). Fairbanks is 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.

City water, sewer and electricity for the city of Fairbanks are provided by Golden Valley Utilities. Some residents use residential septic systems. The majority of residents (approximately 70%) use heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) to heat homes and buildings. Garbage collection services are proved by the city, and refuse is transported to the Fairbanks North Star Borough Class I Landfill on South Cushman Street.

The Fairbanks area includes two distinct topographic areas: the alluvial plain between the Tanana River and the Chena River, and the uplands north of this alluvial plain. The LDS Steese Chapel water system is located on the border of the uplands and the alluvial plain at an elevation of approximately 450 feet above sea level.

According to the well log for this well, the depth of the well is 85 feet below the ground surface and is screened in water bearing rock. 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). Areas with discontinuous permafrost may locally affect the ground water flow directions.

LDS STEESE CHAPEL 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 capture zone. The groundwater capture zone is located in the area circling the well (the area influenced by pumping) and also the area of the water table upgradient of the well, usually forming a parabola shape.

An outline of the immediate watershed was used to determine the size and shape of the protection area for

the LDS Steese Chapel. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

Because of uncertainties and changing site conditions, a factor of safety is added to the groundwater capture zone to form the drinking water protection area for the well.

The protection areas established for wells are usually separated into four zones, limited by the watershed. These zones correspond to times-of-travel (TOT) of the water moving through the aquifer to the well (plus the factor of safety). Because the rate at which water travels through fractured bedrock is unknown but usually relatively fast, the protection area for the LDS Steese Chapel consists only of Zone A.

The following is a summary of the four 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 2 years time-of-travel
C	Less than 5 years time-of-travel
D	Less than 10 years time-of-travel

The time of travel for contaminants within the water varies with their unique physical and chemical characteristics.

The drinking water protection area outlined for the LDS Steese Chapel on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program (DWPP) has completed an inventory of potential and existing sources of contamination within the LDS Steese Chapel 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 each 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 combination of toxicity and volume associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

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 inventoried potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

VULNERABILITY OF LDS STEESE CHAPEL 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 LDS Steese Chapel received a Low Susceptibility rating. The 8/14/98 Sanitary Survey indicated the well is capped with a sanitary seal, the well site is adequately drained, and the well is grouted. A sanitary seal prevents potential contaminant from entering the well while grouting helps to prevent potential contaminants from traveling down the outside of the well casing.

The aquifer in the area the LDS Steese Chapel well is completed in received a High Susceptibility rating. The fractured bedrock can allow contaminants to travel at a fast rate downward from the surface with the precipitation and surface water runoff. Table 2 summarizes the Susceptibility scores and ratings for LDS Steese Chapel.

Table 2. Susceptibility

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

The Contaminant Risk has been derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources. 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	0	Low
Nitrates and/or Nitrites	22	Medium
Volatile Organic Chemicals	50	Very 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	15	Low
Nitrates and Nitrites	40	Medium
Volatile Organic Chemicals	65	High

Bacteria and Viruses

No sources of bacteria and viruses were identified in the protection area.

Only a small amount of bacteria and viruses are required to endanger public health. Coli forms are found naturally in the environment and although they aren't necessarily a health threat, it is an indicator of other potentially harmful bacteria in the water, more specifically, fecal coli forms and E. coli which only come from human and animal fecal waste (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002). Routine sampling has not detected coli forms in the water.

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 low.

Nitrates and Nitrites

The cemetary in the protection area also represents the greatest risk to to nitrates and nitrites for this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have not been detected in significant levels in recent sampling history for the LDS Steese Chapel well.

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 medium.

Volatile Organic Chemicals

The petroleum product bulk station and the DEC-recognized contaminated sites represent the greatest risk for volatile organic chemical contamination to the well.

The ADEC-recognized contaminated sites in Zone A of the protection area are located on Birch Hill at the tank farm and its associated pipelines (RecKey 199231X927401, 199231X127402. and 199231X127403). Fuel contamination has been found in the soil and the groundwater on the hill and in the area downgradient of the tank farm. Free product has been identified in the bedrock of Birch Hill. It is unknown when the contamination occurred. Groundwater and soil treatment systems were installed but are no longer being used. Monitoring is ongoing.

Volatile Organic Chemicals are routinely sampled for but have not been detected in significant quantities (1,2,Dichloroethane is routinely detected but in concentrations well below its maximum contaminant level) in the LDS Steese Chapel 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 high.

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APPENDIX A

LDS Steese Chapel
Drinking Water Protection Area Location Map
(Map 1)

FARMERS LOOP ROAD
BIRCH HILL ROAD
TERRACE DRIVE
HILLSIDE DRIVE
CREST DRIVE
ACADIA DR
WILDERNESS DRIVE
ROAD
ROAD
BENSON STREET
PARKER STREET
CITY LIGHTS BOULEVARD
FAIRHILL ROAD
GREENING WAY
KNIFFEN ROAD
Zone A
LAZELLE ROAD
LAZELLE ROAD
BIRCH HILL LOOP
JOHANSEN EXPRESSWAY
THE ALASKA RAILROAD
STEESE HIGHWAY
JOYCE DRIVE
SHANNON D
COLLEGE

Map 1: Drinking Water Protection Area

PWSID: 312253

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 600 1,200 2,400 3,600 Feet

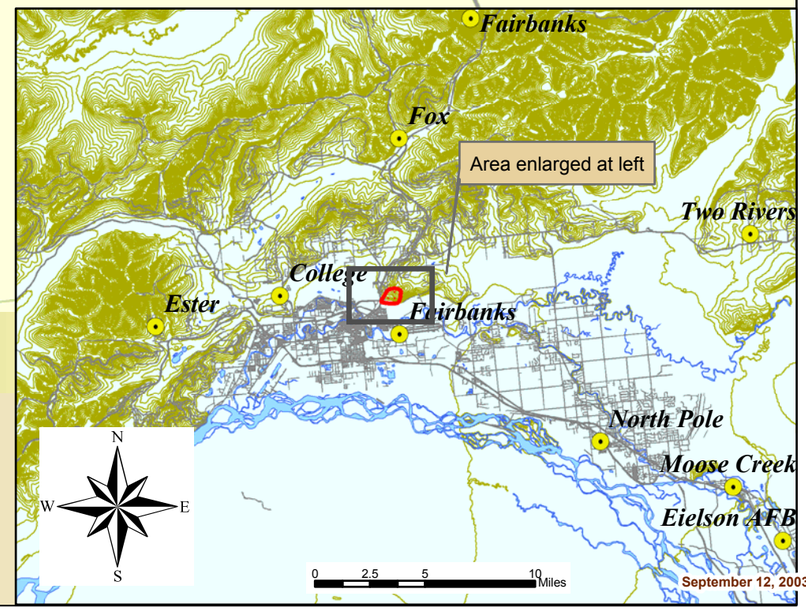
1:14,400

Data Sources:

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

Legend

- LDS Steese Chapel well
- Zone A *Several months travel time*
- Roads
- Surface water
- Elevation Contours (20 m)



APPENDIX B

Contaminant Source Inventory and Risk Ranking for LDS Steese Chapel (Tables 1-4)

Table 1

Contaminant Source Inventory for
LDS / Steese Chapel

PWSID 312253.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	A	2	FTWW (OU-3) FE Pipeline MP2.7/3.0; /File Number 108.38.002
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	A	2	FTWW (OU-3) FBK Eielson Pipe. 15.75; File Number 108.38.002
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-3	A	2	FTWW (OU-3) Birch Hill Tank Farm; File Number 108.38.002
Cemeteries	X01	X01-1	A	2	Birch Hill Cemetary
Petroleum product bulk station/terminals	X11	X11-1	A	2	Ft. Wainwright Birch Hill Tank Farm

Table 2

Contaminant Source Inventory and Risk Ranking for LDS / Steese Chapel Sources of Nitrates/Nitrites

PWSID 312253.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Cemeteries	X01	X01-1	A	Medium	2	Birch Hill Cemetary

Table 3

Contaminant Source Inventory and Risk Ranking for LDS / Steese Chapel Sources of Volatile Organic Chemicals

PWSID 312253.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Petroleum product bulk station/terminals	X11	X11-1	A	Very High	2	Ft. Wainwright Birch Hill Tank Farm

APPENDIX C

LDS Steese Chapel
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

APPENDIX D

Vulnerability Analysis for LDS Steese Chapel Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - LDS/Steese Chapel

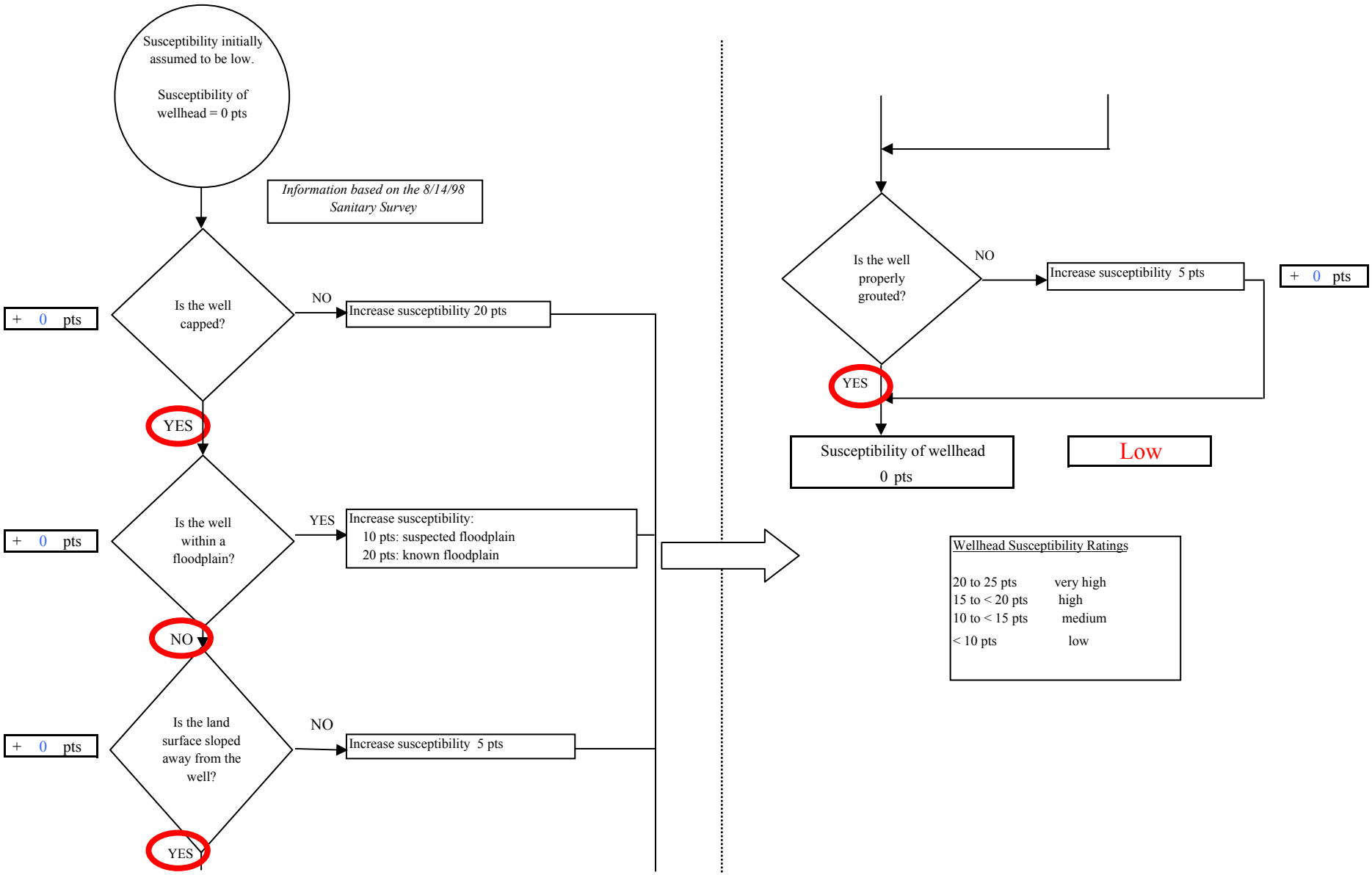


Chart 2. Susceptibility of the aquifer - LDS/Steese Chapel

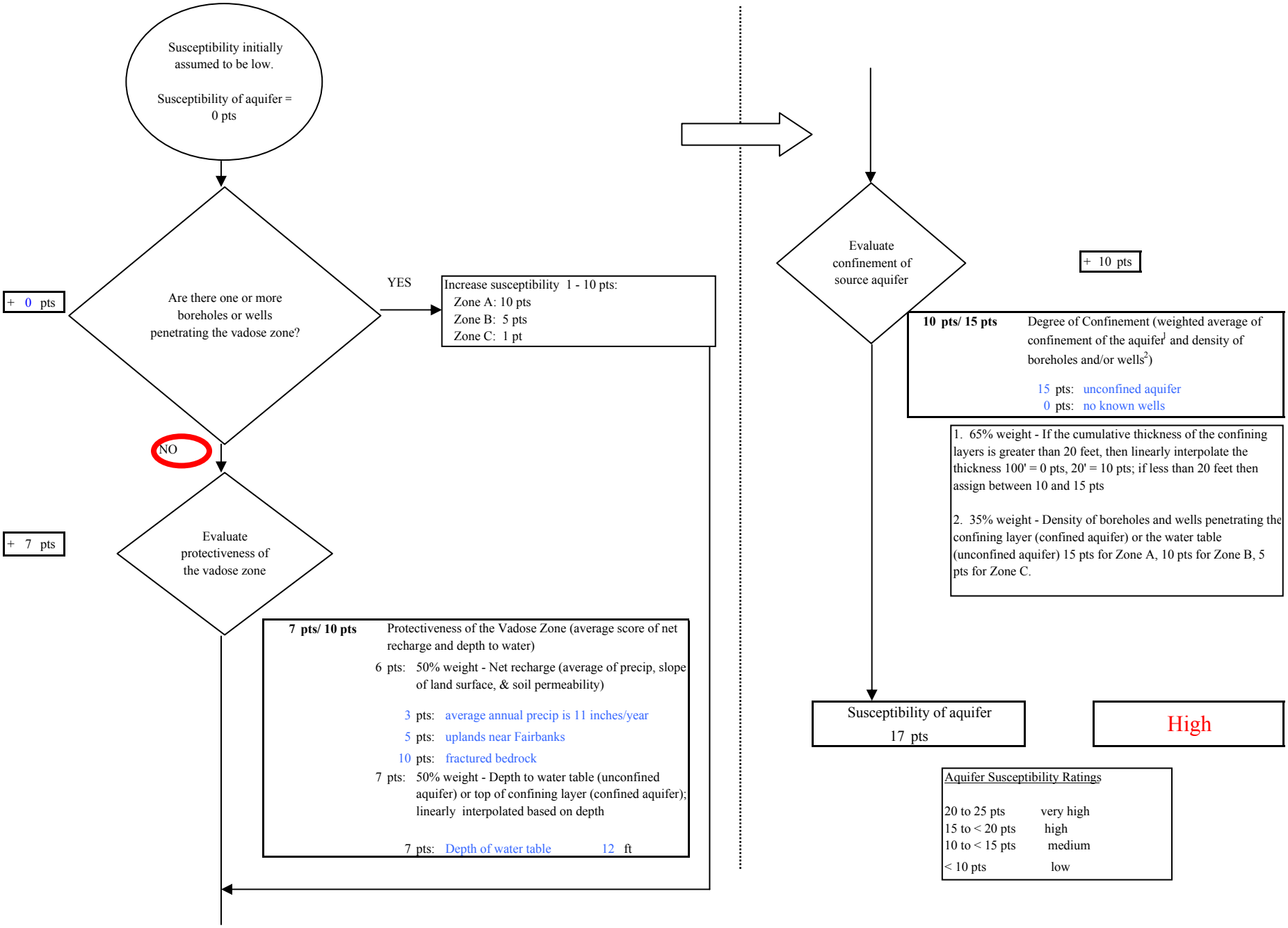
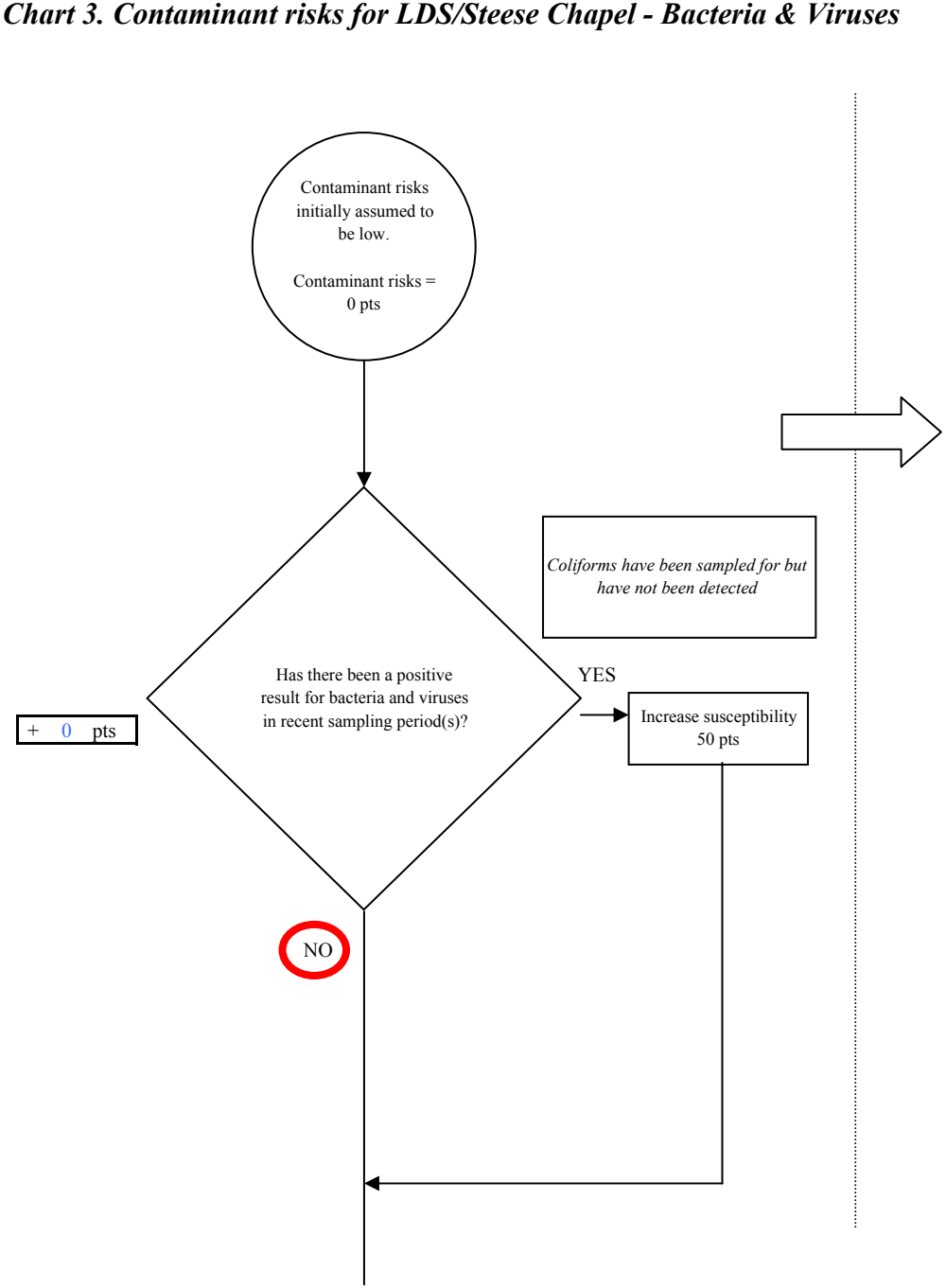
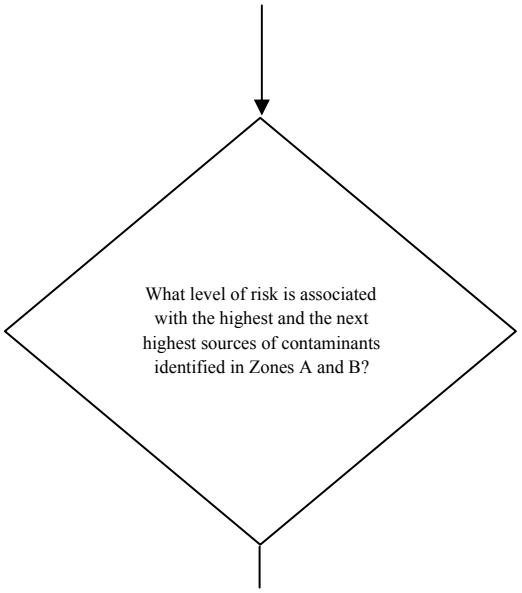


Chart 3. Contaminant risks for LDS/Steese Chapel - Bacteria & Viruses





+ 0 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)	0	0	0

	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 0

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 LDS/Steese Chapel - Bacteria & Viruses

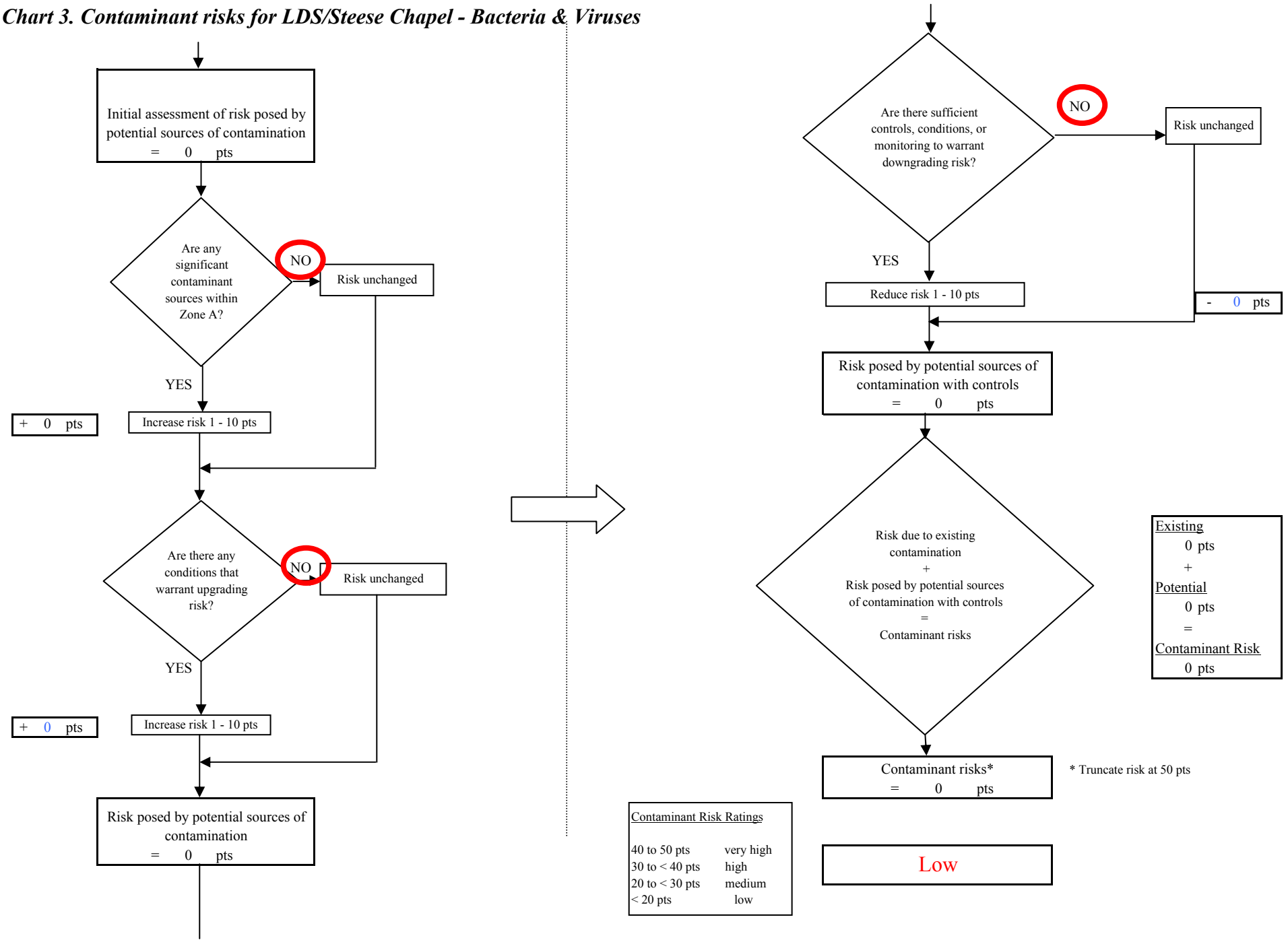


Chart 4. Vulnerability analysis for LDS/Steese Chapel - Bacteria & Viruses

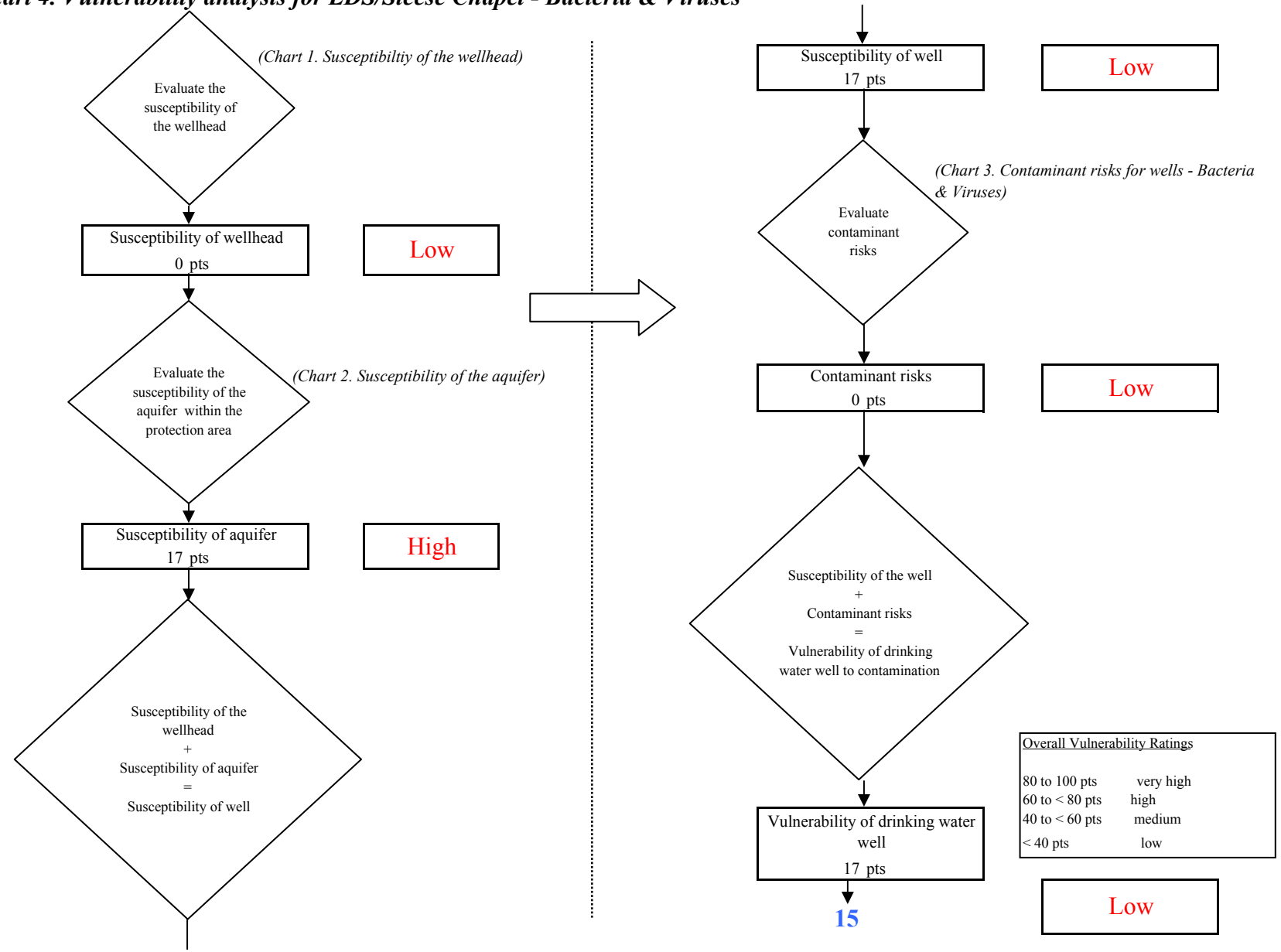


Chart 5. Contaminant risks for LDS/Steese Chapel - Nitrates and Nitrites

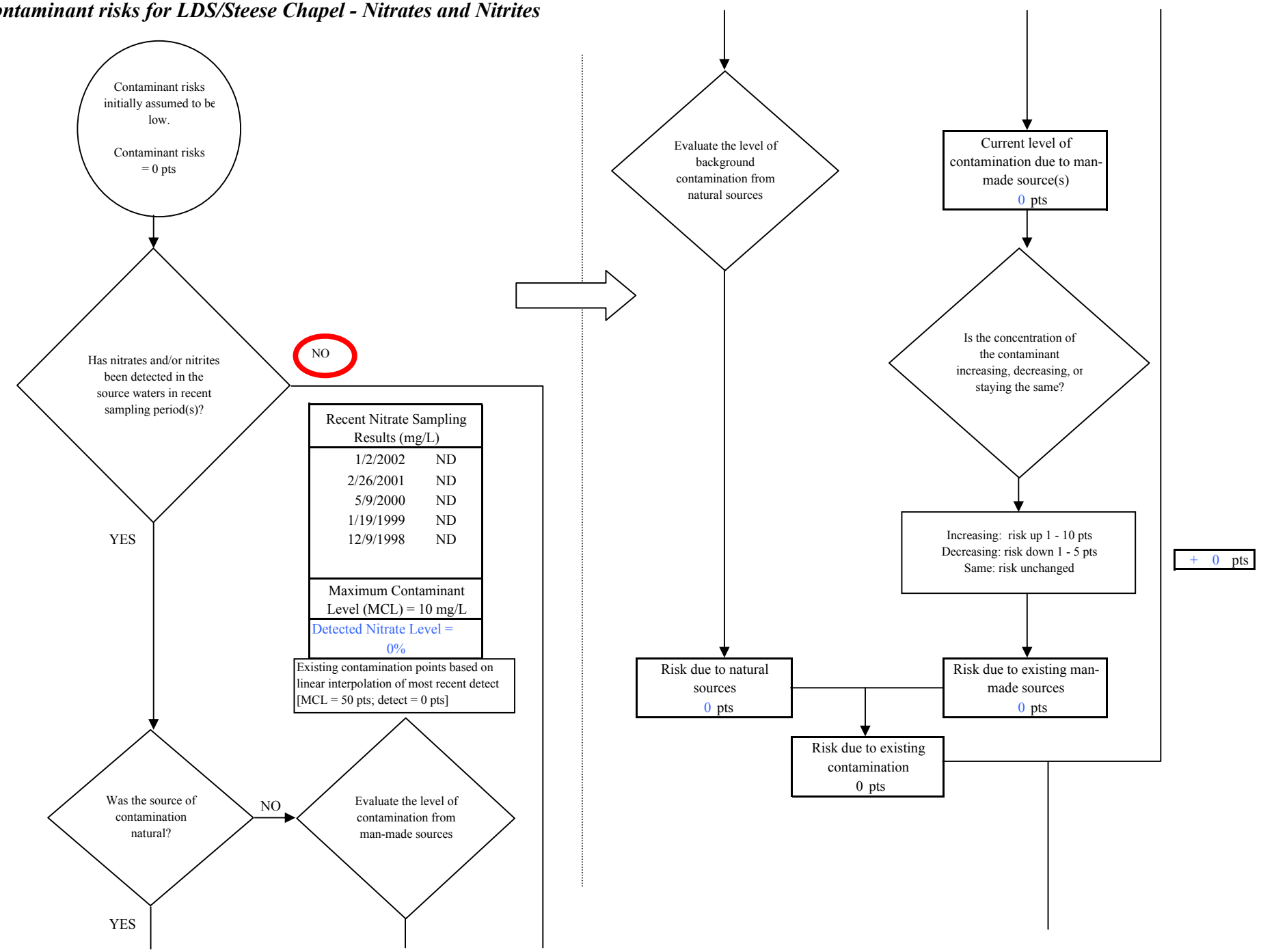


Chart 5. Contaminant risks for LDS/Steese Chapel - Nitrates and Nitrites

+ 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)	1	0	1
Low(s)	0	0	0

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

Matrix Score 20

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

Initial assessment of risk posed by potential sources of contamination = 20 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

The cemetary increases the risk

YES → Increase risk 1 - 10 pts

+ 2 pts

Chart 5. Contaminant risks for LDS/Steese Chapel - Nitrates and Nitrites

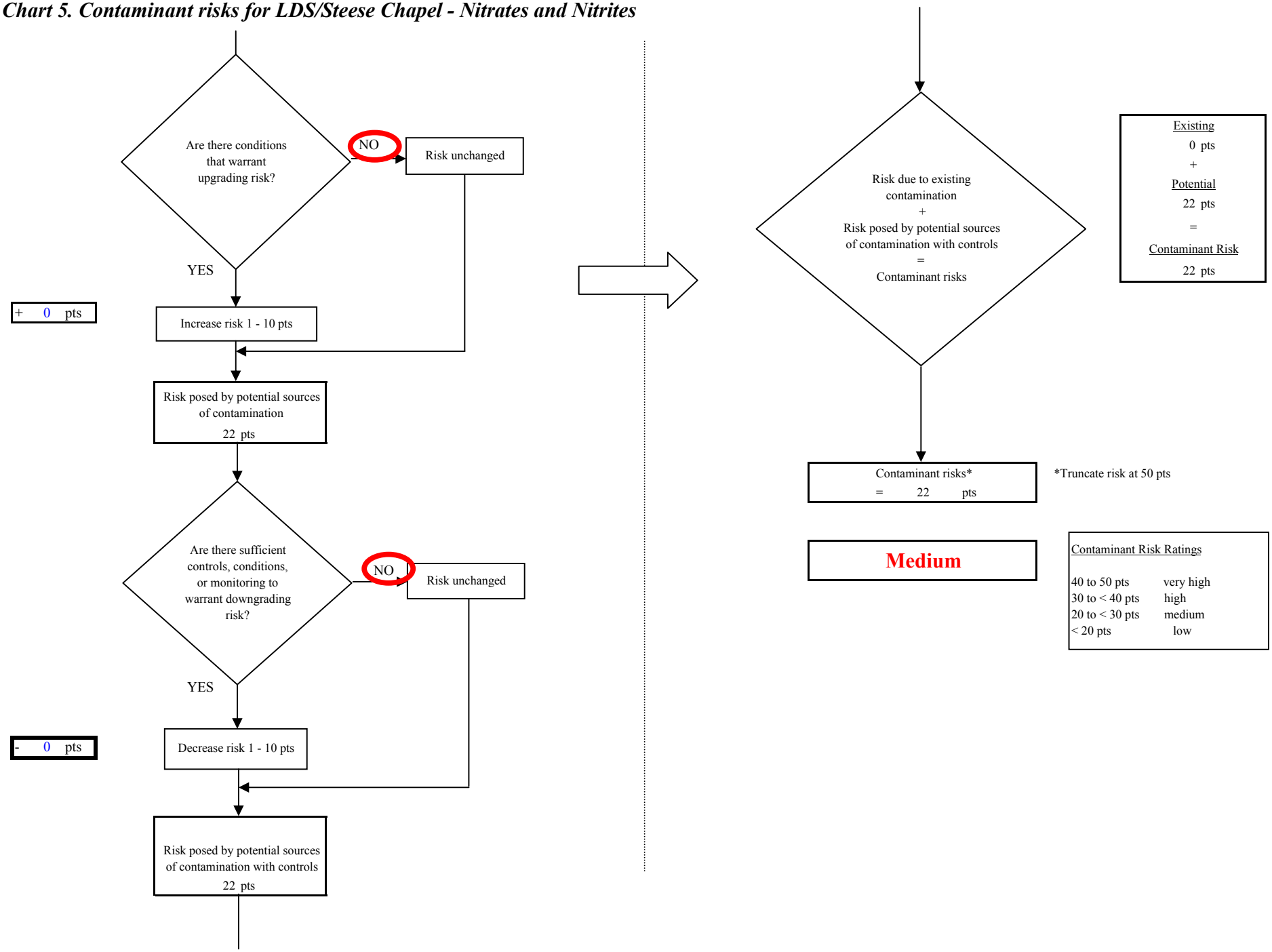


Chart 6. Vulnerability analysis for LDS/Steese Chapel - Nitrates and Nitrites

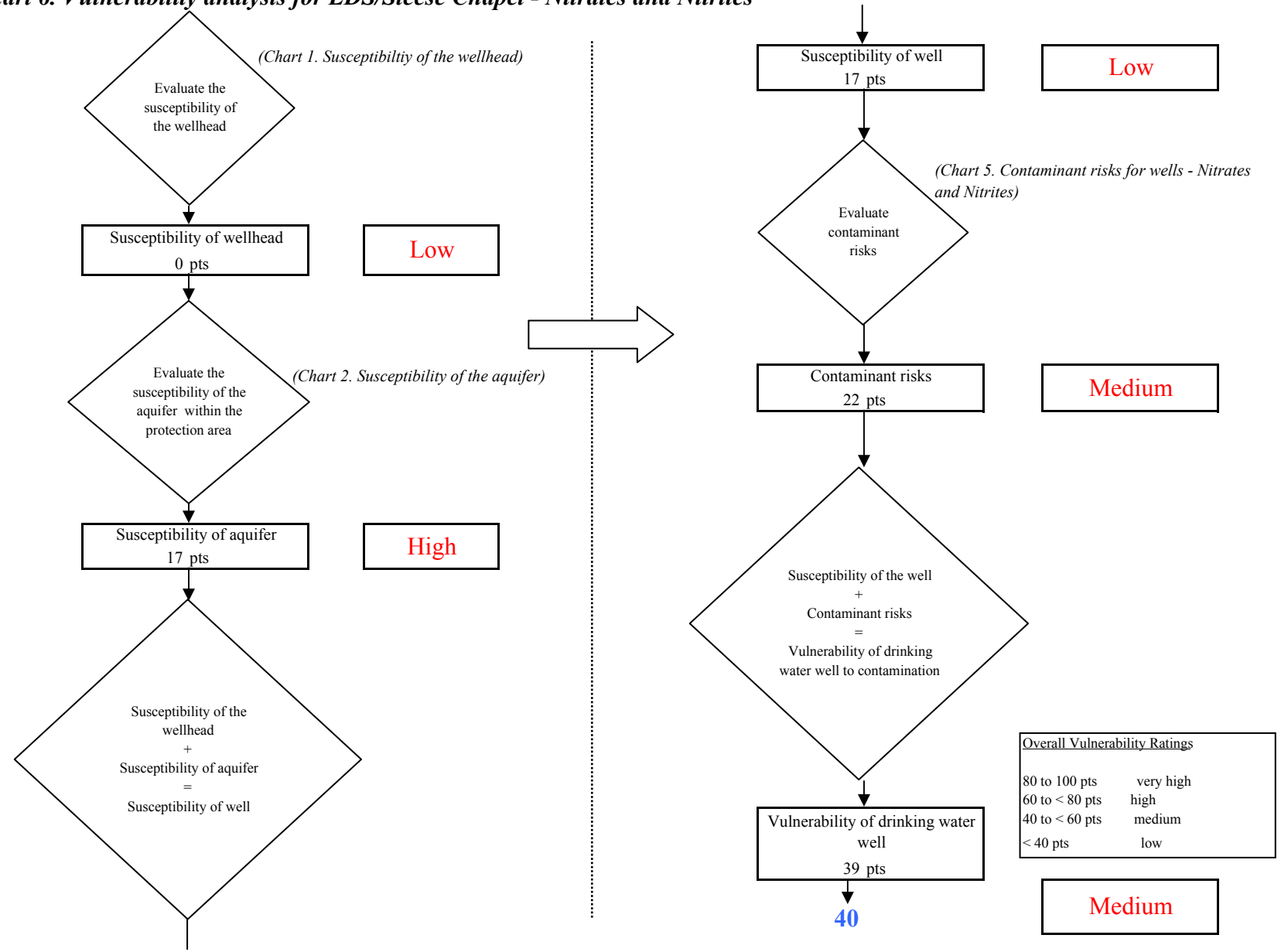


Chart 7. Contaminant risks for LDS/Steese Chapel - Volatile Organic Chemicals

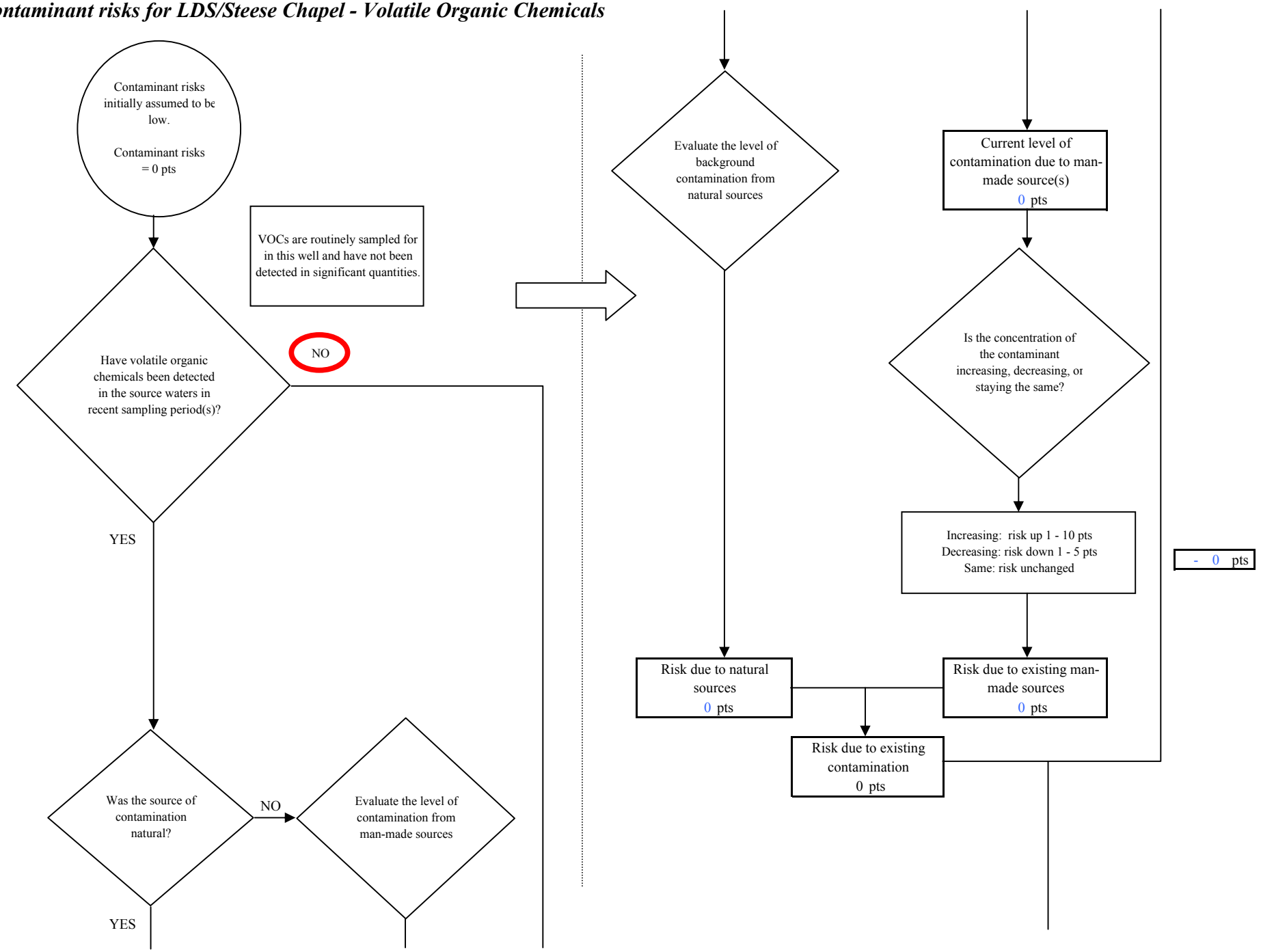


Chart 7. Contaminant risks for LDS/Steese Chapel - Volatile Organic Chemicals

+ 40 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)	1	0	1
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	0	0

	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 40

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 = 40 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

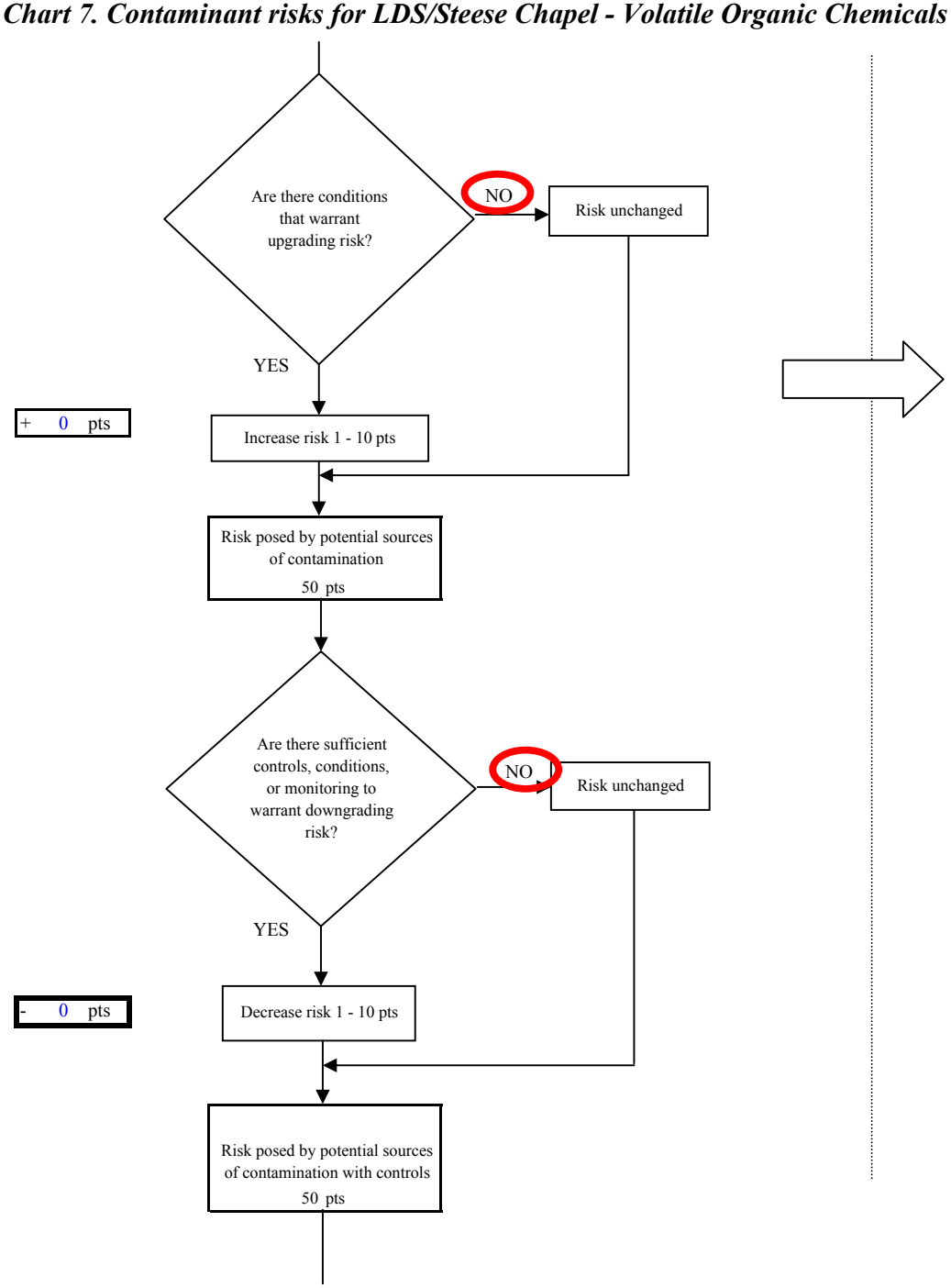
NO → Risk unchanged

YES → Increase risk 1 - 10 pts

+ 10 pts

The Petroleum Product Bulk Station increases the risk

Chart 7. Contaminant risks for LDS/Steese Chapel - Volatile Organic Chemicals



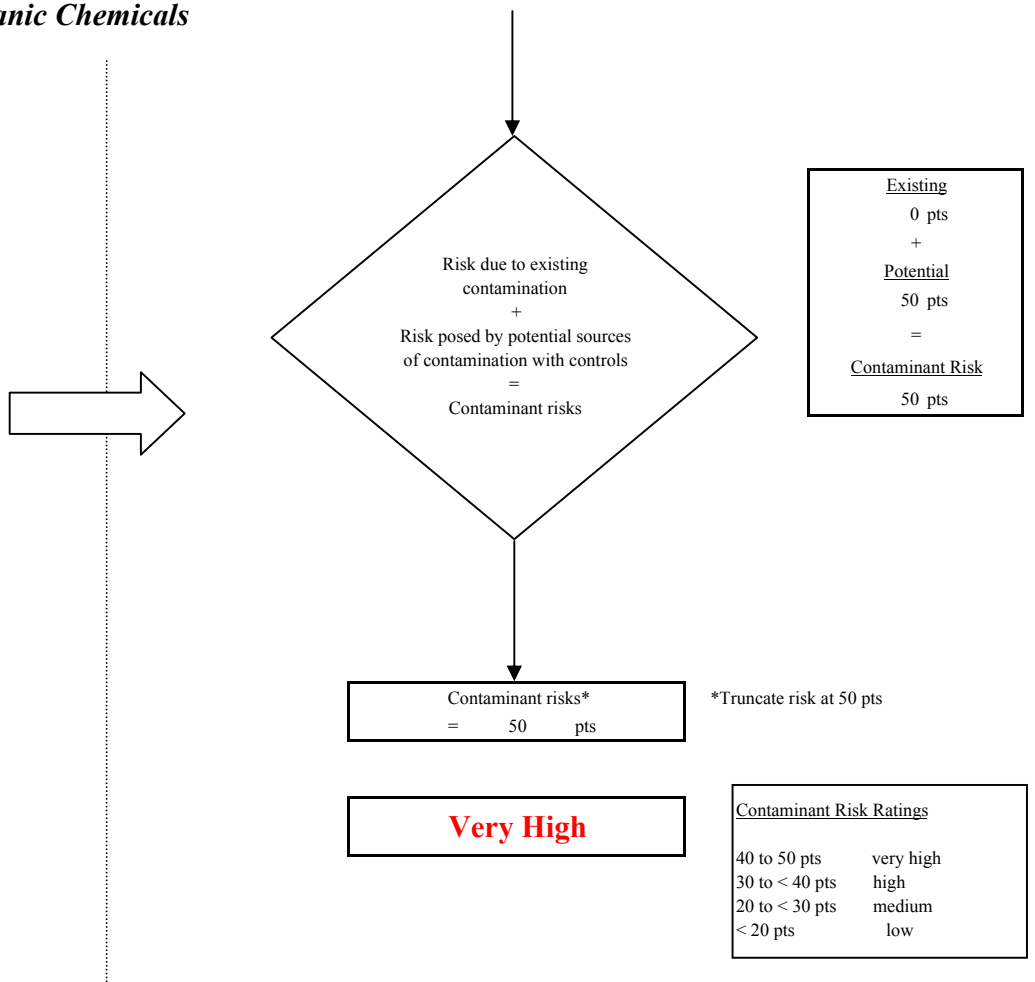


Chart 8. Vulnerability analysis for LDS/Steese Chapel - Volatile Organic Chemicals