Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Badger Road Elementary Drinking Water System,
Fairbanks area, Alaska
PWSID 371265

July 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 1026
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 Badger Road Elementary 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 Badger Road Elementary to potential contamination. This Class A (non-community) water system consists of one well at the intersection of Bradway Road and Woll Road approximately 4 miles northwest of North Pole, Alaska. The wells 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 Badger Road Elementary public water system include: residential heating oil storage tanks, residential septic systems, residential area, a farm machinery area, and a hardware store. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals (VOCs), heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals (SOCs), and other organic chemicals (OOCs). Combining the natural susceptibility of the well with the contaminant risk, the public water system for Badger Road Elementary received an overall vulnerability rating of **Medium** for VOCs and **Low** for bacteria and viruses, nitrates and/or nitrites, heavy metals, cyanide, and other inorganic chemicals; SOCs, and OOCs..

BADGER ROAD ELEMENTARY PUBLIC DRINKING WATER SYSTEM

Badger Road Elementary public water system is a Class A (community) water system. The system consists of one well at the intersection of Bradway Road and Woll Road approximately 4 miles northwest of North Pole, Alaska (T1S R2E Section 30) (See Map 1 of Appendix A). North Pole is located southeast of Fairbanks 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 located in the area surrounding the city of Fairbanks 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 alluvial plain between the Tanana River and the Chena River, and the uplands north of this alluvial plain. The Badger Road Elementary water system is located in the alluvial plain at an elevation of approximately 425 feet above sea level.

According to the most recent sanitary survey (4/24/01) for this water system, the depth of the well is 120 feet below the ground surface. Other wells in this area are screened in a combination of sand and gravel and it is assumed that this one is also. The alluvial plain consists of alternating layers of sand and gravel up to over 500 feet thick, in some locations overlain by 1 to 10 feet of silt or sandy silt or a few feet of peat (Glass and others, 1996).

Primarily the Tanana River, but also the Chena River contribute water to this alluvial aquifer. The Chena River typically only contributes water when its stage is high and the Tanana is low (Nelson, 1978). The Tanana River gets approximately 85% of its water from snowmelt of the Alaska Range and 15% from the Yukon-Tanana uplands (Anderson, 1970).

The Badger Road Elementary public water system serves 422 non-residents through one service connection.

BADGER ROAD ELEMENTARY 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.

The shape of the capture zone is calculated using a combination of two simple groundwater flow equations, the Thiem and uniform flow equations. The orientation of the capture zone is drawn using a water table elevation map of the area.

The parameters used to calculate the shape of the capture zone were obtained from various United State Geological Survey (USGS) reports, well logs in the area, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The water table in the area of the Badger Road Elementary, the area between the Tanana and the Chena Rivers, is primarily influenced by the level of water flow in each river. The capture zones were drawn based on three separate configurations of the water table during various stages of the rivers: a period of high stage in the Chena River (October 14-17, 1986), high stage in the Tanana River (July 16-17, 1987), and low stages in both rivers (March 30-April 3, 1988) (Glass and others, 1996). High water levels in the Chena usually occur in the spring due to runoff from the uplands and in late summer due to rainstorms (Nelson, 1978). The Tanana usually experiences high flow during the hot, dry periods of mid-summer when maximum snowmelt from the Alaska Range occurs (Nelson, 1978). Groundwater in this area generally flows toward the northwest, from the Tanana River to the Chena River, however flow is reversed very near the Chena River during its high stage periods (Glass and others, 1996).

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).

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 Badger Road Elementary 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 Badger Road Elementary 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 A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals;
- Heavy metals, cyanide, and other inorganic chemicals;
- Synthetic organic chemicals; and
- Other 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 7 in Appendix B contain the ranking of inventoried potential and existing sources of

contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals.

VULNERABILITY OF BADGER ROAD ELEMENTARY 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 fourteen 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 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other 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 Badger Road Elementary received a Low Susceptibility rating. The most recent sanitary survey (4/24/01) indicates the well is capped with a sanitary seal and the land surface is sloped away from the well, however, the well is not grouted. A sanitary seal prevents potential contaminant from entering the well while sloping of the land surface and grouting help to prevent potential contaminants from traveling down the outside of the well casing.

The aquifer the Badger Road Elementary well is completed in received a High Susceptibility rating. The highly transmissive aquifer material and the high water table in the area allow contaminants to travel downward from the surface with the precipitation and surface water runoff. Table 2 summarizes the Susceptibility scores and ratings for Badger Road Elementary.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	20	Very High
Natural Susceptibility	25	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	5	Low
Volatile Organic Chemicals	17	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	13	Low
Synthetic Organic Chemicals	10	Low
Other Organic Chemicals	5	Low

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 six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and Nitrites	30	Low
Volatile Organic Chemicals	40	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	35	Low
Synthetic Organic Chemicals	35	Low
Other Organic Chemicals	30	Low

Bacteria and Viruses

The septic systems in the protection area represent the greatest risk for bacteria and viruses to the drinking water well.

Only a small amount of bacteria and viruses are required to endanger public health. Coliforms 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 coliforms 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). Coli forms have been detected in this water system, although fecal coliforms and E. Coli have not.

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 septic systems in the protection area also represent 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 recent sampling history for the Badger Road Elementary 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 low.

Volatile Organic Chemicals

The residential heating oil tanks represent the greatest risk for volatile organic chemical contamination to the well.

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 were sampled on 4/24/01 and 3/13/98 in the Badger Road Elementary public water system. Regulated contaminants were not detected in significant quantities in either sampling event. 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.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The septic systems represent the greatest risk for inorganic chemicals to the well.

Inorganic chemicals were sampled on 4/24/01 and 1/16/96. Arsenic was detected during the 9/27/02 sampling event at a concentration of 16% with respect to its MCL of 0.002 mg/L (EPA, 2002). Studies have linked long-term exposure of arsenic in drinking water to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate. Non-cancer effects of ingesting arsenic include cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects. Short-term exposure to high doses of arsenic can cause other adverse health effects, but such effects are unlikely to occur from U.S. public water supplies that are in compliance with the previous arsenic standard of 50 ppb (EPA, 2001). Barium and fluoride were also detected in extremely low concentrations

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Synthetic Organic Chemicals

The residential septic systems represent the greatest risk for synthetic organic chemicals to the well.

Synthetic organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Other Organic Chemicals

The motor vehicle dealership represents the greatest risk for other organic chemicals to the well.

Other organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

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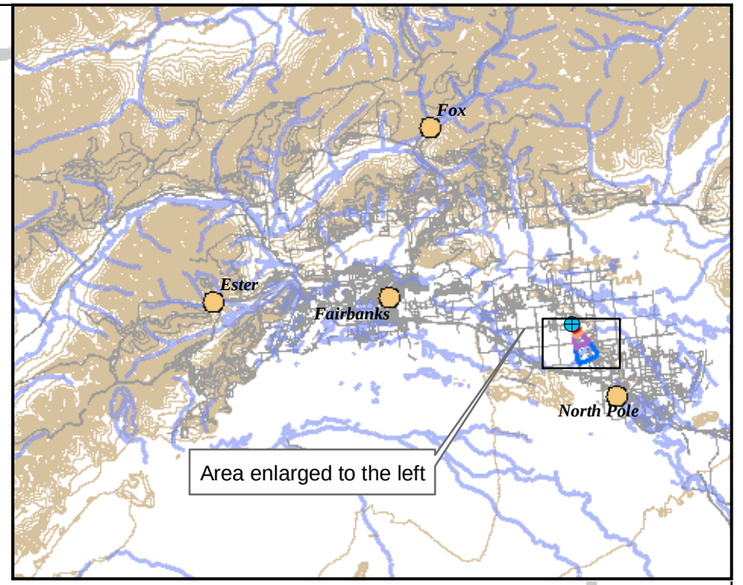
APPENDIX A

Badger Road Elementary
Drinking Water Protection Area Location Map
(Map 1)

ROMA STREET
BECKY STREET
PTARMIGAN WAY
BRADWAY ROAD
BENSHOOF DRIVE
OLD BADGER ROAD
WILLIS COURT
TEE COURT
STONEMAN LANE
BADGER ROAD
CARRIE LYNN DRIVE
LUCINDA COURT
LISA ANN DRIVE
BROCK ROAD
TRACY AVENUE
SCOUGAL ROAD
BENN LANE
TUNNELS ROAD
WOLL ROAD
ARABIAN COURT
CLYDESDALE DRIVE
FOXGLOVE STREET
ASTER DRIVE
COLUMBINE DRIVE
MARIGOLD ROAD
POPPY DRIVE
SUNFLOWER LOOP
OWNBY ROAD
CHRISTINE DRIVE
QUINCY COURT
REPP ROAD
TERRY LANE
BONA STREET
JULIE LANE
BEAR ROAD
BEAR AVENUE
NATALIE AVENUE
BLACKBURN WAY
SAMANTHA COURT
SARA LEE LANE
LIONS ROAD
PERIDOT STREET
GARNET DRIVE
KOONZ DRIVE
TOPAZ AVENUE
DILLON AVENUE
REGAL AVENUE
DRUM AVENUE
MILLIE COURT
STONECREST COURT
BOULDER AVENUE
PLACK ROAD
BADGER ROAD
WILLEDA STREET
LARIX DRIVE
NORTH GOLDENROD CIRCLE

Zone A
Zone B
Zone C
Zone D



N
W
E
S

Legend

- Badger Road Elementary well
- Zone A *Several months travel time*
- Zone B *Less than 2 years travel time*
- Zone C *Less than 5 years travel time*
- Zone D *Less than 10 years travel time*
- Towns
- Rivers
- Roads

0 625 1,250 2,500 3,750 Feet

1:15,000

Data Sources:
Parcels, Roads - Fairbanks North Star Borough
Water bodies, Railroad - Geographic Data Technology
Elevations contours - USGS digital elevation models (DEMs)

Map 1. Badger Road Elementary Drinking Water Protection Area

PWSID 371265.001

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary (Tables 1-7)

Table 1

Contaminant Source Inventory for ***Badger Road Elementary***

PWSID 371265.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Farm machinery areas	A03	A03-1	C	2	2441 Marigold Rd
Hardware stores	C17	C17-1	C	2	2400 Sunflower Loop
Residential Areas	R01	R01-1	C	2	Approximately 80 acres of residential area within Zone C
Septic systems (serves one single-family home)	R02		C	2	52 septics based on tax parcels designated as residential
Tanks, heating oil, residential (above ground)	R08		C	2	52 tanks based on tax parcels designated as residential

Table 2

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary Sources of Nitrates/Nitrites

PWSID 371265.001

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		C	Low	2	52 septics based on tax parcels designated as residential
Hardware stores	C17	C17-1	C	Low	2	2400 Sunflower Loop
Residential Areas	R01	R01-1	C	Low	2	Approximately 80 acres of residential area within Zone C

Table 3

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary Sources of Volatile Organic Chemicals

PWSID 371265.001

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		C	Low	2	52 septics based on tax parcels designated as residential
Tanks, heating oil, residential (above ground)	R08		C	Medium	2	52 tanks based on tax parcels designated as residential
Farm machinery areas	A03	A03-1	C	Low	2	2441 Marigold Rd
Hardware stores	C17	C17-1	C	Low	2	2400 Sunflower Loop
Residential Areas	R01	R01-1	C	Low	2	Approximately 80 acres of residential area within Zone C

Table 4

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 371265.001

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		C	Low	2	52 septics based on tax parcels designated as residential
Farm machinery areas	A03	A03-1	C	Low	2	2441 Marigold Rd
Hardware stores	C17	C17-1	C	Low	2	2400 Sunflower Loop
Residential Areas	R01	R01-1	C	Low	2	Approximately 80 acres of residential area within Zone C

Table 5

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary Sources of Synthetic Organic Chemicals

PWSID 371265.001

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		C	Low	2	52 septics based on tax parcels designated as residential
Farm machinery areas	A03	A03-1	C	Medium	2	2441 Marigold Rd
Residential Areas	R01	R01-1	C	Low	2	Approximately 80 acres of residential area within Zone C

Table 6

Contaminant Source Inventory and Risk Ranking for Badger Road Elementary Sources of Other Organic Chemicals

PWSID 371265.001

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		C	Low	2	52 septics based on tax parcels designated as residential
Farm machinery areas	A03	A03-1	C	Low	2	2441 Marigold Rd
Hardware stores	C17	C17-1	C	Low	2	2400 Sunflower Loop
Residential Areas	R01	R01-1	C	Low	2	Approximately 80 acres of residential area within Zone C

APPENDIX C

Badger Road Elementary
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

N
W
E
S

Zone A
Zone B
Zone C

SCOUGAL ROAD
WOLL ROAD
BADGER ROAD
OLD BADGER ROAD
STONEMAN LANE
LUCINDA COURT
LISA ANN
CLYDESDALE DRIVE
ARABIAN COURT
REPP ROAD
ASTER DRIVE
COLUMBINE DRIVE
FOXGLOVE STREET
MARIGOLD ROAD
POPPY DRIVE
SUNFLOWER LOOP
OWNBY ROAD

52 R08s in Zone C
52 R02s in Zone C
R01-1
A03-1
C17-1

Zone A
Zone B
Zone C
Zone D
Area enlarged at the left

Legend

- Badger Road Elementary well
- Zone A *Several months travel time*
- Zone B *Less than 2 years travel time*
- Zone C *Less than 5 years travel time*
- Zone D *Less than 10 years travel time*
- Hardware store (C17)
- Farm machinery area (A03)
- Residential heating oil AST (R08)
- Parcels
- Residential septic systems (R02)
- Residential area (R01)
- Roads (X20 or X24)

Data Sources:
Parcels, Roads - Fairbanks North Star Borough
Water bodies, Railroad - Geographic Data Technology

0 287.5 575 Feet

1:6,900

Map 2. Badger Road Elementary Potential Contaminant Sources

PWSID 371265

APPENDIX D

Vulnerability Analysis for Badger Road Elementary Public Drinking Water Source

(Charts 1-14)

Chart 1. Susceptibility of the wellhead - Badger Road Elementary

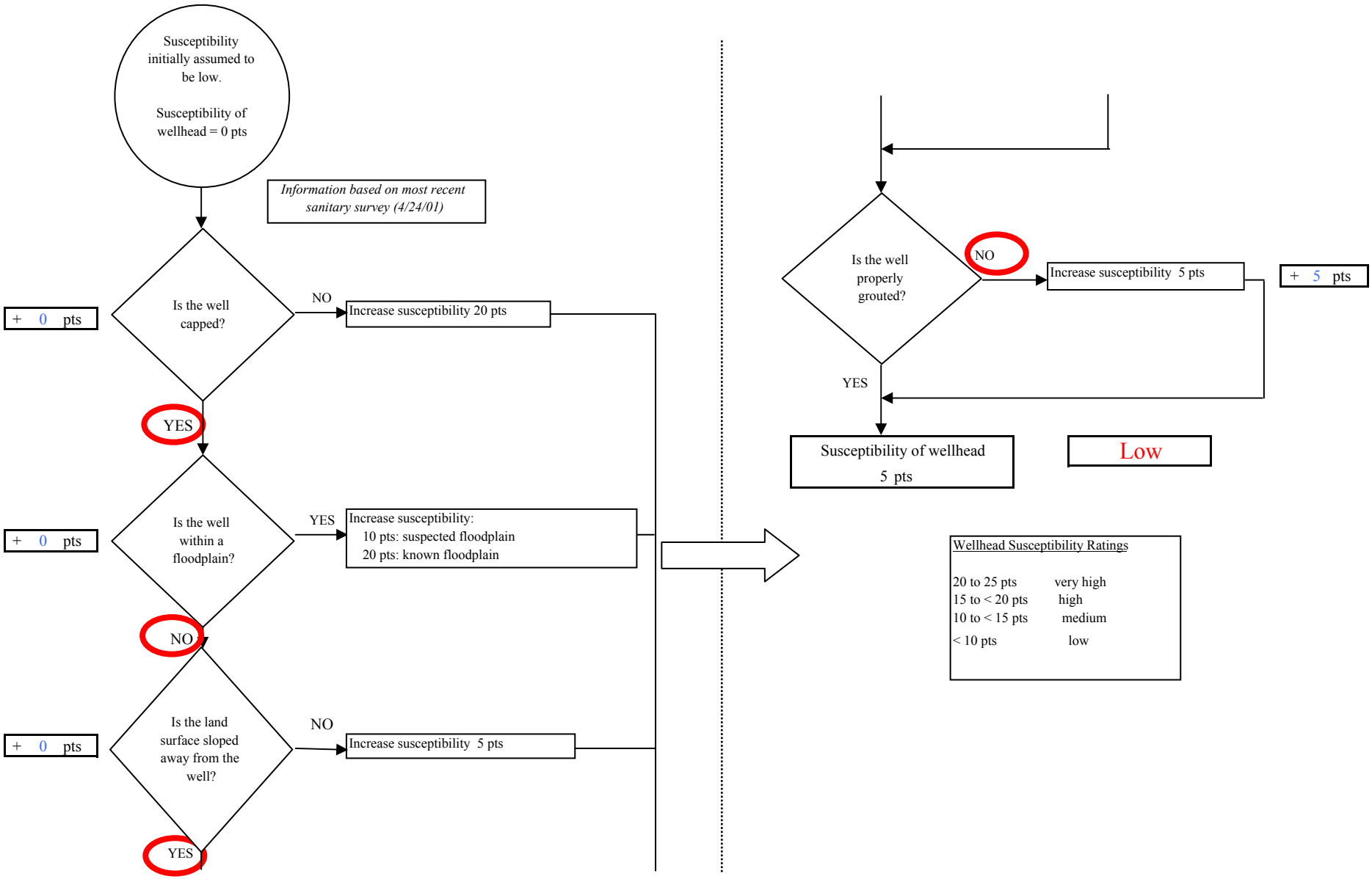


Chart 2. Susceptibility of the aquifer - Badger Road Elementary

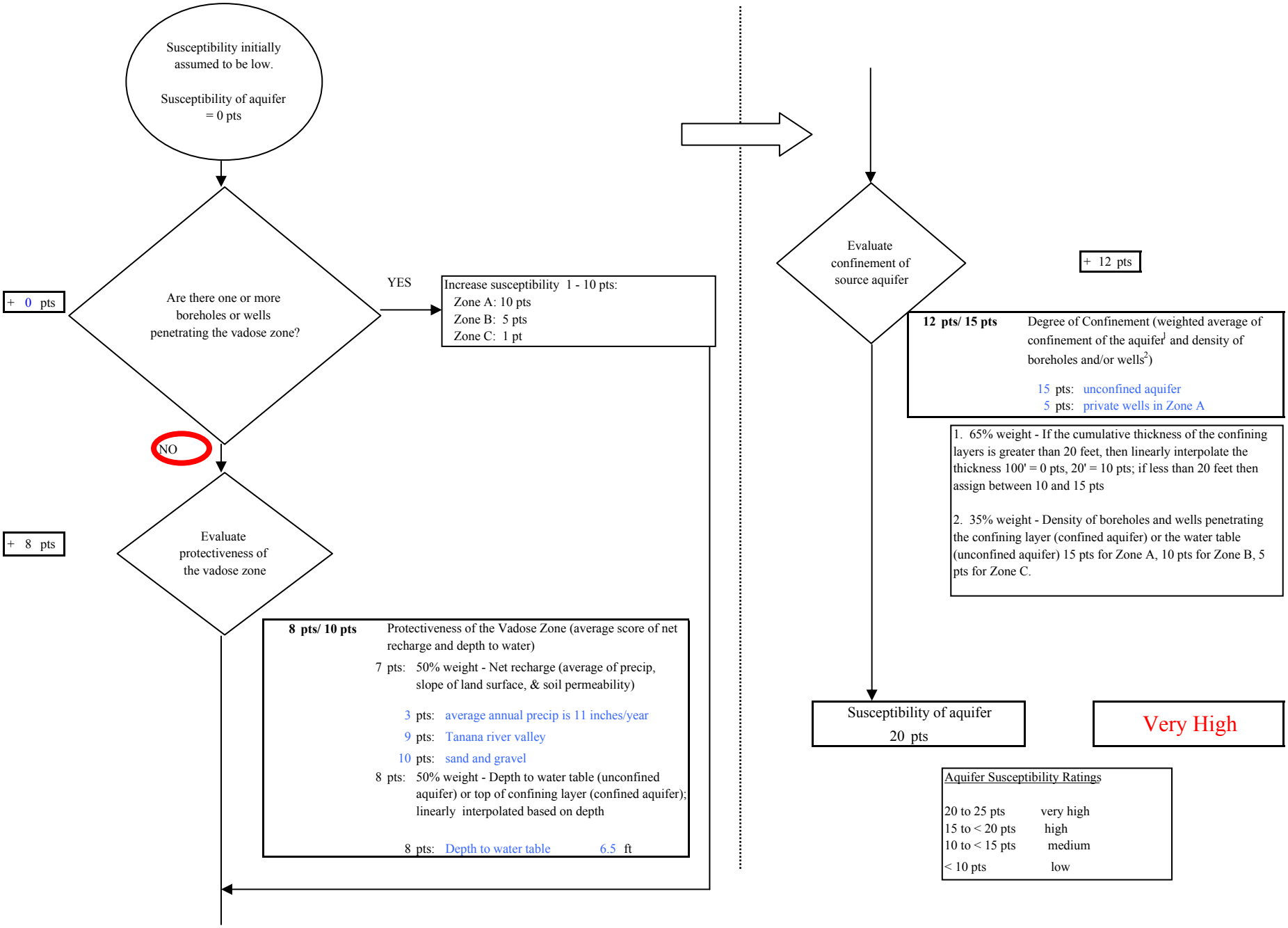
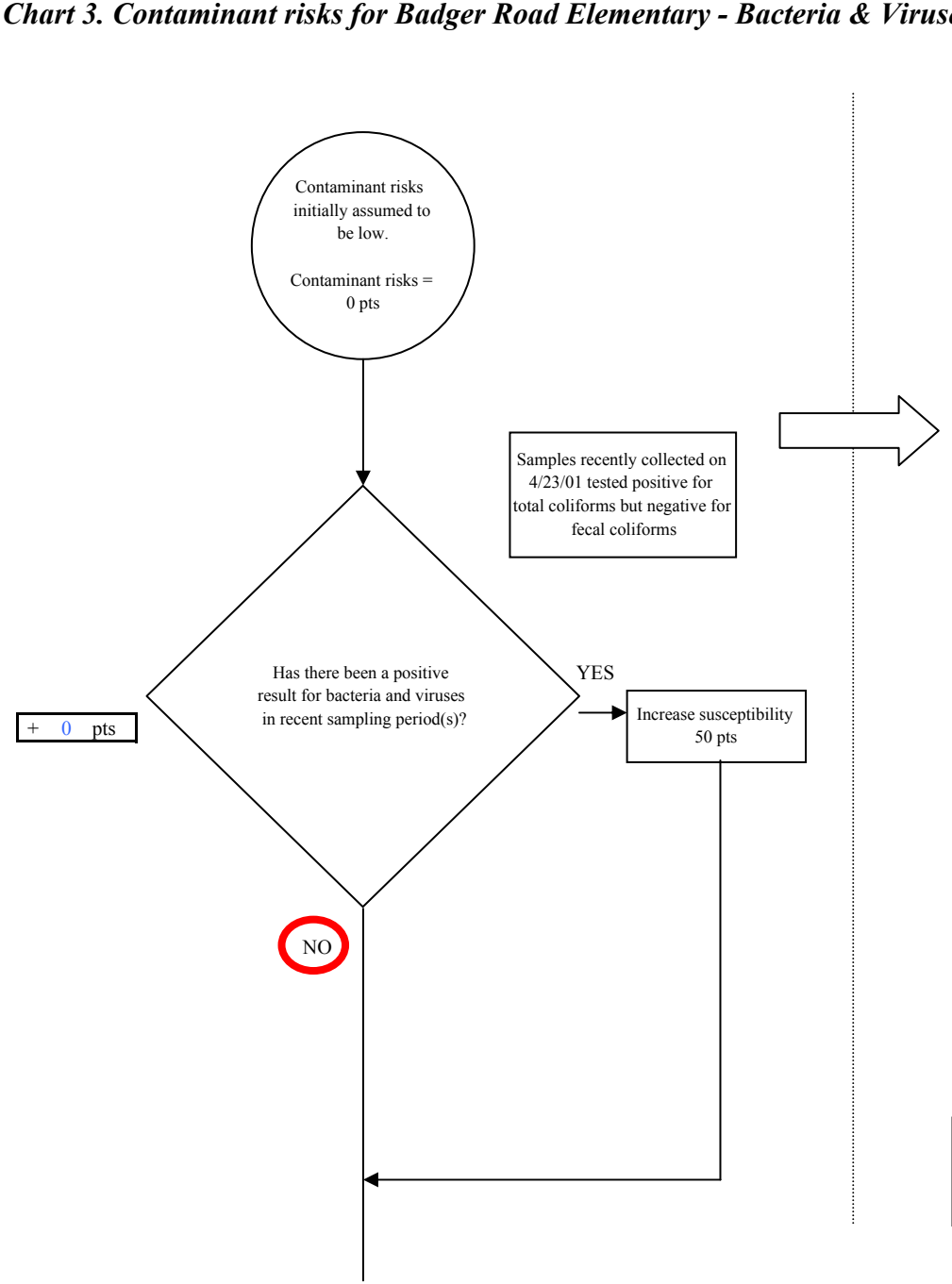
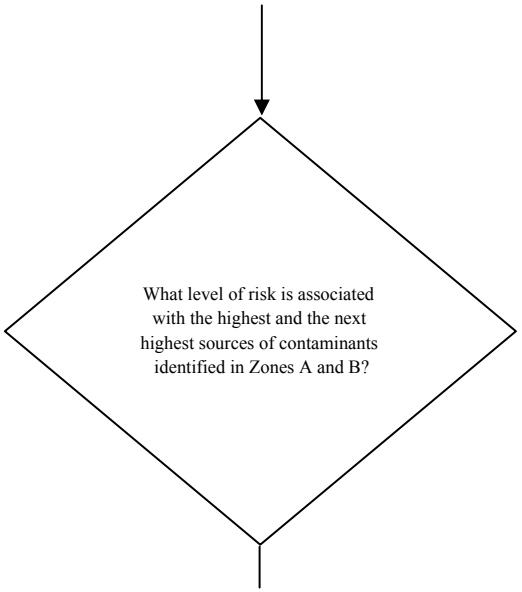


Chart 3. Contaminant risks for Badger Road Elementary - Bacteria & Viruses





+ 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 Badger Road Elementary - Bacteria & Viruses

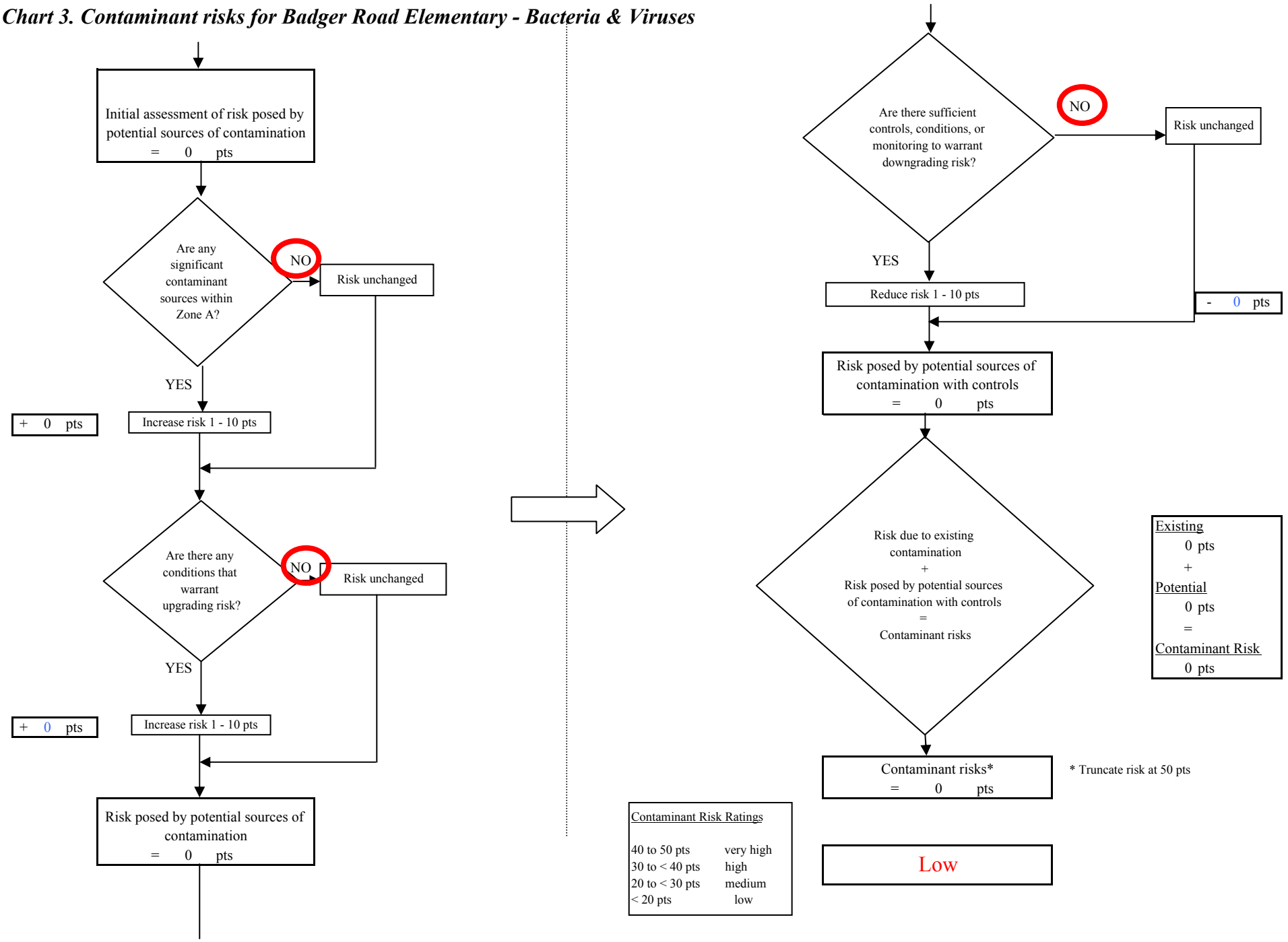


Chart 4. Vulnerability analysis for Badger Road Elementary - Bacteria & Viruses

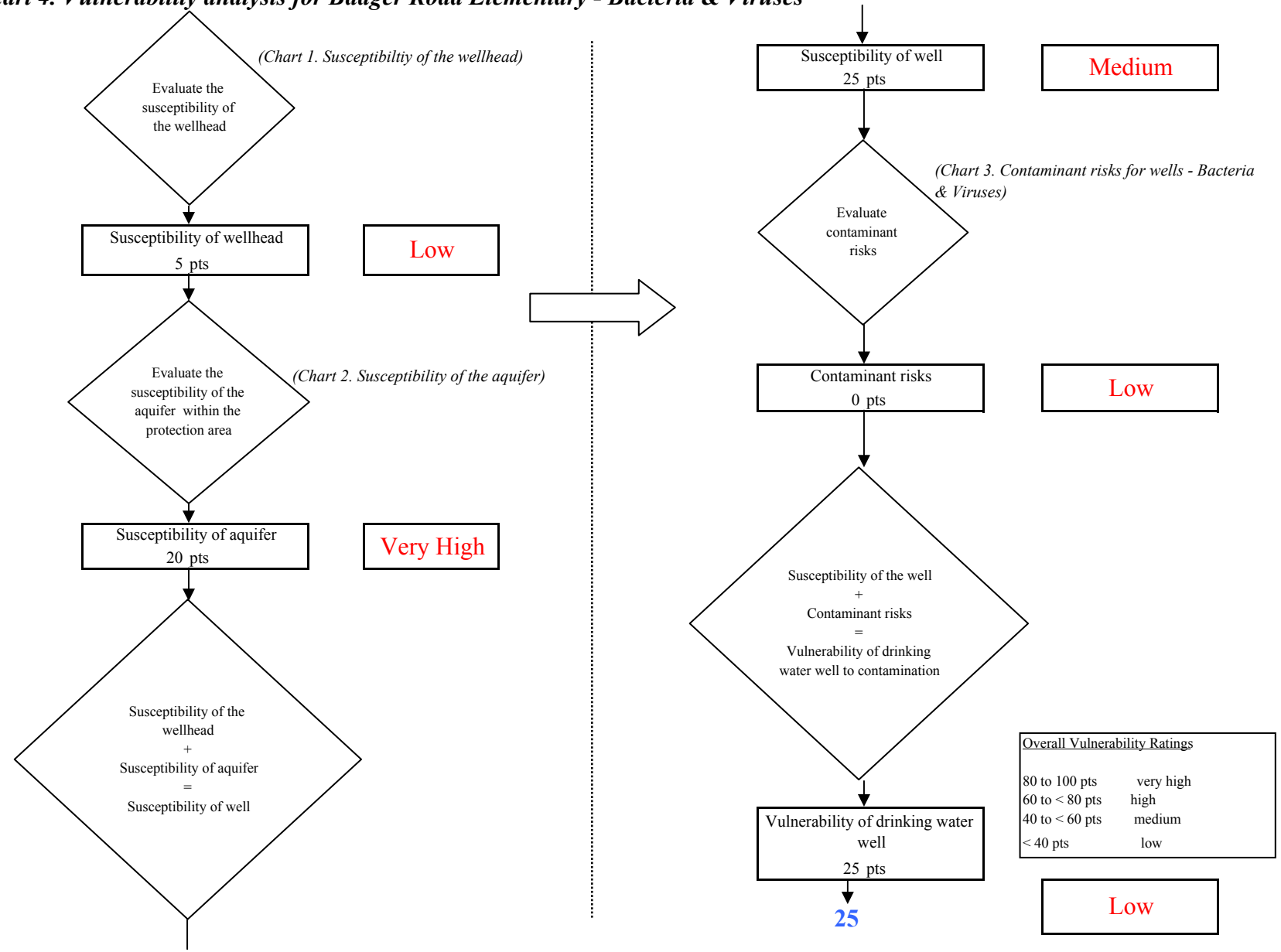


Chart 5. Contaminant risks for Badger Road Elementary - Nitrates and Nitrites

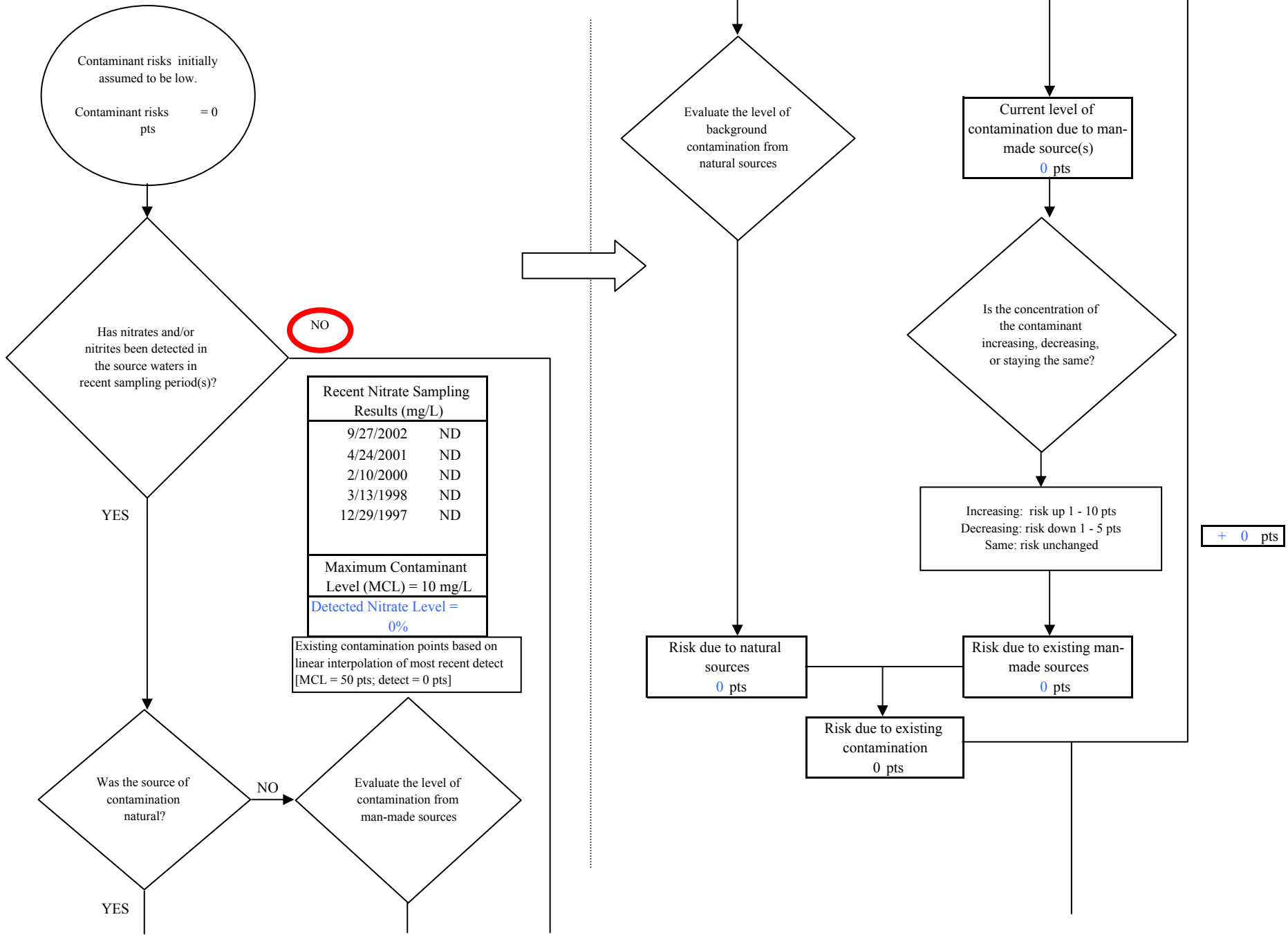
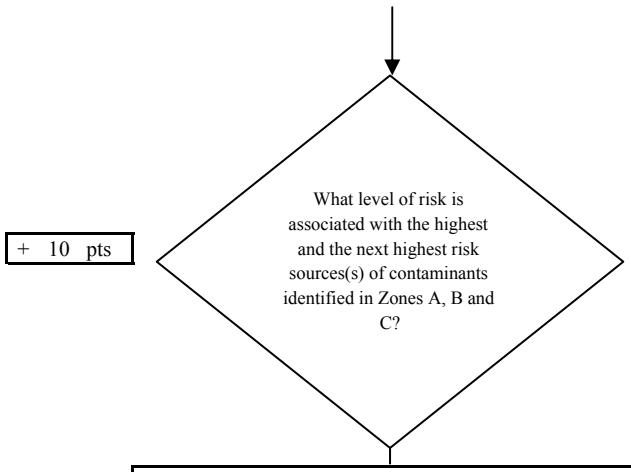


Chart 5. Contaminant risks for Badger Road Elementary - Nitrates and Nitrites



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)	0	8	8

	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 10

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

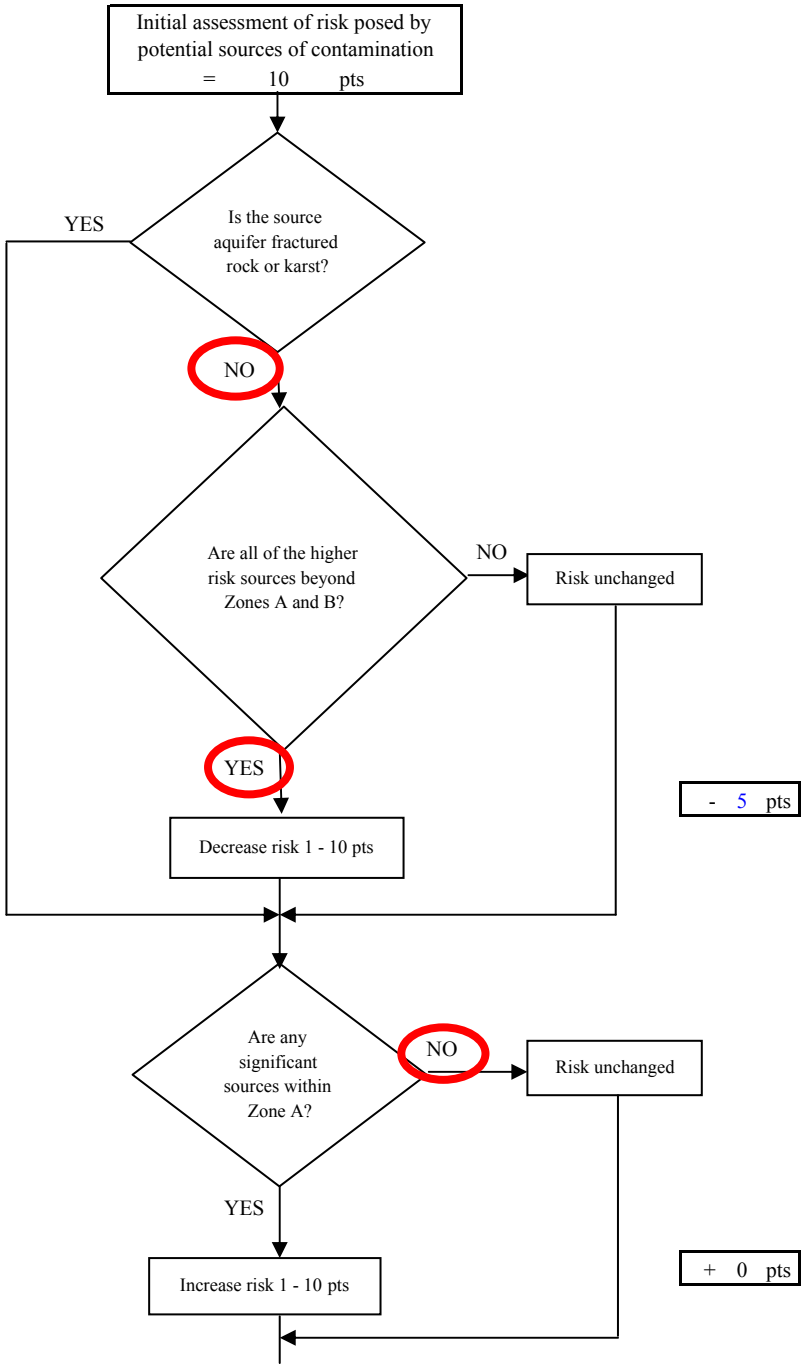
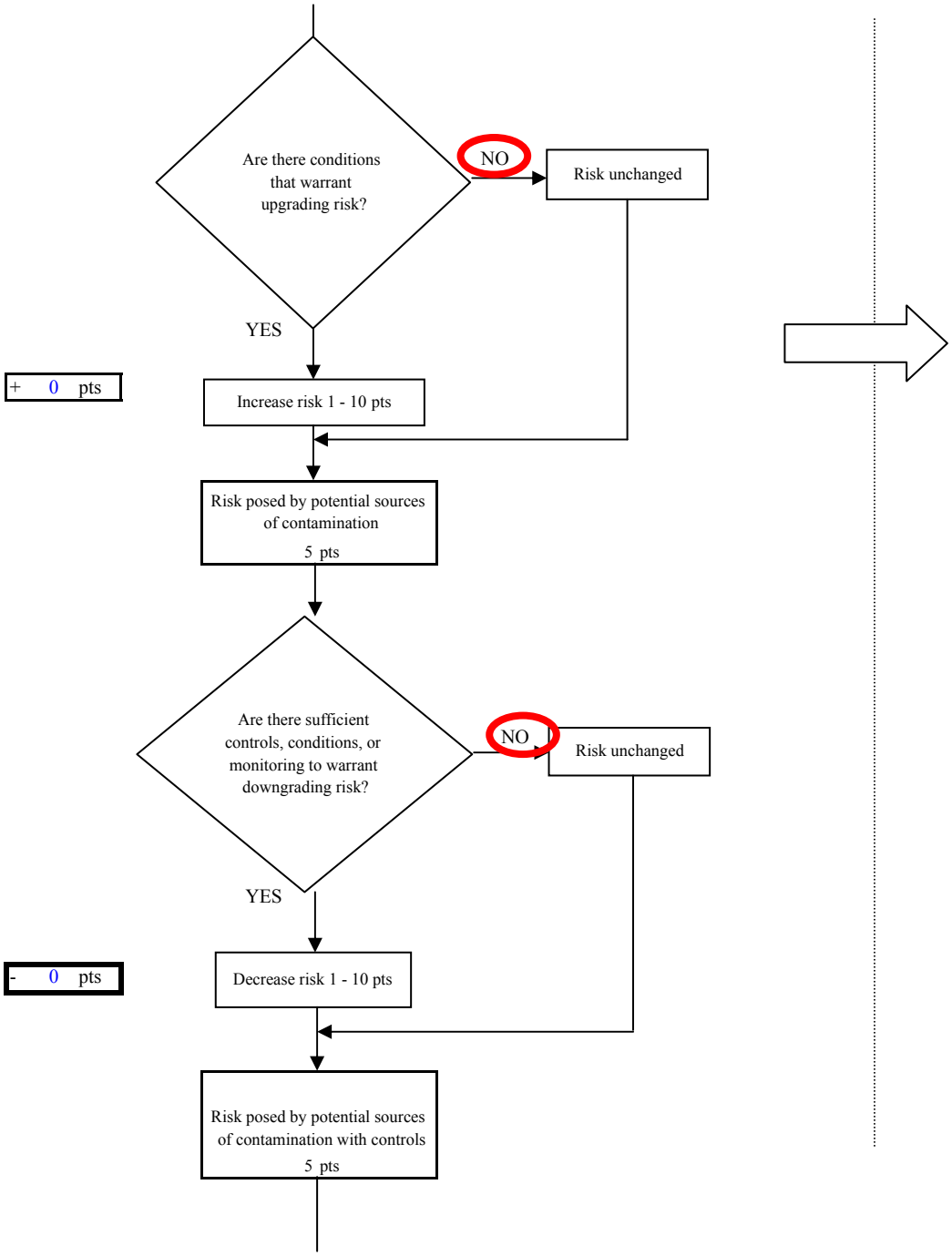


Chart 5. Contaminant risks for Badger Road Elementary - Nitrates and Nitrites



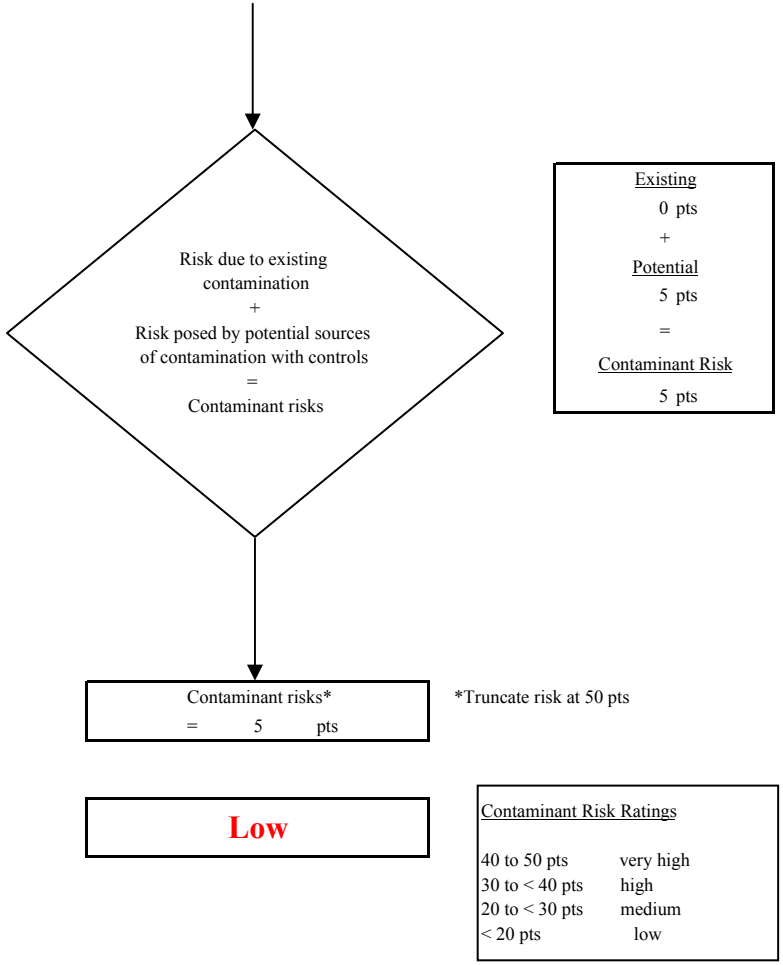


Chart 6. Vulnerability analysis for Badger Road Elementary - Nitrates and Nitrites

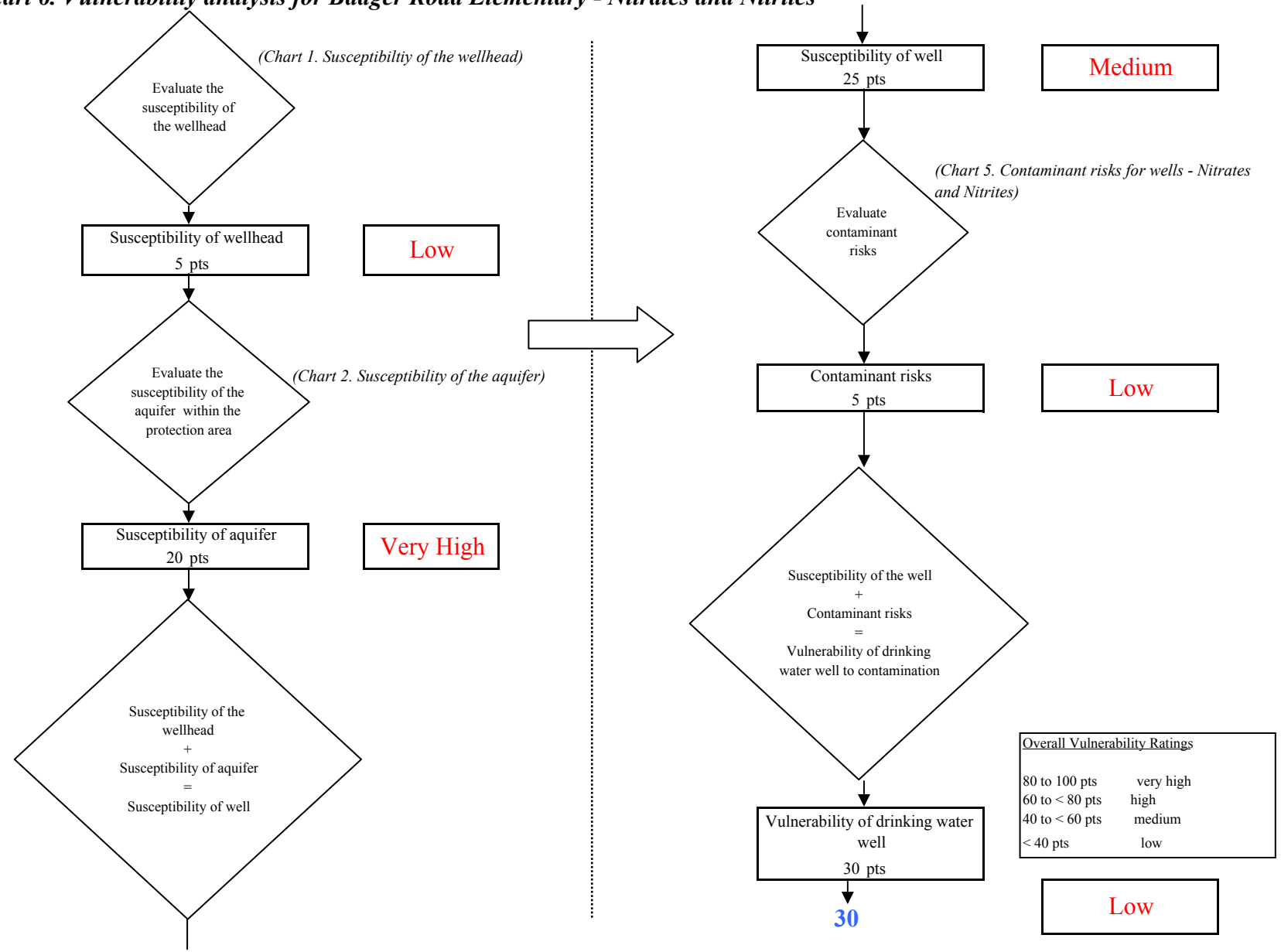


Chart 7. Contaminant risks for Badger Road Elementary - Volatile Organic Chemicals

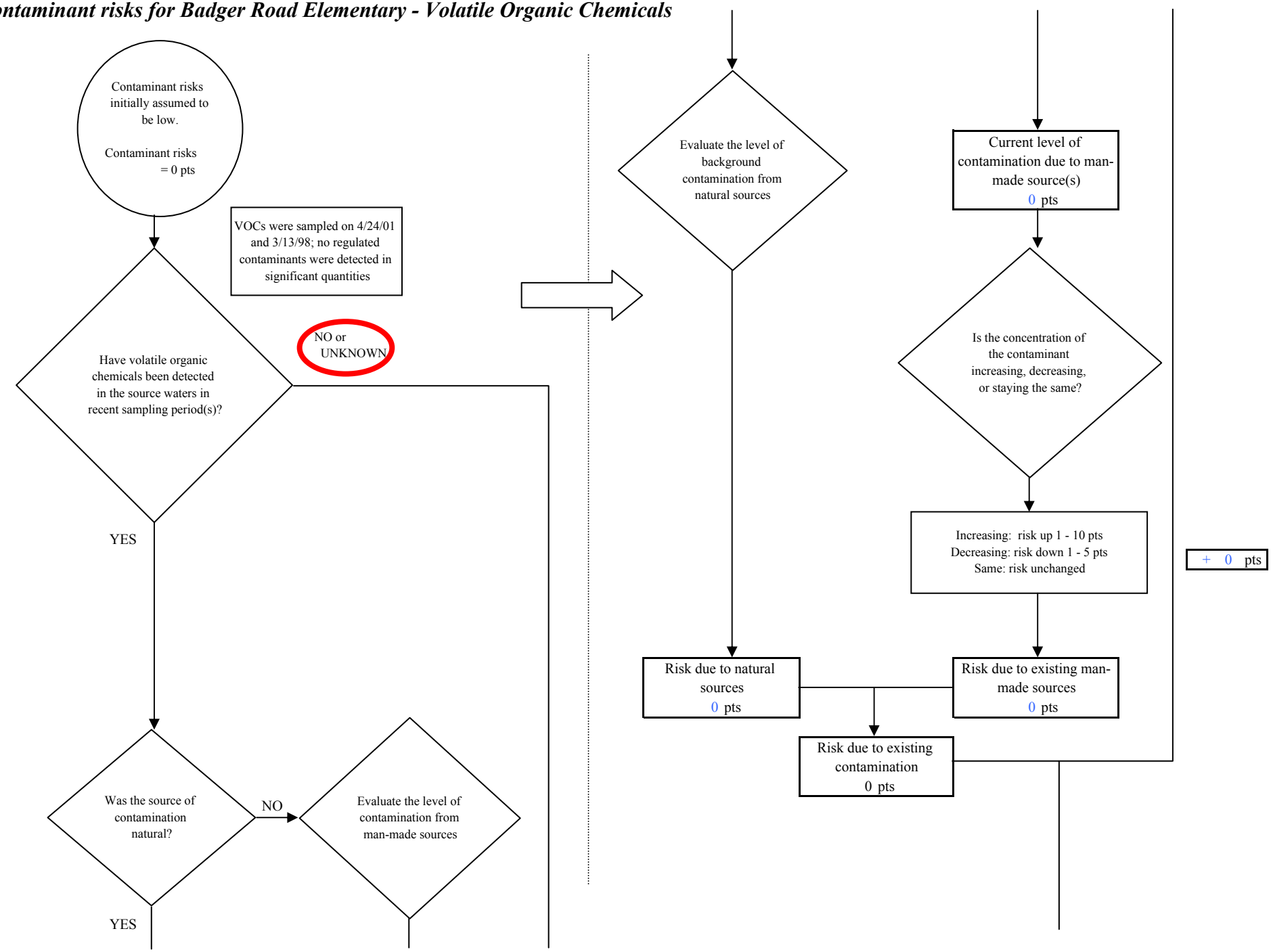


Chart 7. Contaminant risks for Badger Road Elementary - Volatile Organic Chemicals

+ 25 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	53	53
Low(s)	0	4	4

	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.

Initial assessment of risk posed by potential sources of contamination = 25 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

- 8 pts

Are any significant sources within Zone A?

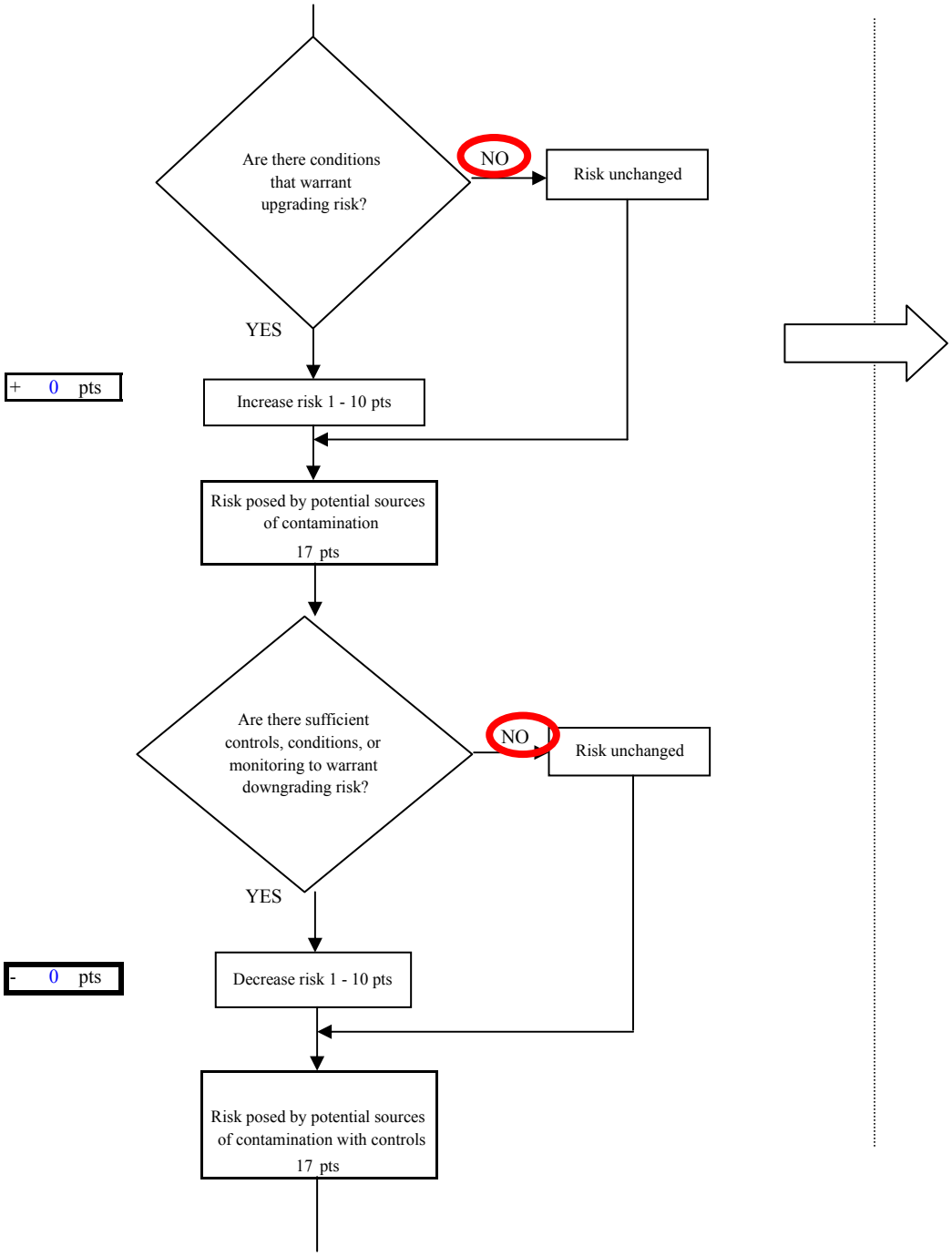
NO → Risk unchanged

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 7. Contaminant risks for Badger Road Elementary - Volatile Organic Chemicals



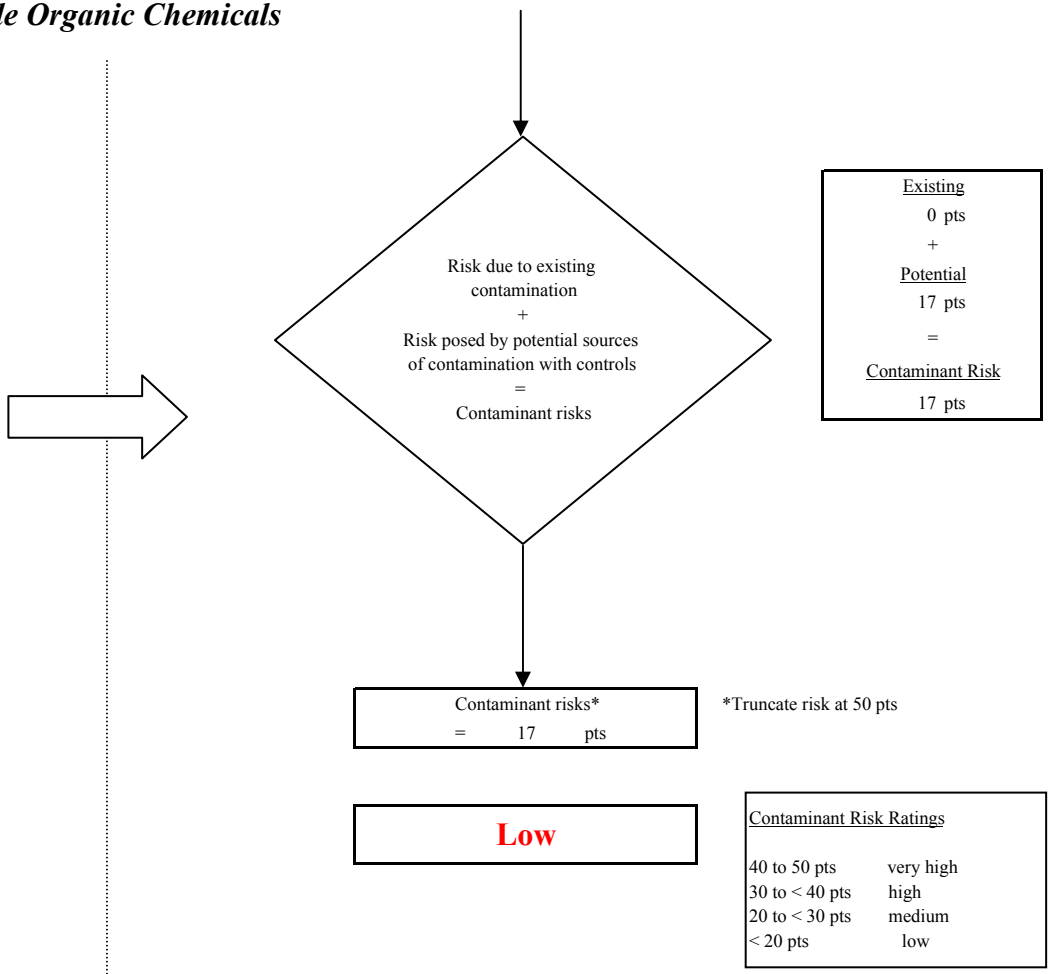


Chart 8. Vulnerability analysis for Badger Road Elementary - Volatile Organic Chemicals

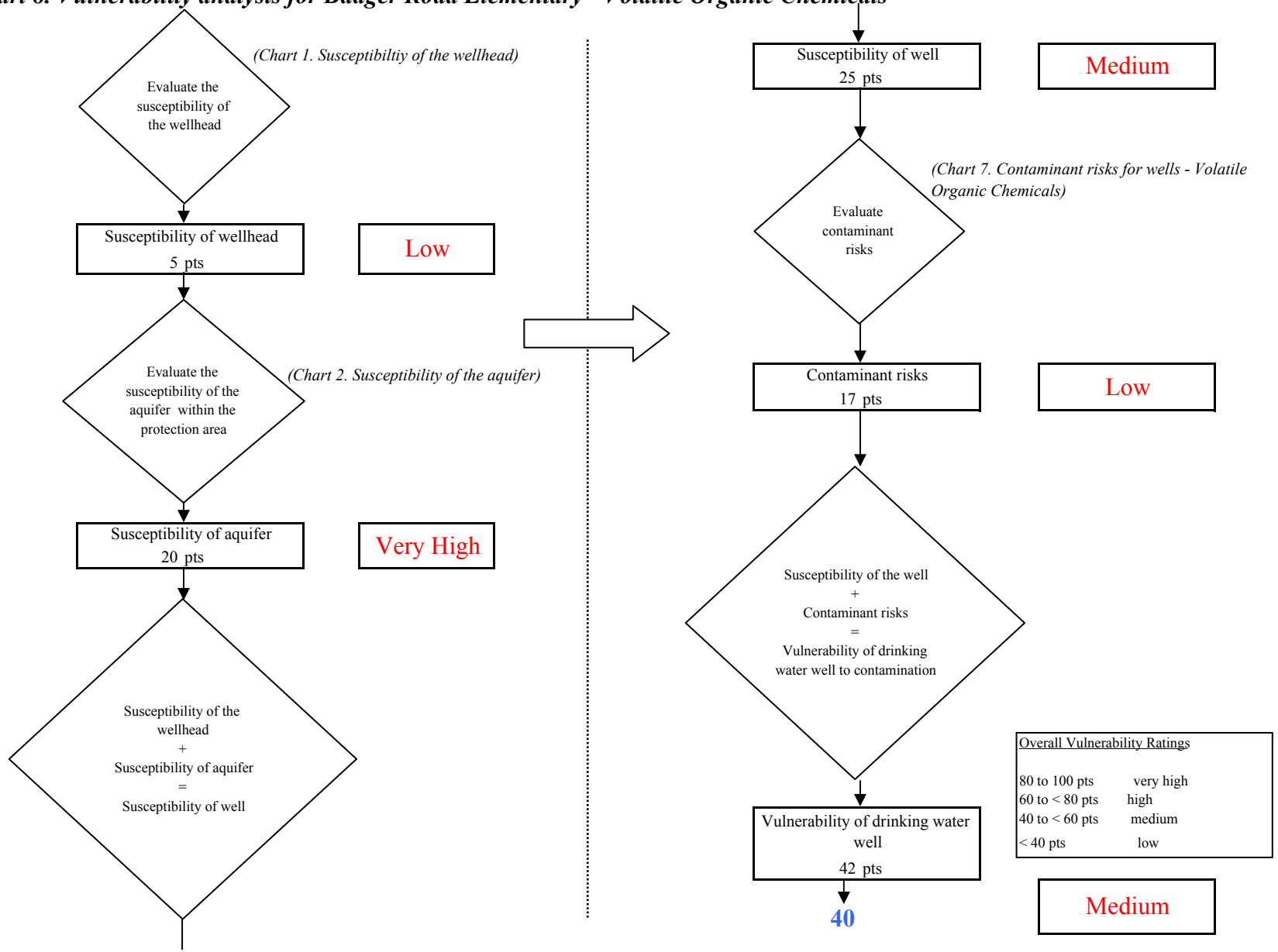


Chart 9. Contaminant risks for Badger Road Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

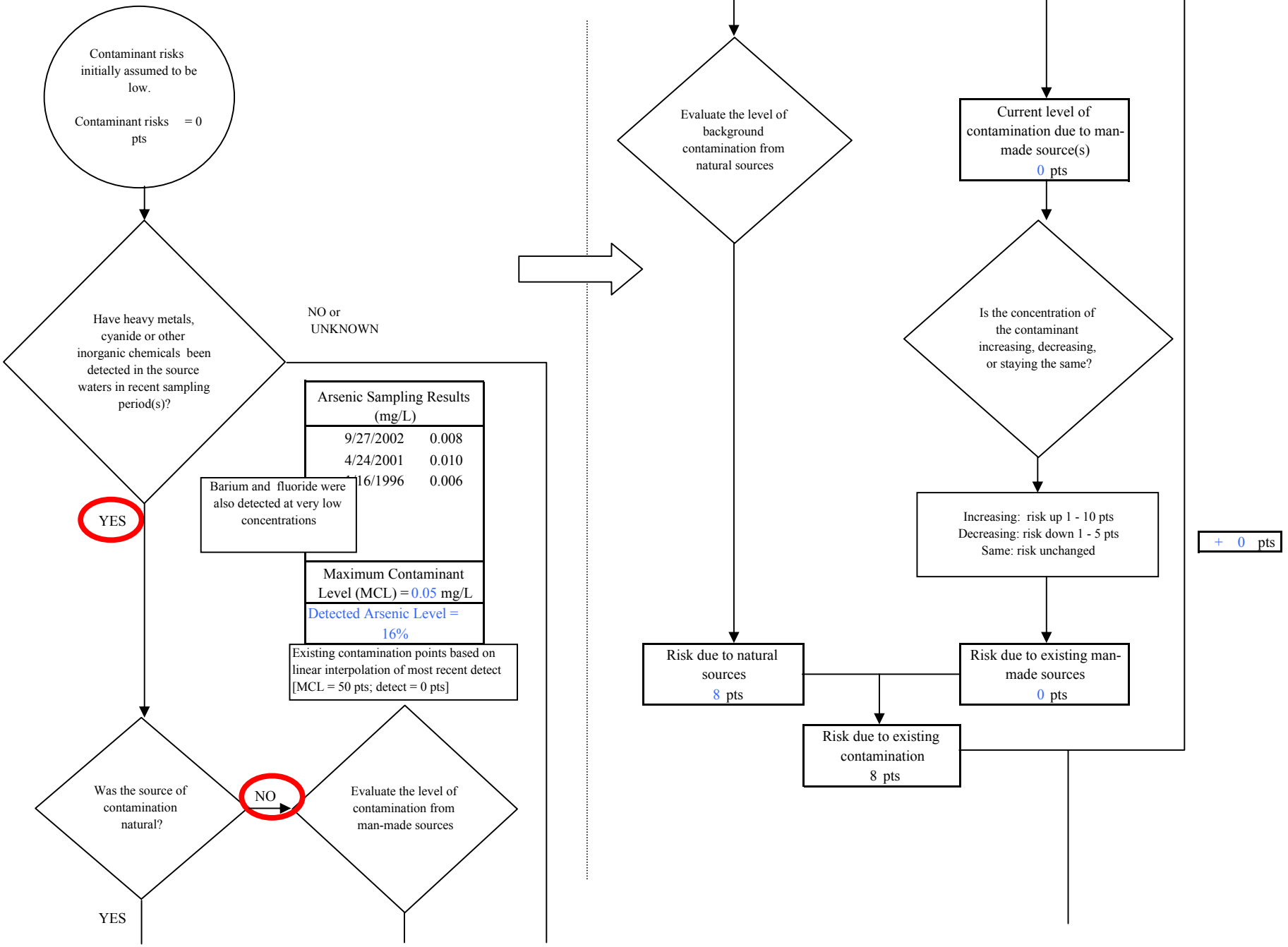


Chart 9. Contaminant risks for Badger Road Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 10 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)	0	4	4

	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 10

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

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

- 5 pts

Are any significant sources within Zone A?

NO → Risk unchanged

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 9. Contaminant risks for Badger Road Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

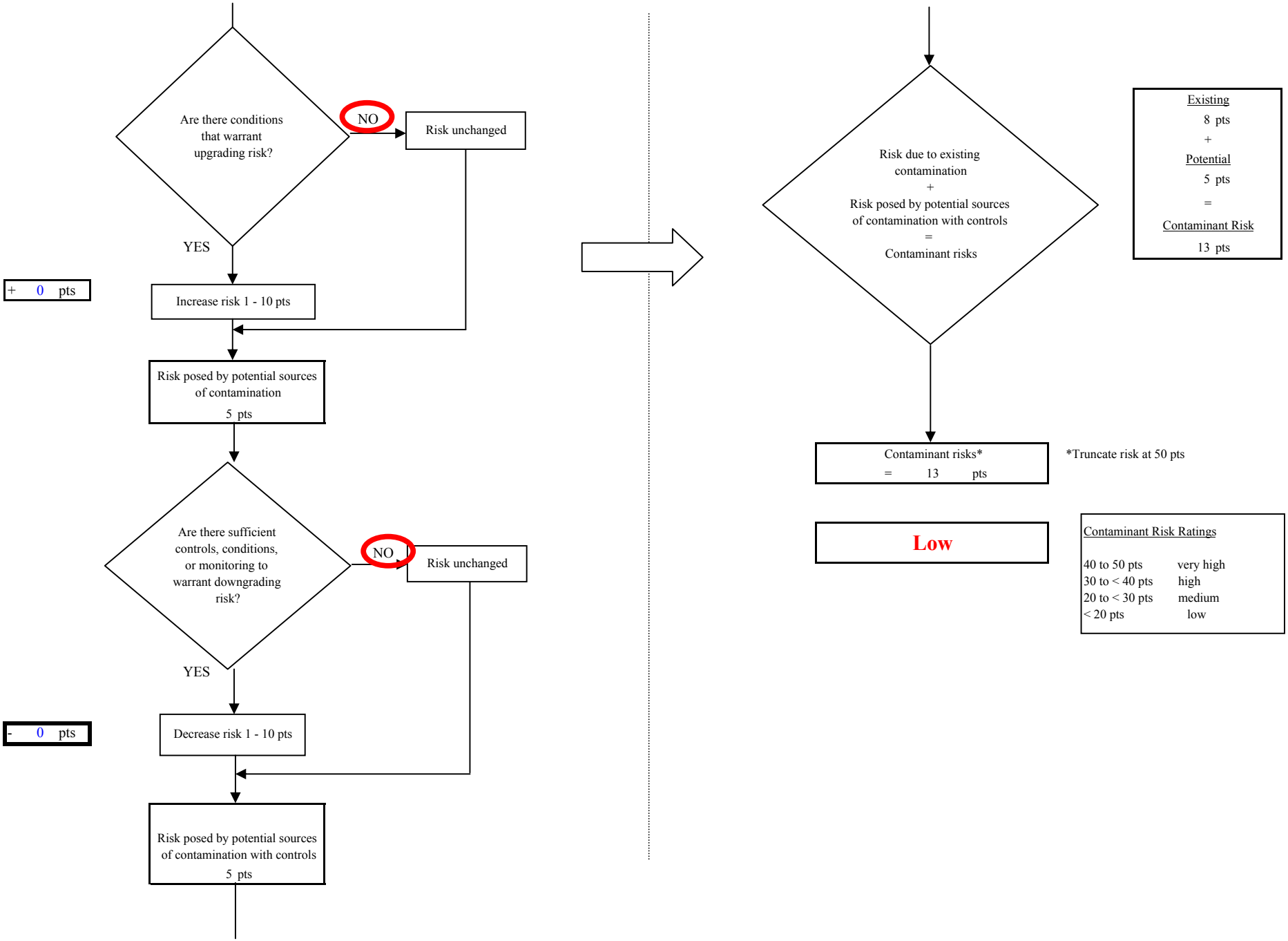


Chart 10. Vulnerability analysis for Badger Road Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

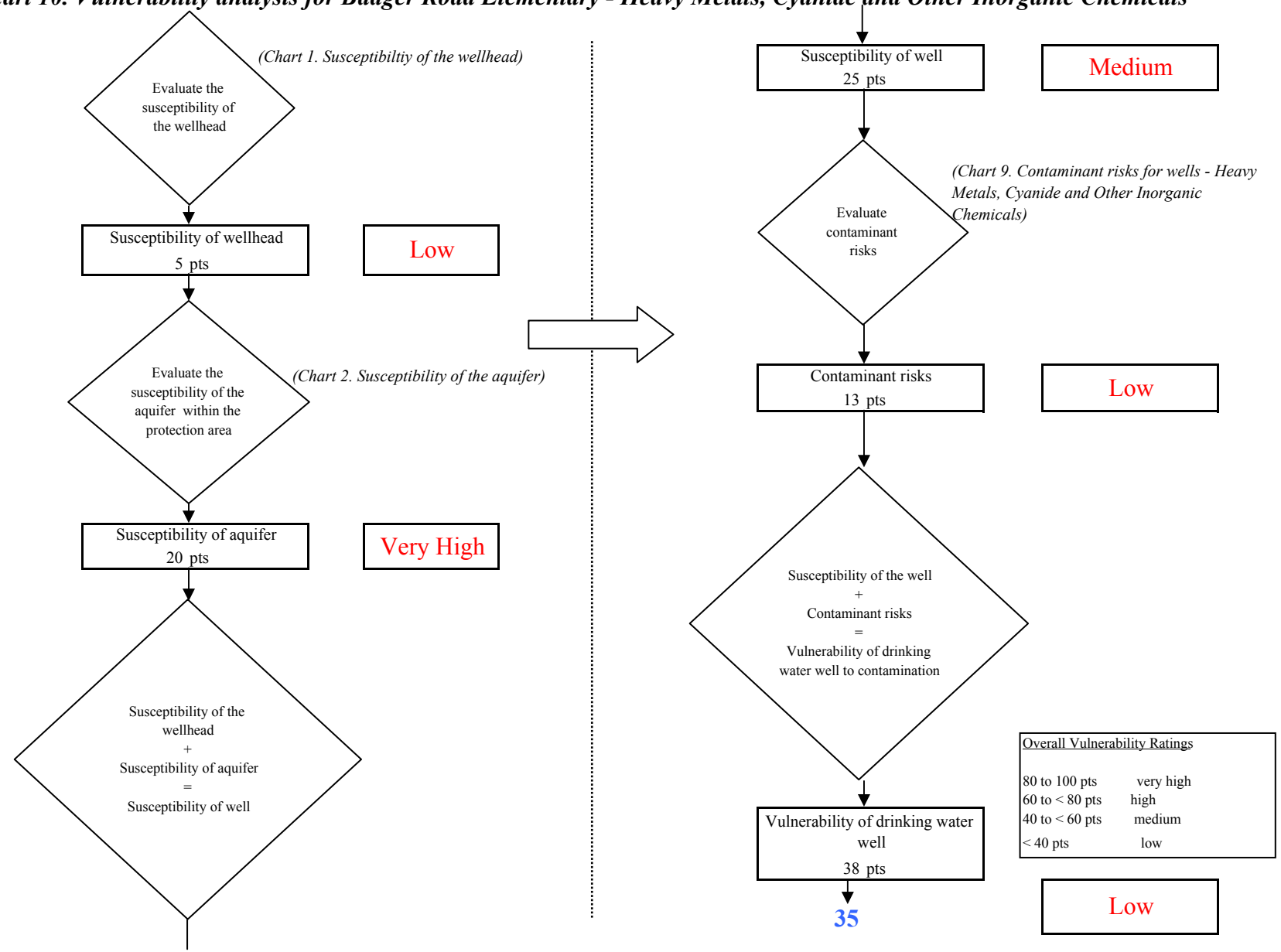


Chart 11. Contaminant risks for Badger Road Elementary - Synthetic Organic Chemicals

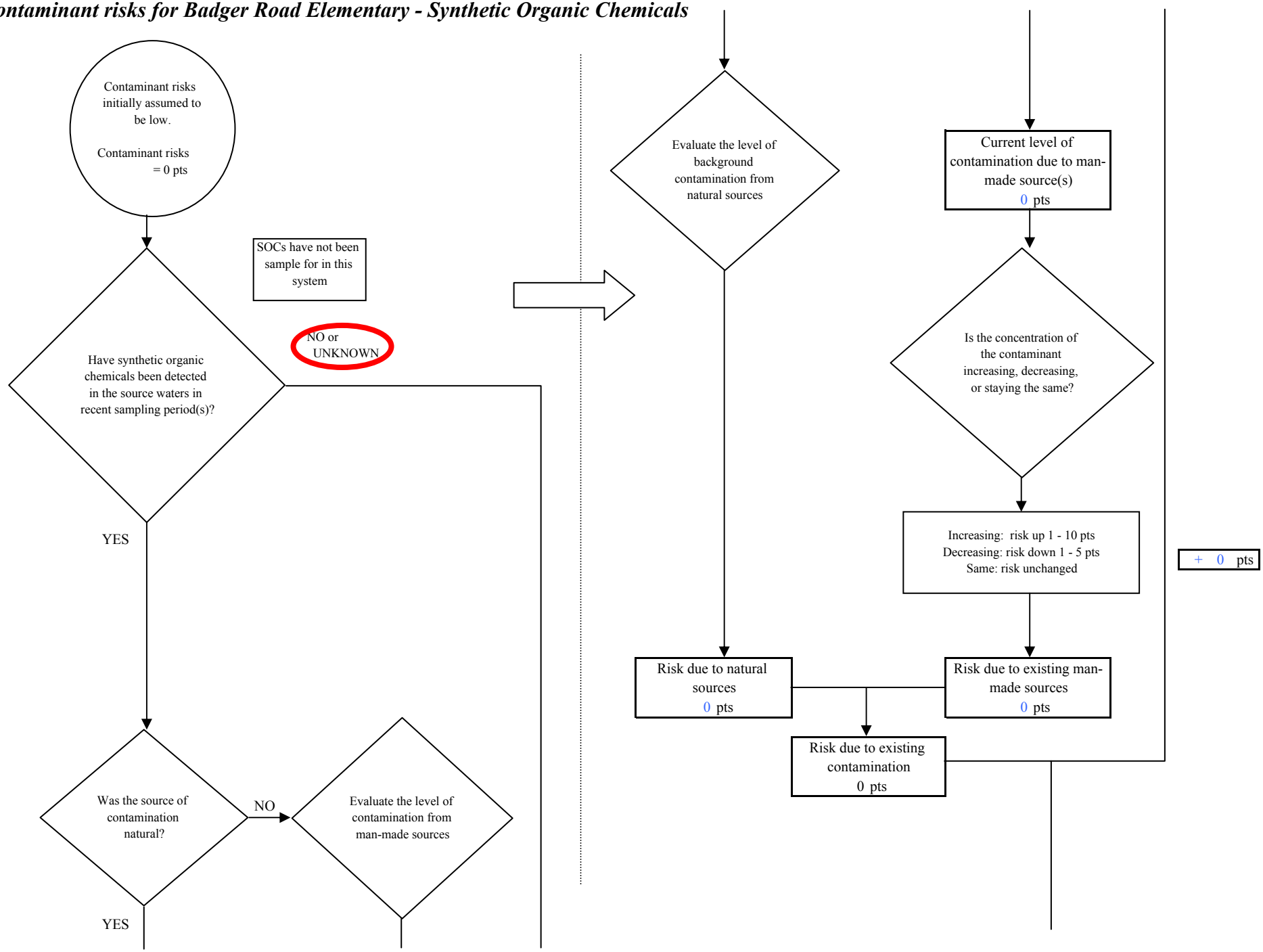


Chart 11. Contaminant risks for Badger Road Elementary - Synthetic Organic Chemicals

+ 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	1	1
Low(s)	0	2	2

	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.

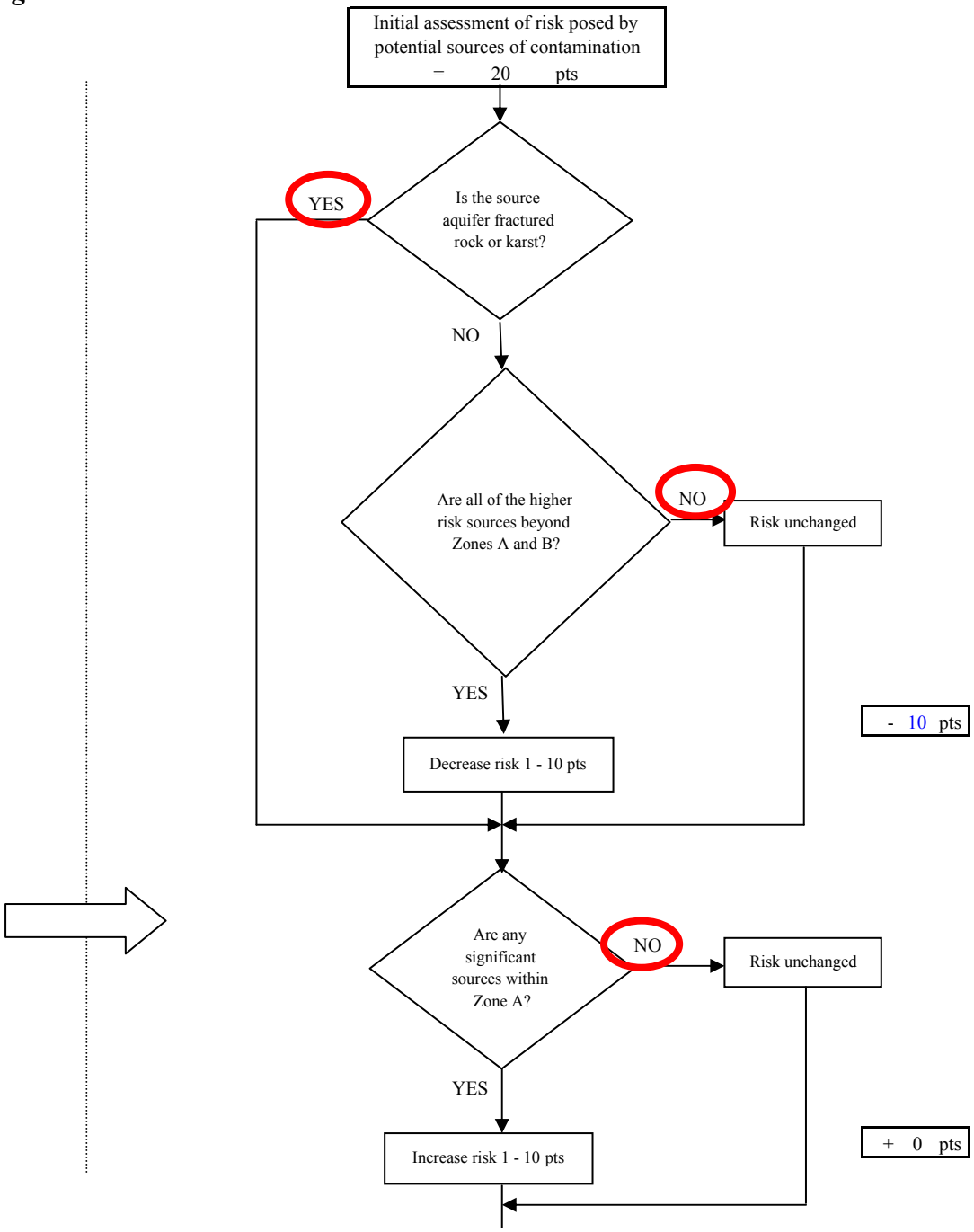


Chart 11. Contaminant risks for Badger Road Elementary - Synthetic Organic Chemicals

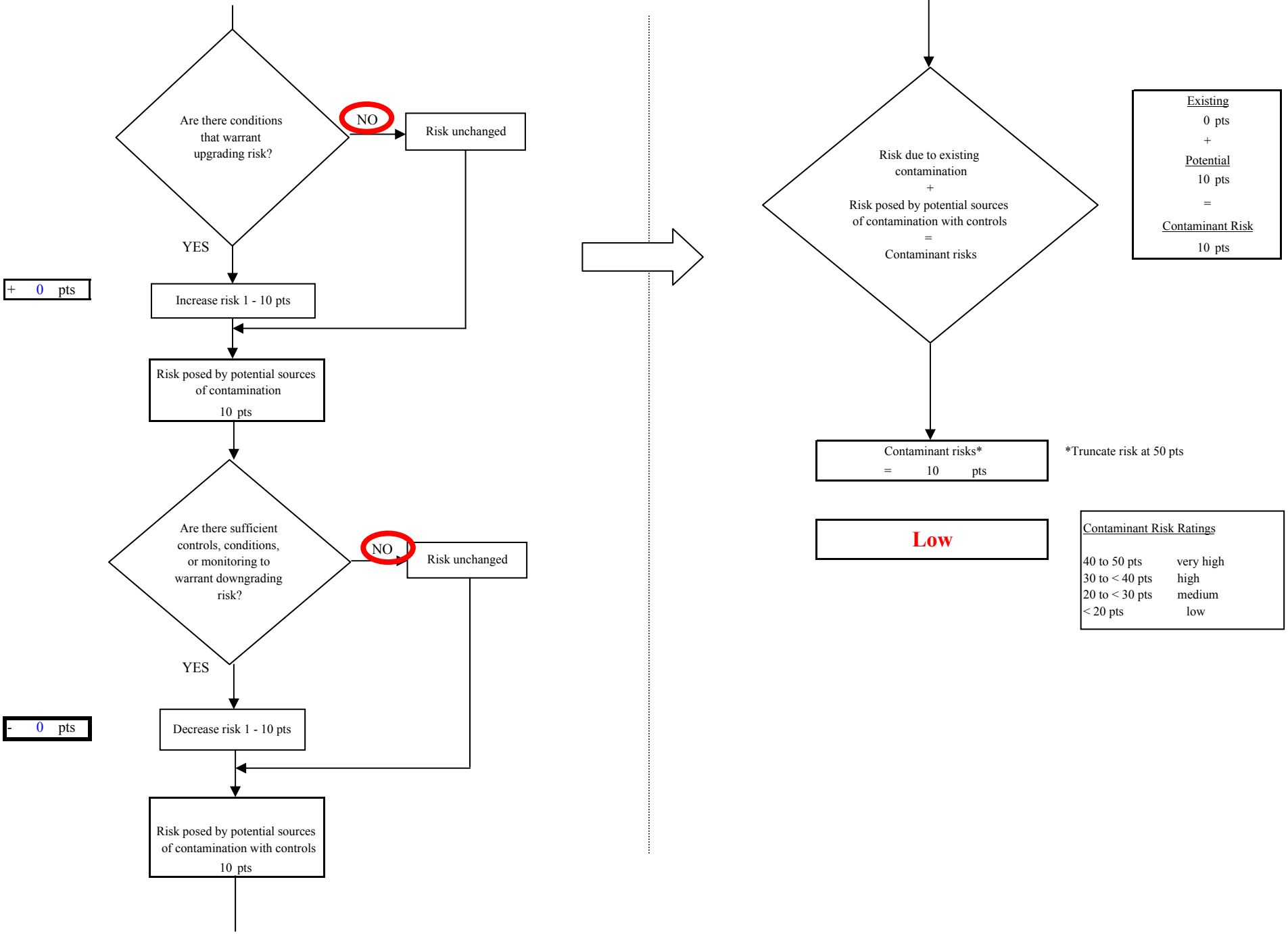


Chart 12. Vulnerability analysis for Badger Road Elementary - Synthetic Organic Chemicals

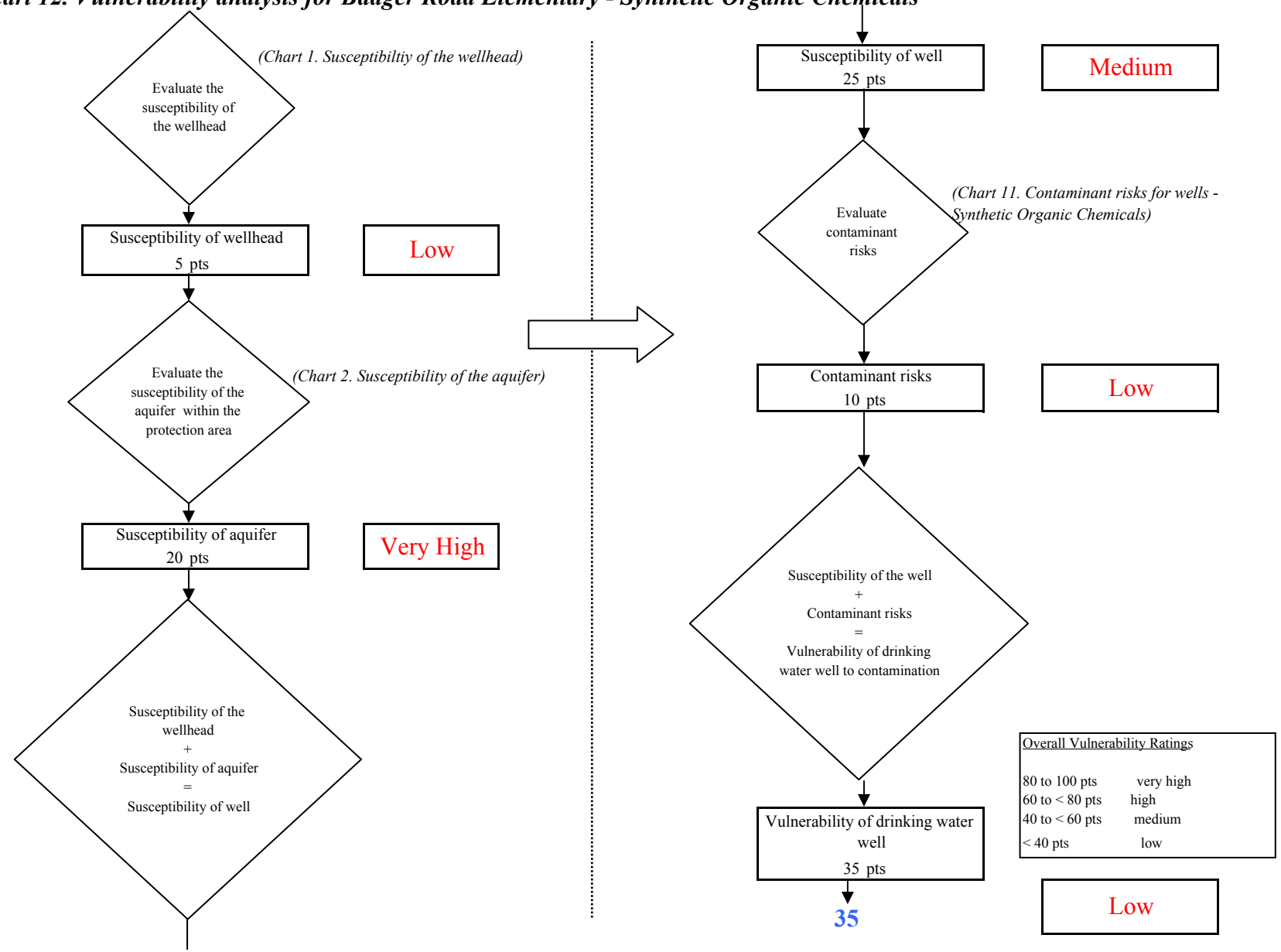


Chart 13. Contaminant risks for Badger Road Elementary - Other Organic Chemicals

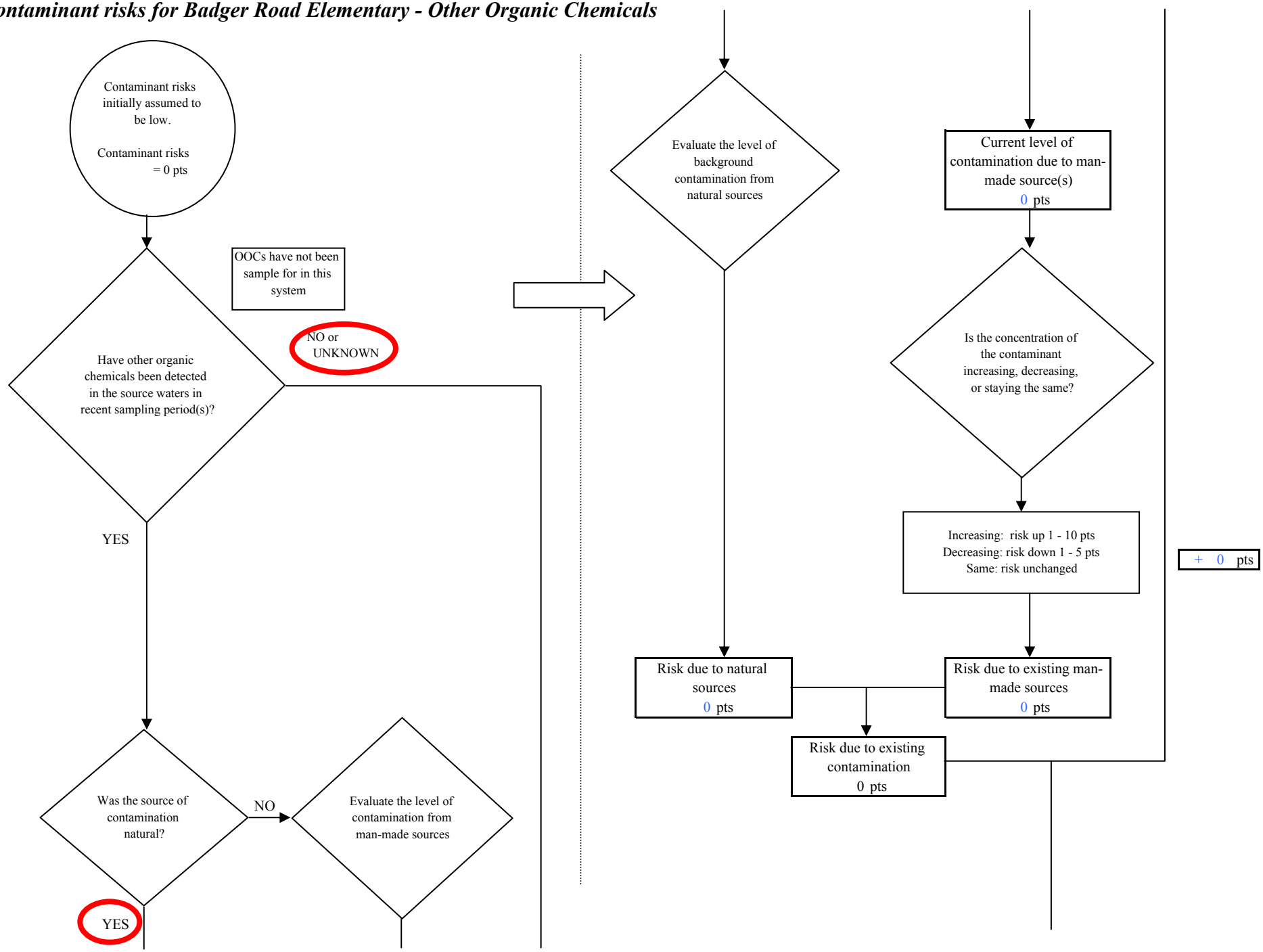
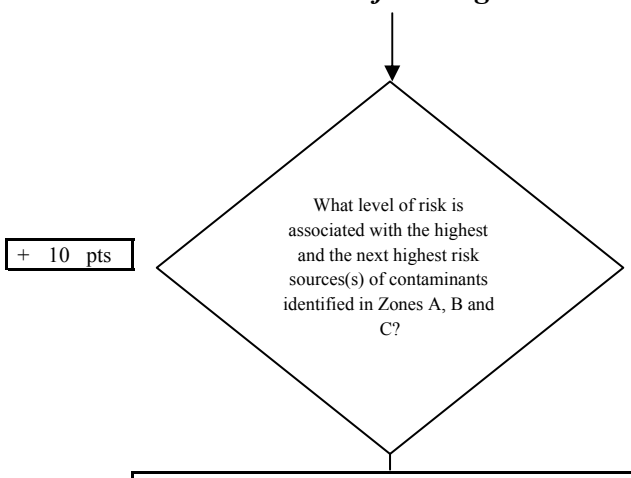


Chart 13. Contaminant risks for Badger Road Elementary - Other Organic Chemicals



+ 10 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)	0	0	0
Low(s)	0	4	4

	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 10

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

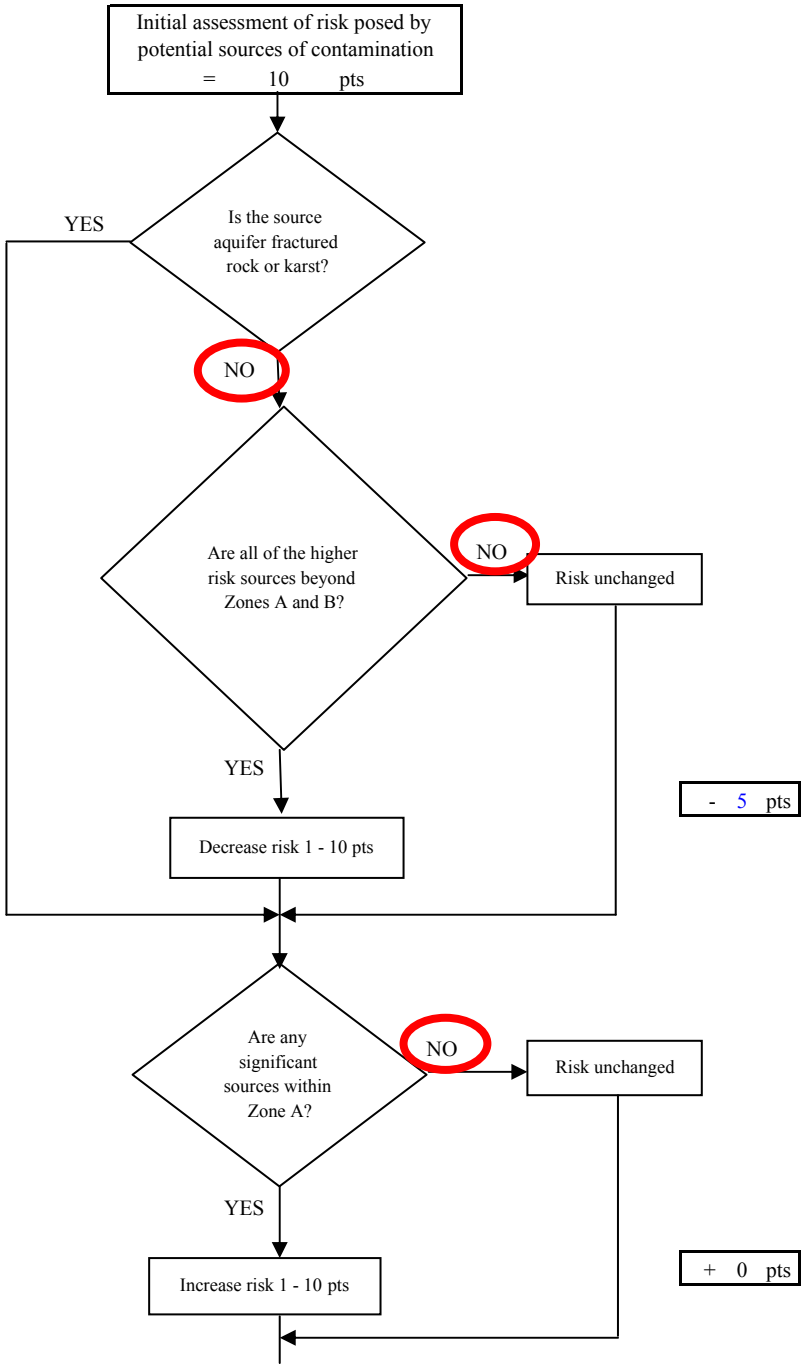
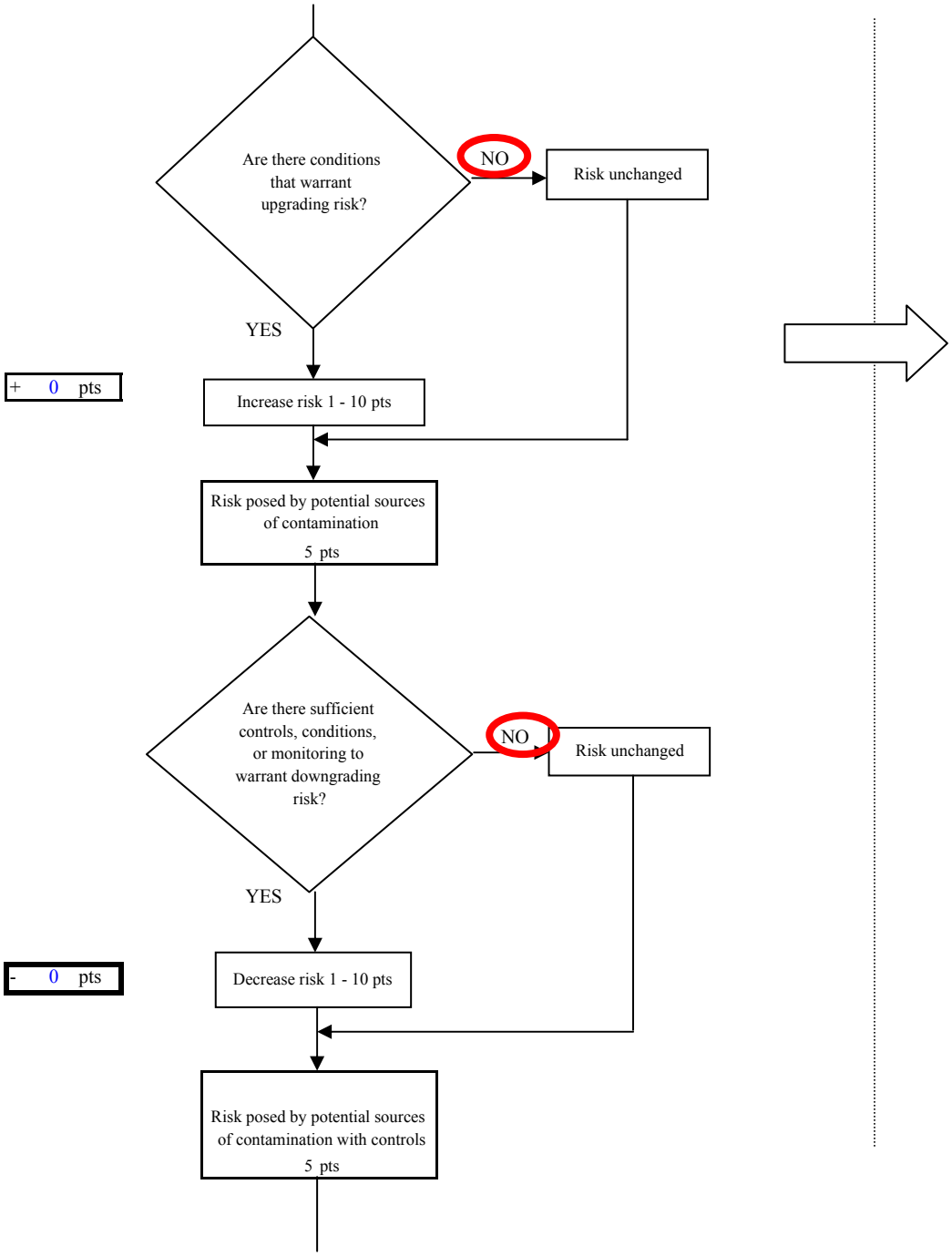
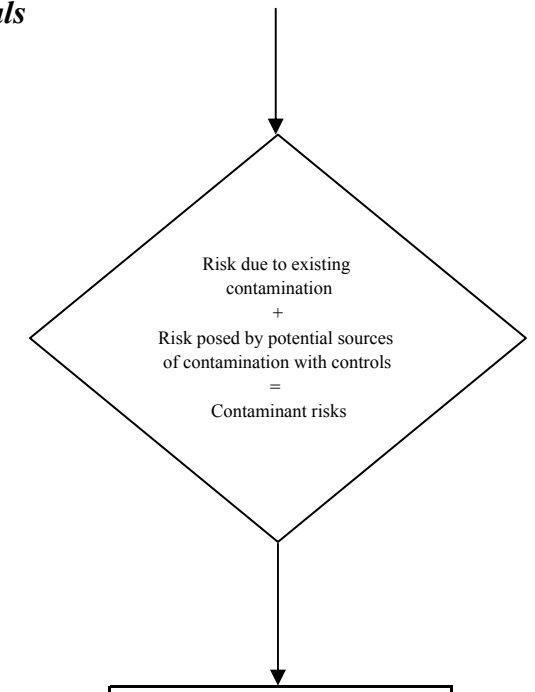


Chart 13. Contaminant risks for Badger Road Elementary - Other Organic Chemicals





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

Contaminant risks*
= 5 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 14. Vulnerability analysis for Badger Road Elementary - Other Organic Chemicals