Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for the City of Juneau, Alaska

Last Chance Basin Wellfield

PWSID # 110342.002

September 2003

DRINKING WATER PROTECTION PROGRAM REPORT #1025

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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Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for the City of Juneau is a Class A water system (community) consisting of two water intake areas. The primary intake area is the Last Chance Basin Wellfield on Gold Creek. The secondary intake for the water system is located on Salmon Creek. For the Last Chance Basin Wellfield, the wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two produces a rating of **Medium** for the natural susceptibility of the well. Identified potential and current sources of contaminants for the Last Chance Basin Wellfield intake area include: inactive mining areas, an underground diesel fuel tank, landslide potential, gravel roads, and foot trails. These identified potential and existing sources of contamination could possibly be sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risks, the Last Chance Basin Wellfield received a vulnerability rating of **High** for heavy metals; **Medium** for volatile organic chemicals; **Low** for bacteria and viruses, nitrates and/or nitrites, synthetic organic chemicals, and other organic chemicals. This assessment can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of the City of Juneau's Public Works Department to protect public health.

DRINKING WATER SYSTEM AND AREA OVERVIEW

The City of Juneau public water system is a Class A (community) water system consisting of two water intake areas. The primary intake area is the Last Chance Basin Wellfield on Gold Creek. This wellfield typically supplies a total demand of about 3.0 million gallons per day (MGD). This source was first built in 1959, with additional wells drilled and other improvements made in 1976 and 1990. Chlorination and fluoridation are the only treatment this water receives (City of Juneau, 2003).

The secondary intake for the water system is located on Salmon Creek. Treatment includes chlorination, fluoridation, and pH and alkalinity adjustment with soda ash before the water enters the distribution system. This source came on-line in 1984 when Alaska Electric Light and Power rehabilitated the lower Salmon Creek power house. Salmon Creek is an intermittent source due to seasonal high turbidity and annual maintenance on the generator by AEL&P. Salmon Creek typically supplies about one third of the water area wide, when on-line (City of Juneau, 2003).

When both sources are available, residents north of Hospital Drive are generally served by water from Salmon Creek, while residents south of Hospital Drive and all of Douglas Island are generally served by Last Chance Basin water (City of Juneau, 2003).

The Last Chance Basin Wellfield is located along Gold Creek, just behind (north) of downtown Juneau (Sec. 23, T041S, R067E, Copper River Meridian) (See Map 1 of Appendix A). Located on the mainland of Southeast Alaska, opposite Douglas Island, Juneau was built at the heart of the Inside Passage along the Gastineau Channel. It lies 900 air miles northwest of Seattle and 577 air miles southeast of Anchorage. (Please see the inset of Map 1 in Appendix A for location). The current population is approximately 31,000 (ADCED, 2002).

Juneau has a mild, maritime climate. Average summer temperatures range from 44 to 65; winter temperatures range from 25 to 35. It is in the mildest climate zone in Alaska. Annual precipitation is 92 inches in downtown Juneau, and 54 inches ten miles north at the airport. Snowfall averages 101 inches (ADCED, 2003).

The Borough's piped sewage system serves almost 80% of residents, and receives secondary treatment. Sludge is incinerated. North Douglas Island residents use individual septic tanks, and funds have been provided to begin planning a sewer main extension to this area. Refuse collection, the landfill and incinerator are owned by a private firm, Waste Management Co. Juneau has a sludge site, hazardous waste collection facility, and local organizations also provide recycling programs. AEL&P receives the majority of its power from the

state-owned Snettisham Hydroelectric Facility south of town. AEL&P owns the Annex Creek, Upper Salmon Creek and Lower Salmon Creek Hydro Plants, and the Gold Creek, Lemon Creek and Auke Bay Diesel back-up systems. The U.S. Geological Survey and AEL&P are collecting streamgaging data at Dorothy Lake for hydroelectric potential (ADCED, 2003).

The Last Chance Basin Wellfield consists of 5 wells, with depths ranging from 95 – 133 feet. Each of these wells is screened. Previous review of well logs indicates that the depth to bedrock in mid-basin exceeds 240-ft. Principle aquifers in the Last Chance Basin consists of both a confined and unconfined aquifer *(Motyka, et. al., 1990).*

The Sanitary Survey (2001) indicates the wells have been 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. System operators report that wells 1-5 are properly housed. The wells are grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

LAST CHANCE BASIN WELLFIELD 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. 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. Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate and adjacent watershed was used to determine the size and shape of the protection area for the Last Chance Basin Wellfield. Available geology was also considered in accounting for uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area. The input parameters describing the attributes of the aquifer in this calculation were adopted from a 1979 groundwater publication by Allan Freeze and John A. Cherry.

The time of travel for contaminants (TOT) within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four protection area zones for wells and the calculated TOT of the water 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

The protection area for the Last Chance Basin Wellfield is limited by its immediate watershed and does not include Zone D (See Appendix C).

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 Last Chance Basin Wellfield protection area. 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 Map 2 of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

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

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

The TOT for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants travel to the well.

Tables 2 through 7 (if necessary) in Appendix B contain the ranking of potential and existing sources of contamination with respect each contaminant source.

VULNERABILITY OF THE DRINKING WATER SYSTEM

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. Chart 4 contains the 'Vulnerability Analysis for Bacteria & 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.

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

- Natural susceptibility; and
- Contaminant risks.

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 wells in the Last Chance Basin are completed in a confined aquifer, which helps reduce the possibility of surface contaminants reaching the water source. Table 2 shows the Susceptibility scores and ratings for the basin.

Table 2. Susceptibility of the Wellfield

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	16	High
Natural Susceptibility	21	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	14	Low
Volatile Organic Chemicals	30	High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	41	Very High
Synthetic Organic Chemicals	0	Low
Other Organic Chemicals	12	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	30	Low
Nitrates and Nitrites	35	Low
Volatile Organic Chemicals	50	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	60	High
Synthetic Organic Chemicals	20	Low
Other Organic Chemicals	30	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is low with human, animal, and vehicular activity along gravel roads and hiking trails presenting the most significant risk to the drinking water wells (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at the Last Chance Basin. 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 contaminant risk for nitrates and nitrites is low with human, animal, and vehicular activity along gravel roads and hiking trails 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 the Last Chance Basin wells indicates that low concentrations of nitrate have been detected in samples collected in 1997. The Maximum Contaminant Level (MCL) for nitrate is 10 milligrams per liter (mg/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 mg/L, or 20% of the MCL, 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 well, the overall vulnerability of the well to contamination is low.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is high with the underground diesel storage tank for the well pumps creating the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). The most common causes of fuel leaks of these tanks are overfilling with fuel, 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 detected in significant levels during recent sampling of the Last Chance Basin Wellfield. 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 contaminant risk for heavy metals is very high with Jualapa Tunnel creating the greatest risk of contamination (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Heavy metals, cyanide and other inorganic chemicals have not been detected in significant concentrations during recent sampling. After combining the contaminant risk for heavy metals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is low. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to synthetic organic chemicals of the well remains low (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

Review of the historical sampling data indicates that no synthetic organic chemicals have been detected in amounts exceeding the MCL within the past 5 years.

Other Organic Chemicals

The contaminant risk for other organic chemicals is low with the gravel roads within the protection area creating the risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is low (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

Review of the historical sampling data indicates that no other organic chemicals have been detected in amounts exceeding the MCL within the past 5 years.

Using the Source Water Assessment

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 City of Juneau 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 the City of Juneau drinking water source.

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APPENDIX A

City of Juneau
Drinking Water Protection Area Location Map
(Map 1)

City of Juneau -
Drinking Water Protection Areas

Map 1: City of Juneau - Drinking Water Protection Areas

PWSID: 110342.001 / .002

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 4,500 9,000 18,000 27,000 36,000 Feet

1:108,000

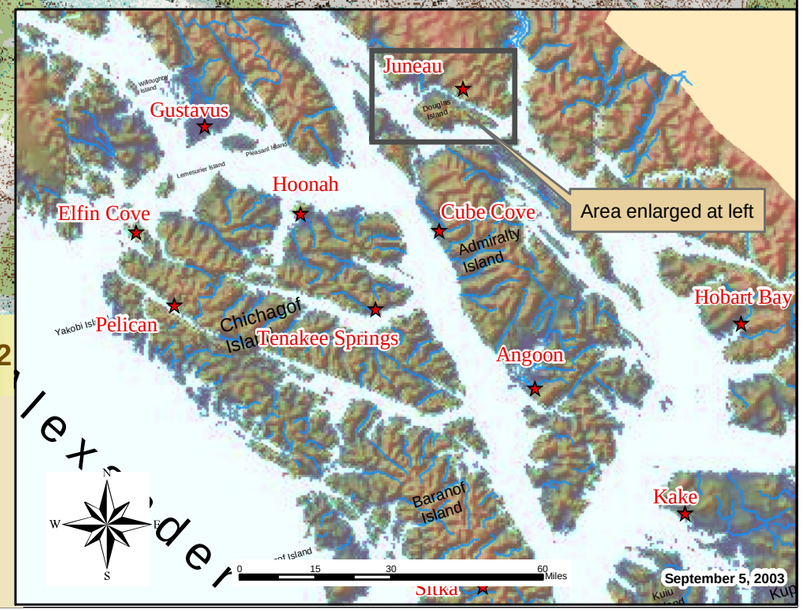
Data Sources:
Background image
- USGS 1:63,000 mapping
Lakes, streams, & roads
- U.S. Forest Service, Tongass

Protection zones for the Salmon Creek Reservoir were delineated based upon streams noted on USGS 1:63,000 mapping.

Protection Zones for the Last Chance Basin Wellfield were delineated based upon watershed area and groundwater flow information.

Legend

- City of Juneau - Water Intake
- Zone A Protection Area
- Zone B Protection Area
- Zone C Protection Area
- Roads
- Stream
- Lake



APPENDIX B

Contaminant Source Inventory and Risk Ranking

(Tables 1-6)

Table 1

Contaminant Source Inventory for ***City of Juneau***

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Landslides or other hillside areas subject to significant erosion	B06	B06 - 1	A	2	From 2001 Sanitary Survey
Metals mining, placer (inactive)	E04	E04 - 1	A	2	From DNR mines data - Abandoned mine is currently the Last Chance Mining Museum
Metals mining, underground (inactive)	E05	E05 - 1	A	2	From DWPP Contaminated Sites Database
Tanks, diesel (underground)	T08	T08 - 1	A	2	ADEC UST Site 2160
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08 - 1	A	2	ADEC Closed LUST site 2160
Highways and roads, dirt/gravel	X24	X24 - 1	A	2	From 2002 Tiger Census GIS data
Dog walking areas/foot trails	X46	X46 1-3	A	2	From 2000 Tiger Census GIS data
Metals mining, placer (inactive)	E04	E04 - 2	B	2	From DNR mines data - Silver Bow Basin - Perseverance Mill
Metals mining, placer (inactive)	E04	E04 - 3	B	2	From DNR mines data - Lurvey

Table 2

Contaminant Source Inventory and Risk Ranking for City of Juneau Sources of Bacteria and Viruses

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, dirt/gravel	X24	X24 - 1	A	Low	2	From 2002 Tiger Census GIS data
Dog walking areas/foot trails	X46	X46 1-3	A	Low	2	From 2000 Tiger Census GIS data

Table 3

Contaminant Source Inventory and Risk Ranking for City of Juneau Sources of Nitrates/Nitrites

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, dirt/gravel	X24	X24 - 1	A	Low	2	From 2002 Tiger Census GIS data
Dog walking areas/foot trails	X46	X46 1-3	A	Low	2	From 2000 Tiger Census GIS data

Table 4

Contaminant Source Inventory and Risk Ranking for City of Juneau Sources of Volatile Organic Chemicals

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Metals mining, underground (inactive)	E05	E05 - 1	A	Medium	2	From DWPP Contaminated Sites Database
Tanks, diesel (underground)	T08	T08 - 1	A	High	2	ADEC UST Site 2160
Highways and roads, dirt/gravel	X24	X24 - 1	A	Low	2	From 2002 Tiger Census GIS data

Table 5

Contaminant Source Inventory and Risk Ranking for City of Juneau

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Metals mining, placer (inactive)	E04	E04 - 1	A	Low	2	From DNR mines data - Abandoned mine is currently the Last Chance Mining Museum
Metals mining, underground (inactive)	E05	E05 - 1	A	Very High	2	From DWPP Contaminated Sites Database
Highways and roads, dirt/gravel	X24	X24 - 1	A	Low	2	From 2002 Tiger Census GIS data
Metals mining, placer (inactive)	E04	E04 - 2	B	Low	2	From DNR mines data - Silver Bow Basin - Perseverance Mill
Metals mining, placer (inactive)	E04	E04 - 3	B	Low	2	From DNR mines data - Lurvey

Table 6

Contaminant Source Inventory and Risk Ranking for City of Juneau
Sources of Other Organic Chemicals

PWSID 110342.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, dirt/gravel	X24	X24 - 1	A	Low	2	From 2002 Tiger Census GIS data

APPENDIX C

Last Chance Basin Wellfield
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Salmon Creek Reservoir Protection Area

U08 - 1, T08-1
(Closed LUST site #2160, plus an existing UST)
Wellfield pump house

E05 - 1
(Abandoned Underground Gold Mining Tunnel)
Jualapa Tunnel

E04 - 2
(Abandoned Placer Mine - Silver Bow Basin)
Perseverance Mill

B06-1
(Landslide potential - multiple areas)

X46- 1 through 3
(Foot trails)

E04 - 3
(Abandoned Placer Mine - Lurvey)

Last Chance Wellfield

E04 - 1
(Abandoned Placer Mine - Last Chance Basin)
(Last Chance Mining Museum location)

X24 - 1
(Gravel Road)

Mill Tunnel
(Abandoned)

Area enlarged at left

Map 2: Potential and Existing Contaminant Sources

PWSID: 110342.002

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 1,000 2,000 4,000 6,000 8,000 Feet

1:24,000

Data Sources:

Background image - USGS 1:63,000 mapping
Lakes, streams, & roads - U.S. Forest Service

Protection zones were delineated based upon overall watershed area and groundwater flow information.

Legend

- Last Chance Basin Wellfield
- Zone A Protection Area
- Zone B Protection Area
- Zone C Protection Area
- Lake
- Stream
- Road
- Trail

0 2.5 5 Miles

September 5, 2003

APPENDIX D

Vulnerability Analysis for the Last Chance Basin Wellfield

(Charts 1-14)

Chart 1. Susceptibility of the Wellhead - City of Juneau, Last Chance Basin Wellfield

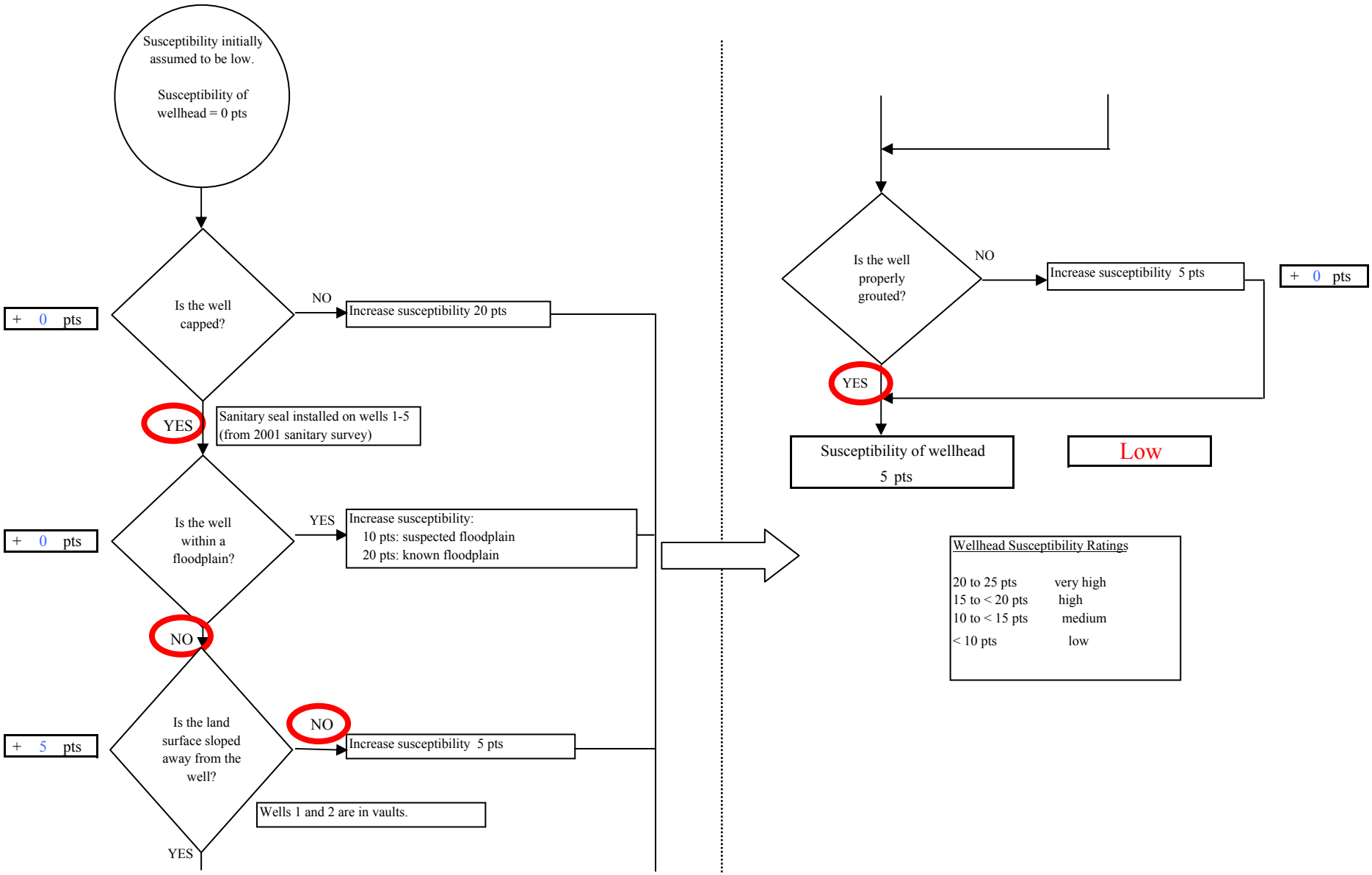


Chart 2. Susceptibility of the Aquifer - City of Juneau, Last Chance Basin Wellfield

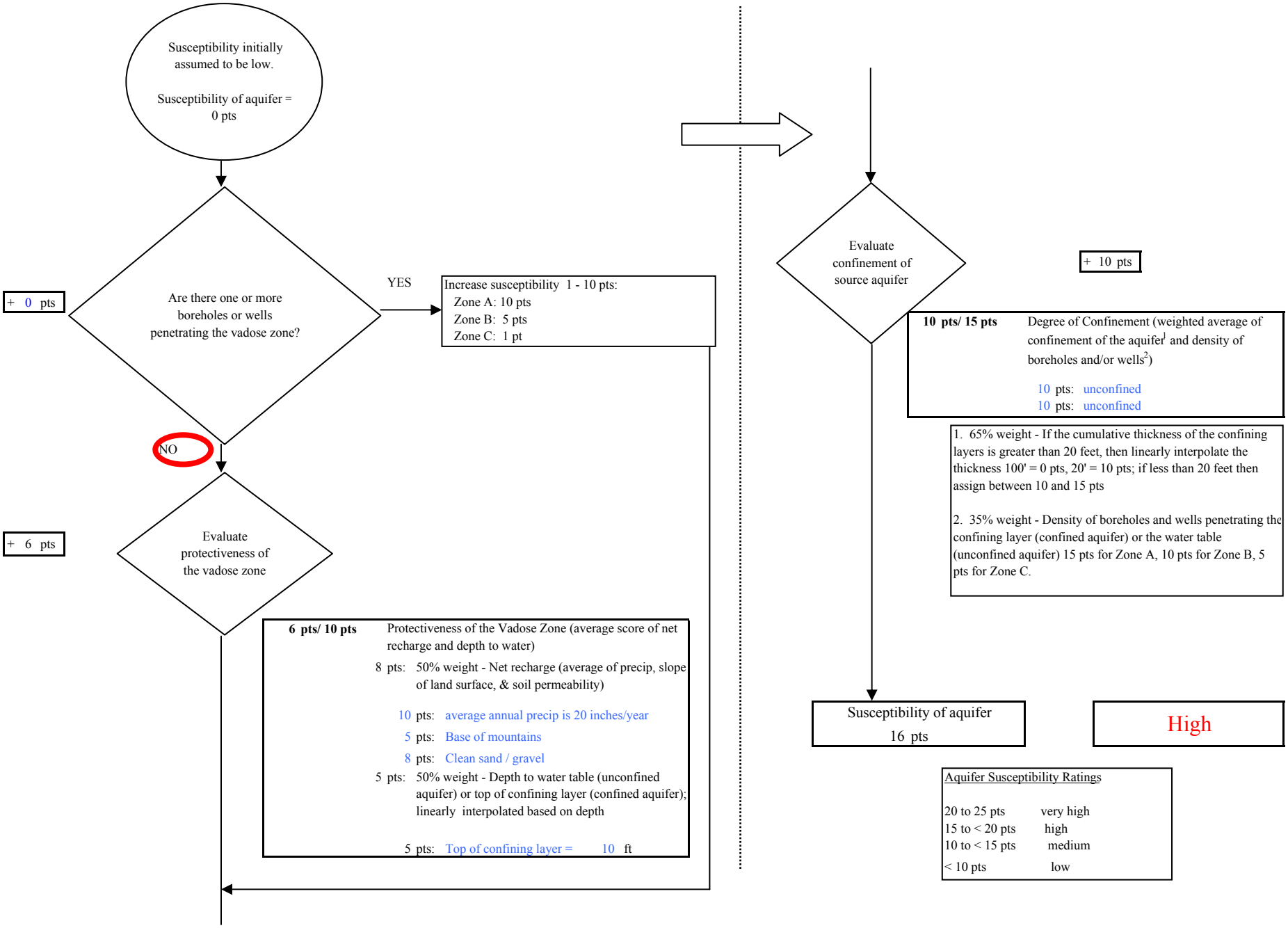
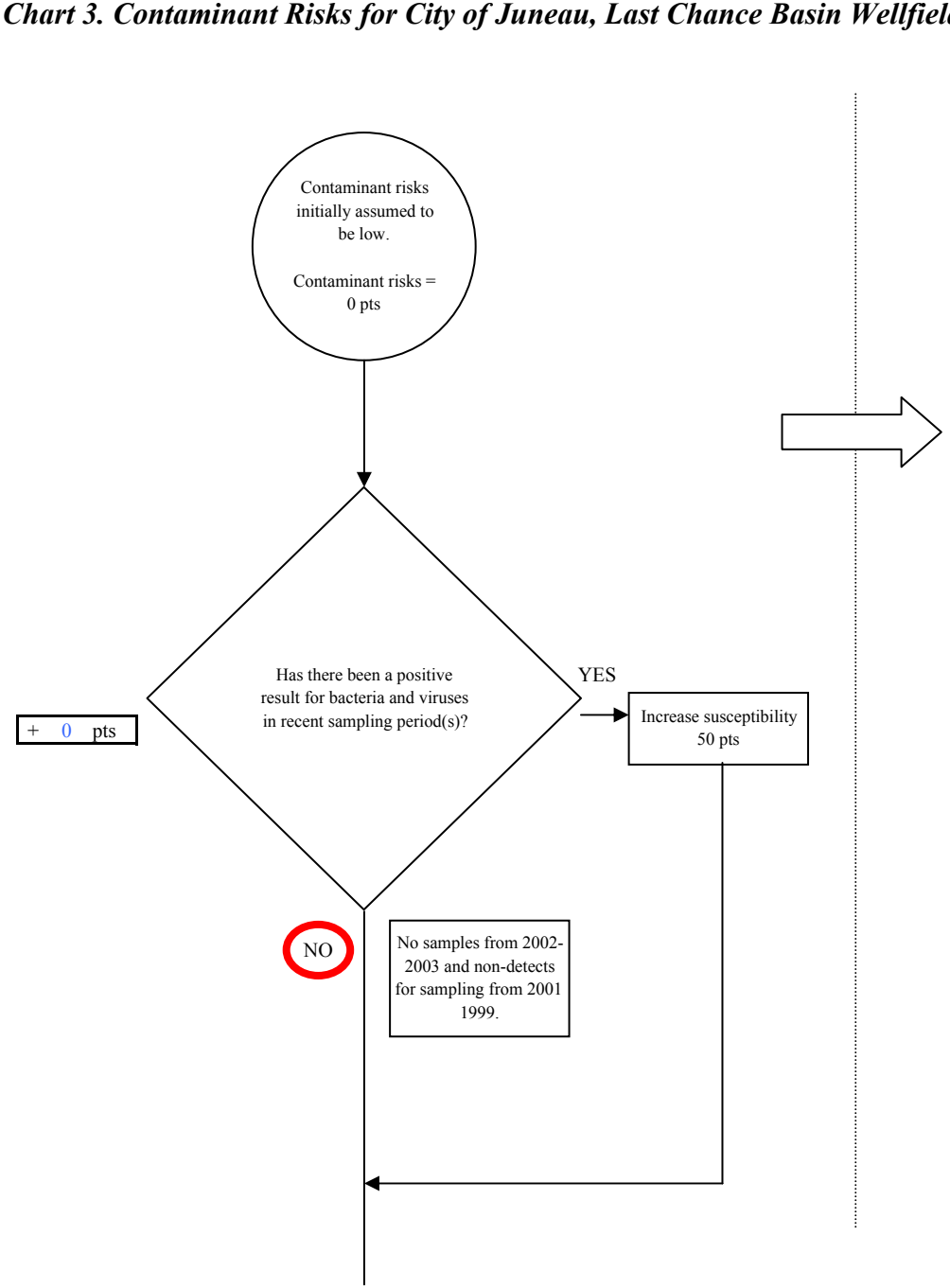
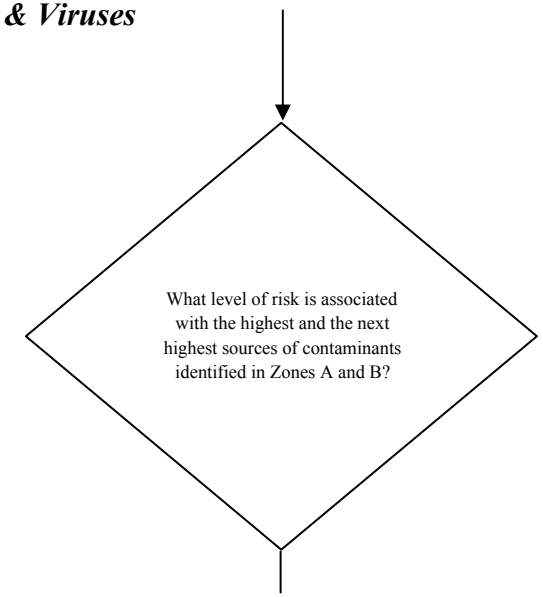


Chart 3. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Bacteria & Viruses





+ 10 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)	2	0	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 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 3. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Bacteria & Viruses

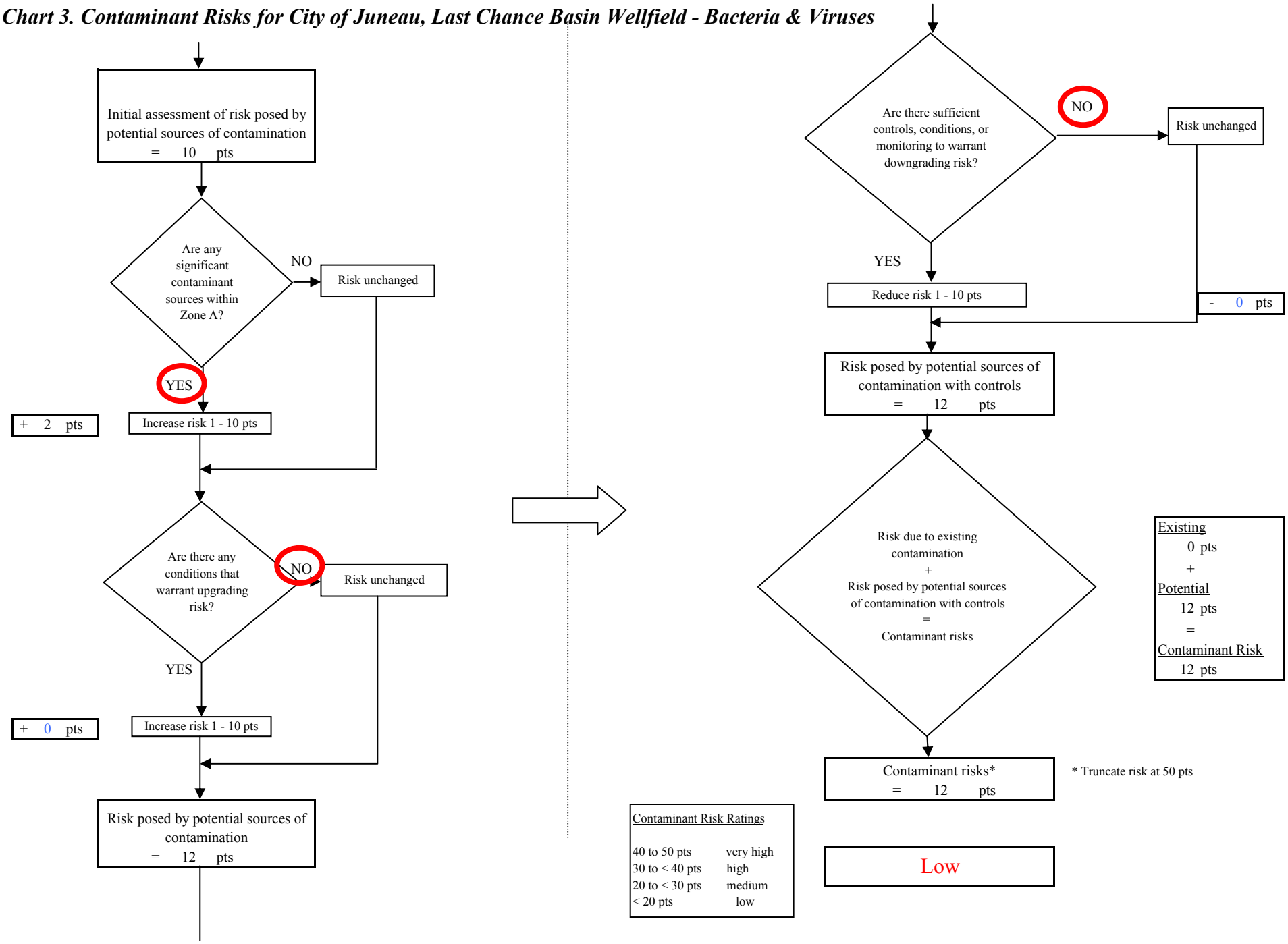


Chart 4. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Bacteria & Viruses

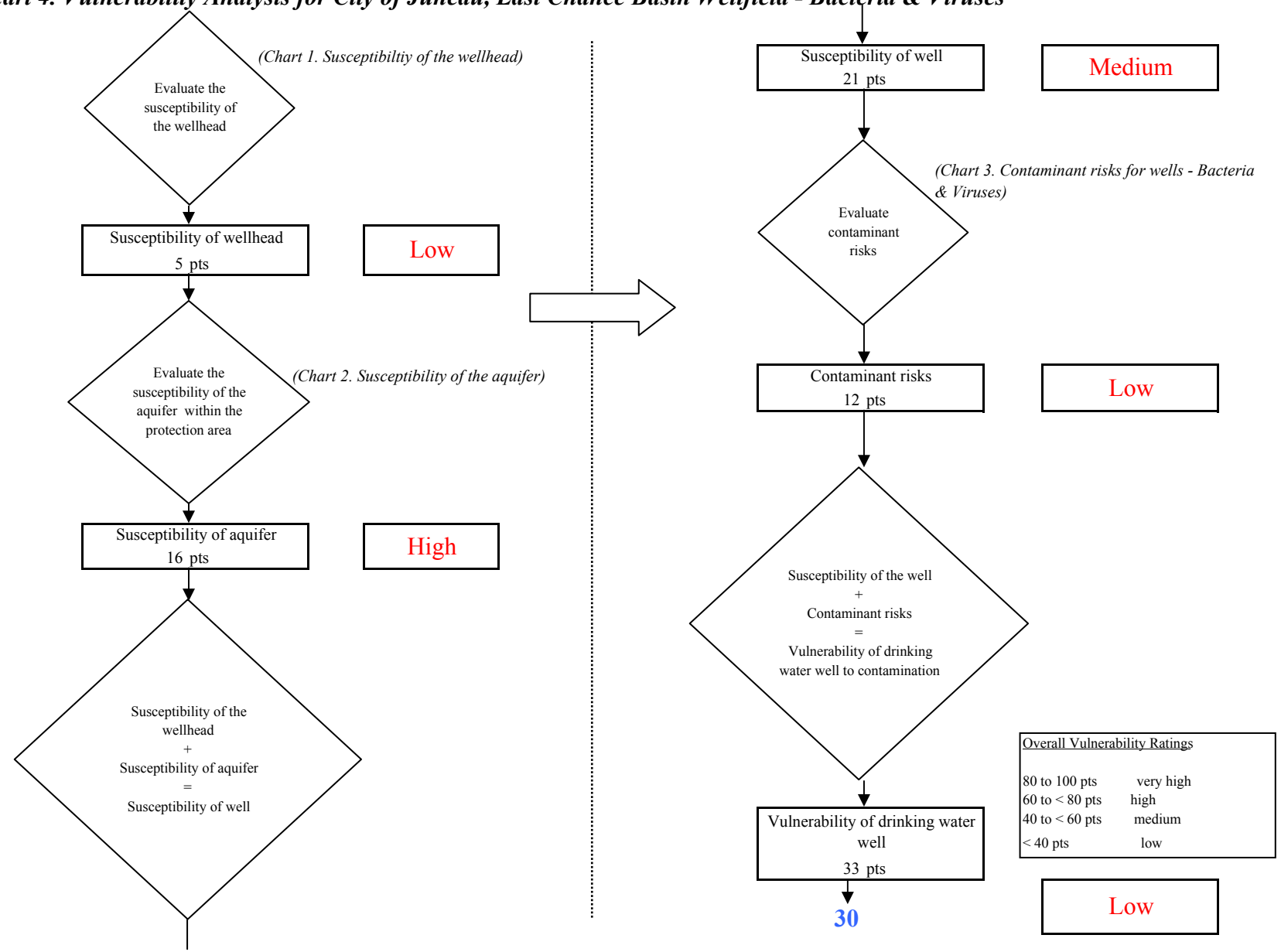


Chart 5. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Nitrates and Nitrites

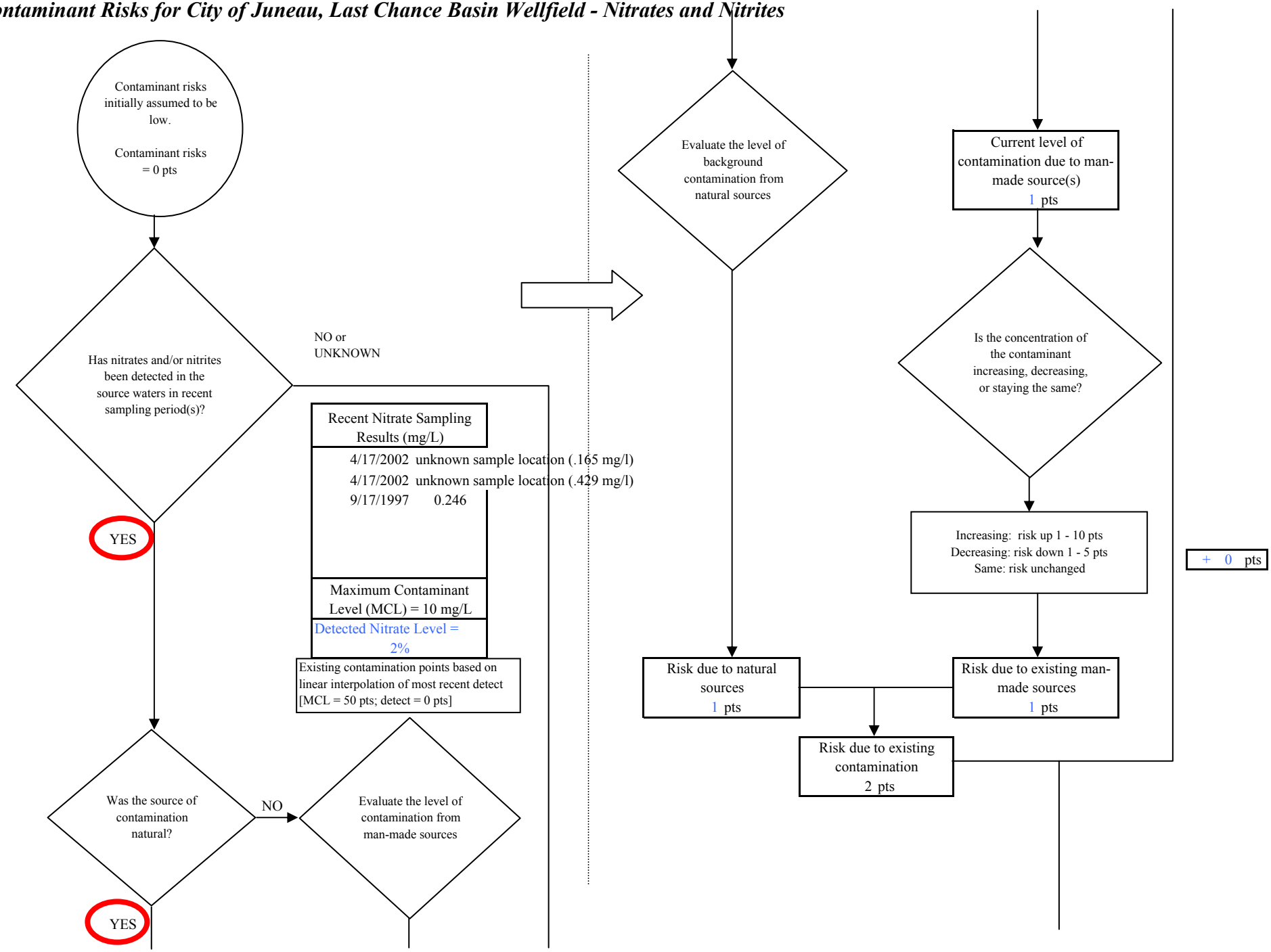
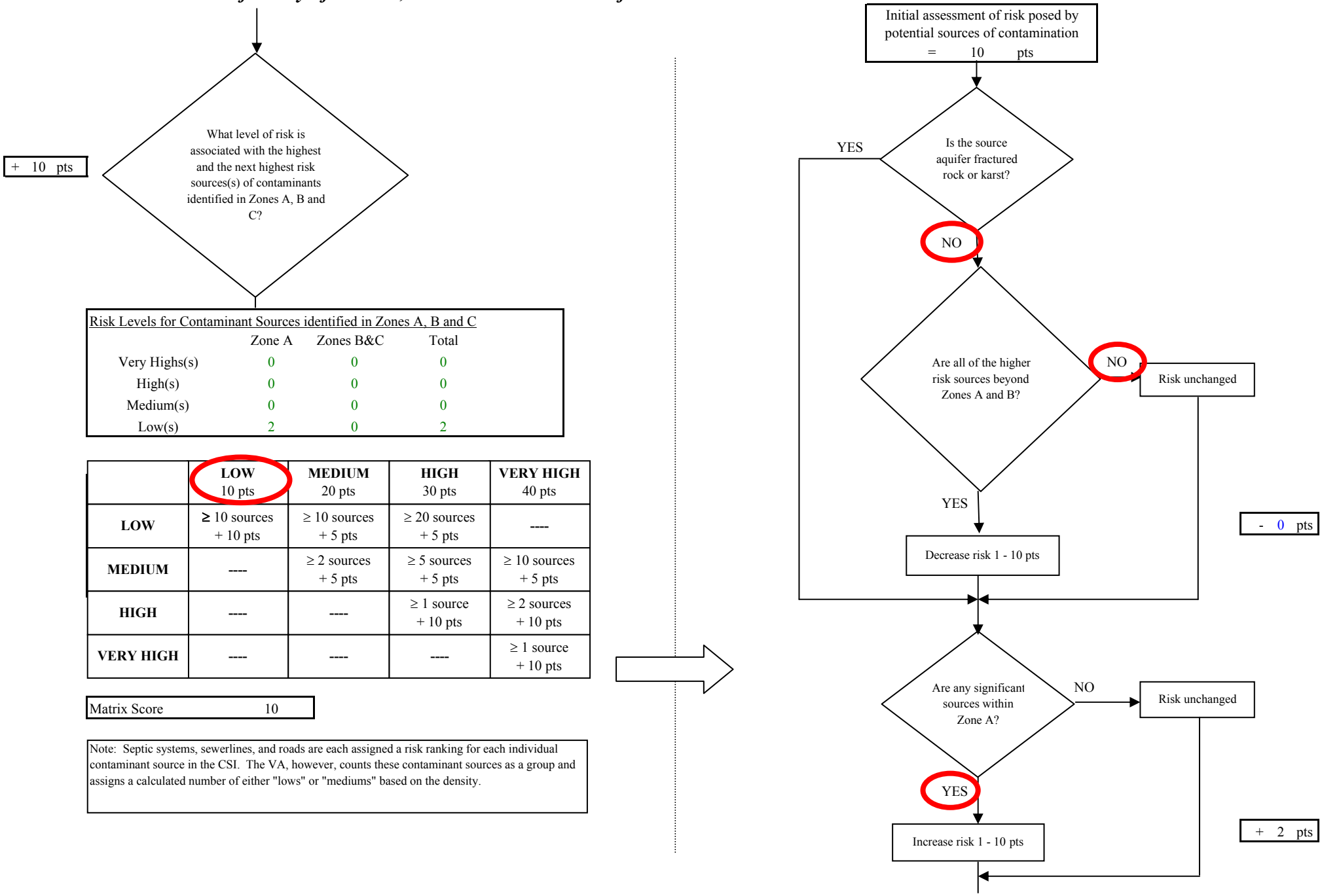


Chart 5. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Nitrates and Nitrites



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)	2	0	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 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 City of Juneau, Last Chance Basin Wellfield - Nitrates and Nitrites

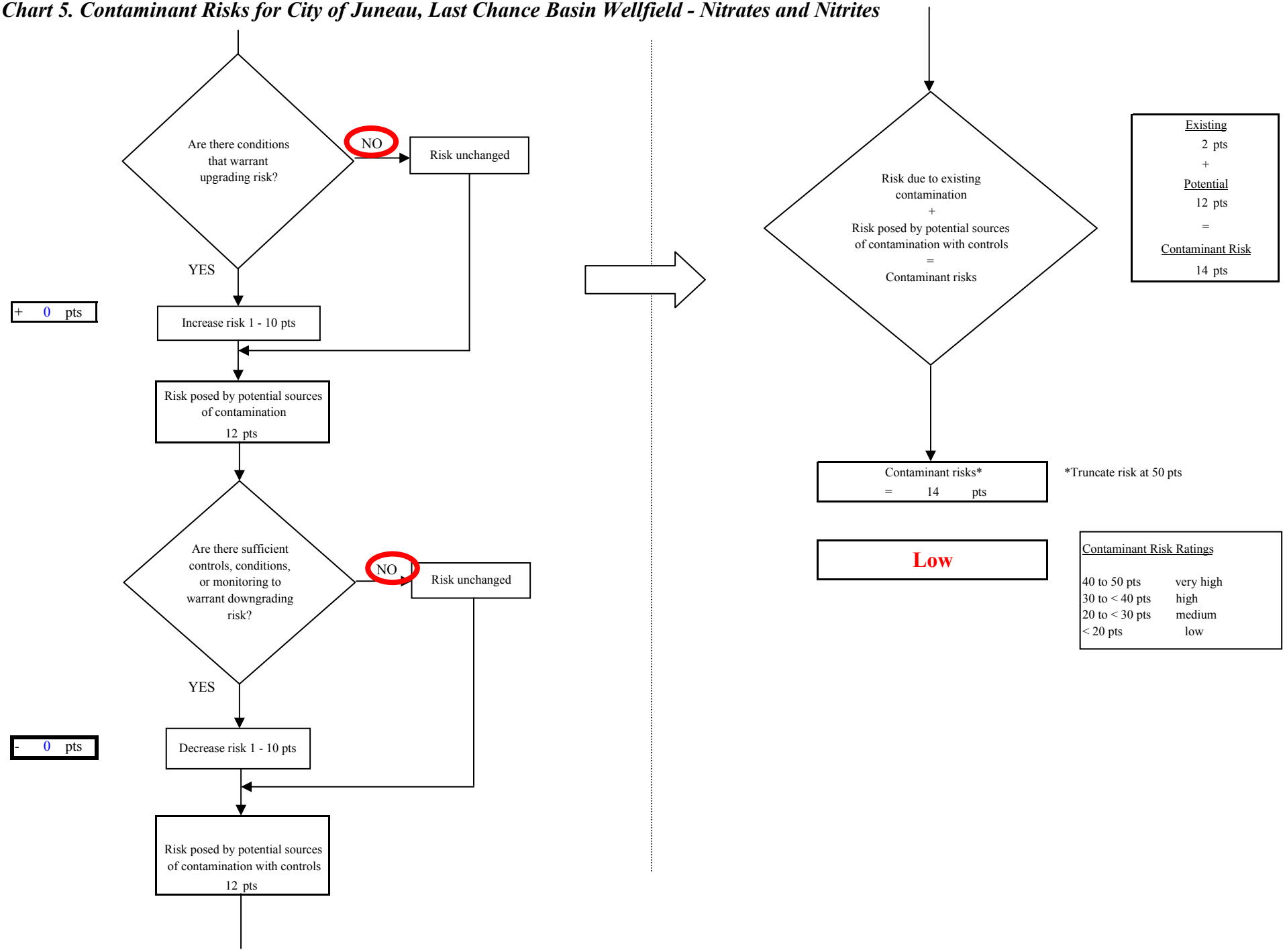


Chart 6. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Nitrates and Nitrites

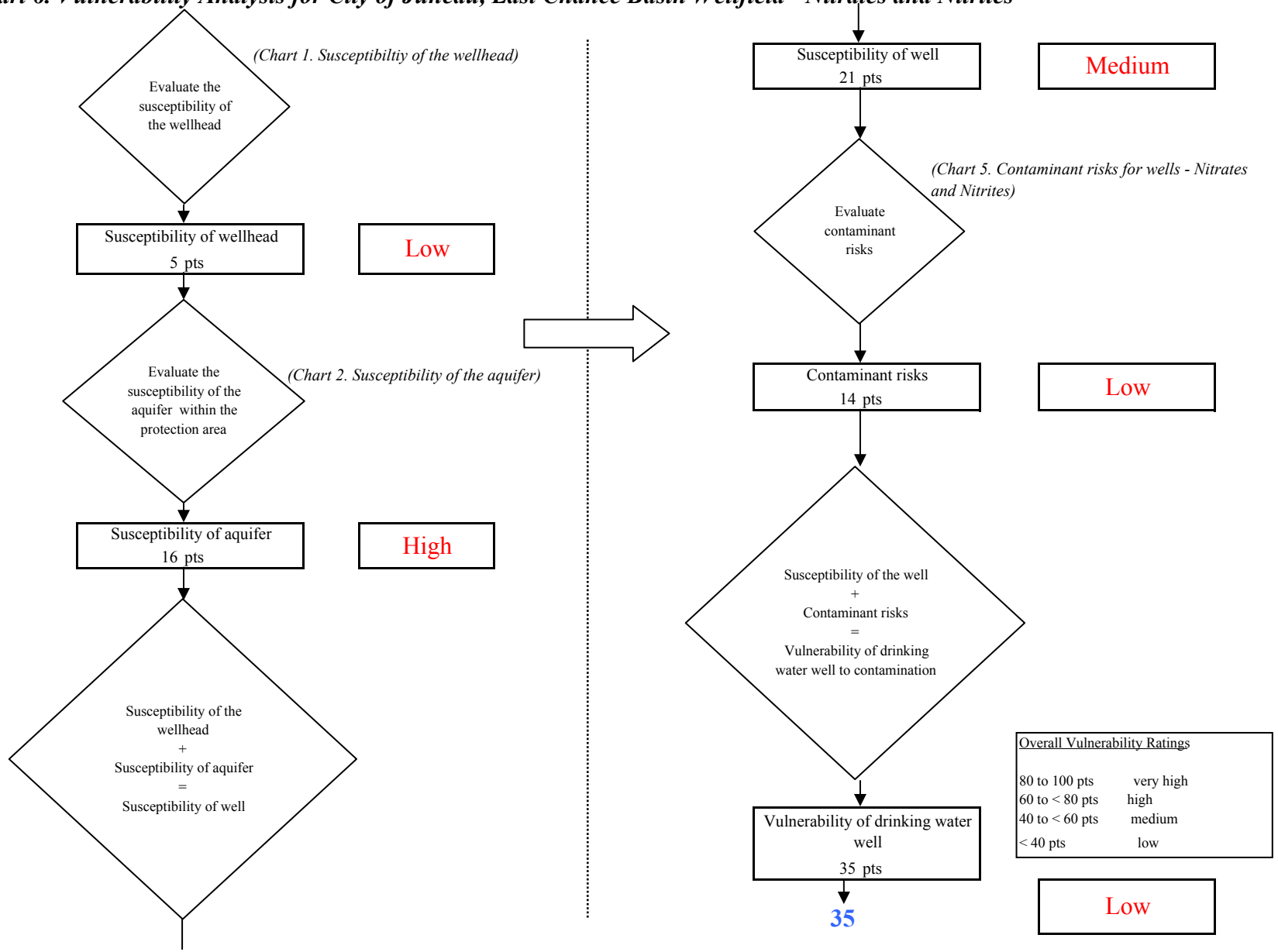


Chart 7. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Volatile Organic Chemicals

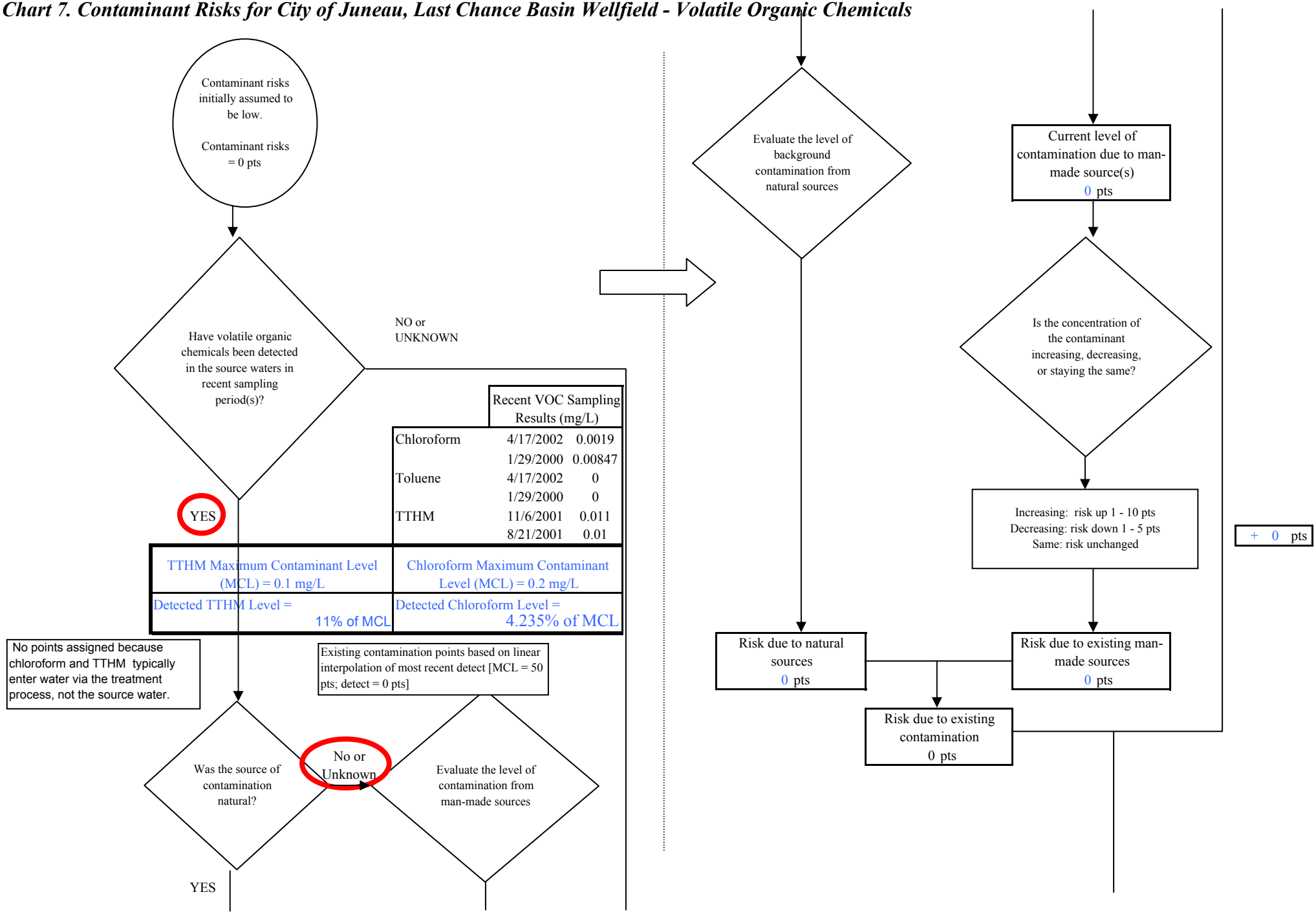
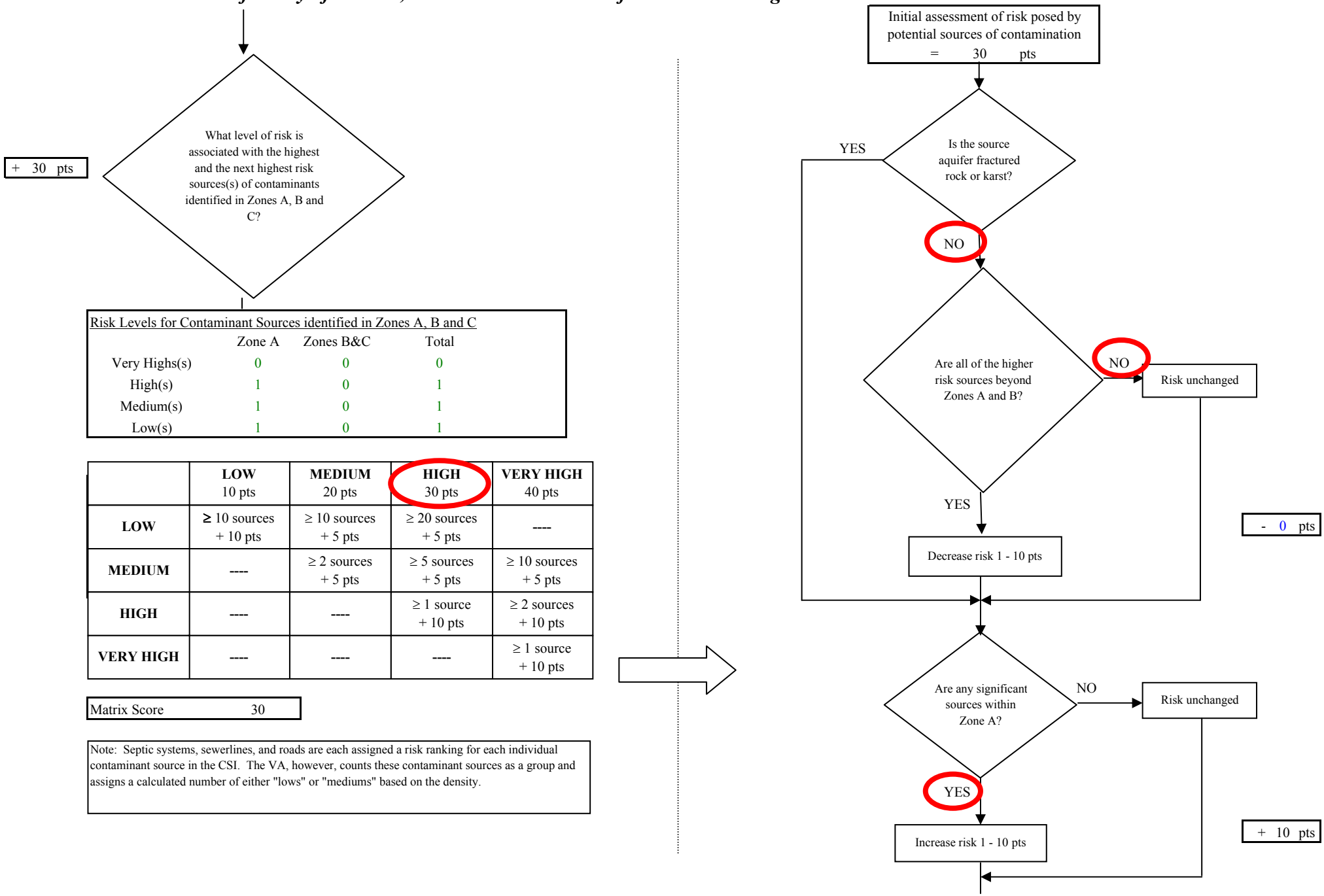


Chart 7. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Volatile Organic Chemicals



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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	1	0	1
Medium(s)	1	0	1
Low(s)	1	0	1

	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 30

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

Chart 7. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Volatile Organic Chemicals

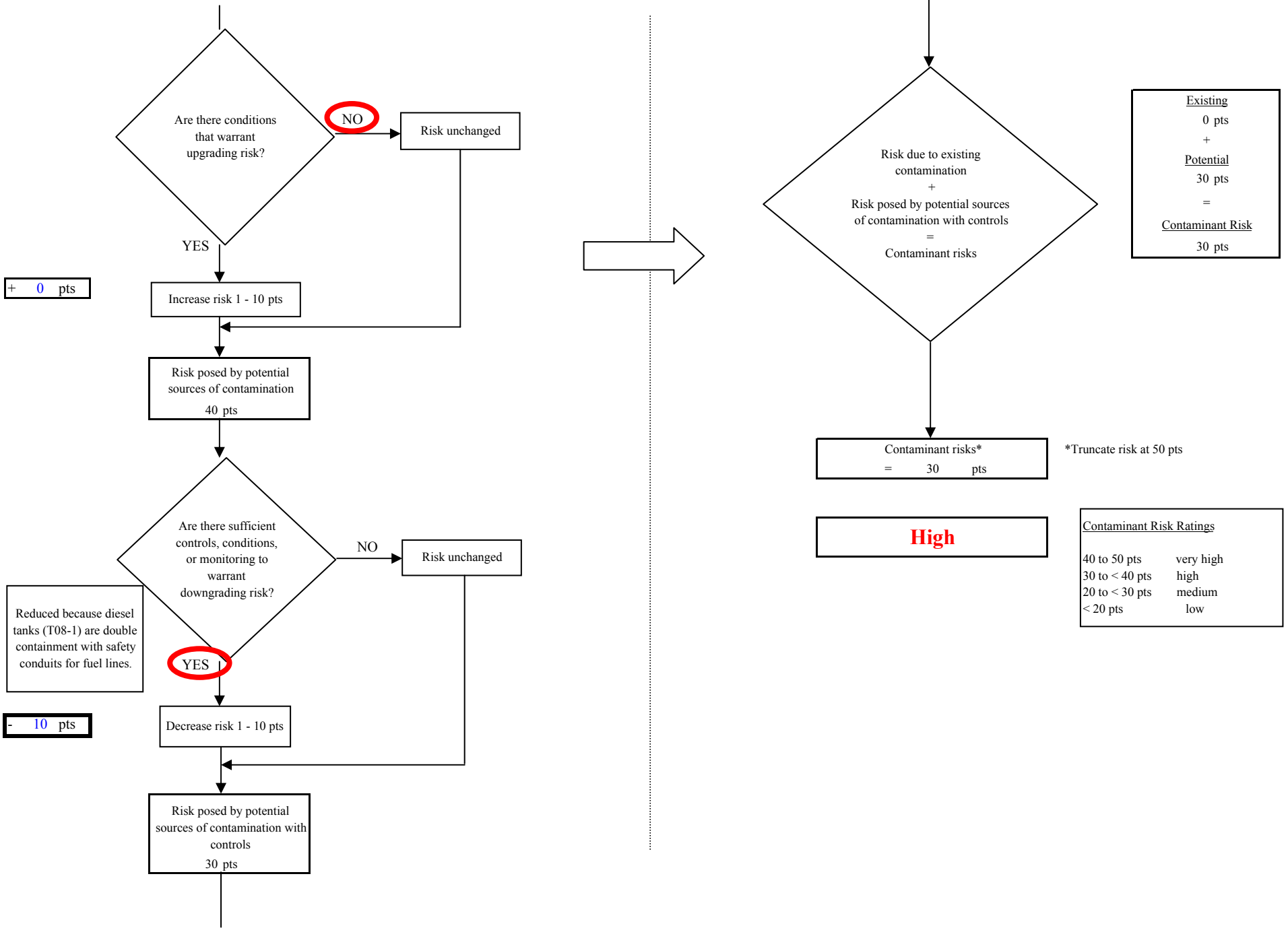


Chart 8. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Volatile Organic Chemicals

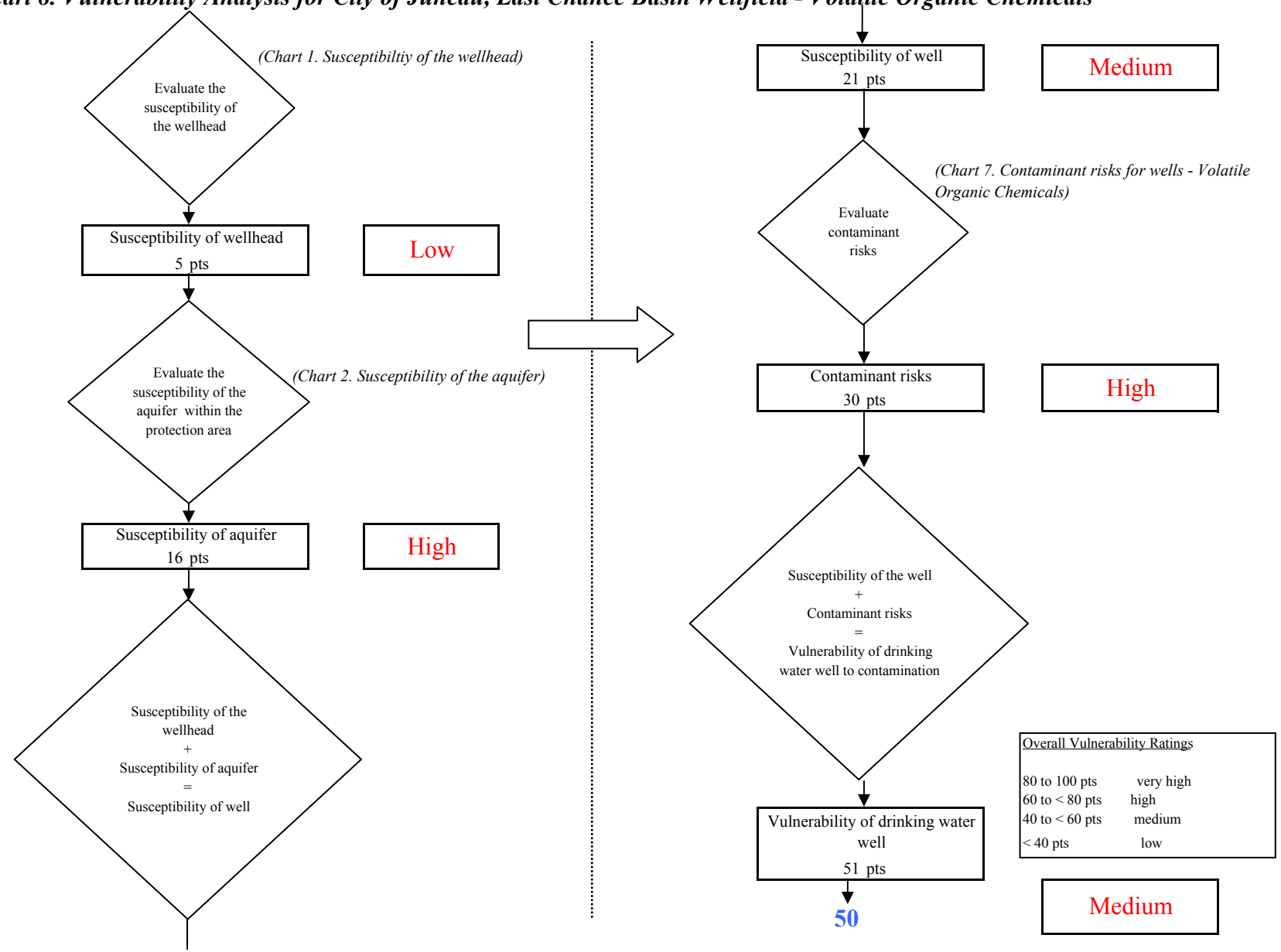


Chart 9. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Heavy Metals, Cyanide and Other Inorganic Chemicals

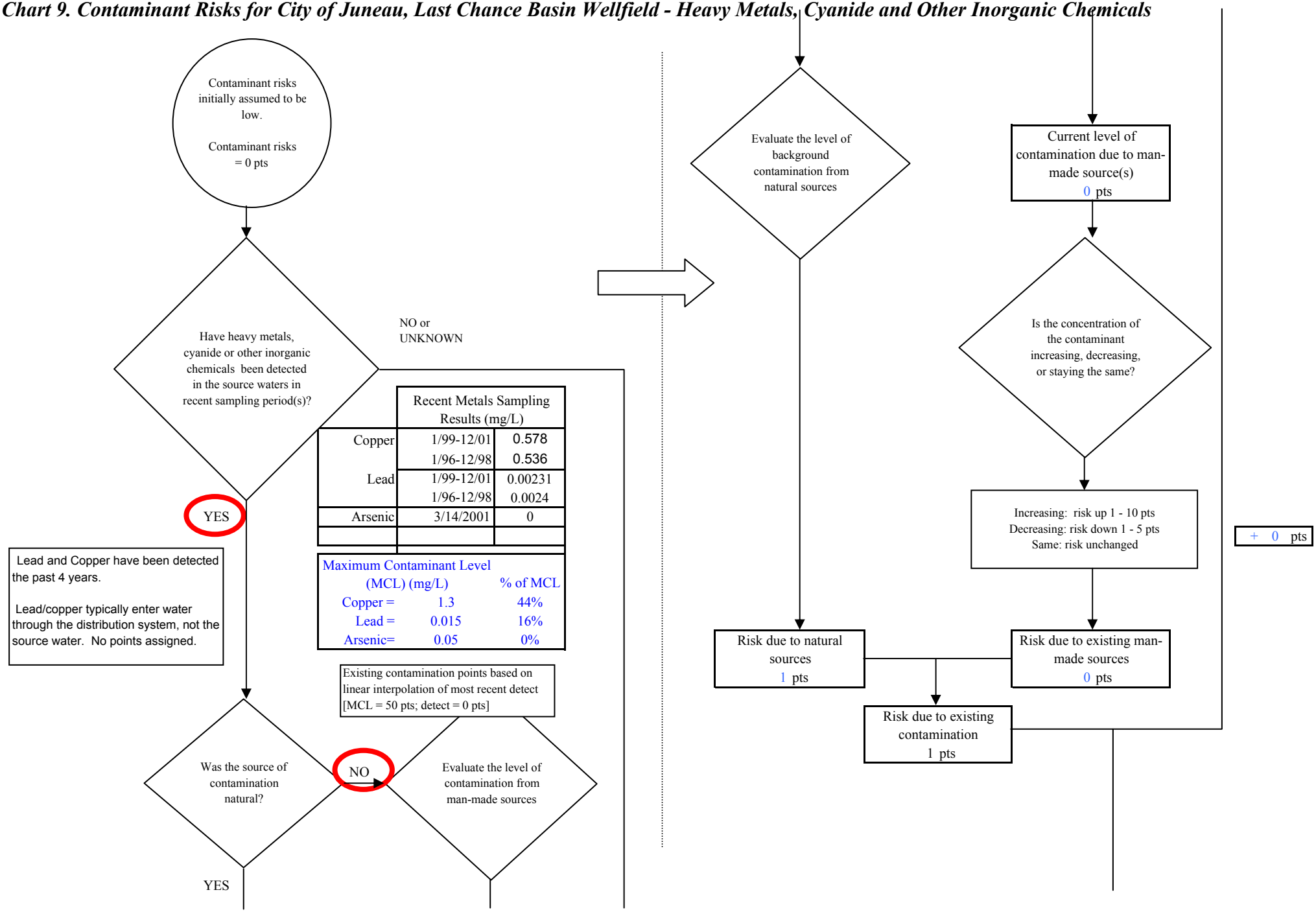


Chart 9. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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)	2	2	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 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 9. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Heavy Metals, Cyanide and Other Inorganic Chemicals

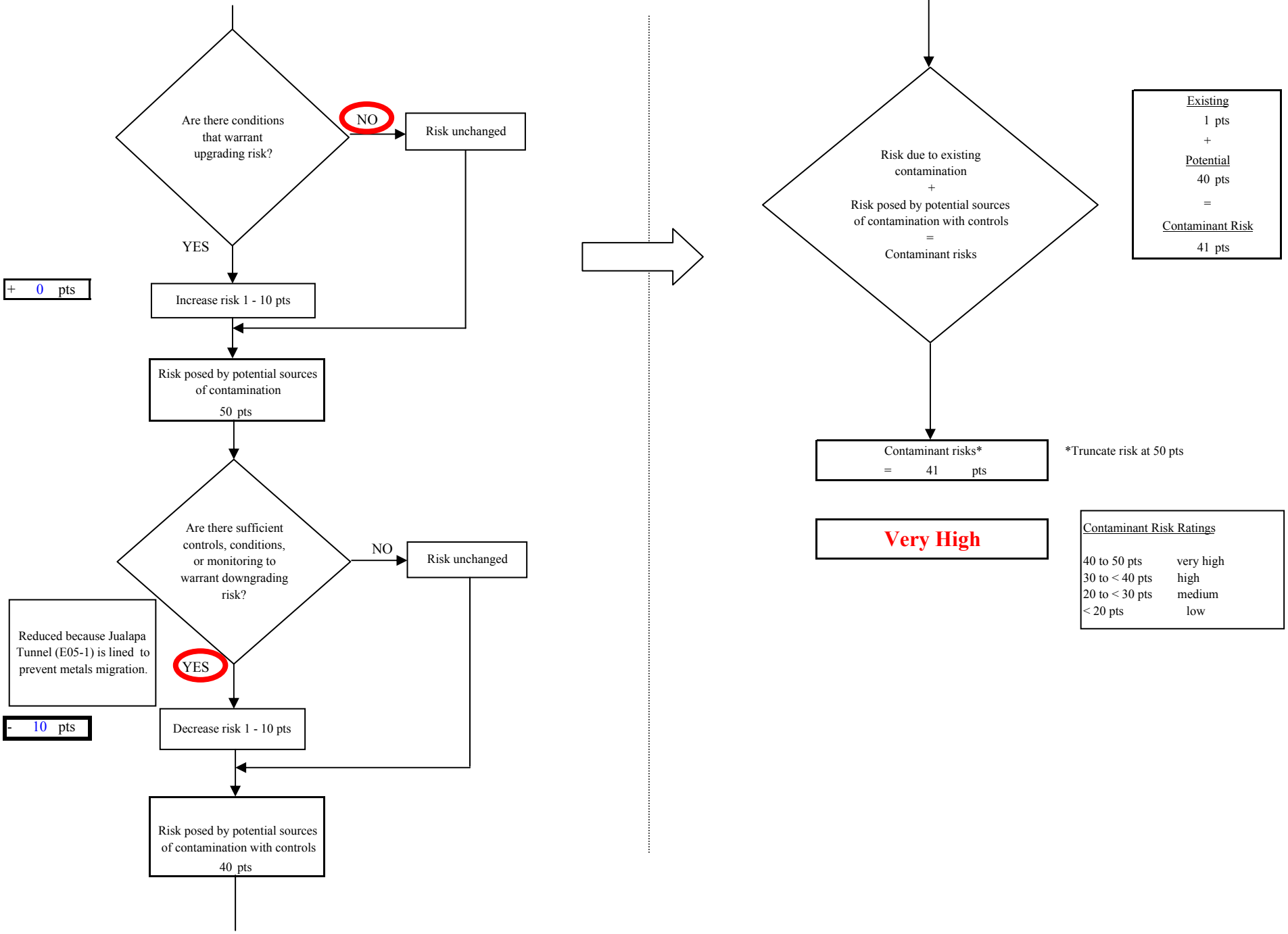


Chart 10. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Heavy Metals, Cyanide and Other Inorganic Ch

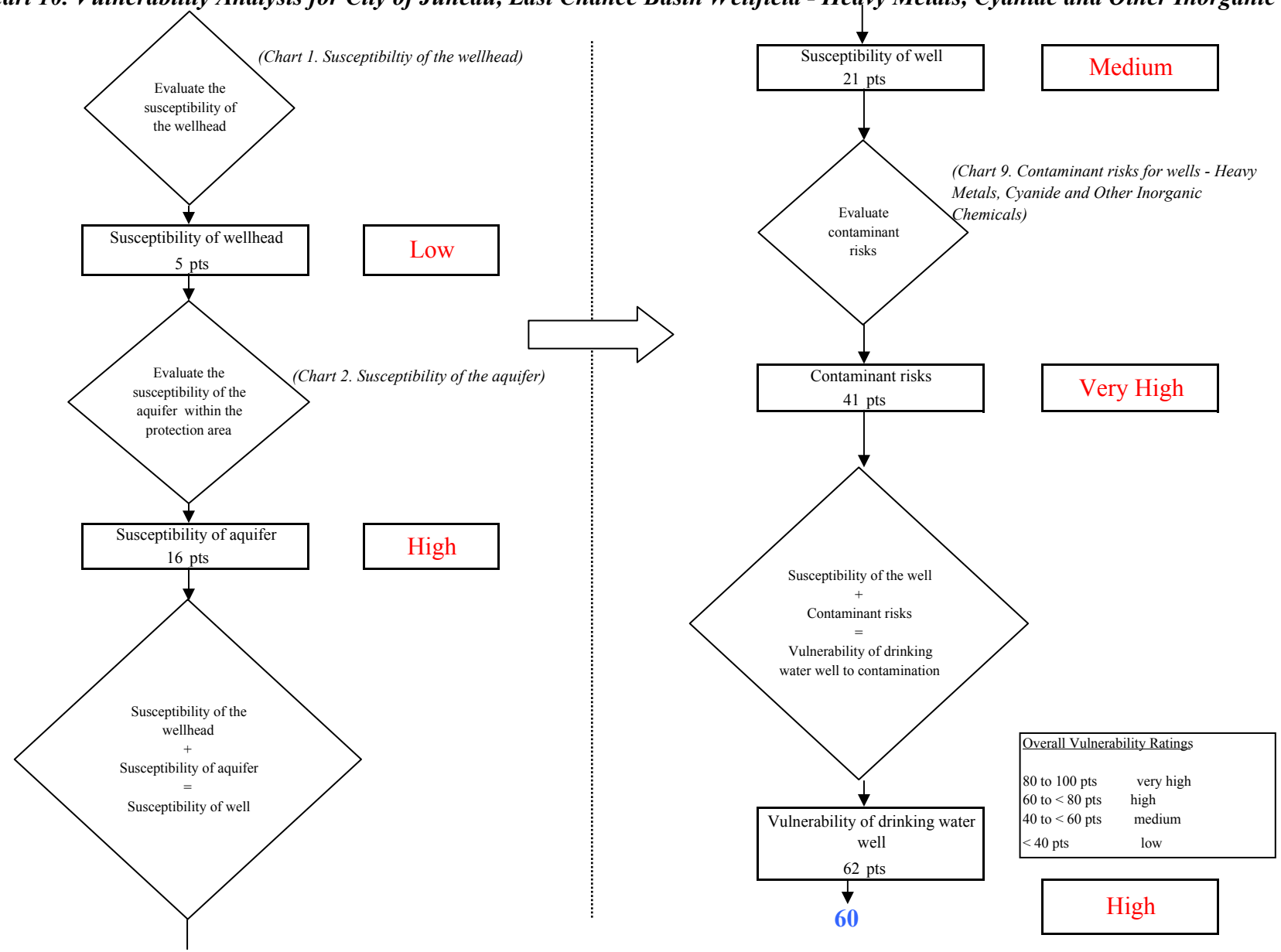


Chart 11. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Synthetic Organic Chemicals

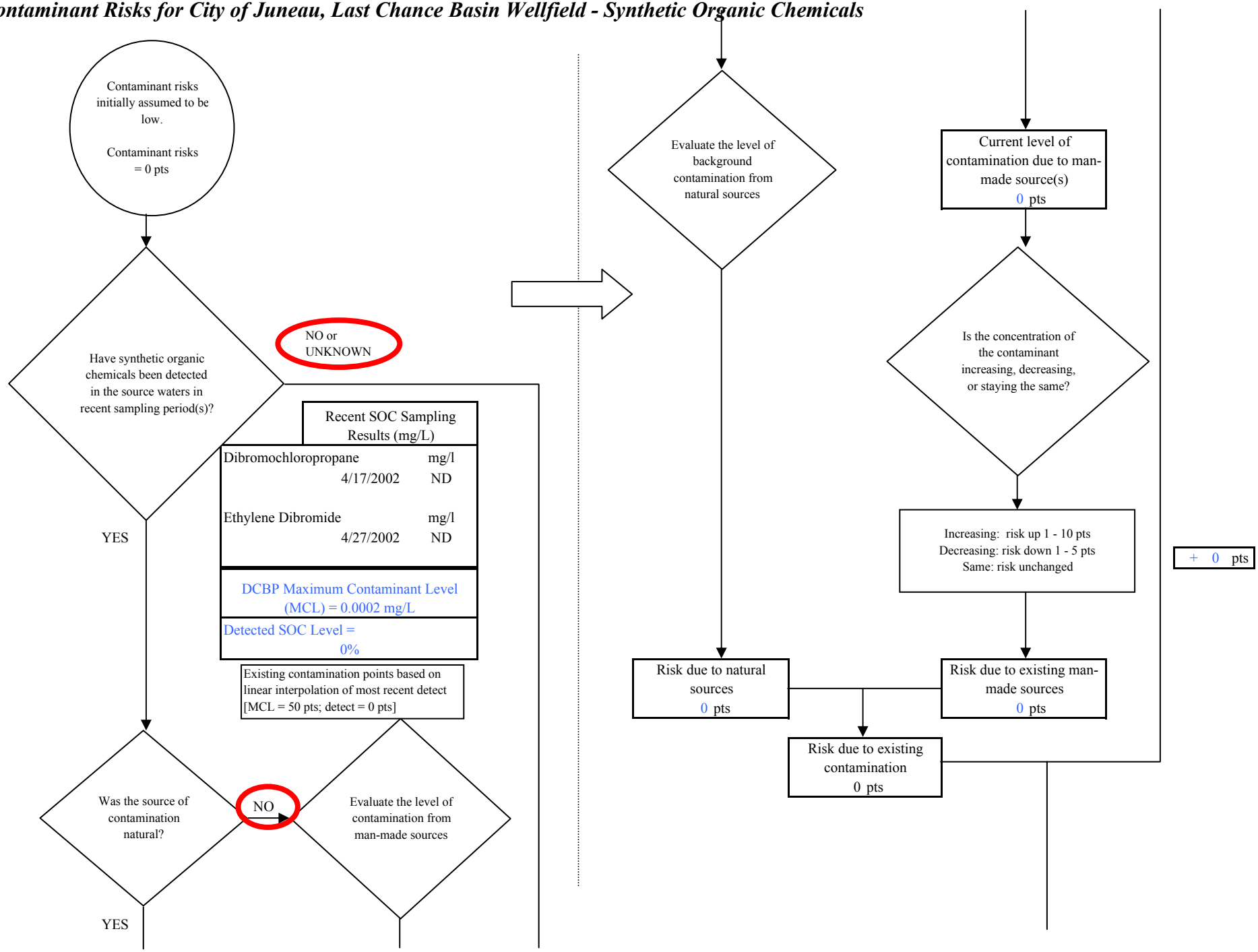


Chart 11. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Synthetic Organic Chemicals

+ 0 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?

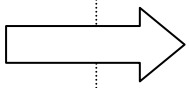
Risk Levels for Contaminant Sources identified in Zones A, B and C

	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	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.



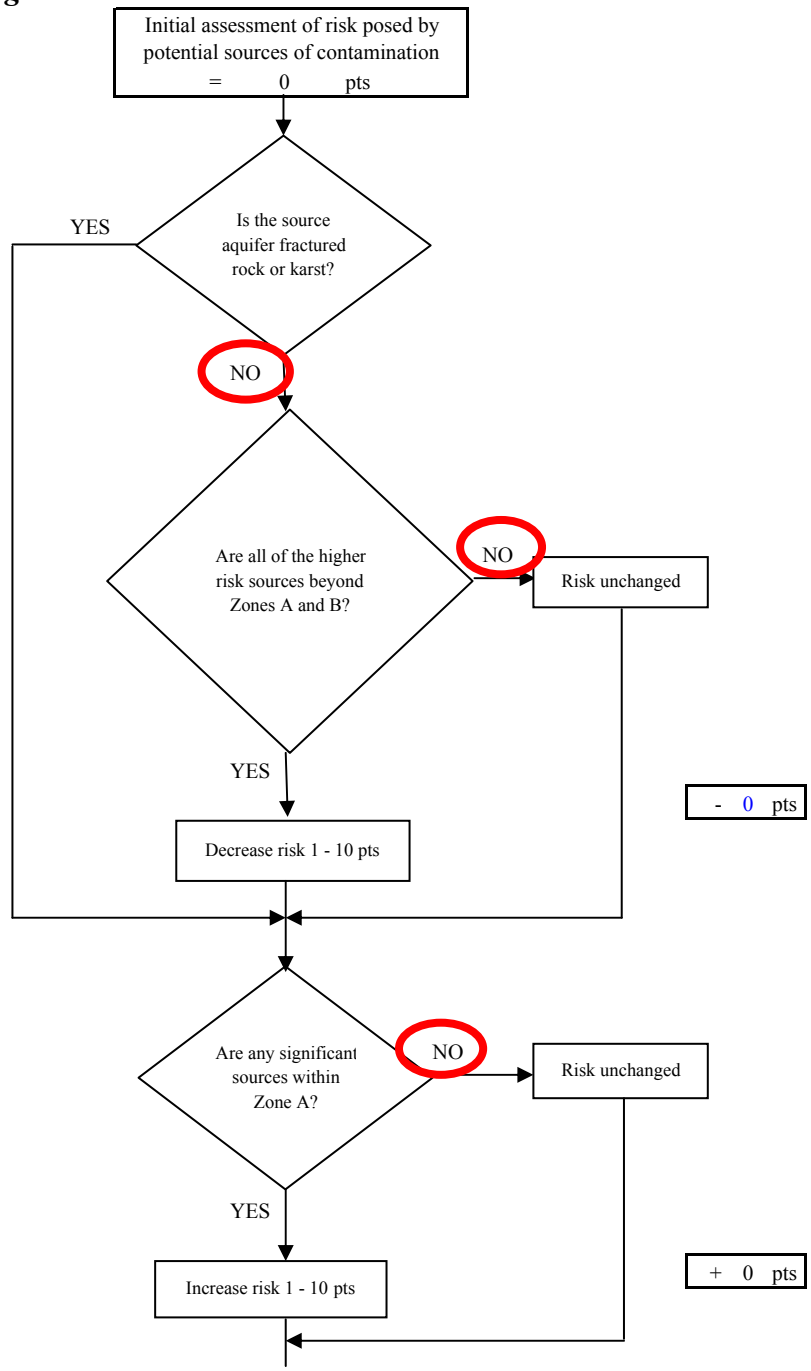


Chart 11. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Synthetic Organic Chemicals

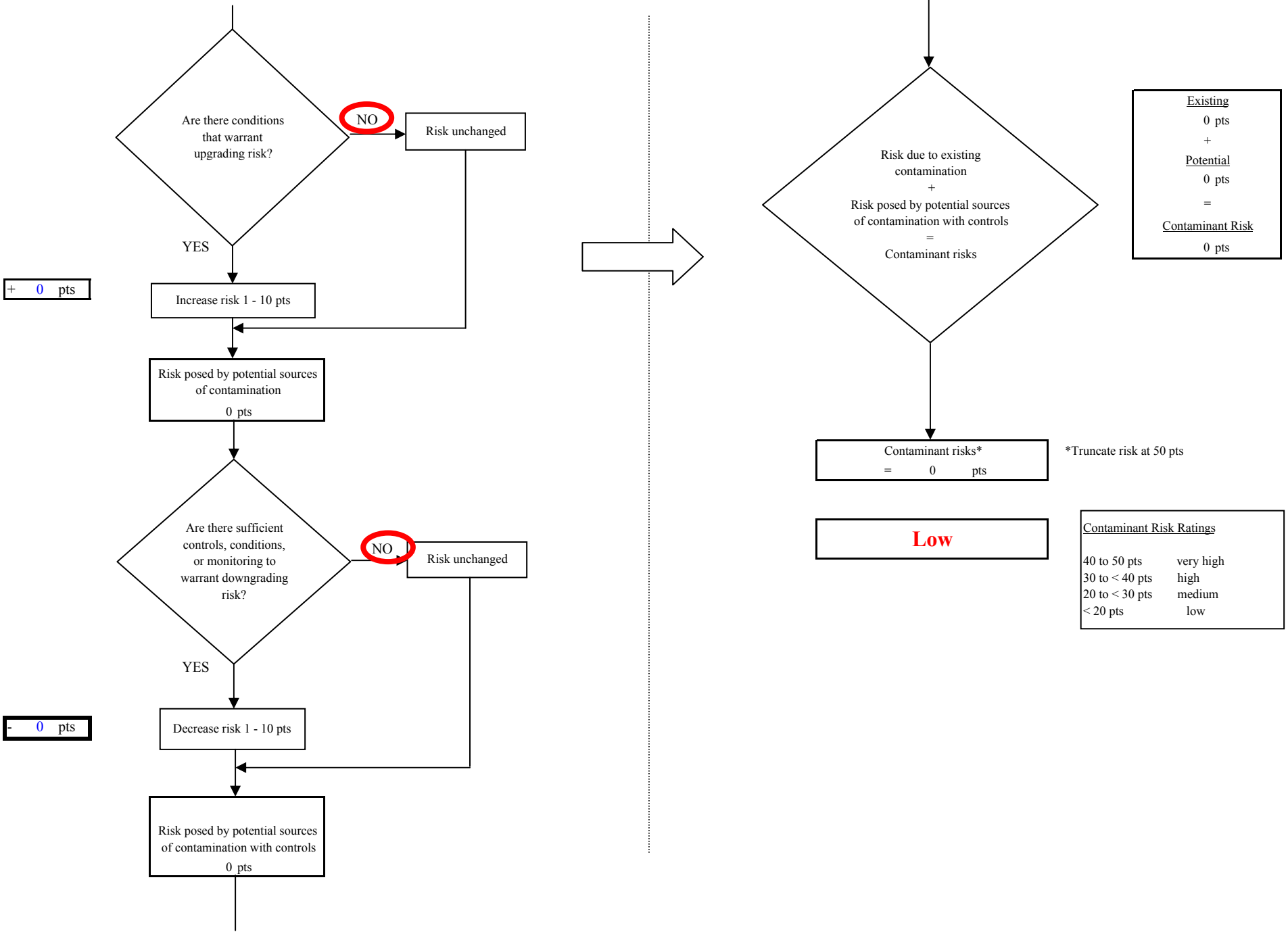


Chart 12. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Synthetic Organic Chemicals

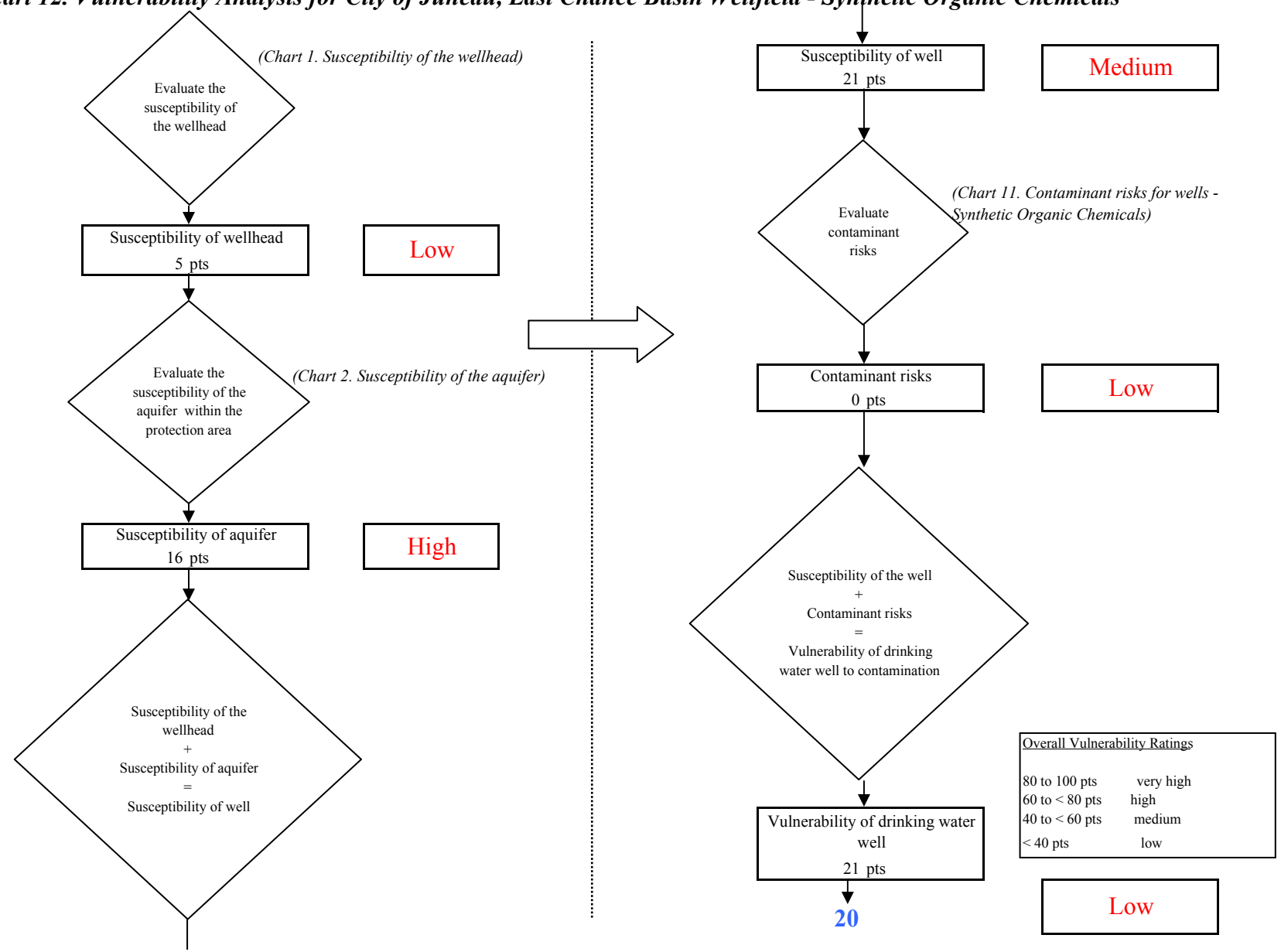


Chart 13. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Other Organic Chemicals

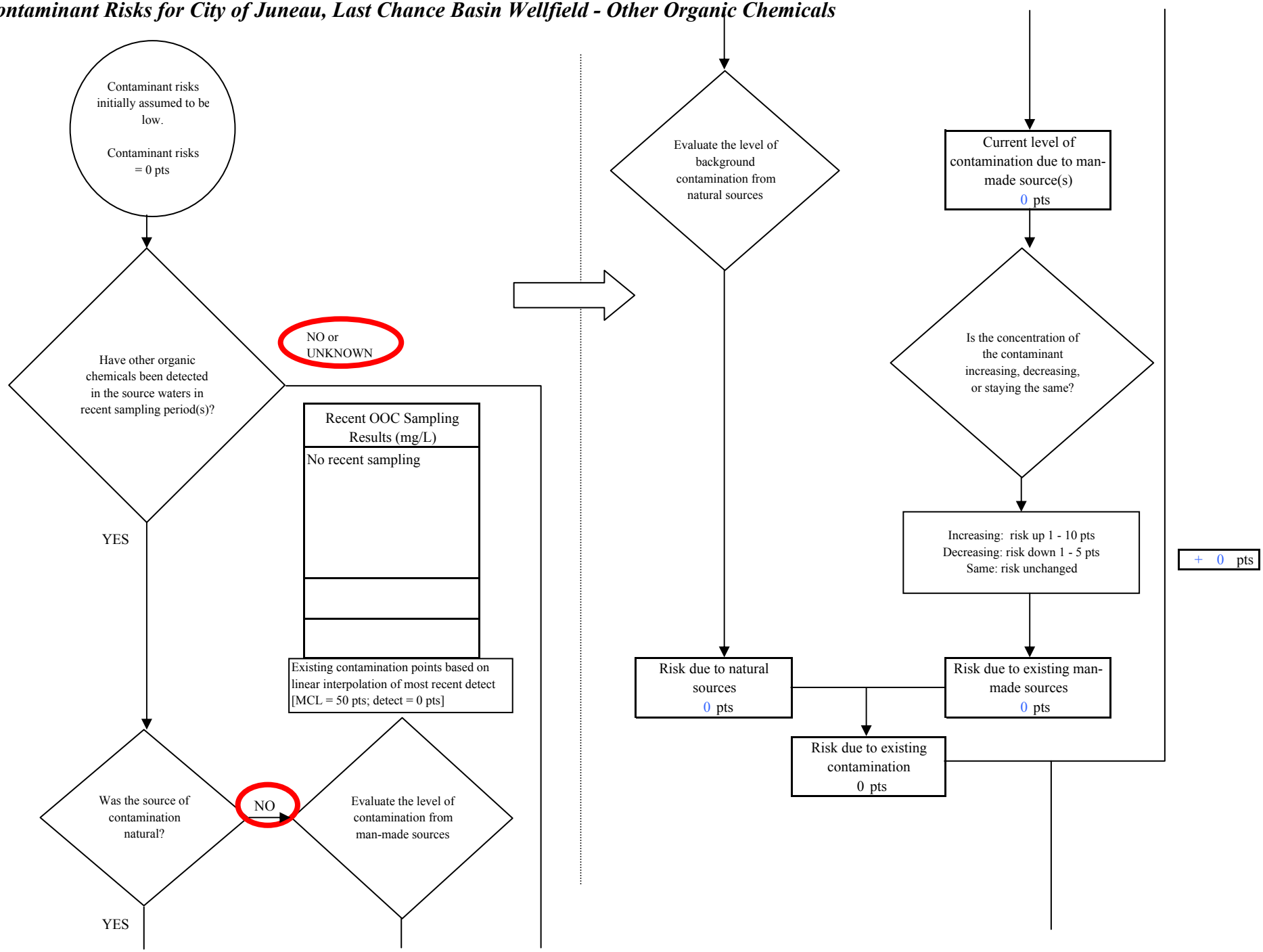


Chart 13. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Other Organic Chemicals

+ 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)	1	0	1

	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

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 13. Contaminant Risks for City of Juneau, Last Chance Basin Wellfield - Other Organic Chemicals

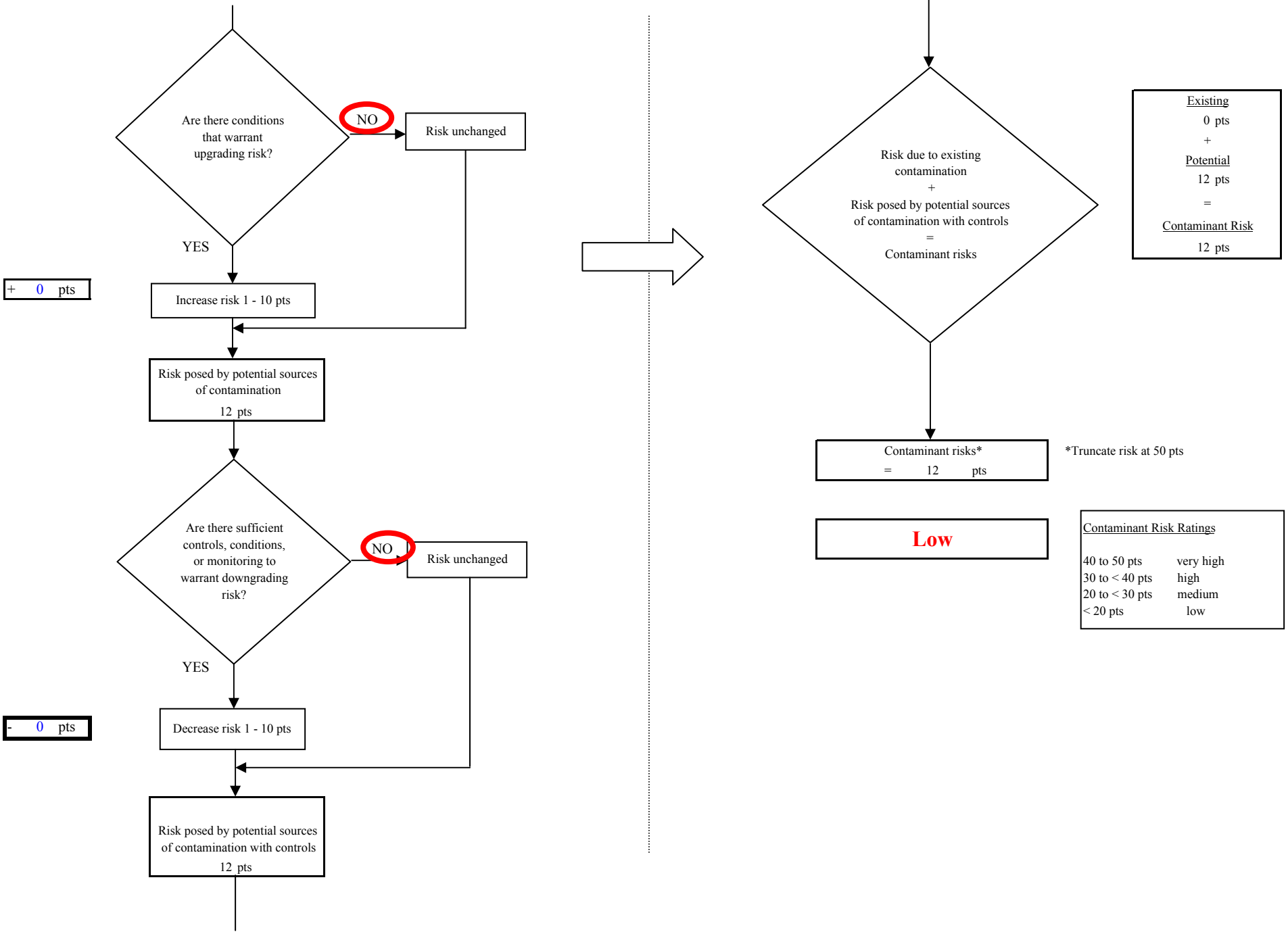


Chart 14. Vulnerability Analysis for City of Juneau, Last Chance Basin Wellfield - Other Organic Chemicals