Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Badger Den Drinking Water System, Fairbanks area, Alaska PWSID 311184

October 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 1246
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 Den 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 Den to potential contamination. This Class B (non-community) water system consists of one well near the intersection of Badger Road and Joy Drive west of downtown Fairbanks, Alaska. The well received a natural susceptibility rating of **Medium**. This rating is a combination of a susceptibility rating of **Low** for the actual wellhead and a **Very High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Badger Den public water system include: residential area, septic systems, fuel storage tanks, roads, construction trade areas, and DEC 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 Badger Den received an overall vulnerability rating of **High** for volatile organic chemicals; and a **Medium** for bacteria and viruses, and nitrates and/or nitrites.

BADGER DEN PUBLIC DRINKING WATER SYSTEM

Badger Den public water system is a Class B (non-community) water system. The system consists of one well near the intersection of Badger Road and Joy Drive west of downtown Fairbanks, Alaska (T1S, R1E, Section 14) (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.

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 Den water system is located in 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 240 feet below the ground surface and is screened in hard bedrock. 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 alluvial plain consists of alternating layers of silt, 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). Discontinuous permafrost (perennially frozen areas) is also common in the alluvial plain. The depth to permafrost in these areas ranges between 2 and 45 feet below the ground surface with the thickness of the permafrost ranging between 5 and 265 feet (Pewe, T.L. 1958). Areas with discontinuous permafrost may locally affect the ground water flow directions.

Primarily the Tanana River, but also the Chena River contribute water to this 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).

BADGER DEN 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.

There are many different methods for calculating the size of capture zones. The DWPP uses a combination of two simple groundwater flow equations, the Thiem and uniform flow equations for all groundwater wells screened in unconsolidated material. The orientation of the capture zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The capture zone calculated by the DWPP is an estimate using the available information and resources, and may differ slightly from the actual capture zone.

The parameters used to calculate the shape of this capture zone are general for the whole alluvial plain and were obtained from various United States Geological Survey (USGS) reports, area well logs, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The water table in the area of the Badger Den, 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). These flow reversals are of short duration (i.e. days versus months) and of limited extent, generally within 1000 feet of the river (Nakanishi, et all, 1998).

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 Den 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 Den 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 BADGER DEN 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 Badger Den received a Low Susceptibility rating. The 10/16/99 Sanitary Survey indicates a sanitary seal is properly capping the well and the land surface is sloped away from the well; however the well casing has not been grouted. A sanitary seal prevents potential contaminants 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 Den well is completed in received a Very 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. Wells within the protection area can also provide a quick pathway to the aquifer if they are not grouted correctly. Table 2 summarizes the Susceptibility scores and ratings for Badger Den.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	21	Very High
Natural Susceptibility	26	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	20	Medium
Nitrates and/or Nitrites	21	Medium
Volatile Organic Chemicals	40	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	50	Medium
Nitrates and Nitrites	50	Medium
Volatile Organic Chemicals	70	High

Bacteria and Viruses

The residential septic systems in the protection area represent the greatest risk to the drinking water well.

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 medium.

Nitrates and Nitrites

The residential 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 significant levels in recent sampling history for the Badger Den 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 ADEC-recognized contaminated sites and the residential heating oil tanks represent the greatest risk for volatile organic chemical contamination to the well.

There are two ADEC-recognized contaminated sites located in Zone B of the protection area. The first is located at 1522 Calabash Drive (RecKey 1991310112801). Drums of kerosene, used oil, motor oil, and truck batteries were found to be leaking due to flooding in the area.

The second site is located at 921 Doyle Drive (RecKey 1991310119801). Eleven drums were removed from the property on 7/17/91 after the area had been flooded. Surface water contamination from the drums (containing waste oil and lead) was documented at this time. The site did not appear to be contaminated on a follow-up site visit on 10/21/94, although no sampling was done so contamination is unconfirmed.

The third ADEC-recognized contaminated site is located in Zone C at 1442 Holmes Road (RecKey 2000310129101). Contaminated soil was found during the removal of an underground heating oil tank on 10/17/00. The contaminated soil was excavated and groundwater sampling of a monitoring well at the site revealed concentrations below ADEC cleanup levels. The site was closed on 3/28/02.

Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the area surrounding Fairbanks. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and

vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

Volatile Organic Chemicals have not been sampled for in this 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

Badger Den
Drinking Water Protection Area Location Map
(Map 1)

MICHAEL LANE
BADGER ROAD
LOOSE MOOSE LOOP
PERSINGER DRIVE
ROAD
LOUD ROAD
HICKMAN AVENUE
BORDA STREET
OOD STREET
BADGER ROAD
LINCOLNWOOD DRIVE
LLOYD DRIVE
STAR COURT
MAITTIE STREET
ALDER STREET
ENDECOTT AVENUE
RIDGE LOOP ROAD
REDMOND AVENUE
RANGE VIEW ROAD
DOYLE DRIVE
PEEDE ROAD
TRAMON AVENUE
AIRLINE DRIVE
HOLMES ROAD
STOL DRIVE
VASI WAY
STILL VALLEY ROAD
VICKI LANE
DENNIS ROAD
AZTEC ROAD
CHARLOTTE ROAD
LAKLOEY DRIVE
BADGER ROAD
EAR CREEK
COPPER STREET
LUCKIES LANE
ATIGUN STREET
TOOLIK DRIVE
BRADWAY ROAD
HITE STREET
MILO STREET
OLD RICHARDSON
MOSES DRI
ORIS ROAD

Map 1: Badger Den Drinking Water Protection Area

PWSID: 311184

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 800 1,600 3,200 4,800 Feet

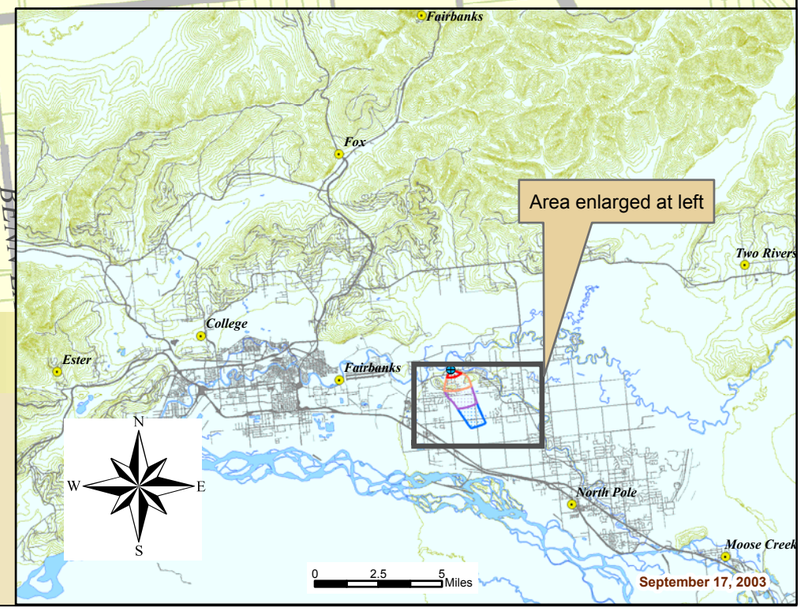
1:19,200

Data Sources:

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

Legend

- Zone A *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
- Surface water
- Roads
- Parcels



APPENDIX B

Contaminant Source Inventory and Risk Ranking for Badger Den (Tables 1-4)

Table 1

Contaminant Source Inventory for ***Badger Den***

PWSID 311184.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Residential Areas	R01		A	2	Less than 1 acre of residential area in Zone A
Septic systems (serves one single-family home)	R02		A	2	Estimated 1 septic system based on number of tax parcels identified as residential
Tanks, heating oil, residential (above ground)	R08		A	2	Estimated 1 tank based on number of tax parcels identified as residential
Highways and roads, paved (cement or asphalt)	X20		A	2	Badger Road; Joy Drive
Residential Areas	R01		B	2	Approximately 60 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02		B	2	Estimated 60 septic systems based on number of tax parcels identified as residential
Tanks, heating oil, residential (above ground)	R08		B	2	Estimated 60 tanks based on number of tax parcels identified as residential
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	B	2	1512 Calabash; RecKey 1991310112801
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	B	2	End of Doyle Street; RecKey 1991310119801
Highways and roads, paved (cement or asphalt)	X20		B	2	8 roads in Zone B
Construction trade areas and materials	C09	C09-1	C	2	989 Lakloey
Residential Areas	R01		C	2	Approximately 30 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02		C	2	Estimated 40 septic systems based on number of tax parcels identified as residential
Tanks, heating oil, residential (above ground)	R08		C	2	Estimated 40 tanks based on number of tax parcels identified as residential
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-3	C	2	1442 Holmes Road; File Number 100.38.156
Highways and roads, paved (cement or asphalt)	X20		C	2	8 roads in Zone C

Table 2

Contaminant Source Inventory and Risk Ranking for Badger Den

Sources of Bacteria and Viruses

PWSID 311184.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01		A	Low	2	Less than 1 acre of residential area in Zone A
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	Badger Road; Joy Drive
Septic systems (serves one single-family home)	R02		A	Low	2	Estimated 1 septic system based on number of tax parcels identified as residential
Residential Areas	R01		B	Low	2	Approximately 60 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02		B	Low	2	Estimated 60 septic systems based on number of tax parcels identified as residential
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	8 roads in Zone B

Table 3

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

PWSID 311184.001

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	Badger Road; Joy Drive
Residential Areas	R01		A	Low	2	Less than 1 acre of residential area in Zone A
Septic systems (serves one single-family home)	R02		A	Low	2	Estimated 1 septic system based on number of tax parcels identified as residential
Residential Areas	R01		B	Low	2	Approximately 60 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02		B	Low	2	Estimated 60 septic systems based on number of tax parcels identified as residential
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	8 roads in Zone B
Residential Areas	R01		C	Low	2	Approximately 30 acres of residential area in Zone C
Highways and roads, paved (cement or asphalt)	X20		C	Low	2	8 roads in Zone C
Septic systems (serves one single-family home)	R02		C	Low	2	Estimated 40 septic systems based on number of tax parcels identified as residential

Table 4

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

PWSID 311184.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Tanks, heating oil, residential (above ground)	R08		A	Medium	2	Estimated 1 tank based on number of tax parcels identified as residential
Residential Areas	R01		A	Low	2	Less than 1 acre of residential area in Zone A
Septic systems (serves one single-family home)	R02		A	Low	2	Estimated 1 septic system based on number of tax parcels identified as residential
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	Badger Road; Joy Drive
Tanks, heating oil, residential (above ground)	R08		B	Medium	2	Estimated 60 tanks based on number of tax parcels identified as residential
Septic systems (serves one single-family home)	R02		B	Low	2	Estimated 60 septic systems based on number of tax parcels identified as residential
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	8 roads in Zone B
Residential Areas	R01		B	Low	2	Approximately 60 acres of residential area in Zone B
Residential Areas	R01		C	Low	2	Approximately 30 acres of residential area in Zone C
Highways and roads, paved (cement or asphalt)	X20		C	Low	2	8 roads in Zone C
Septic systems (serves one single-family home)	R02		C	Low	2	Estimated 40 septic systems based on number of tax parcels identified as residential
Tanks, heating oil, residential (above ground)	R08		C	Medium	2	Estimated 40 tanks based on number of tax parcels identified as residential
Construction trade areas and materials	C09	C09-1	C	Low	2	989 Lakloey

APPENDIX C

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

Zone A

Zone B

Zone C

BADGER ROAD

HAPPY LANE

FOX DRIVE

DELIGHT AVENUE

JUBILEE WAY

STAR COURT

LINCOLNWOOD DRIVE

GRANOLA DRIVE

REDMOND AVENUE

CALABASH DRIVE

BASKERVILLE STREET

MYSTERY DRIVE

DOYLE DRIVE

MORIARTY AVENUE

HOLMES ROAD

RIDGE TOP ROAD

VIEW ROAD

VALLEY DRIVE

LAKLOEY DRIVE

GORDY WAY

TRAMON AVENUE

CORDELIA WAY

AIRLINE DRIVE

STILL VALLEY ROAD

U04-1

U04-2

U04-3

C09-1

Area enlarged at left

N

W

E

S

0 0.35 0.7 1.4 Miles

September 17, 2003

Map 2: Badger Den Potential Contaminant Sources

PWSID: 311184

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 362.5 725 1,450 Feet

1:8,700

Data Sources:

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

Legend

- Badger Den well
- C09, Construction trade areas
- U04, Contaminated sites, DEC recognized
- R01, Residential area
- R02, Septic systems
- R08, Heating oil AST

APPENDIX D

Vulnerability Analysis for Badger Den Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - Badger Den

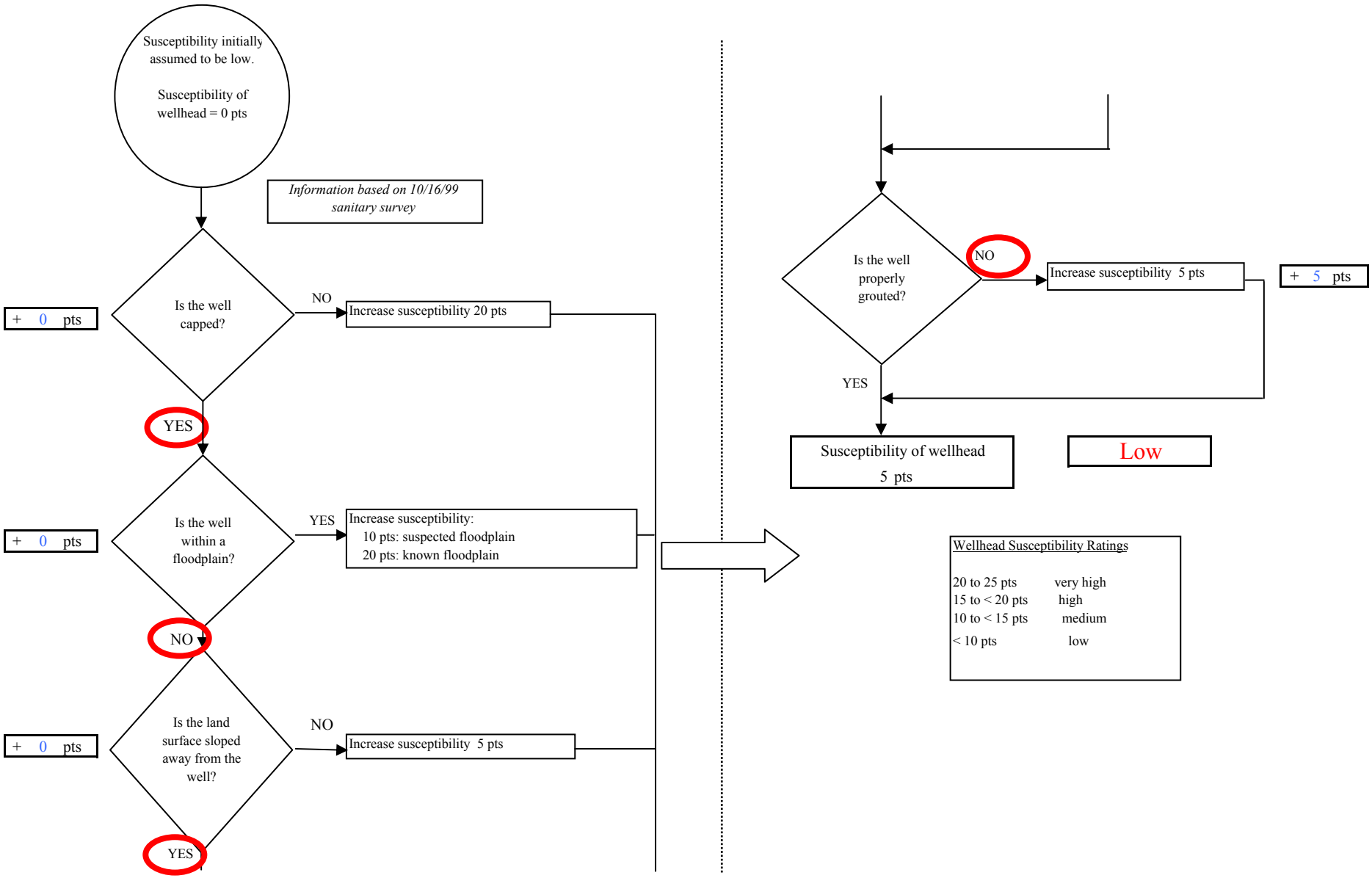


Chart 2. Susceptibility of the aquifer - Badger Den

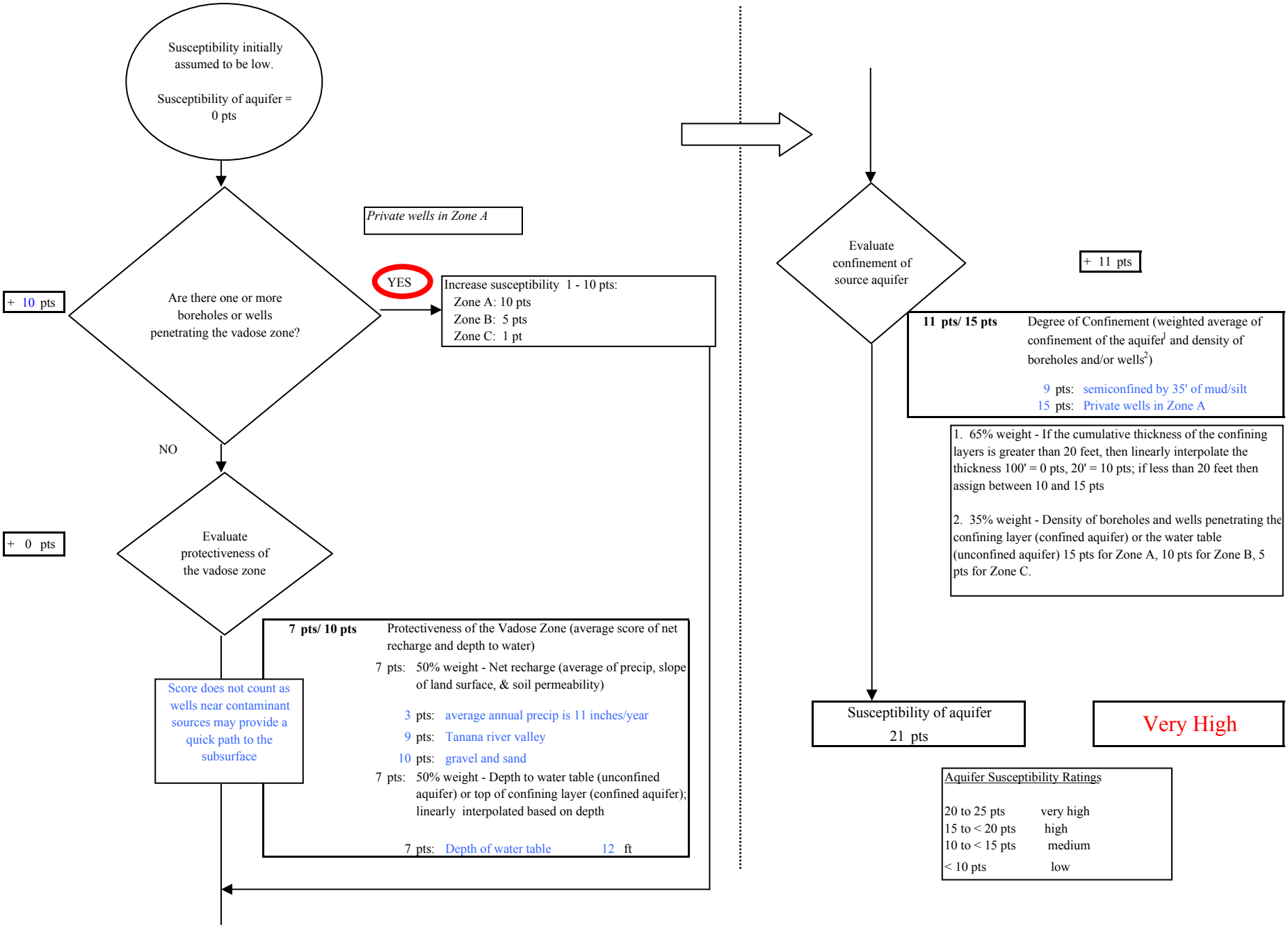
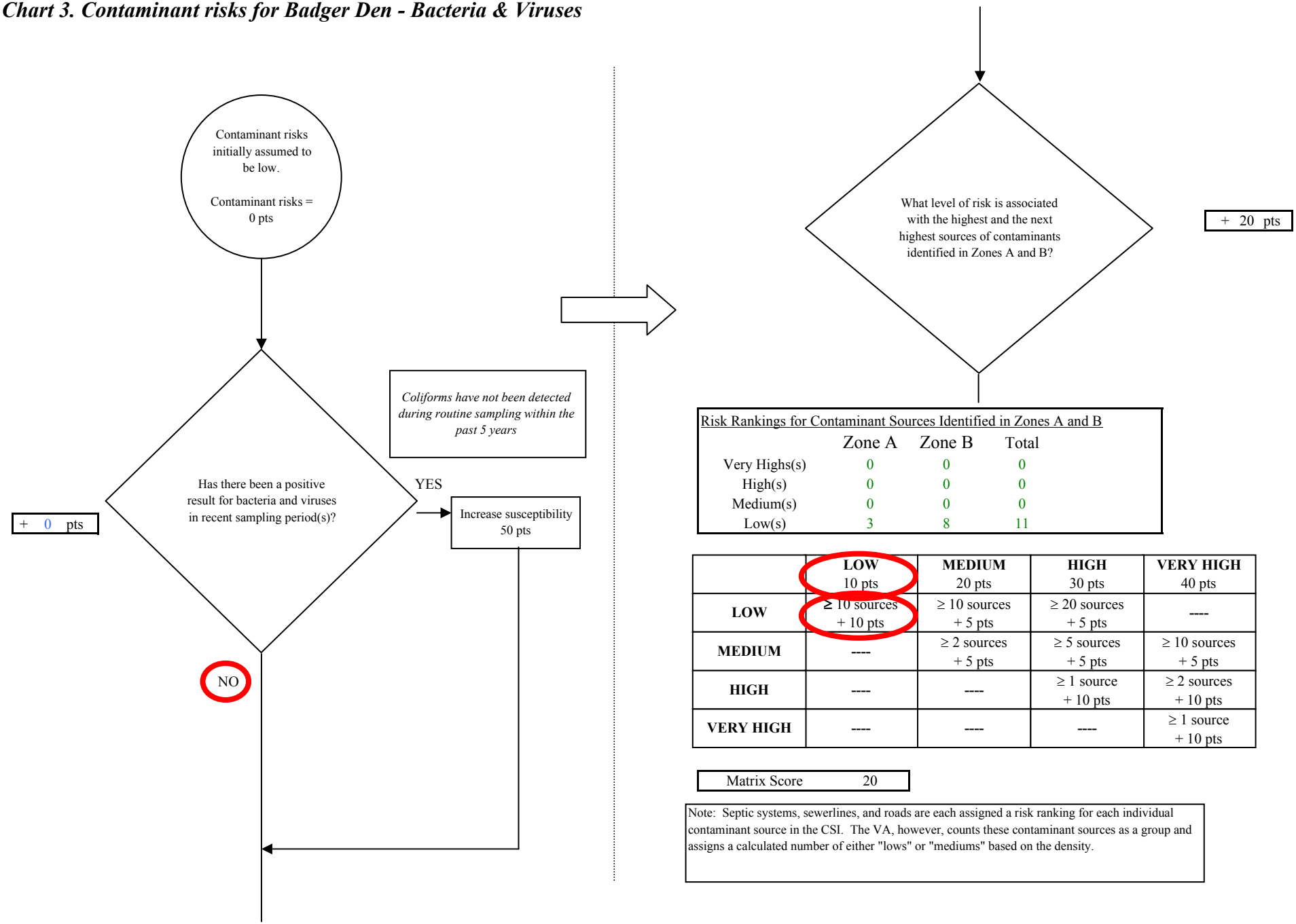


Chart 3. Contaminant risks for Badger Den - Bacteria & Viruses



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)	3	8	11

	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 Badger Den - Bacteria & Viruses

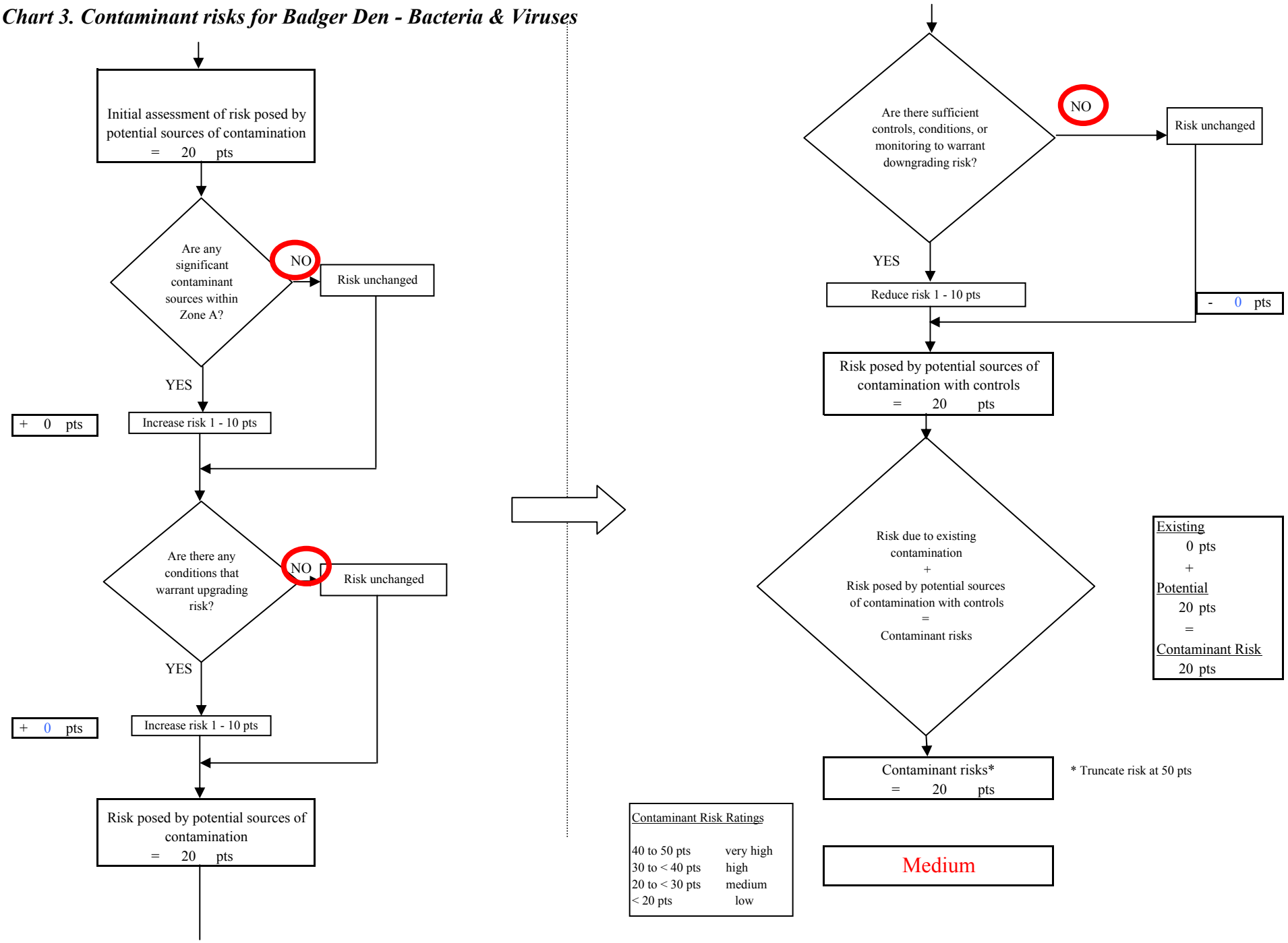


Chart 4. Vulnerability analysis for Badger Den - Bacteria & Viruses

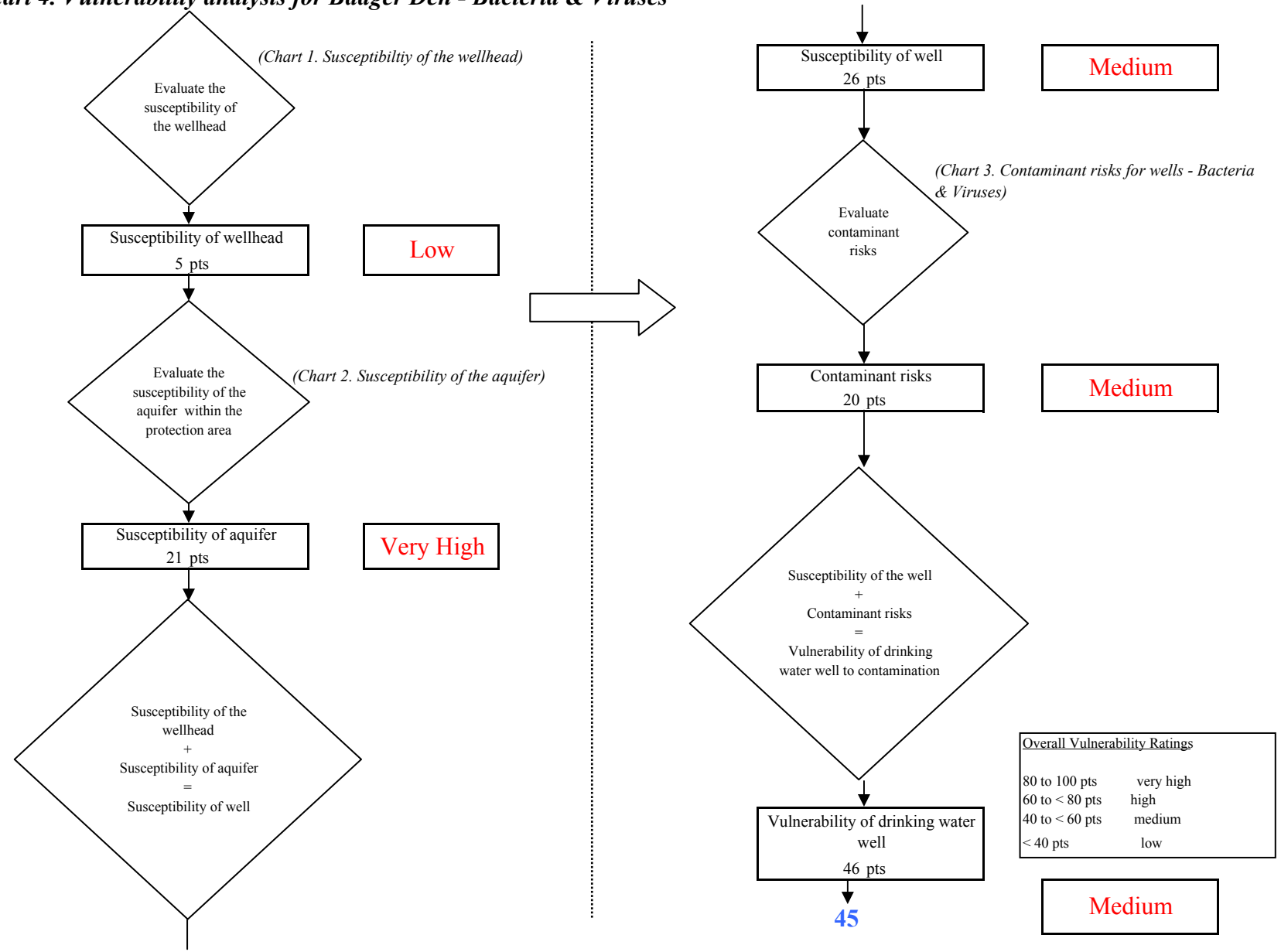


Chart 5. Contaminant risks for Badger Den - Nitrates and Nitrites

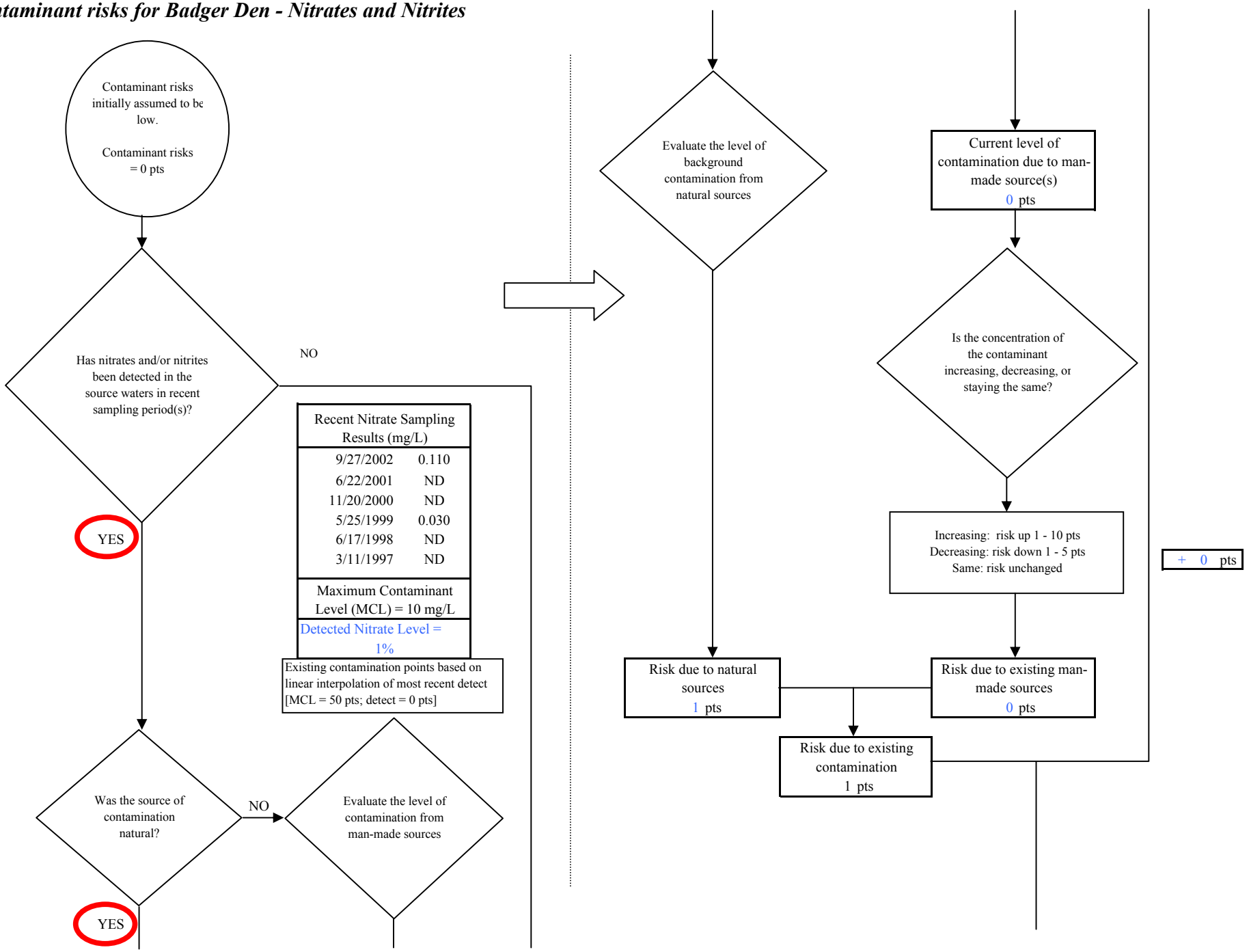


Chart 5. Contaminant risks for Badger Den - Nitrates and Nitrites

+ 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)	3	12	15

	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

YES → Increase risk 1 - 10 pts

+ 0 pts

Chart 5. Contaminant risks for Badger Den - Nitrates and Nitrites

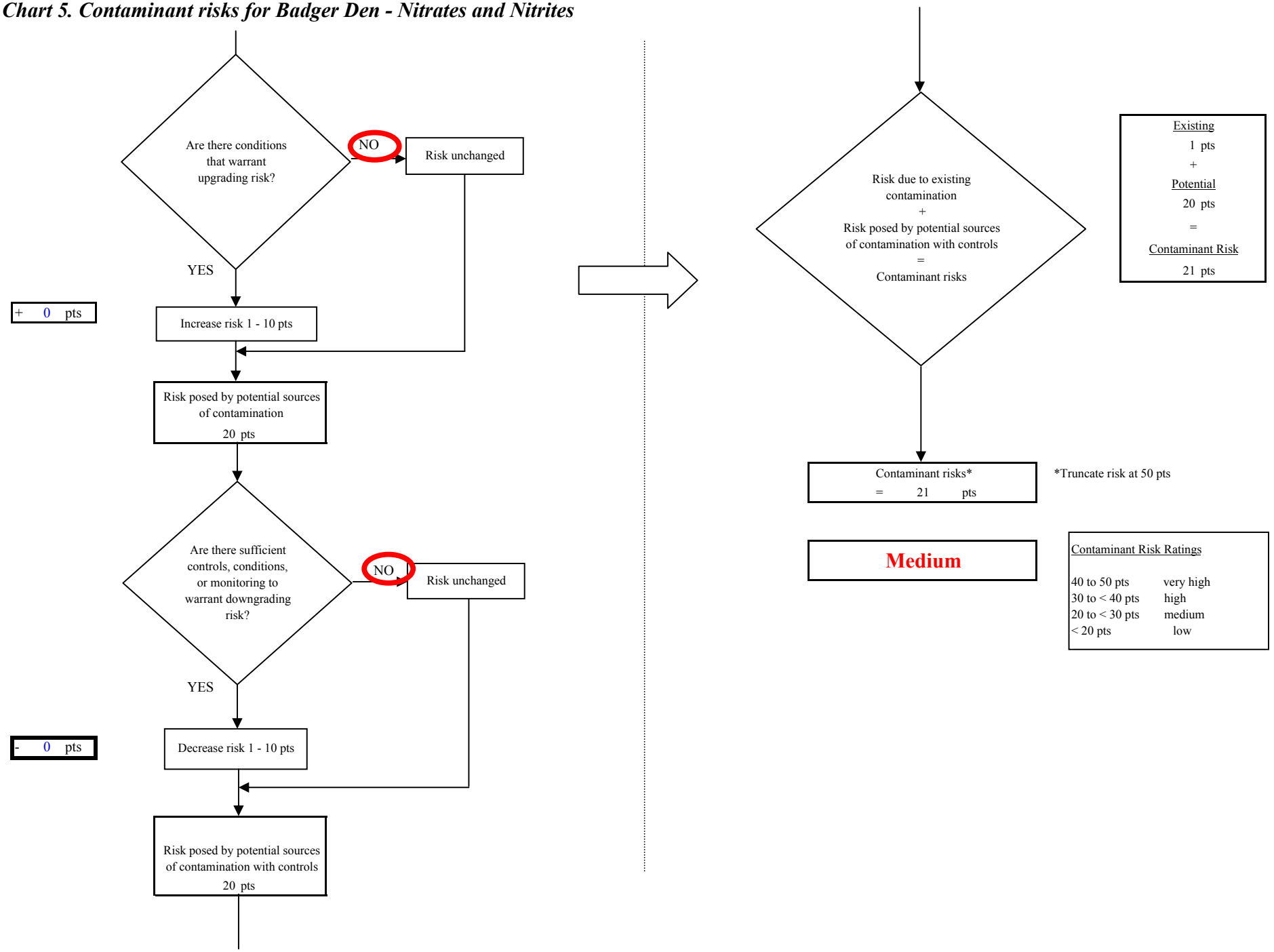


Chart 6. Vulnerability analysis for Badger Den - Nitrates and Nitrites

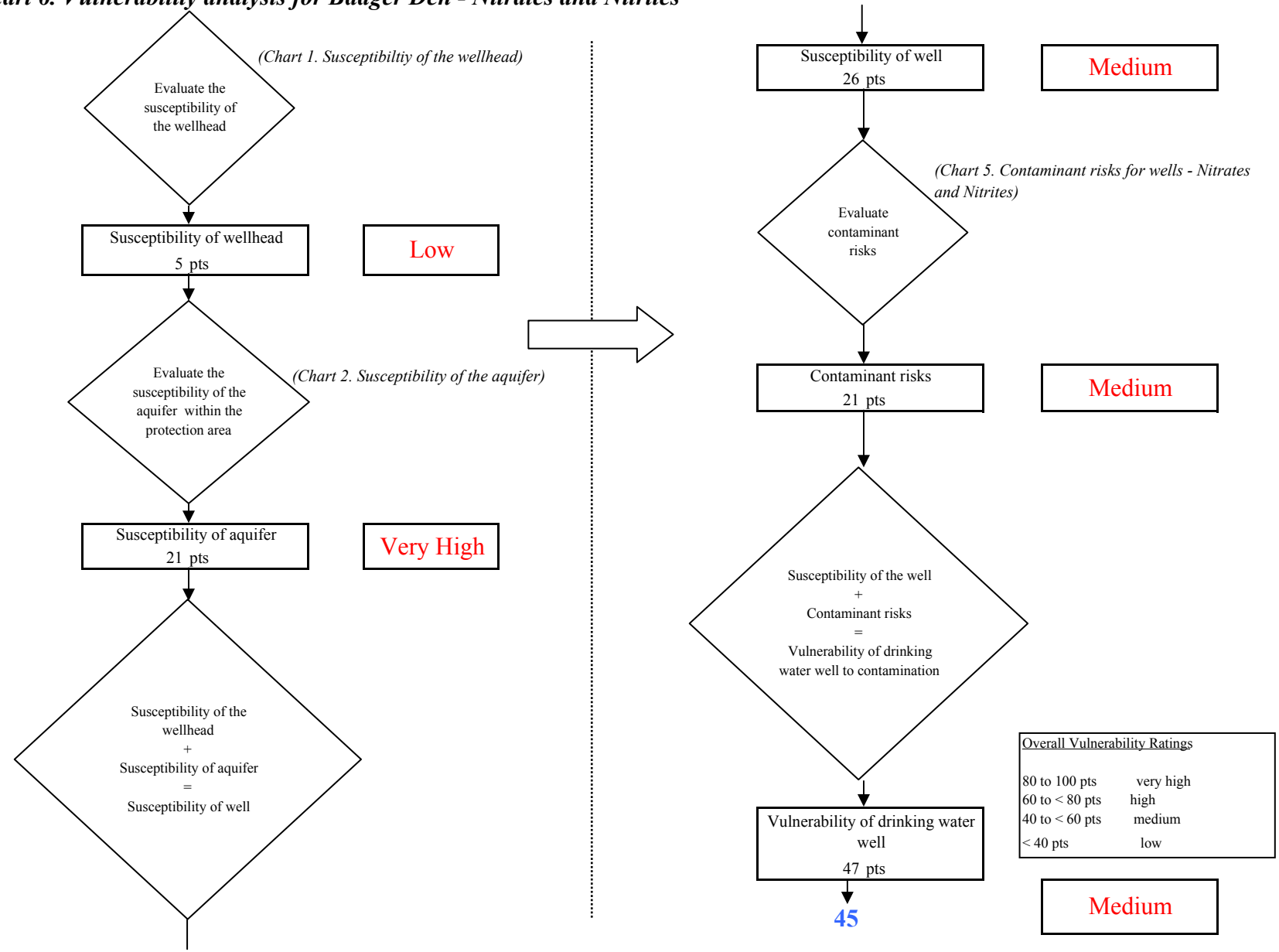


Chart 7. Contaminant risks for Badger Den - Volatile Organic Chemicals

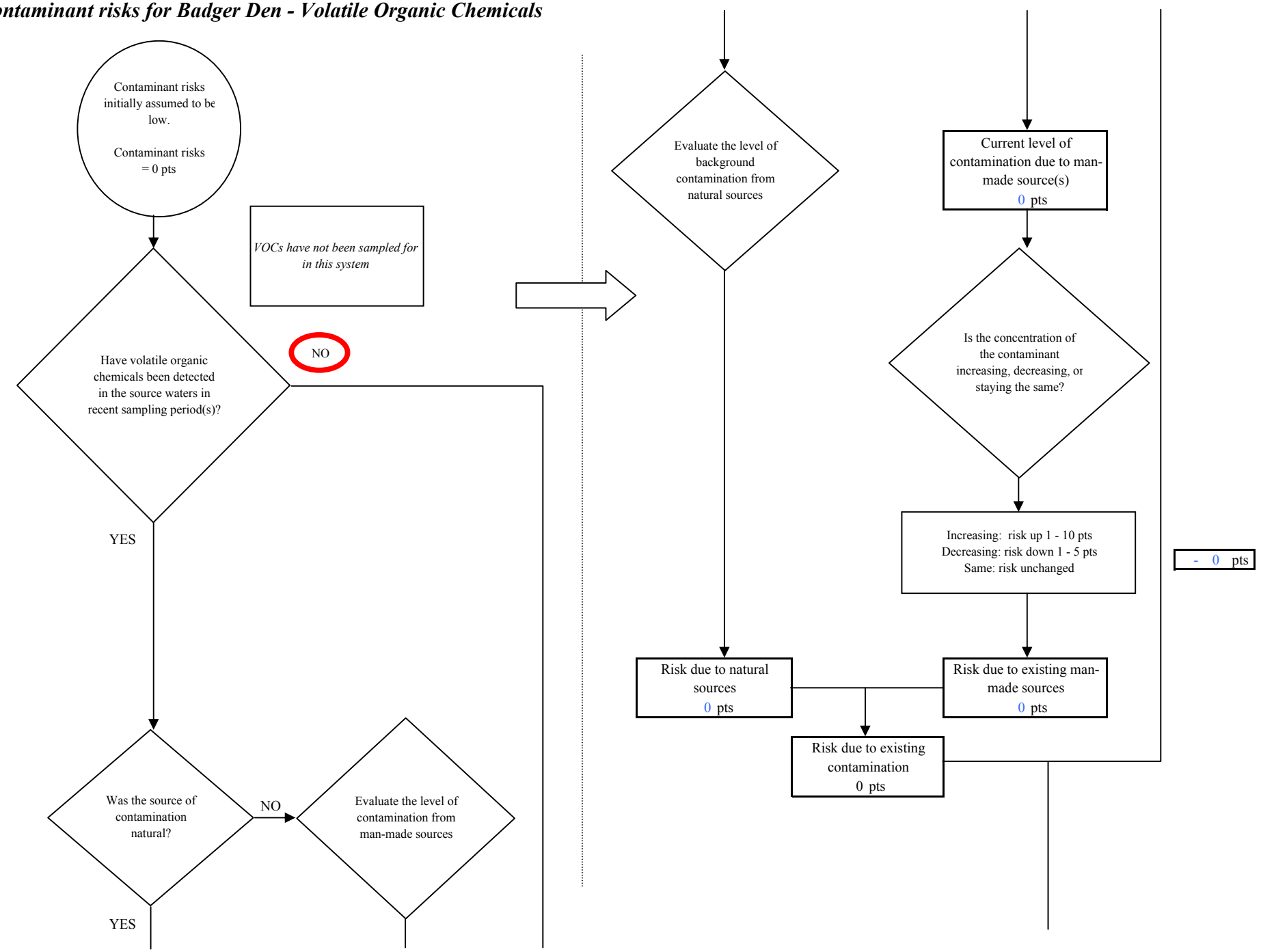


Chart 7. Contaminant risks for Badger Den - Volatile Organic Chemicals

+ 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)	0	0	0
High(s)	0	2	2
Medium(s)	2	103	105
Low(s)	3	4	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 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

+ 0 pts

Chart 7. Contaminant risks for Badger Den - Volatile Organic Chemicals

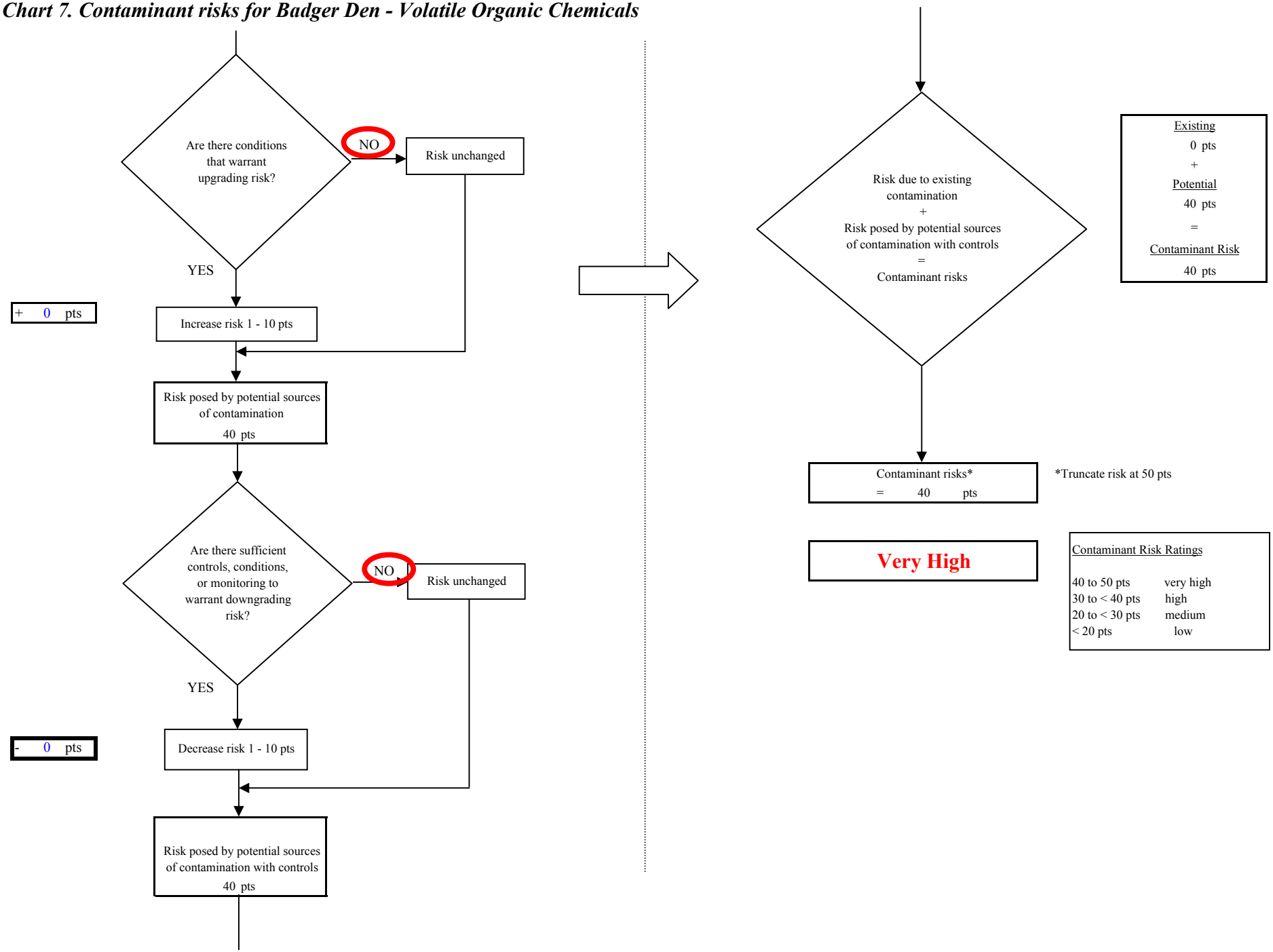


Chart 8. Vulnerability analysis for Badger Den - Volatile Organic Chemicals