Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Chugiak Benefit Association Drinking Water System, Chugiak, Alaska PWSID # 214586.001, .002, and .003

DRINKING WATER PROTECTION PROGRAM REPORT #989

Alaska Department of Environmental Conservation

June, 2003

Source Water Assessment for Chugiak Benefit Association Drinking Water System
Chugiak, Alaska
PWSID# 214586.001, .002, and .003

By Suzan J. Hill

DRINKING WATER PROTECTION PROGRAM REPORT 989

The Drinking Water Protection Program 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. 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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Chugiak, Alaska

By Suzan J. Hill

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Chugiak Benefit Association is a Class A (non-transient/non-community) water system consisting of three wells in the Chugiak, Alaska area. Identified potential and current sources of contaminants for Chugiak Benefit Association public drinking water source include a cement manufacturing facility, two DEC recognized contaminated sites, residential septic systems, roads, and approximately 20 acres of residential area. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. Overall, the public water source for Chugiak Benefit Association received a vulnerability rating of **Medium** for bacteria and viruses, **High** for nitrates and nitrites; volatile organic chemicals; and other organic chemicals, and **Low** for heavy metals and synthetic organic chemicals.

INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this assessment is to provide public water system owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE CHUGACH MOUNTAIN FRONT EAST OF ANCHORAGE

Location

Between the Chugach Mountain Front east of Anchorage and Knik Arm lie the communities of Eagle River, Chugiak, Peters Creek, and Eklutna. The Eagle River Valley is one of the largest valleys in the western Chugach Mountains. Eagle River and the neighboring communities are located in the Municipality of Anchorage Borough.

Glacial and alluvial forces have shaped the Eagle River Valley and Chugach Mountain front in this area. These forces have resulted in the U-shaped river valleys and moraine-mantled mountain flanks of the mountain front and lakes, streams and undulating ridges and hills of the glaciated lowlands extending to Knik Arm.

Precipitation

Eagle River averages between 20 and 25 inches of precipitation per year, including about 68 inches of snowfall.

Topography and Drainage

The area topography varies from sea level to about 400 feet in the area surrounding Knik Arm to several thousand feet on the surrounding ridges and mountain flanks.

Groundwater

Although the quality can vary significantly in a short distance, groundwater supplies are generally abundant in the area, except for some reported well failures that have occurred within the city limits of Eagle River. Groundwater occurs within both confined and unconfined aquifers and from both unconsolidated and bedrock aquifers. Many homes and businesses in the

area rely on individual wells for their water supply. Most of these wells are shallow with depths of less than 100 feet to 200 feet. Static water levels in many of these wells are less than 15 feet below the surface.

Geology and Soils

Most of the soils in the area provide good sources of sand, gravel and topsoil. The deposition of silt, clay and organic muck in old lakes, oxbows and depressions means that some areas have soil conditions that vary over relatively short distances.

CHUGIAK BENEFIT ASSOCIATION PUBLIC DRINKING WATER SYSTEM

Chugiak Benefit Association is a Class A (non-transient/non-community) water system. The system consists of three wells and is located at 18606 Old Gelnn Highwater. (See Map 1 of Appendix A). This area is at an elevation of approximately 425 feet above sea level.

According to the Well Log for Well #1, there is silty gravel from 0 to 10 feet; boulders from 10 to 11 feet; sandy gravel from 11 to 20 feet; silty sand from 20 to 41 feet; small gravel from 41 to 84 feet; hardpan and gravel from 84 to 94 feet; silty gravel from 94 to 133 feet; pea gravel from 133 to 137 feet; and sandy brown clay from 137 feet to a total well depth of 142 feet. The well was drilled on 3/10/75, and had a static water level of 100 feet. There are no Well Logs available for Well #2 and Well #3. The Sanitary Survey (12/15/01) indicates the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is also appropriately sloped away from the wells providing adequate surface water drainage. The wells are grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system operates year-round and serves 4 residents and 200 non-residents through 2 service connections.

CHUGIAK BENEFIT ASSOCIATION WELL DRINKING WATER PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. Some areas are more likely to allow contamination to reach the well than others. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The DWPA's established for wells by the ADEC are separated into four zones. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (Patrick, Brabets, and Glass, 1989), and State of Alaska Department of Water Resources (Jokela et. al., 1991).

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

Table 1. Definition of Zones

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

As an example, water moving through the aquifer in Zone B will reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area down-gradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

The DWPA for the Chugiak Benefit Association contain three zones: Zone A, Zone B, and Zone C (see Map 1 in Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Chugiak Benefit Association DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class 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 Maps 2 and 3 of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a function of toxicity and volumes of specific contaminants associated with that source.

Tables 2 through 7 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF CHUGIAK BENEFIT ASSOCIATION DRINKING WATER SOURCE

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

- Natural susceptibility; and
- Contaminant risks.

Each of the six categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

Natural Susceptibility (Susceptibility of the Well)
(0 – 50 Points)

The wells for Chugiak Benefit Association are completed in an unconfined aquifer setting. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer. Table 2 shows the Susceptibility scores and ratings for Chugiak Benefit Association.

Table 2. Susceptibility

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

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	33	High
Nitrates and/or Nitrites	47	High
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide, and		

Other Inorganic Chemicals	25	Medium
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	50	Very High

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 naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

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	50	Medium
Nitrates and Nitrites	65	High
Volatile Organic Chemicals	65	High
Heavy Metals, Cyanide and Other Inorganic Chemicals	35	Low
Synthetic Organic Chemicals	30	Low
Other Organic Chemicals	65	High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is high with residential septic systems and a municpal park in Zones A presenting the most significant risk to the drinking water wells (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Recent sampling of Chugiak Benefit Association shows no detection of Bacteria and Viruses. 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 contaminant risk for nitrates and nitrites is high with a municipal park and residential septic systems in Zones A posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history for Chugiak Benefit Association wells indicates that low concentrations of nitrate have been detected. At the latest sampling period, a low concentration of nitrate and/or nitrite was detected at 2.750 mg/L or 27% of the Maximum Contaminant Level (MCL) of 10mg/L. The MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects.

It is unknown how much of the existing nitrate concentration can be attributed to natural or human-made sources. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000].

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the wells, the overall vulnerability of the well to contamination is High.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is very high with two ADEC recognized contaminated sites presenting the most significant risk to the drinking water wells (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). The contaminated site at 18631 Old Glenn Highway resulted from a waste oil spill at a former drum storage location. This contaminated site has been prioritized as Medium. The contaminated site at 21625 Swanee Court resulted from gasoline contaminating the soil and is prioritized as High. However, recent sampling history of Chugiak Benefit Association did not detect any chemicals in the Volatile Organic Chemicals category. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the wells, the overall vulnerability of the well to contamination is High.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is medium with no contaminant sources posing significant risk to the drinking water wells (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D). Monitoring samples analyzing chemicals within the Heavy Metals, Cyanide and Other Inorganic Chemicals collected on 10/8/98 did not show any detection of contaminants in this category.

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

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is low with no contaminant sources representing a significant risk. After combining the contaminant risk with the natural susceptibility of the wells, the overall vulnerability of the wells is Low.

Other Organic Chemicals

The contaminant risk for other organic chemicals is very high with a cement manufacturing facility in Zone A posing a significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the wells is High.

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals were detected in Chugiak Benefit Association' drinking water the last time it was sampled (See Charts 11 and 13 – Contaminant Risks for Synthetic Organic Chemicals and Other Organic Chemicals in Appendix D, respectively).

SUMMARY

This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Chugiak Benefit Association to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of Chugiak Benefit Association public drinking water sources.

REFERENCES CITED

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Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.

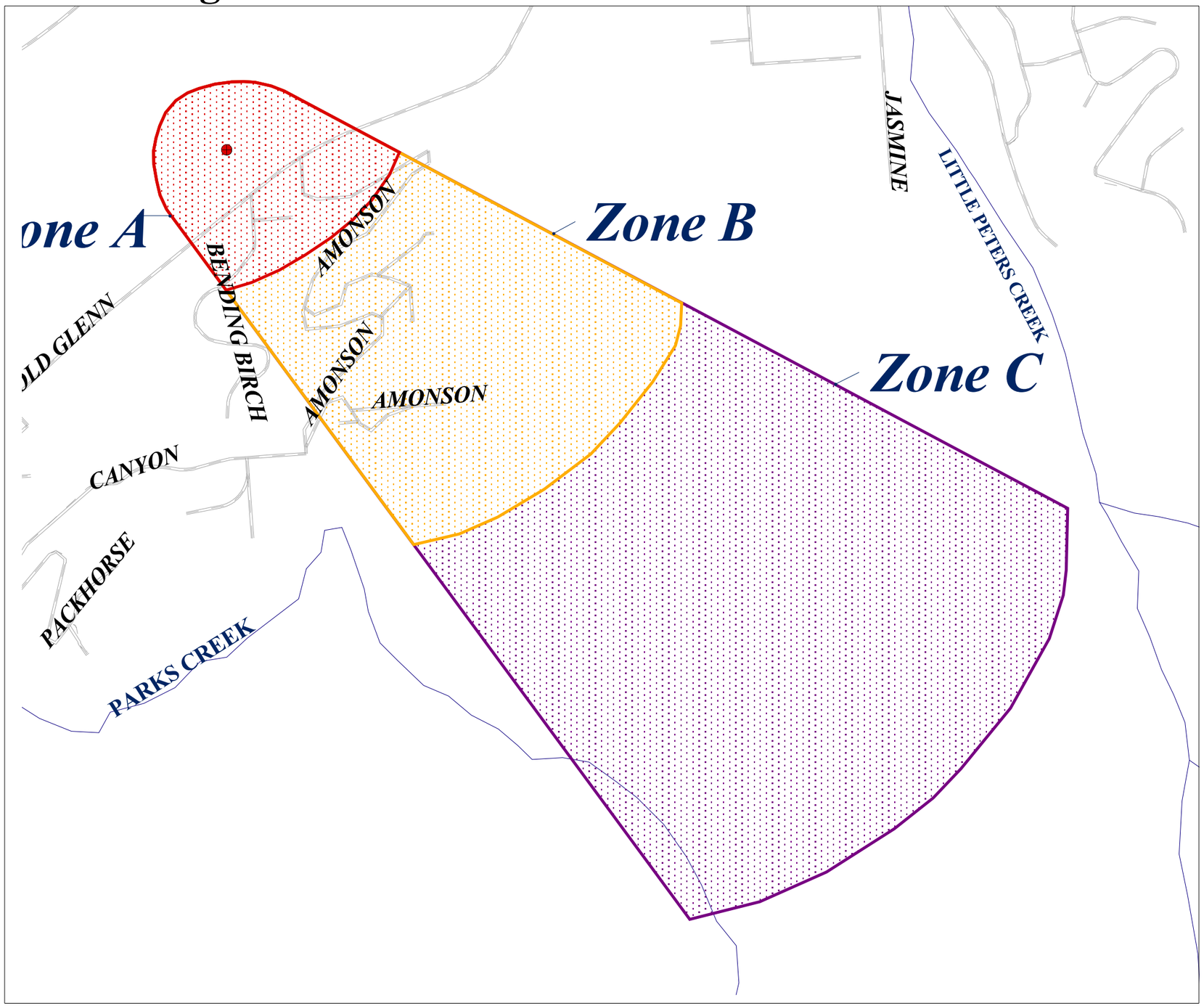
Wang, B., Strelakos, P.M., and Jokela, J.B., 2000, Nitrate source indicators in ground water of the scimitar subdivision, Peters Creek Area, Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 00-4137.

Weather Underground, June 18, 2002, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wunderground.com

APPENDIX A

Chugiak Benefit Association Well #1, #2, and #3 Drinking Water Protection Area Location Map (Map 1)

Chugiak Benefit Assoc. Protection Area - #214586



400 0 400 800 1200 1600 Yards

Legend

- Chugiak Benefit Assoc. Well Location

Zone A
- Several Months Travel Time

Zone B
- Less Than Two Years Time of Travel

Zone C
- Less Than Five Years Time of Travel
- Roads
- Rivers or Streams

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Map One

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Well #1, #2, and #3 (Tables 1-7)

Table 1

Contaminant Source Inventory for
Chugiak Benefit Association

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Cement manufacturing	I08	I08-1	A	2	
Residential Areas	R01	R01-1	A	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	2	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	A	2	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	A	2	
Municipal or city parks (with green areas)	X04	X04-1	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	2	
Residential Areas	R01	R01-2	B	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	2	

Table 2

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Sources of Bacteria and Viruses

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Municipal or city parks (with green areas)	X04	X04-1	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	Low	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Sources of Nitrates/Nitrites

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Municipal or city parks (with green areas)	X04	X04-1	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	Low	2	

Table 4

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Sources of Volatile Organic Chemicals

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Cement manufacturing	I08	I08-1	A	High	2	
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	A	High	2	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	
Septic systems (serves one single-family home)	R02	R02-17-56	B	Very High	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	Low	2	

Table 5

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Cement manufacturing	I08	I08-1	A	Medium	2	
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Municipal or city parks (with green areas)	X04	X04-1	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	Low	2	

Table 6

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Sources of Synthetic Organic Chemicals

PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Municipal or city parks (with green areas)	X04	X04-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	

Table 7

Contaminant Source Inventory and Risk Ranking for Chugiak Benefit Association Sources of Other Organic Chemicals

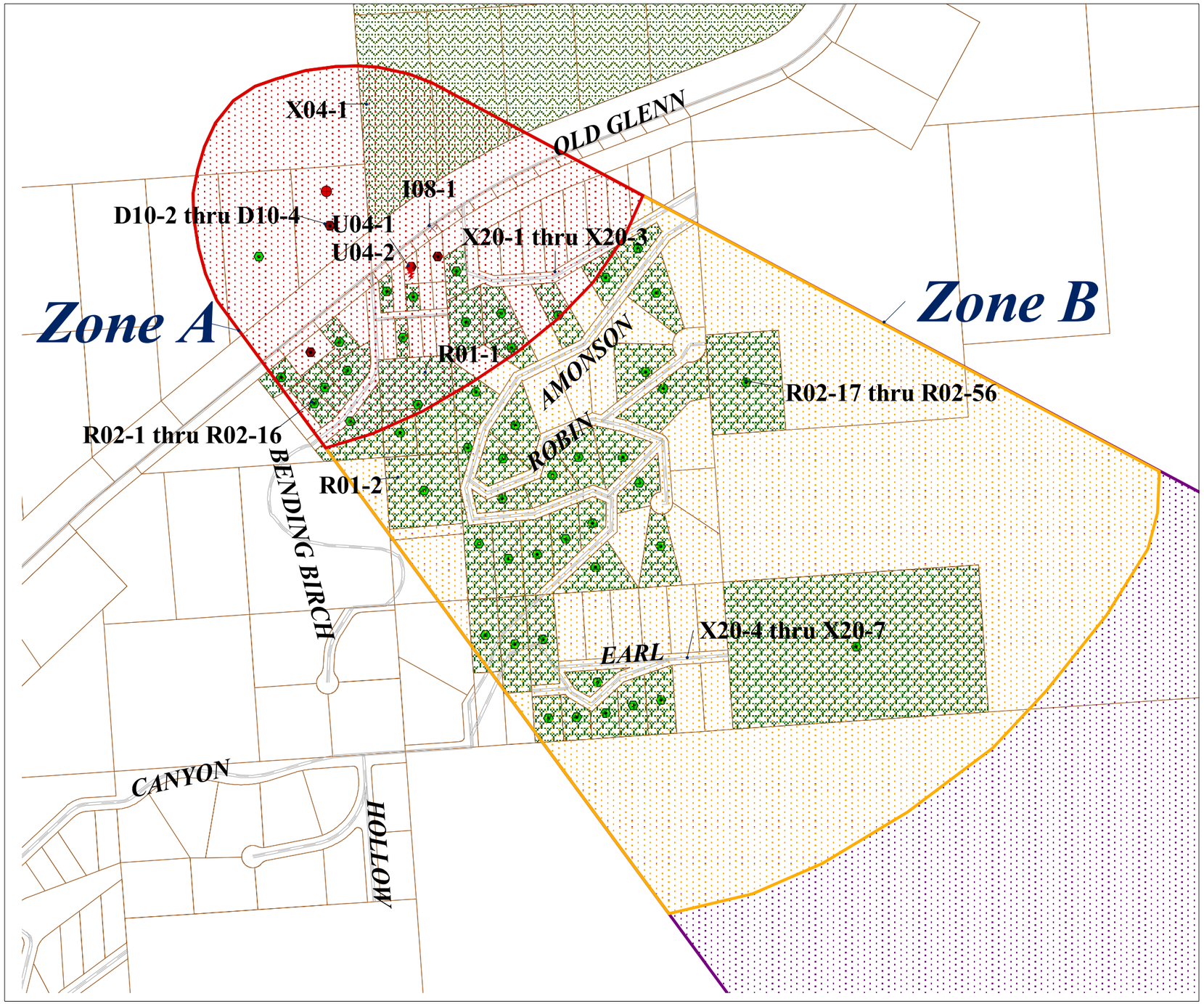
PWSID 214586.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Cement manufacturing	I08	I08-1	A	Very High	2	
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-16	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	17 Acres
Septic systems (serves one single-family home)	R02	R02-17-56	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-7	B	Low	2	

APPENDIX C

Chugiak Benefit Association Well #1, #2, and #3 Drinking Water Protection Area and Potential and Existing Contaminant Sources (Maps 2-3)

Chugiak Benefit Assoc. Existing and Potential Contaminant Sources



300 0 300 600 900 1200 Yards

Legend

- Chugiak Benefit Assoc. Well Location

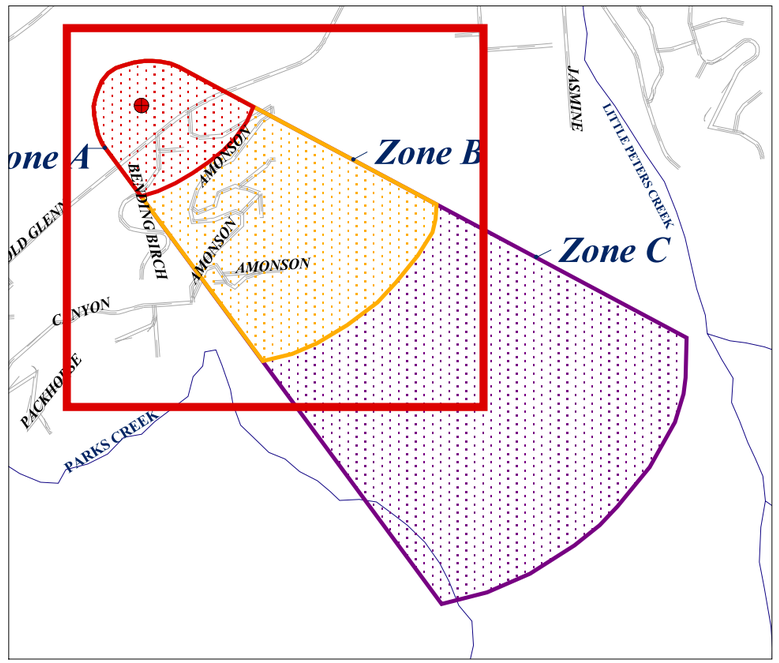
Zone A
- Several Months Travel Time

Zone B
- Less Than Two Years Time of Travel

Zone C
- Less Than Five Years Time of Travel
- Roads (X20)
- Land Parcels
- Residential Areas (R01)

Contaminant Sources
- Cement Manufacturing (I08)
- Contaminated Site (U04)

Septic systems.shp
- Large Capacity Septic Systems (D10)
- Residential Septic Systems (R02)
- Park (X04)



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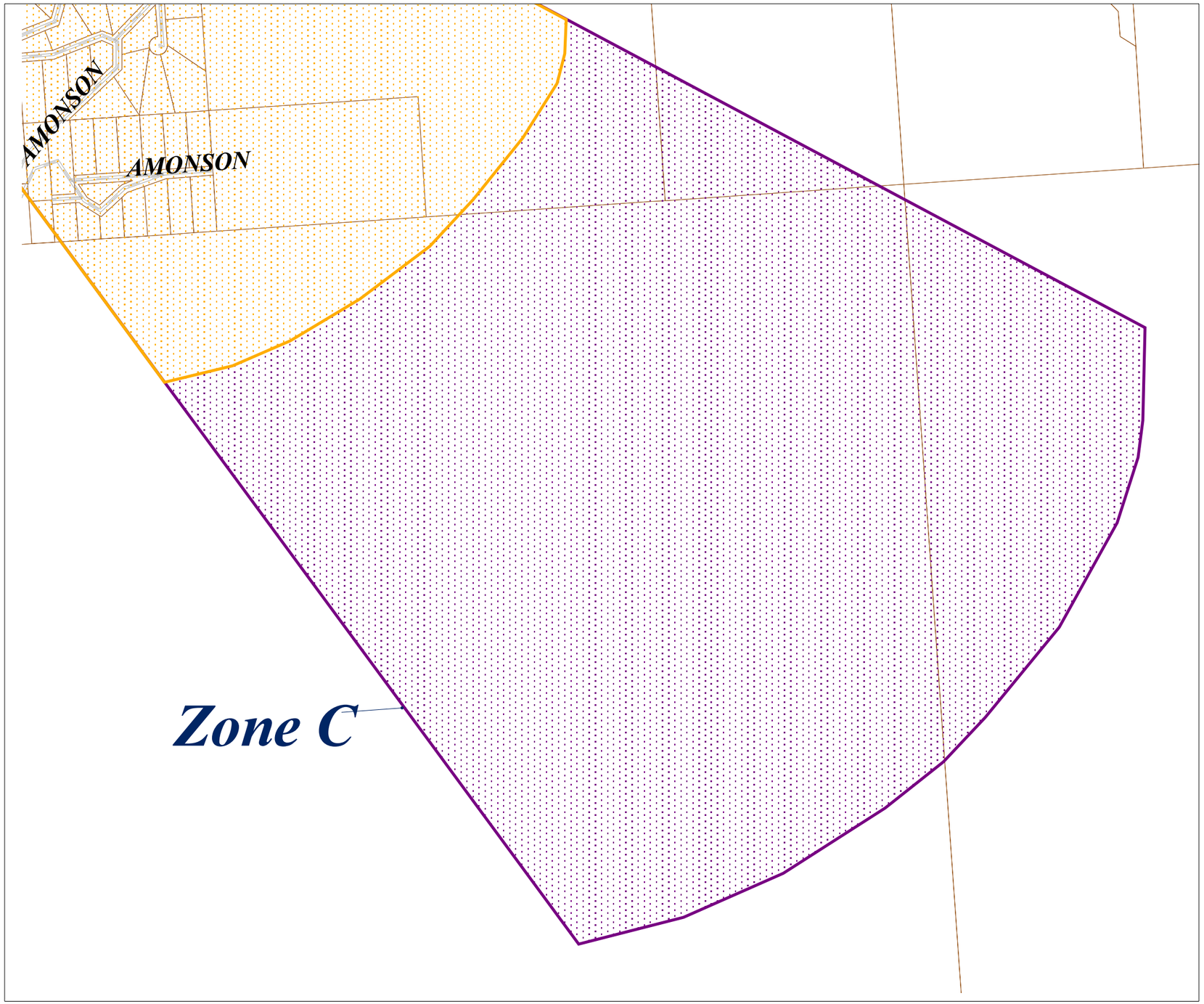
Map Two

Chugiak Benefit Assoc. Existing and Potential Contaminant Sources



Legend

- Chugiak Benefit Assoc. Well Location

Zone A
- Several Months Travel Time

Zone B
- Less Than Two Years Time of Travel

Zone C
- Less Than Five Years Time of Travel
- Roads (X20)
- Land Parcels

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Map Three

APPENDIX D

Vulnerability Analysis for Chugiak Benefit Association Well #1, #2, and #3
Public Drinking Water Source
(Charts 1-14)

Chart 1. Susceptibility of the wellhead - Chugiak Benefit Association

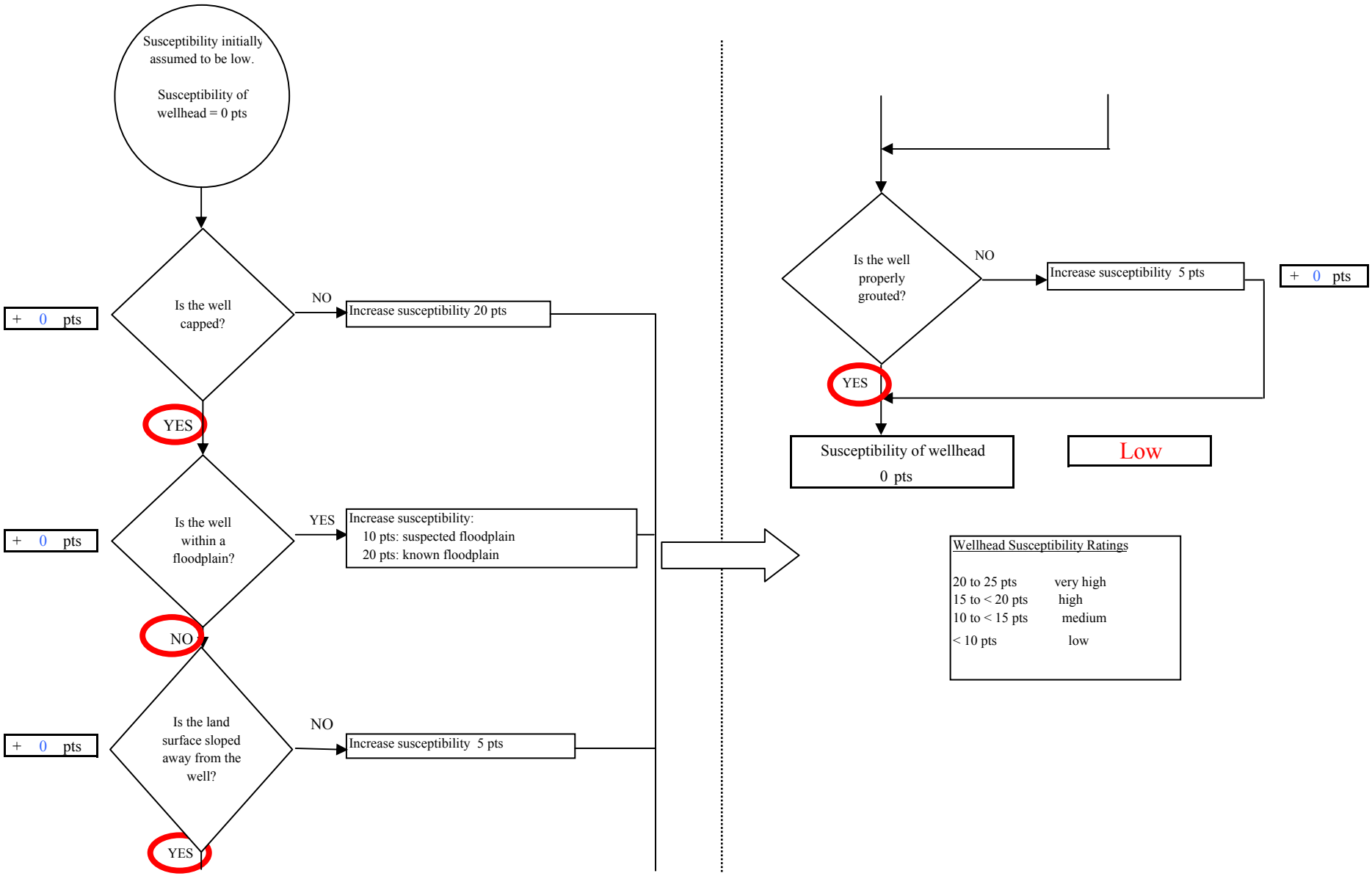


Chart 2. Susceptibility of the aquifer - Chugiak Benefit Association

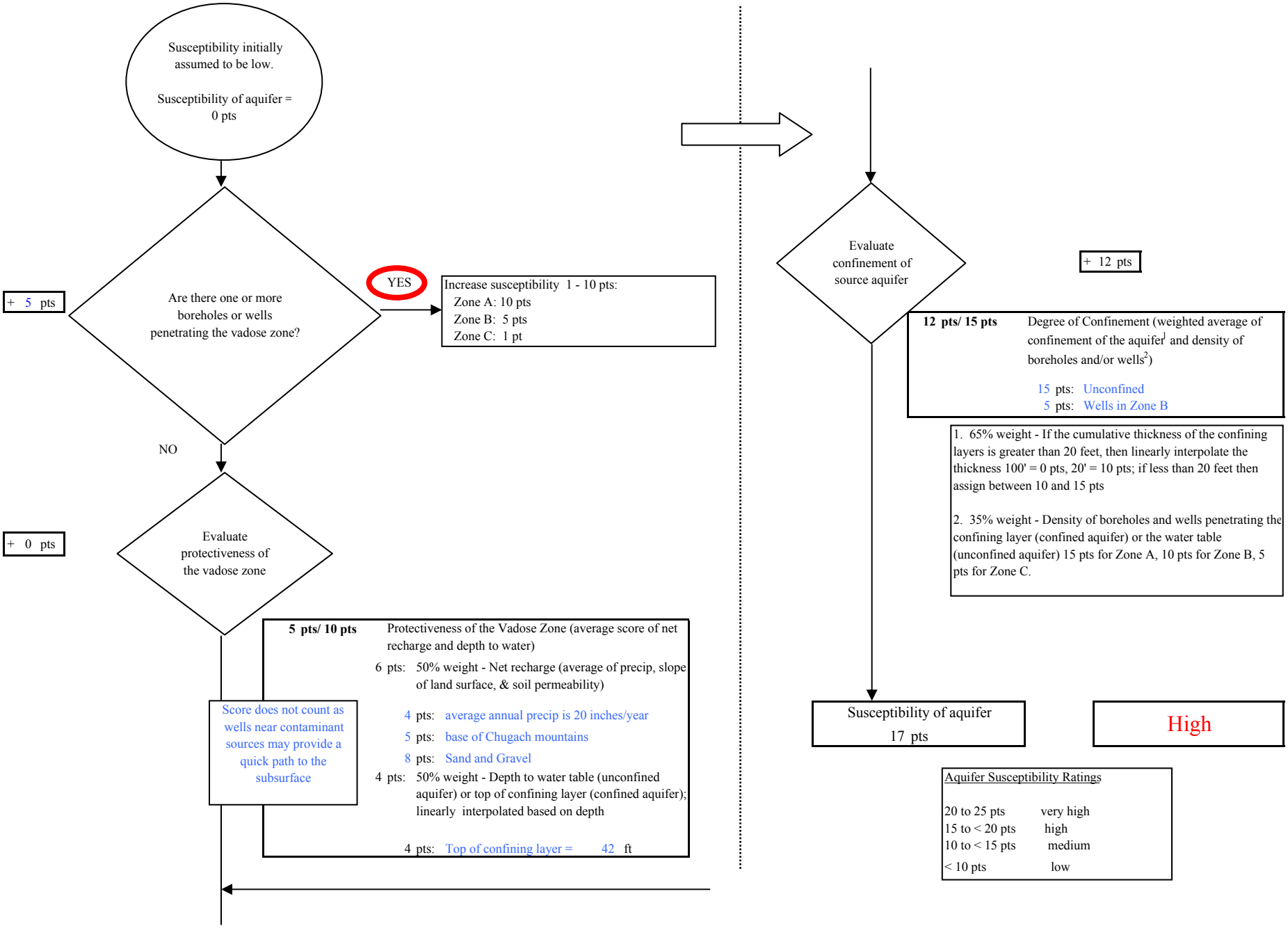
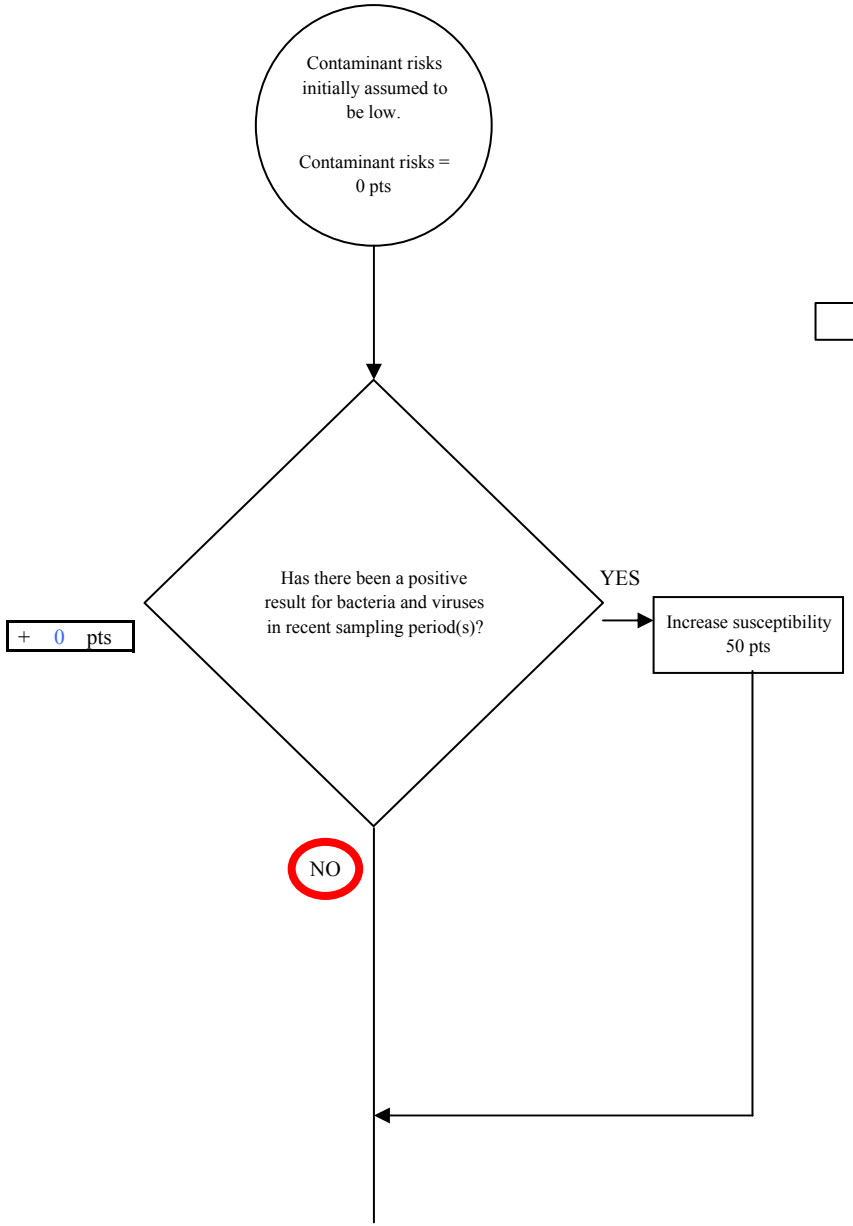
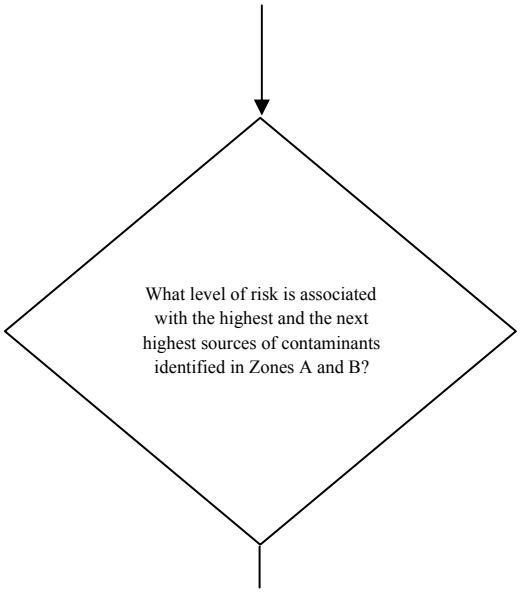


Chart 3. Contaminant risks for Chugiak Benefit Association - Bacteria & Viruses





+ 25 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)	1	0	1
Low(s)	18	6	24

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

Matrix Score 25

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

Chart 3. Contaminant risks for Chugiak Benefit Association - Bacteria & Viruses

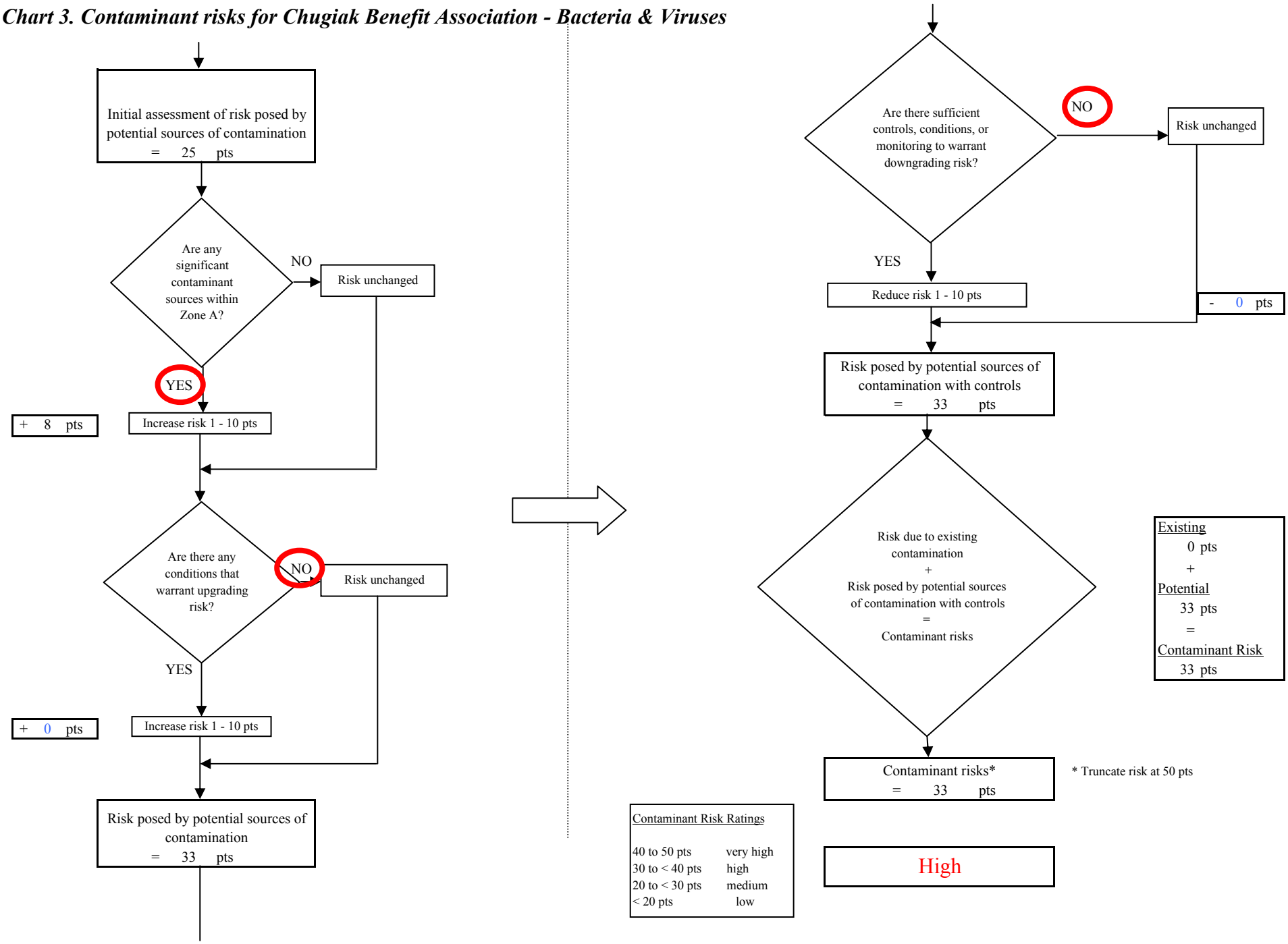


Chart 4. Vulnerability analysis for Chugiak Benefit Association - Bacteria & Viruses

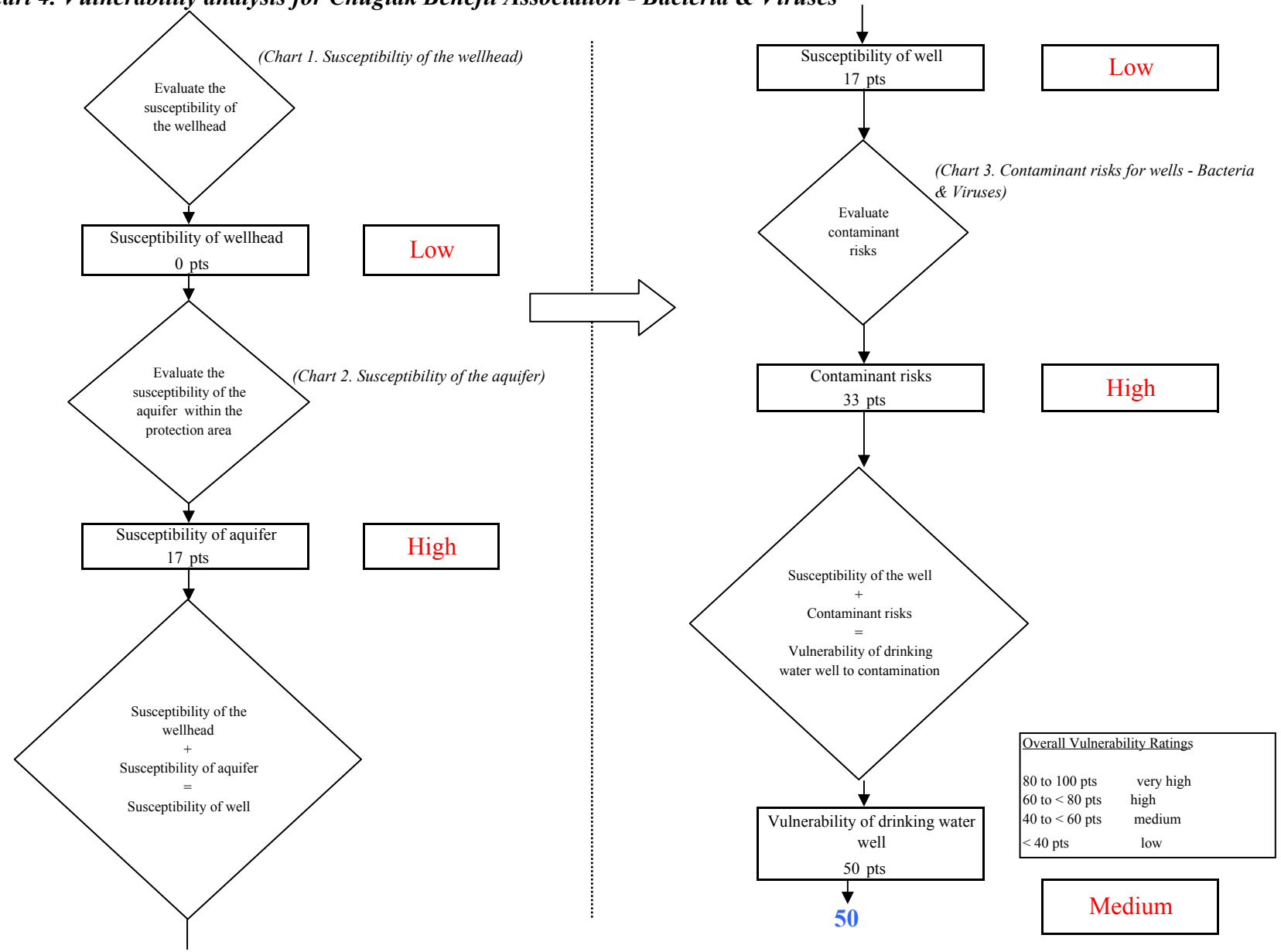


Chart 5. Contaminant risks for Chugiak Benefit Association - Nitrates and Nitrites

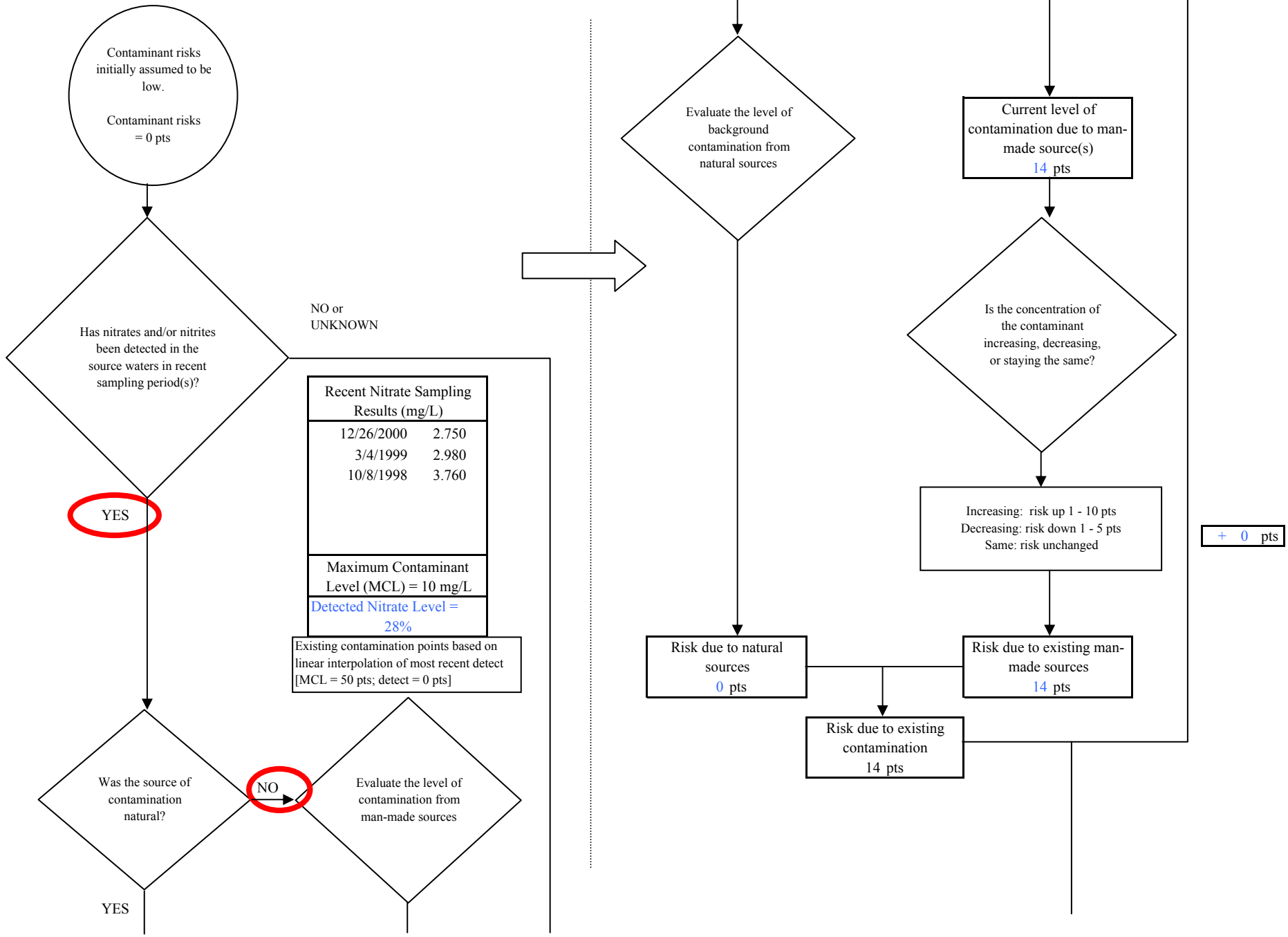


Chart 5. Contaminant risks for Chugiak Benefit Association - Nitrates and Nitrites

+ 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)	1	0	1
Low(s)	18	6	24

	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

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 8 pts

Chart 5. Contaminant risks for Chugiak Benefit Association - Nitrates and Nitrites

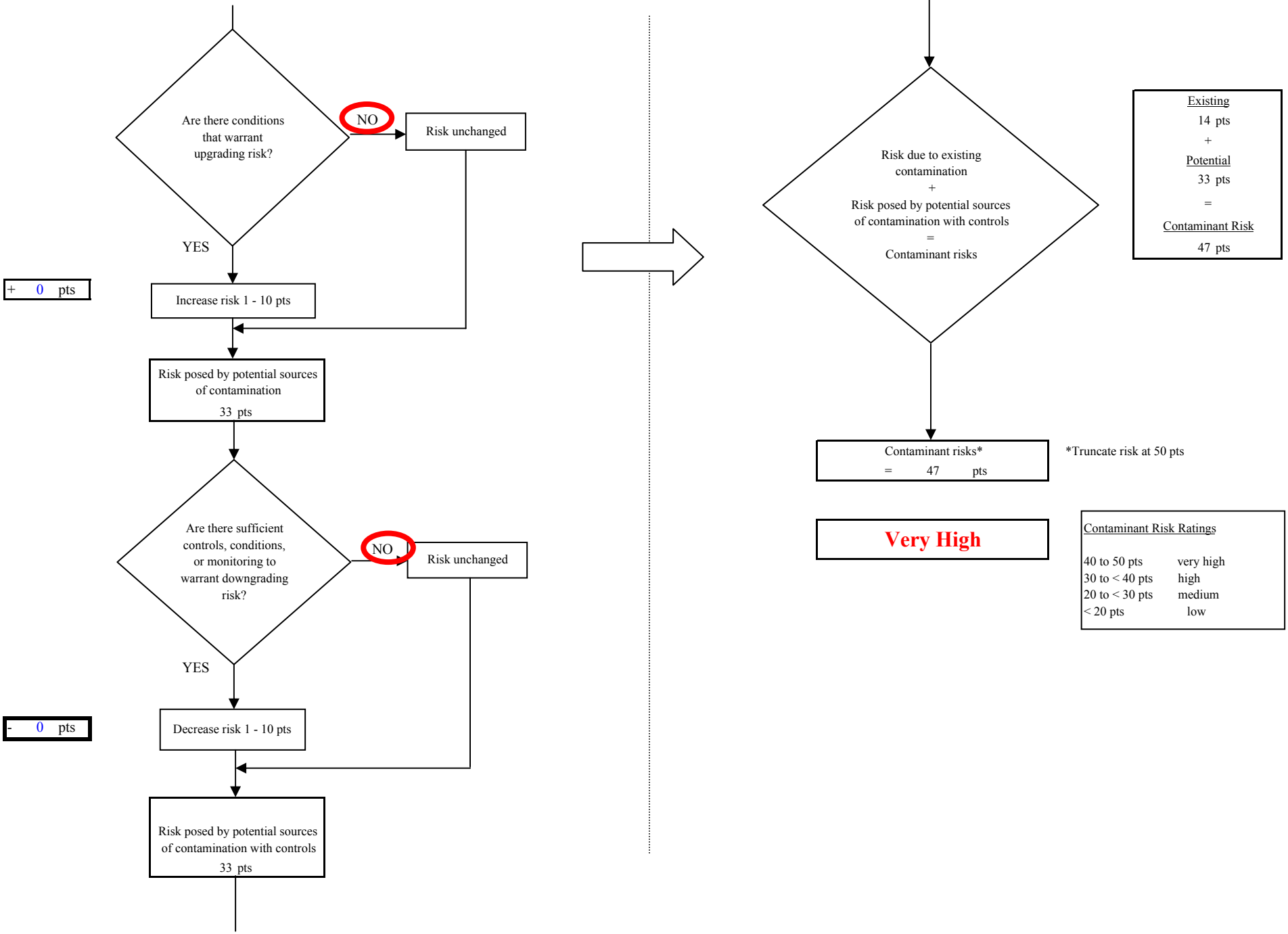


Chart 6. Vulnerability analysis for Chugiak Benefit Association - Nitrates and Nitrites

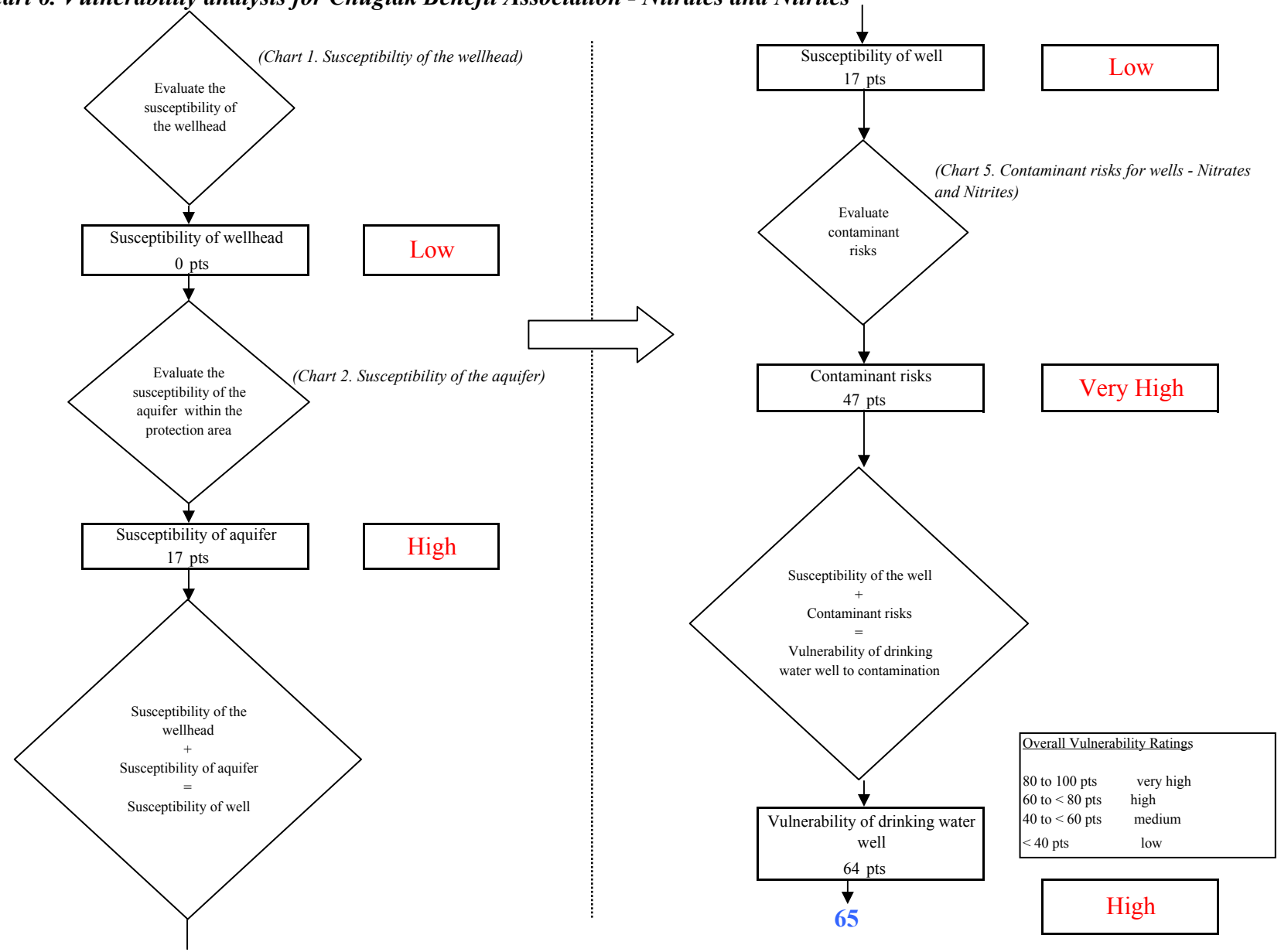


Chart 7. Contaminant risks for Chugiak Benefit Association - Volatile Organic Chemicals

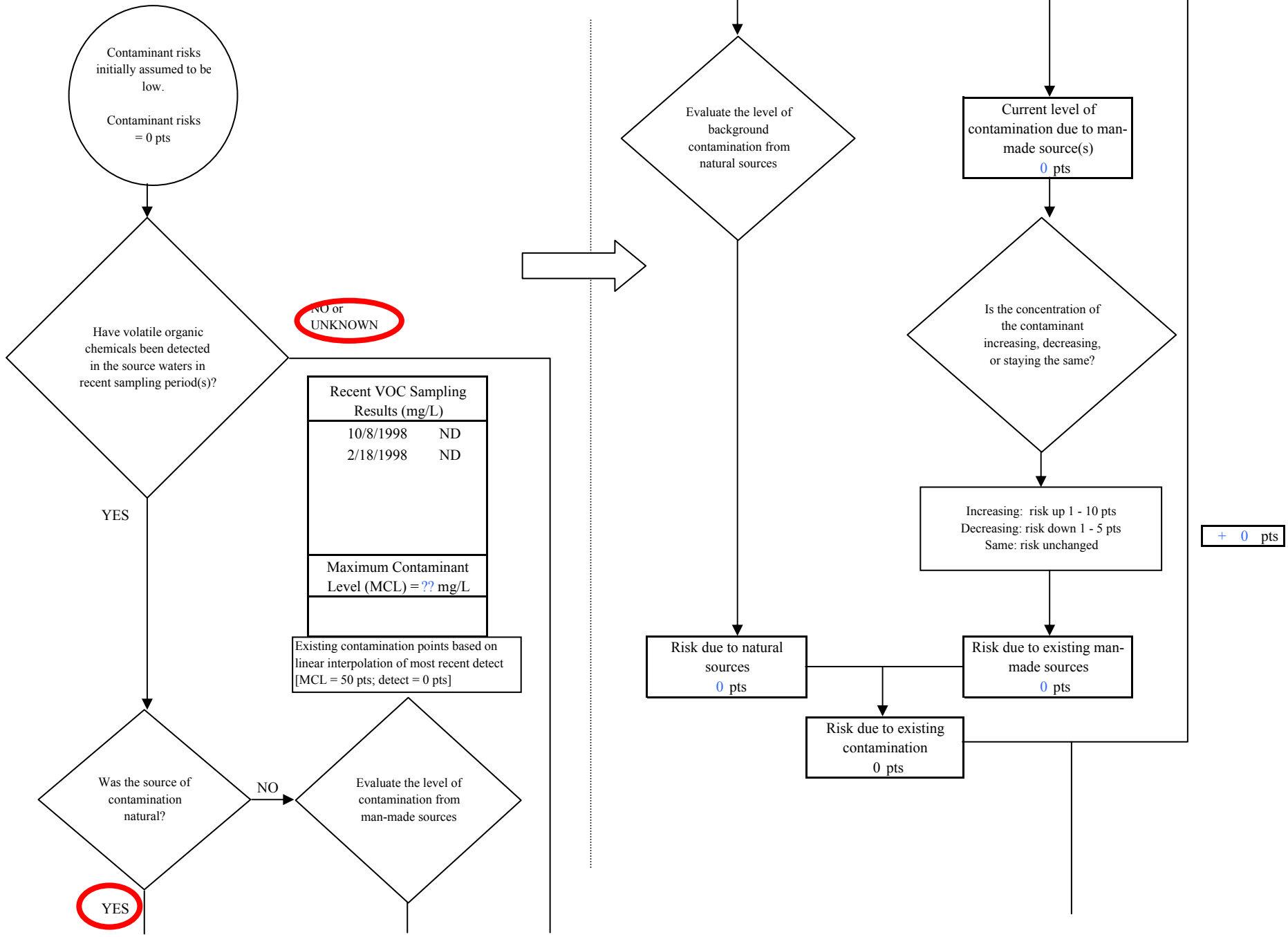


Chart 7. Contaminant risks for Chugiak Benefit Association - Volatile Organic Chemicals

+ 50 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	1	1
High(s)	2	0	2
Medium(s)	1	0	1
Low(s)	3	3	6

	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 50

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 = 50 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

Chart 7. Contaminant risks for Chugiak Benefit Association - Volatile Organic Chemicals

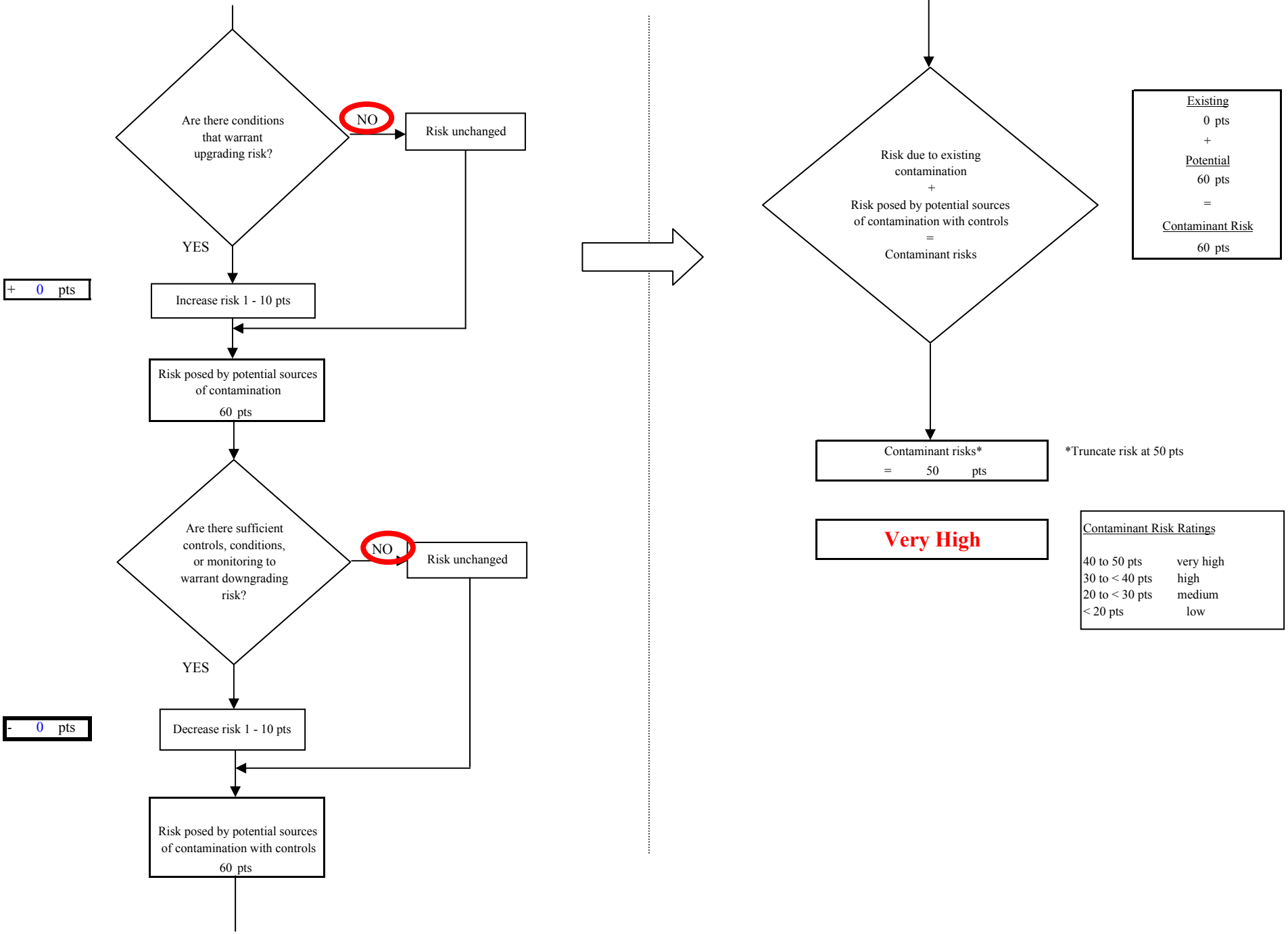


Chart 8. Vulnerability analysis for Chugiak Benefit Association - Volatile Organic Chemicals

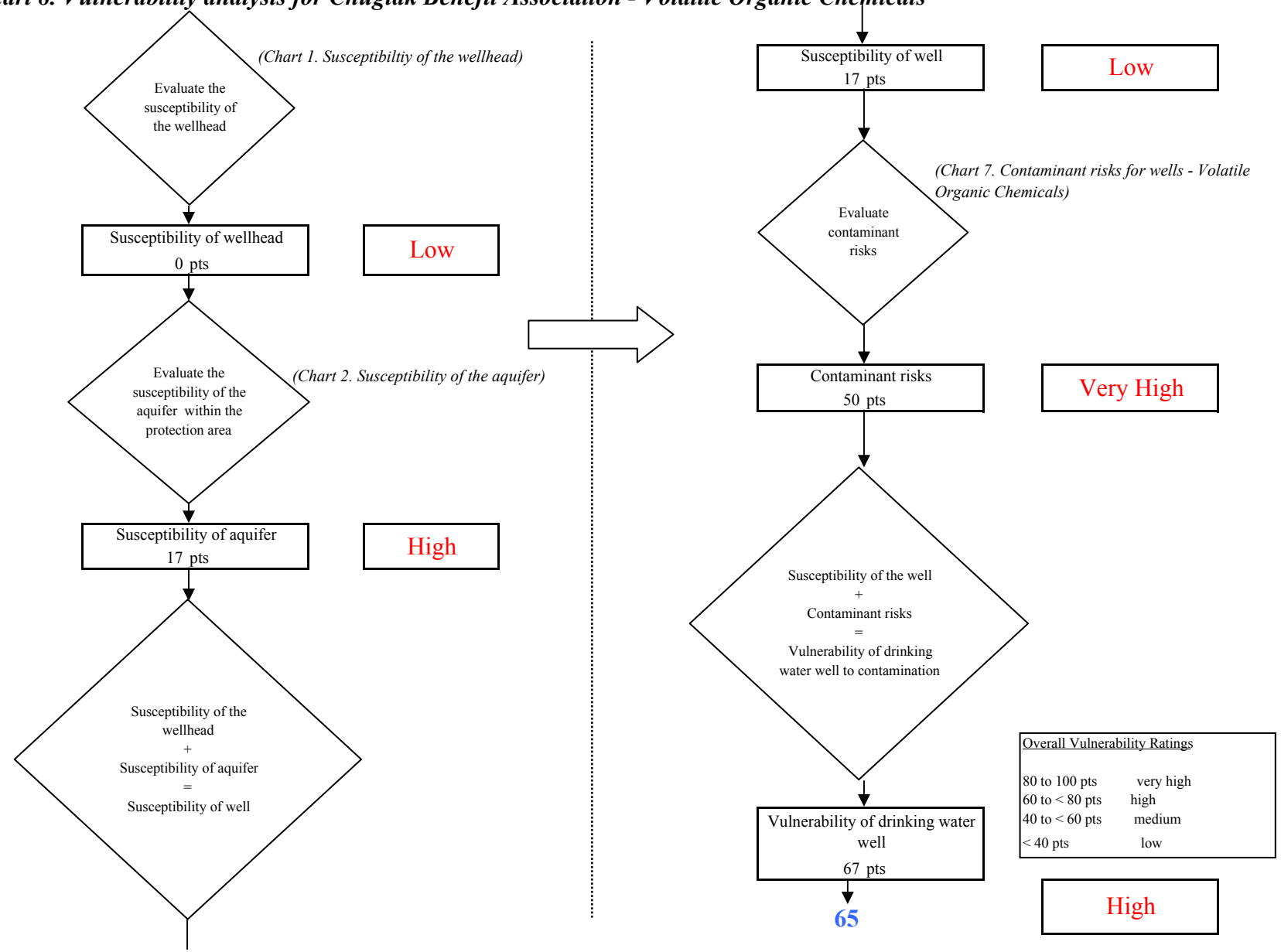


Chart 9. Contaminant risks for Chugiak Benefit Association - Heavy Metals, Cyanide and Other Inorganic Chemicals

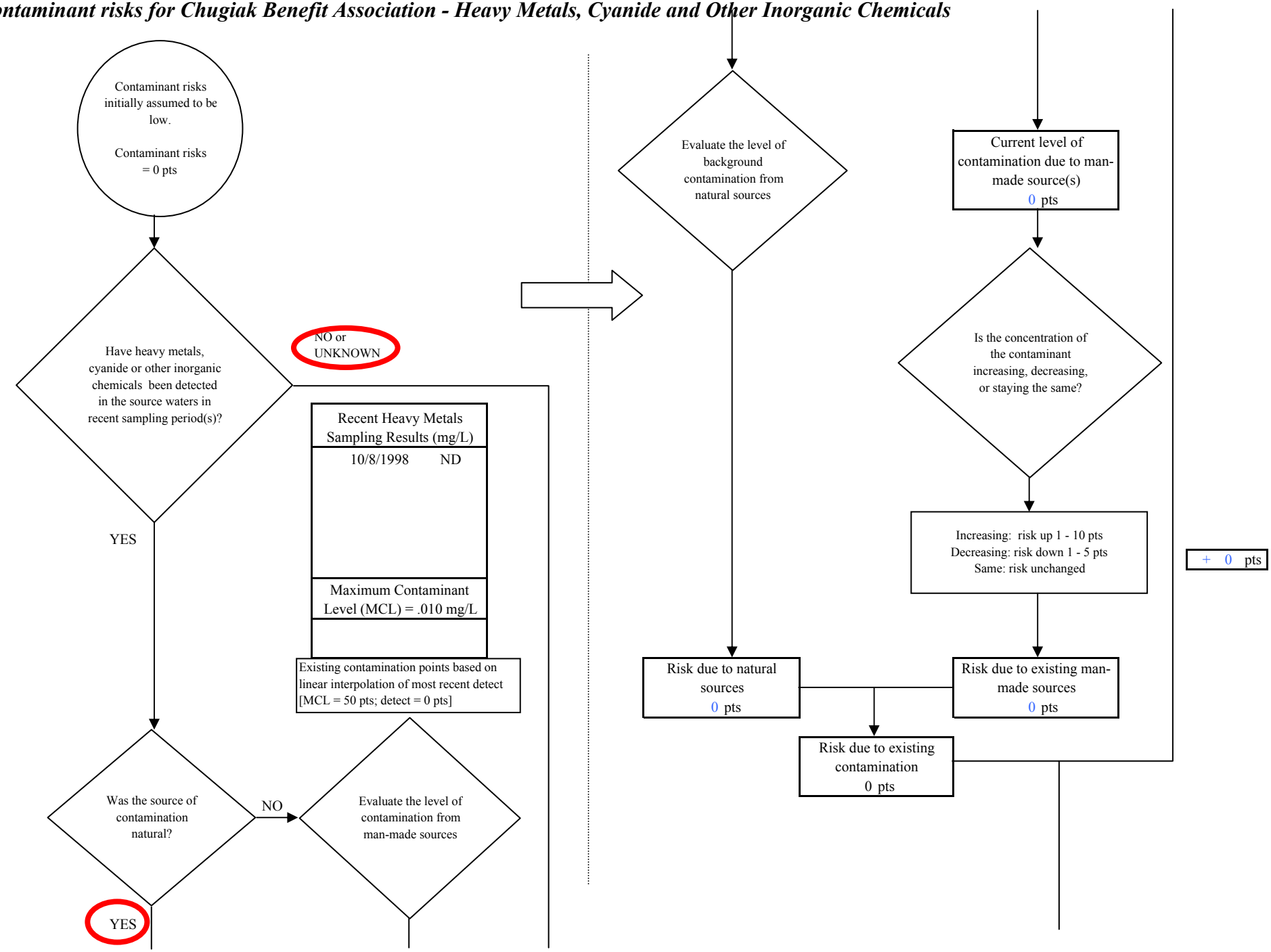


Chart 9. Contaminant risks for Chugiak Benefit Association - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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)	1	0	1
Low(s)	4	3	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 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

+ 5 pts

Chart 9. Contaminant risks for Chugiak Benefit Association - Heavy Metals, Cyanide and Other Inorganic Chemicals

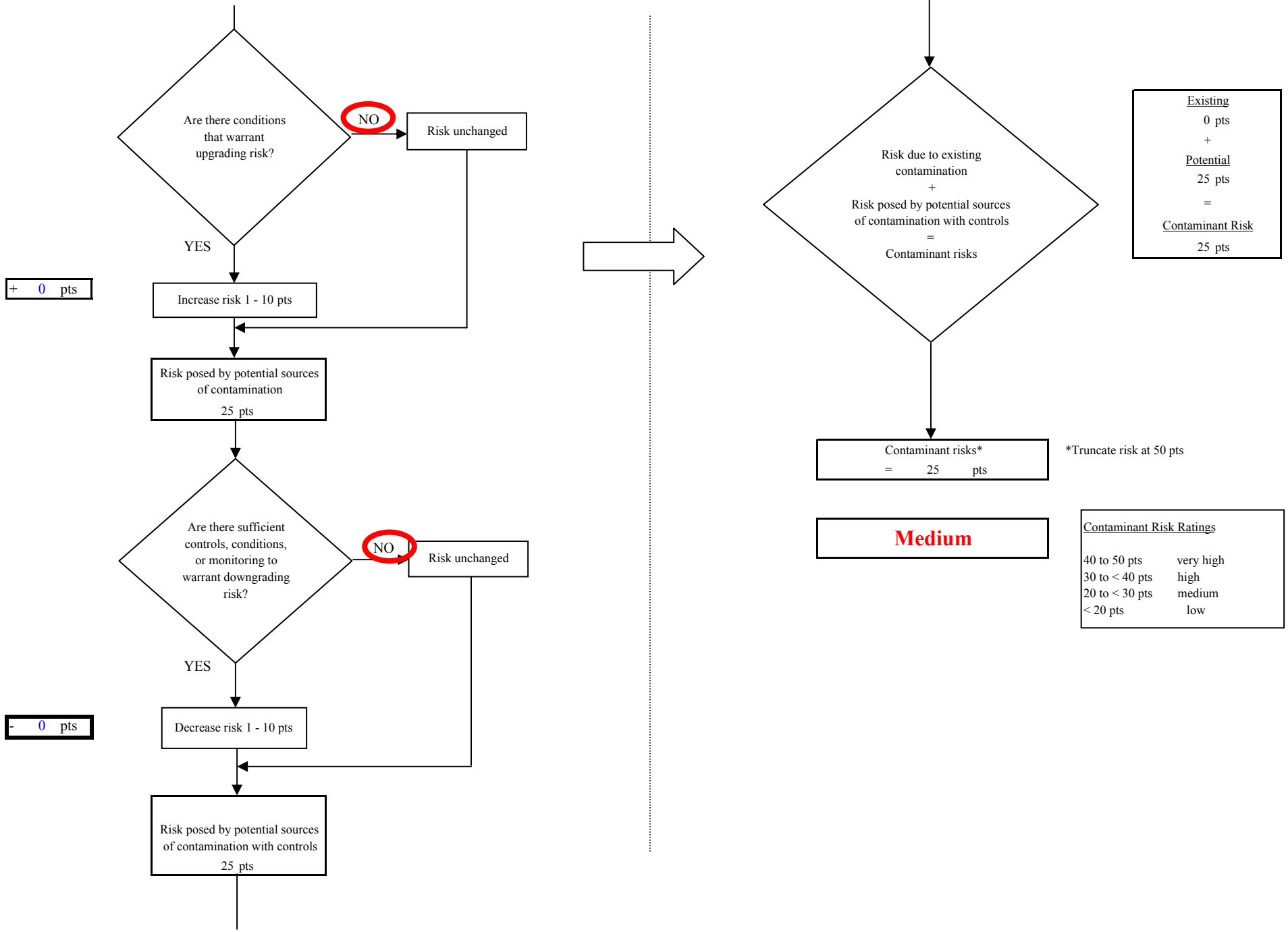


Chart 10. Vulnerability analysis for Chugiak Benefit Association - Heavy Metals, Cyanide and Other Inorganic Chemicals

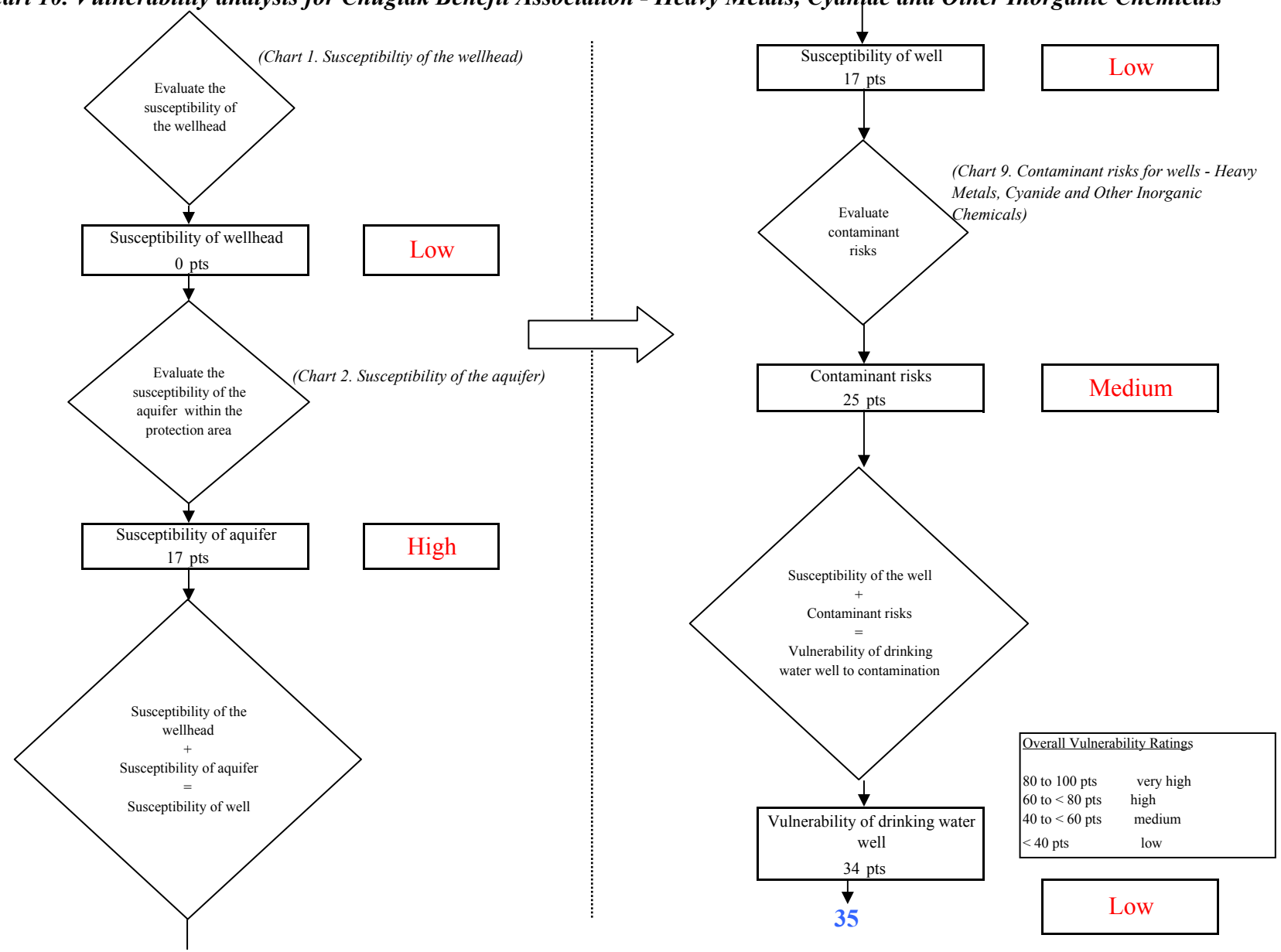


Chart 11. Contaminant risks for Chugiak Benefit Association - Synthetic Organic Chemicals

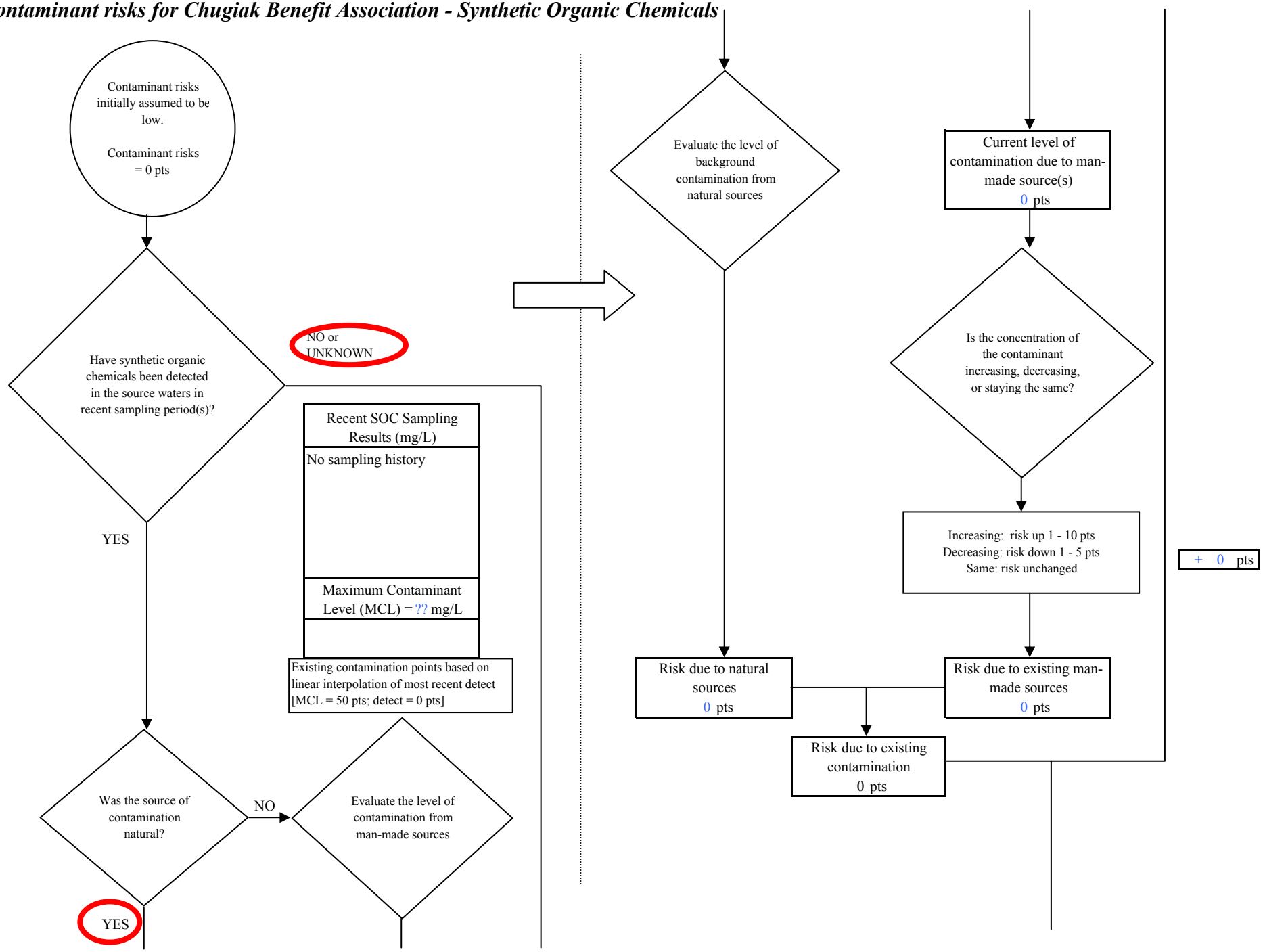
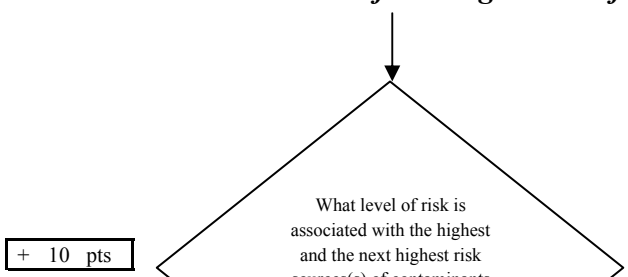


Chart 11. Contaminant risks for Chugiak Benefit Association - Synthetic Organic Chemicals



+ 10 pts

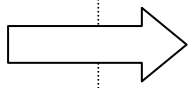
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	2	5

	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.



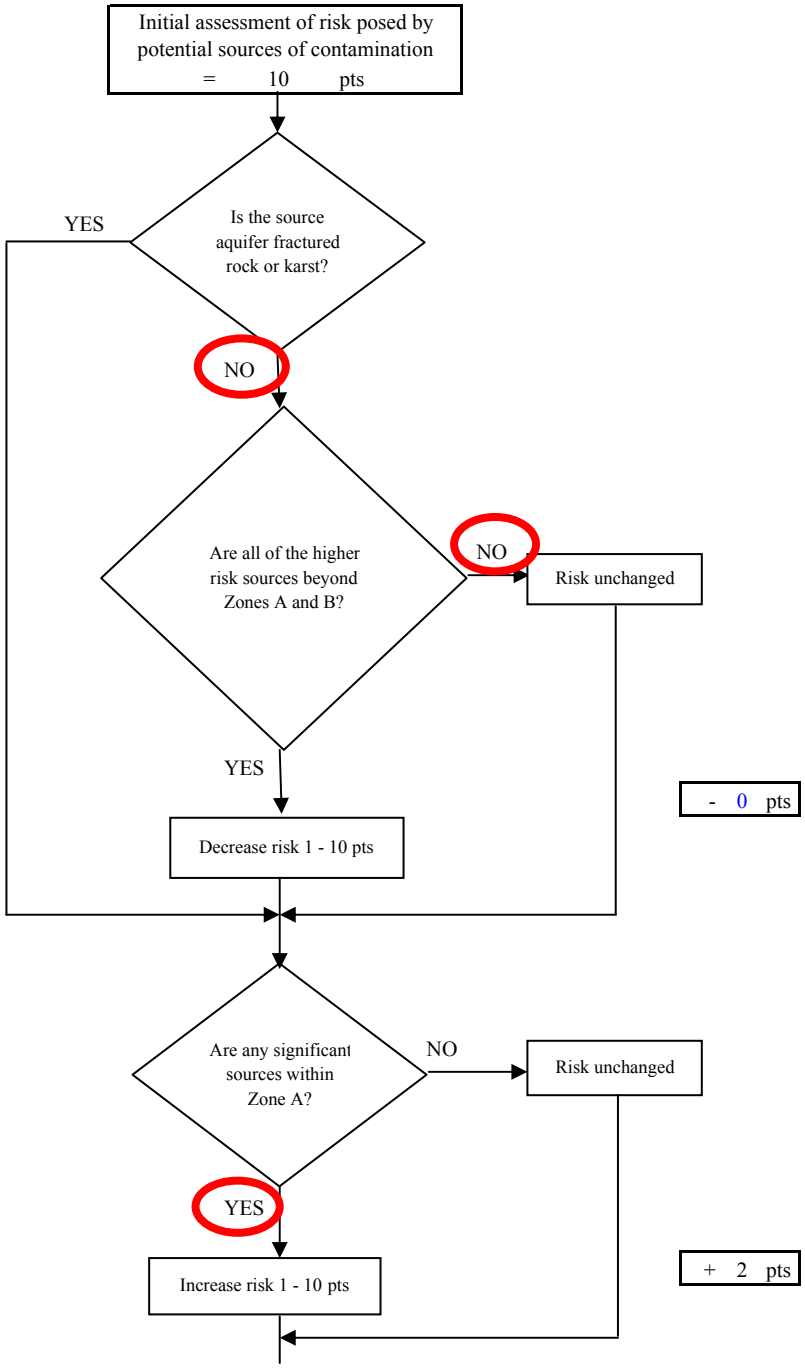


Chart 11. Contaminant risks for Chugiak Benefit Association - Synthetic Organic Chemicals

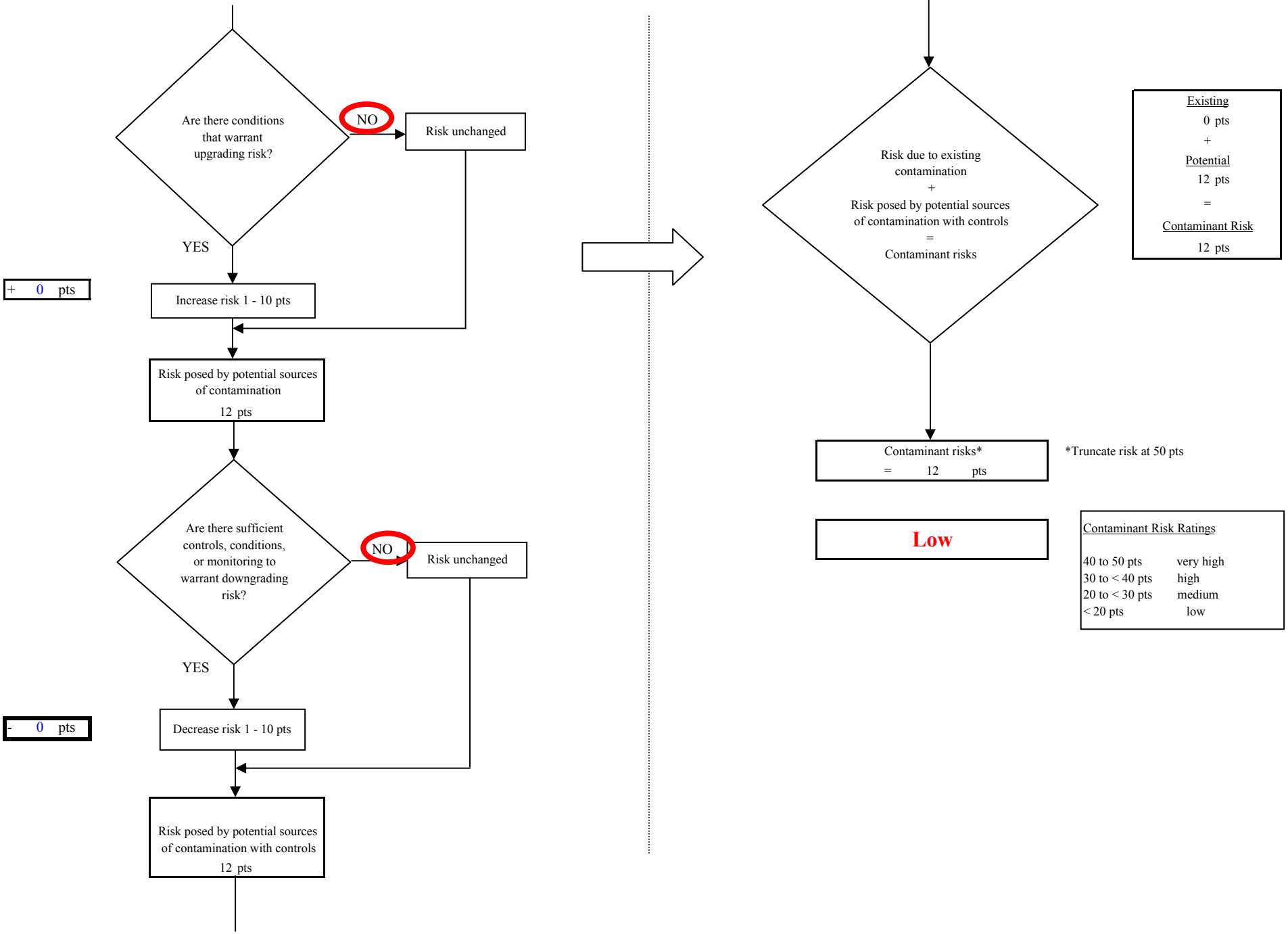


Chart 12. Vulnerability analysis for Chugiak Benefit Association - Synthetic Organic Chemicals

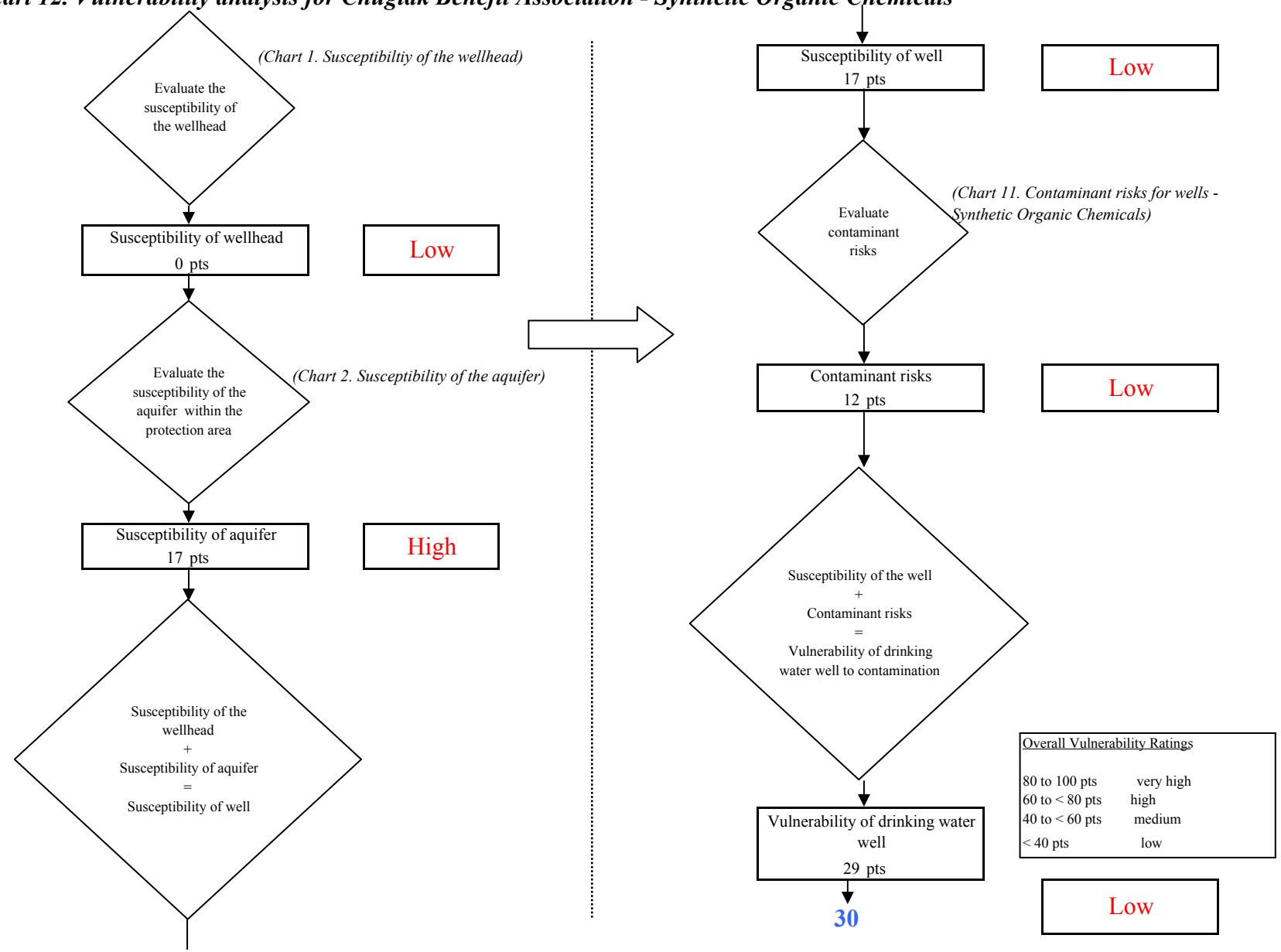


Chart 13. Contaminant risks for Chugiak Benefit Association - Other Organic Chemicals

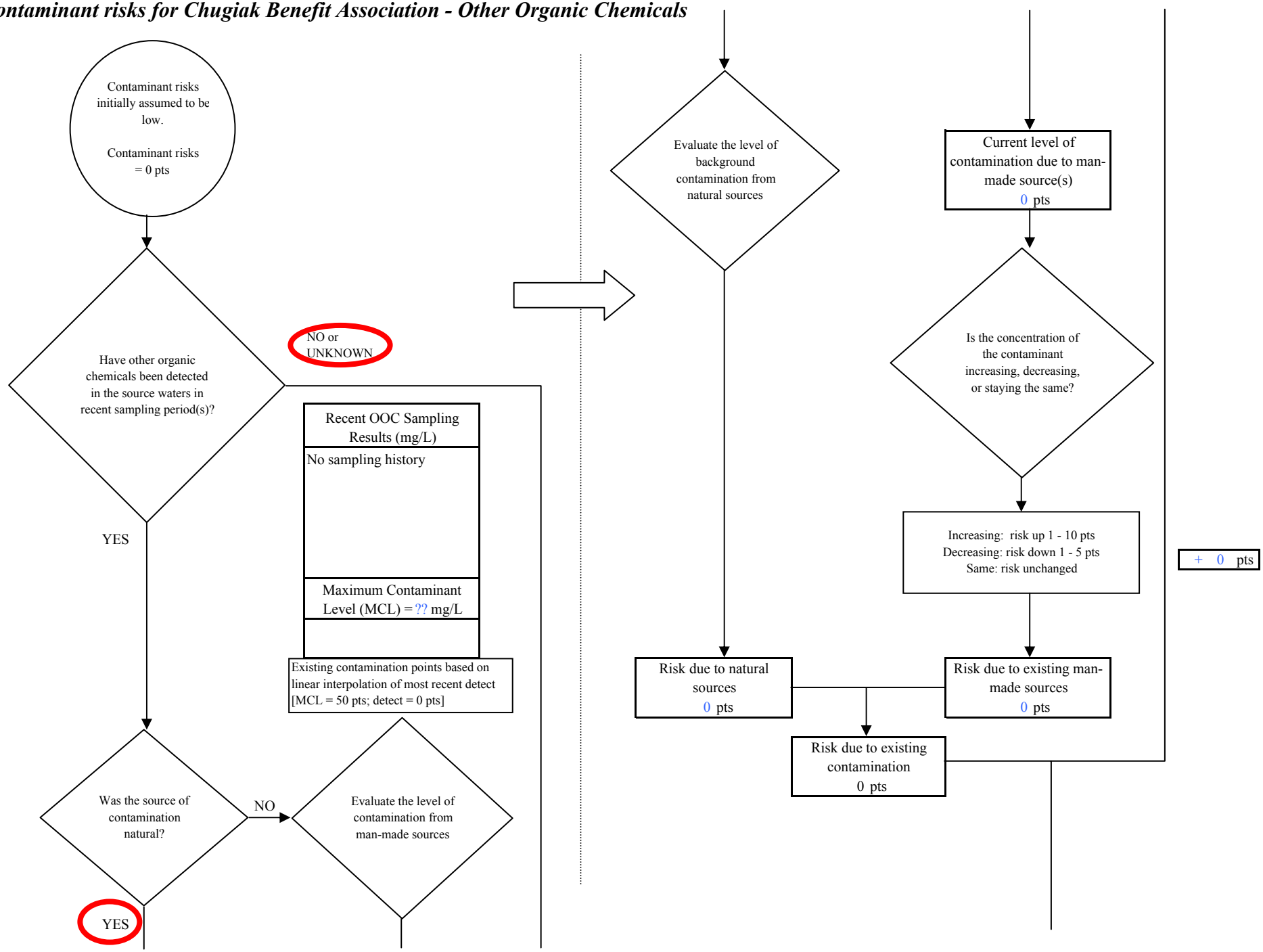


Chart 13. Contaminant risks for Chugiak Benefit Association - Other Organic Chemicals

+ 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)	3	3	6

	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

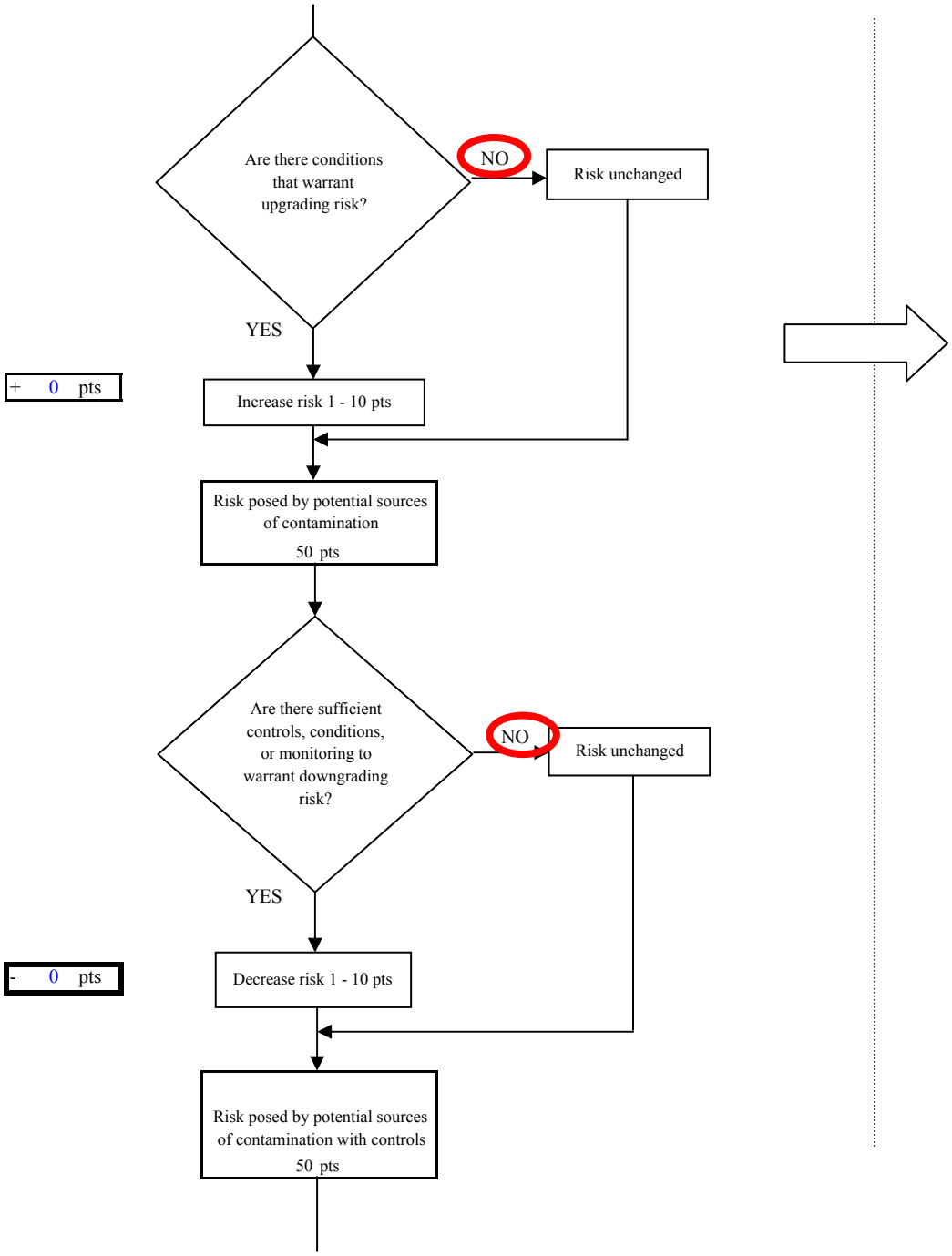
Risk unchanged

YES

Increase risk 1 - 10 pts

+ 10 pts

Chart 13. Contaminant risks for Chugiak Benefit Association - Other Organic Chemicals



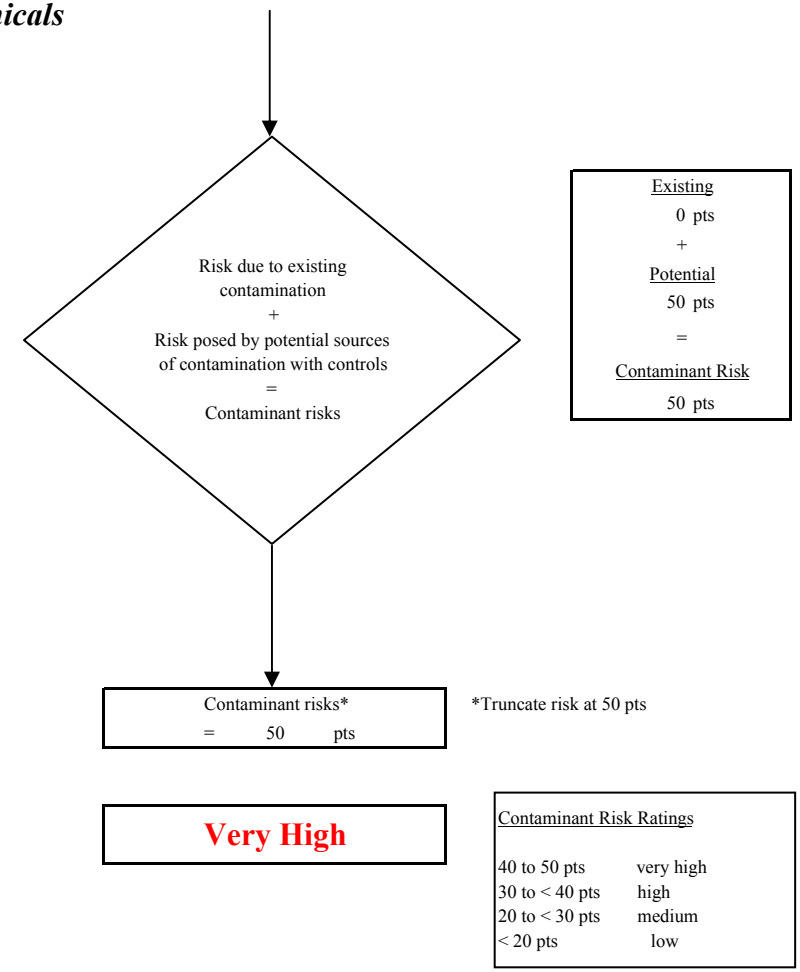


Chart 14. Vulnerability analysis for Chugiak Benefit Association - Other Organic Chemicals