Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for
Beluga Power Plant
Drinking Water System,
Western Cook Inlet, Alaska
PWSID # 243624
June 2003

DRINKING WATER PROTECTION PROGRAM REPORT # 628
Alaska Department of Environmental Conservation

Source Water Assessment for Beluga Power Plant Drinking Water System, Western Cook Inlet, Alaska PWSID # 243624

By Ecology & Environment, Inc.

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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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APPENDICES

Source Water Assessment for Beluga Power Plant Source of Public Drinking Water, Western Cook Inlet, Alaska

By Ecology & Environment, Inc.

Drinking Water Protection Program
Alaska Department of Environmental Conservation

Executive Summary

Beluga Power Plant is a Class B (transient/non-community) water system consisting of two wells in Western Cook Inlet, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Low.** Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Beluga Power Plant public drinking water source include: a lubrication shop. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water source for Beluga Power Plant received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and nitrites, and **Low** for volatile 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 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. Ecology and Environment, Inc. has been contracted to perform these assessments under the supervision of ADEC.

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 Western Cook Inlet Area

Location

The wells in this area are located on the western shores of Cook Inlet, in the flatlands between the Inlet and the slopes of the Alaska Range. The community of Beluga is located approximately 8 miles northeast of Tyonek (See Inset of Map 1 of Appendix A).

Precipitation

The Western Cook Inlet area averages about 24 inches of precipitation per year, with approximately 82 inches of snowfall (ACRC 2002).

Topography and Drainage

Numerous creeks and rivers provide drainage from the hills and slopes of the Alaska Range into Cook Inlet. The presence of numerous small ponds and marshy areas may result in indistinct local drainage patterns.

Groundwater Use

Most homes in the area are used only seasonally. A power plant located in Beluga is one of the principal users of groundwater.

Geology and Soils

The vast majority of sediments exposed along the western side of the Kenai Peninsula and the eastern part of the upper Alaskan Peninsula along Cook Inlet are Quaternary sediments. These Quaternary sediments are from glacial fed streams, abandoned-channel deposits, glacial moraines and alluvium from existing streams. Aquifers may be either confined or unconfined, depending on the distribution of confining beds within the local stratigraphic sequence (Magoon, Adkison, and Egbert, 1976).

Beluga Power Plant Public Drinking Water System

Beluga Power Plant is a Class B (transient/non-community) water system. The system consists of two wells located on the west side of Cook Inlet near the Beluga River.

The wells were installed with sanitary seals to a total depth of 295 feet on November 11, 1977 and 315 feet on October 6, 1982. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The wells are properly drained and assumed not to be grouted. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters. The well operates year-round and serves approximately 0 residents and 50 non-residents.

Beluga Power Plant 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 a release of contaminants within the DWPA is most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An analytical calculation was used to determine the size and shape of the DWPA. The input parameters describing the attributes of this aquifer were derived from Freeze and Cherry (1979), Glass (1996), and from a review of well logs in the area found in the Alaska Department of Natural Resources and United States Geological Survey databases. Additional methods were also used to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class B Water Systems for additional information).

The DWPAs 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. 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 to the 2-year time-of-travel
B	Less than the 2-year time-of-travel
C	Less than the 5-year time-of-travel
D	Less than the 10 year time-of-travel

As an example, water moving through the aquifer in Zone B will most likely 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 downgradient 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.

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 Beluga Power Plant 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 B water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites; and
- Volatile organic chemicals.

Inventoried potential sources of contamination within the drinking water protection area were associated with residential and light industrial type activities. The sources are displayed on Map 2 of Appendix C and summarized in the tables in Appendix B.

Ranking of Contaminant Risks

Once the potential and existing sources of contamination have been identified, they are sorted and

ranked 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. Further, contaminant risks are a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the well. Rankings include:

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

The time-of-travel 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 get to the well.

Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

Vulnerability of Beluga Power Plant Drinking Water Source

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 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 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

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)
(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 well for Beluga Power Plant is completed in a confined aquifer. Confined aquifers are somewhat protected from migration of water from the surface by an overlying low-permeability layer, such as a clay. However, contaminants at the surface have the potential to impact this aquifer adversely because wells penetrating the aquifer can act as conduits. The confining layers in this area can be somewhat discontinuous, which also increases the susceptibility of the aquifer. Table 2 shows the Susceptibility scores and ratings for Beluga Power Plant (see Charts 1 and 2).

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	7	Low
Natural Susceptibility	12	Low

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 or 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 (see Charts 3, 5, and 7).

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	0	Low
Nitrates and/or Nitrites	0	Low
Volatile Organic Chemicals	25	Medium

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 (see Charts 4, 6, and 8).

Table 4. Overall Vulnerability to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and Nitrites	10	Low
Volatile Organic Chemicals	35	Low

Bacteria and Viruses
The contaminant risk for bacteria and viruses is Low, with no known contaminant sources representing a risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination by bacteria and viruses is Low.

Nitrates and Nitrites
The contaminant risk for nitrates and nitrites is Low, with no known contaminant sources representing a 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.

The last five years' sampling history for Beluga Power Plant public water source indicates the most recent concentration detected was ND on 1/10/02, which represents 0% of the Maximum Contaminant Level (MCL). (A value of ND means that no detectable concentrations of nitrates or nitrites were found within the last 5 years of samples.) While nitrates and nitrites can occur naturally in groundwater, a level of 20% of the MCL or more is considered to be due to manmade sources. Water with levels of nitrates and nitrites below 100% of the MCL is considered safe to drink by ADEC. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination by nitrates and nitrites is Low.

Volatile Organic Chemicals
The contaminant risk for volatile organic chemicals is Medium, with the lubrication shop representing the highest risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Buildings in the area typically are heated with various types of on-site fuel sources, including propane and heating oil stored in aboveground or underground storage tanks. Although this report does not address heating oil tanks (unless their location is known), they can pose a risk of volatile organic chemical

contamination to drinking water sources. 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. Secondary containment around the tank and regular system maintenance can help prevent many of these harmful fuel leaks and help protect the drinking water supply.

Class B water systems generally are not required to test for volatile organic chemicals. After combining the potential contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination by volatile organic chemicals is Low.

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Freeze, R.A. and Cherry, J.A., 1979, *Groundwater*, Upper Saddle River, NJ: Prentice Hall, Inc.

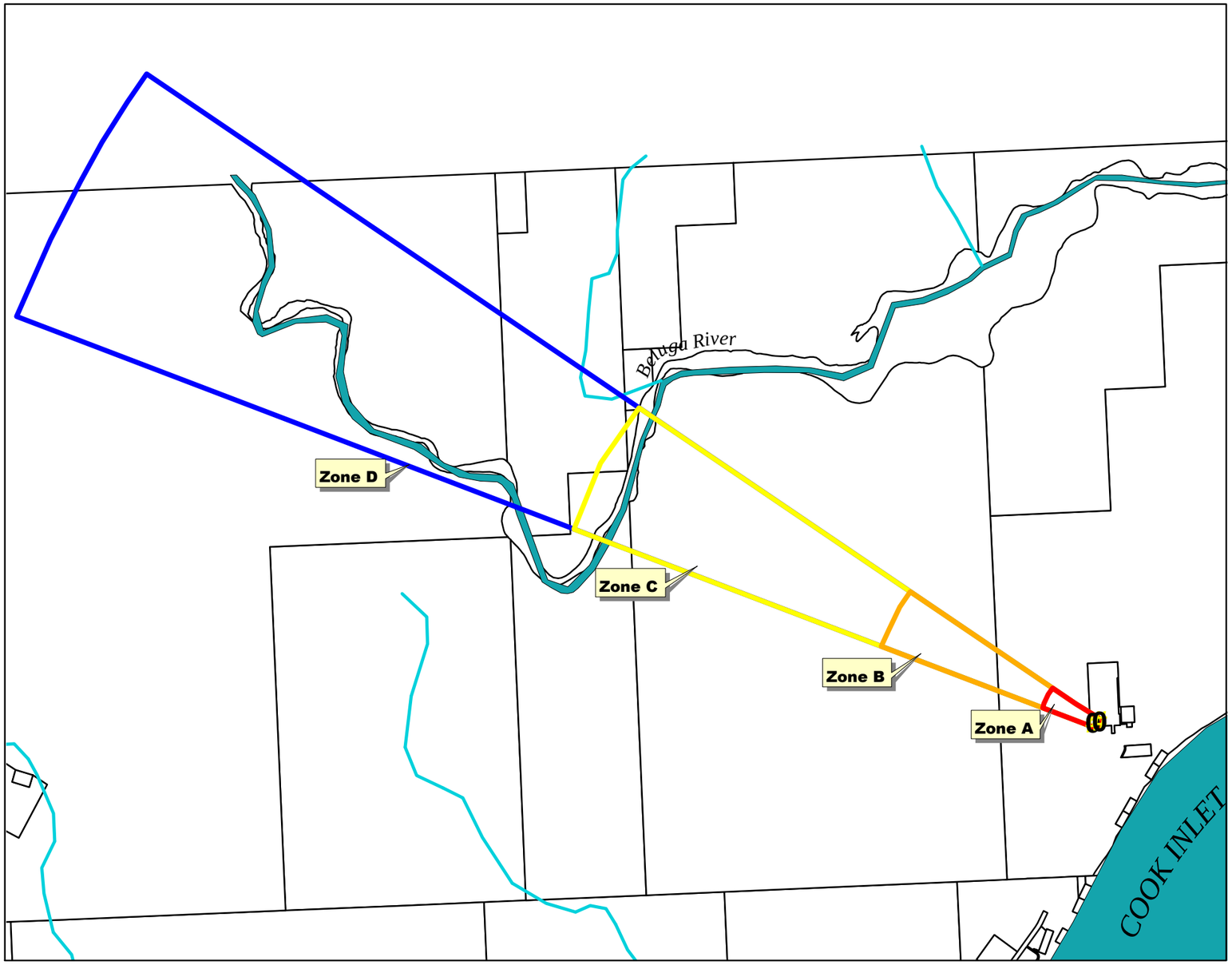
Glass, R.L., 1996, Ground-water conditions and quality in the western part of Kenai Peninsula, southcentral Alaska, Prepared in cooperation with the Alaska Department of Natural Resources, Kenai Peninsula Borough, Kenai Soil and Water Conservation District, U.S. Geological Survey, Anchorage, AK, and Branch of Information Services, Denver, CO.

Magoon, L. B., W.L. Adkison, and R. M. Egbert, 1976, *Map Showing Geology, Wildcat Wells, Tertiary Plant Fossil Localities, K-AR Age Dates, And Petroleum Operations, Cook Inlet Area, Alaska*, Department of the Interior, U.S. Geological Survey, Reston, VA.

APPENDIX A

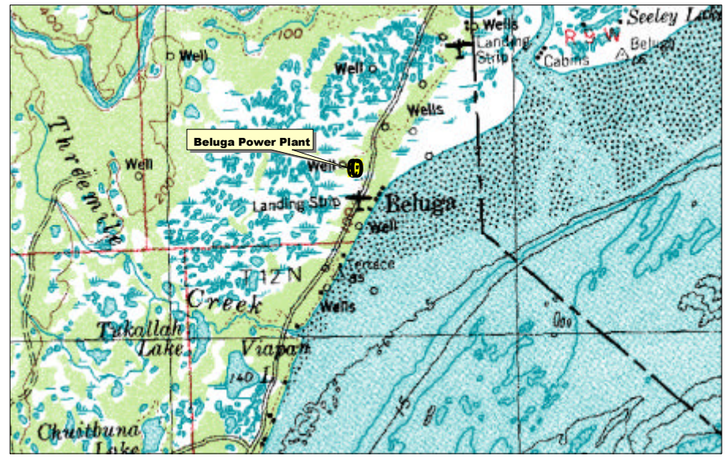
Beluga Power Plant
Drinking Water Protection Area
(Map 1)

Drinking Water Protection Area for Beluga Power Plant



0 Beluga Power Plant Wells
Zone A (Few 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)

N
W E
S



8000 0 8000 16000 24000 32000 Feet

PWSID 243624.002

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Beluga Power Plant (Tables 1-4)

Table 1 *Contaminant Source Inventory for* ***PWSID 243624.001***

Beluga Power Plant

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Lubrication shops	C25	C25-1	A	Beluga Power Plant	2	

Table 1

Contaminant Source Inventory and Risk Ranking for Beluga Power Plant Sources of Bacteria and Viruses

PWSID 243624.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
No Contaminant Sources Identified							

Table 2

Contaminant Source Inventory and Risk Ranking for Beluga Power Plant Sources of Nitrates/ Nitrites

PWSID 243624.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Location***	***Map Number***	***Comments***
No Contaminant Sources Identified							

Table 3

Contaminant Source Inventory and Risk Ranking for Beluga Power Plant
Sources of Volatile Organic Chemicals

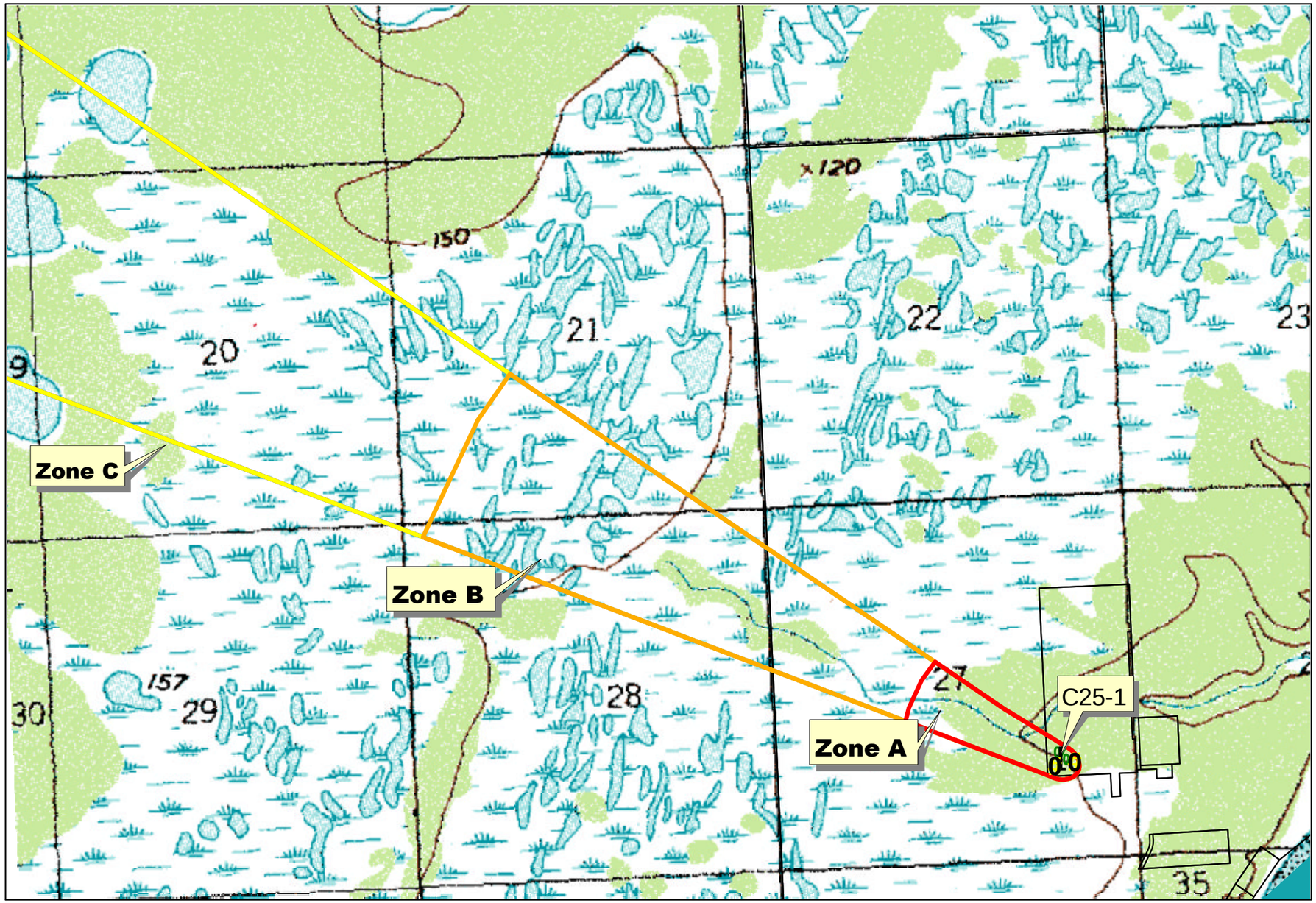
PWSID 243624.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Lubrication shops	C25	C25-1	A	Medium	Beluga Power Plant	2	

APPENDIX C

Beluga Power Plant
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Drinking Water Protection Area for Beluga Power Plant and Existing and Potential Sources of Contamination



Beluga Power Plant Wells
Lubrication Shop-C25
Zone A (Few 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)

N
W E
S

3000 0 3000 6000 9000 Feet

PWSID 243624.001 & 243624.002

Map 2

APPENDIX D

Vulnerability Analysis for Beluga Power Plant Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - Beluga Power Plant

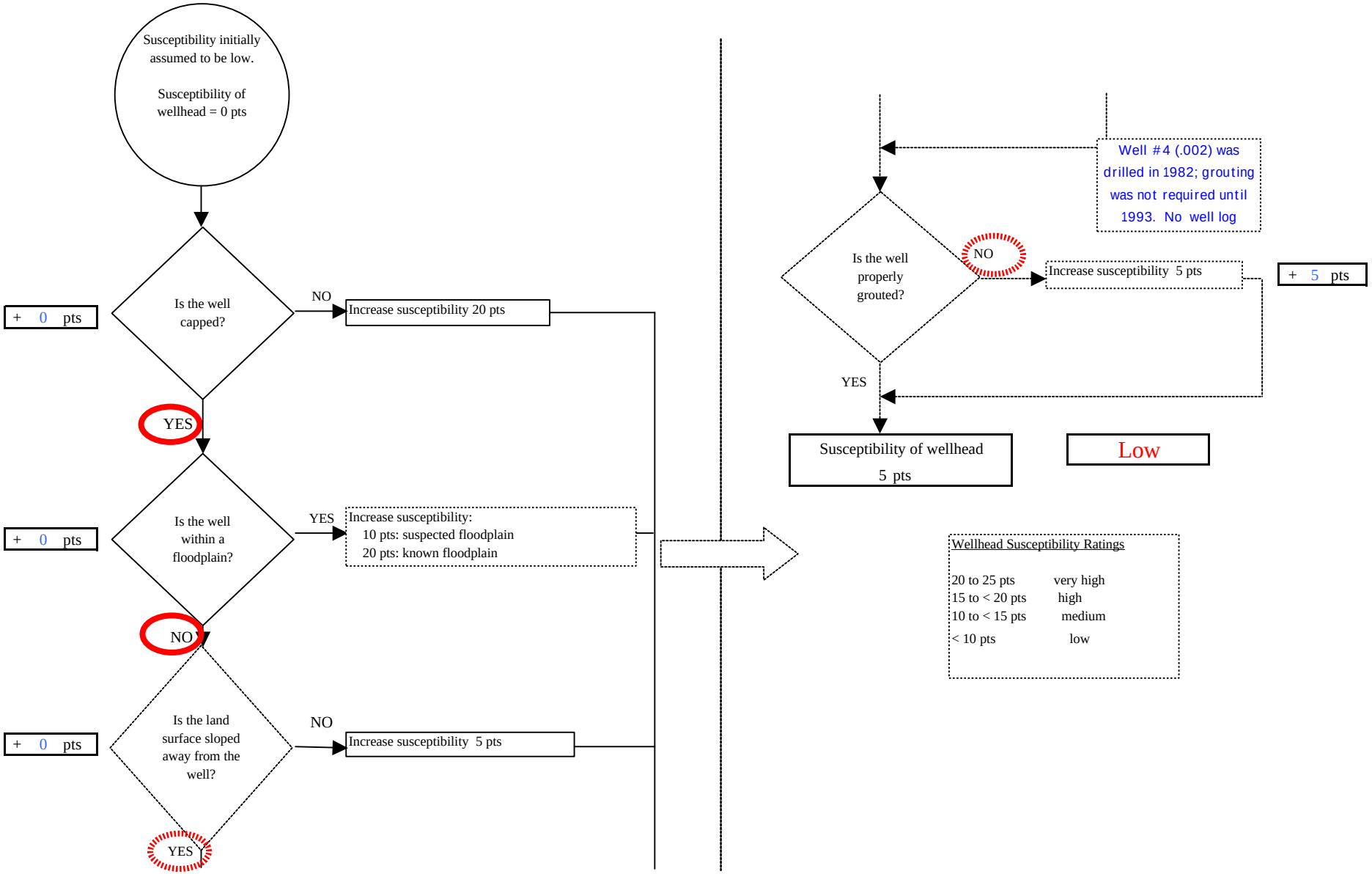


Chart 2. Susceptibility of the aquifer - Beluga Power Plant

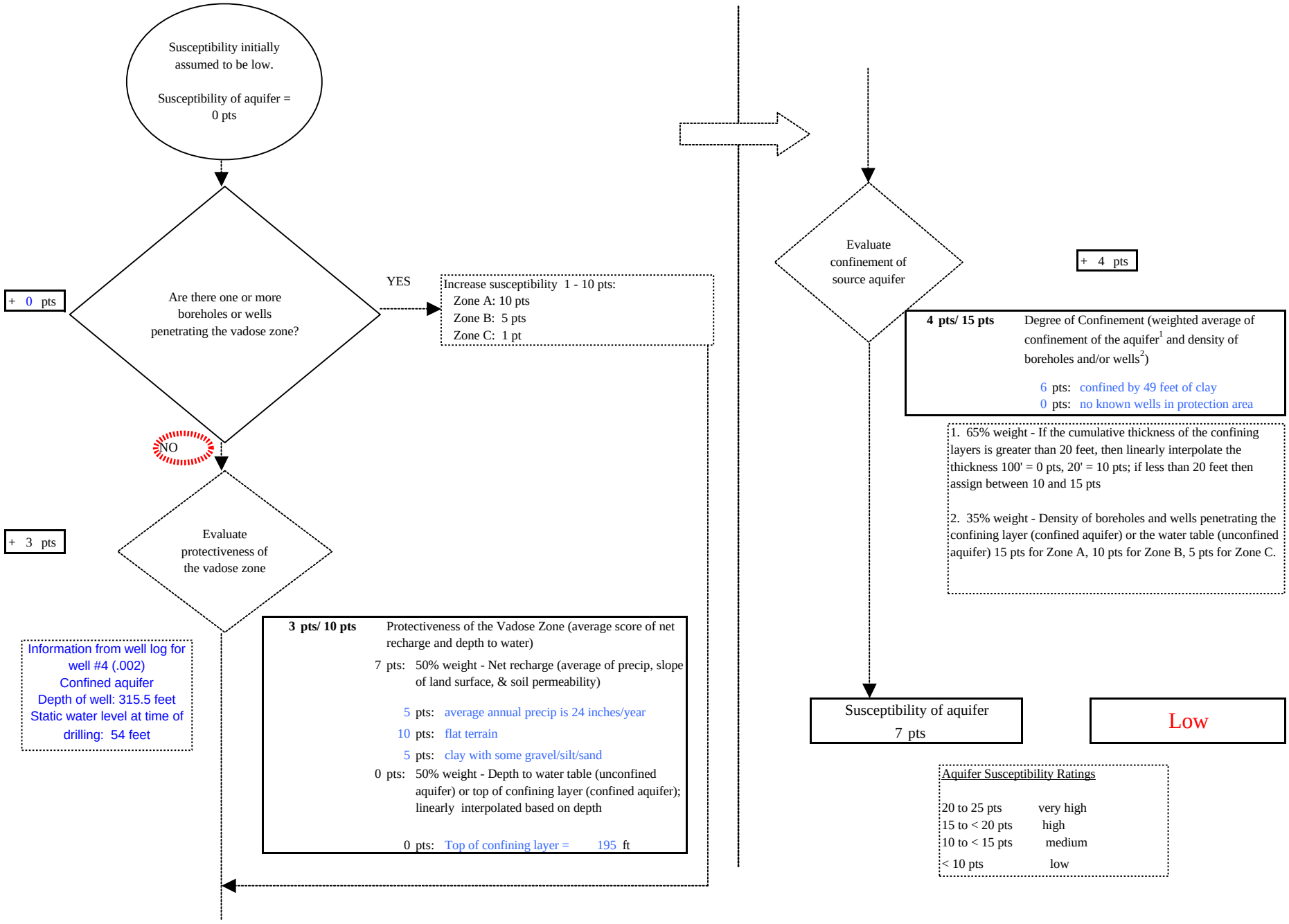
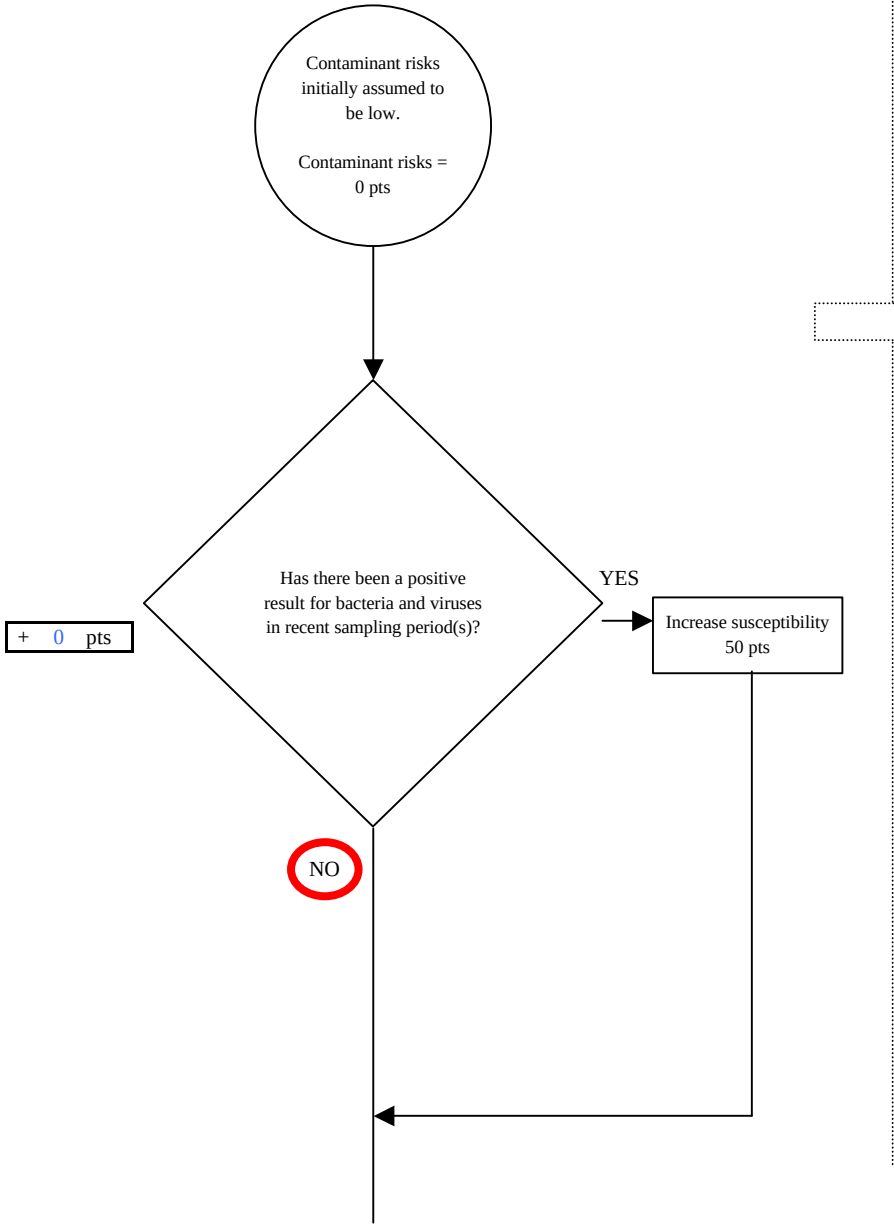
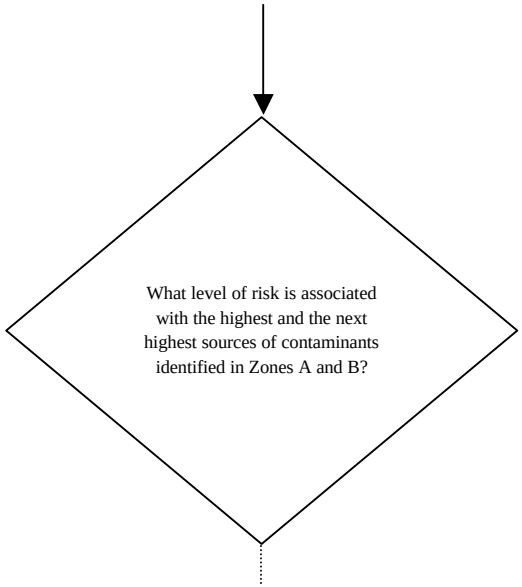


Chart 3. Contaminant risks for Beluga Power Plant - Bacteria & Viruses





+ 0 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	0	0

	LOW 10 pts	**MEDIUM** 20 pts	**HIGH** 30 pts	**VERY HIGH** 40 pts
LOW	[3] 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source + 10 pts

Matrix Score 0

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

Chart 3. Contaminant risks for Beluga Power Plant - Bacteria & Viruses

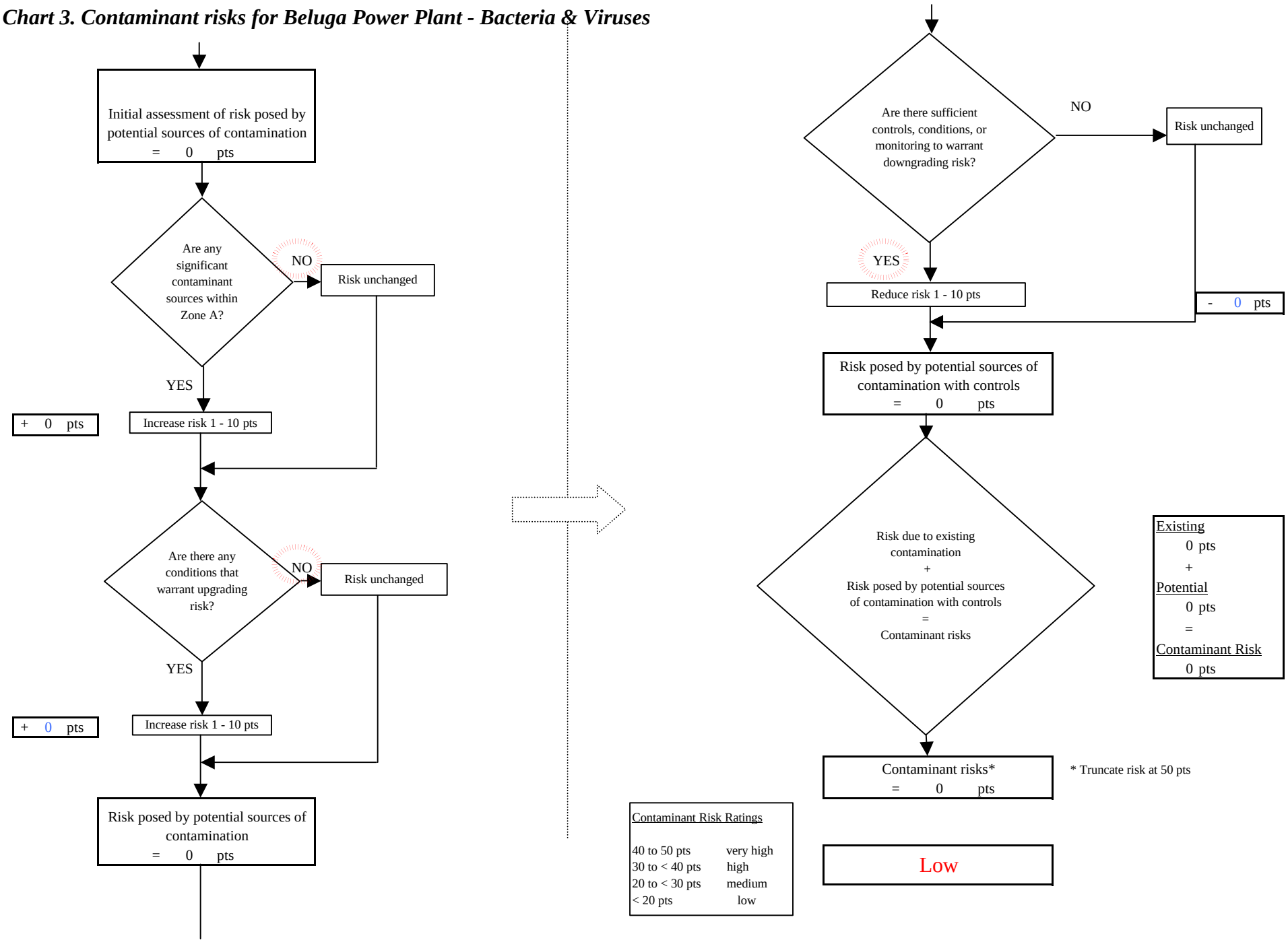


Chart 4. Vulnerability analysis for Beluga Power Plant - Bacteria & Viruses

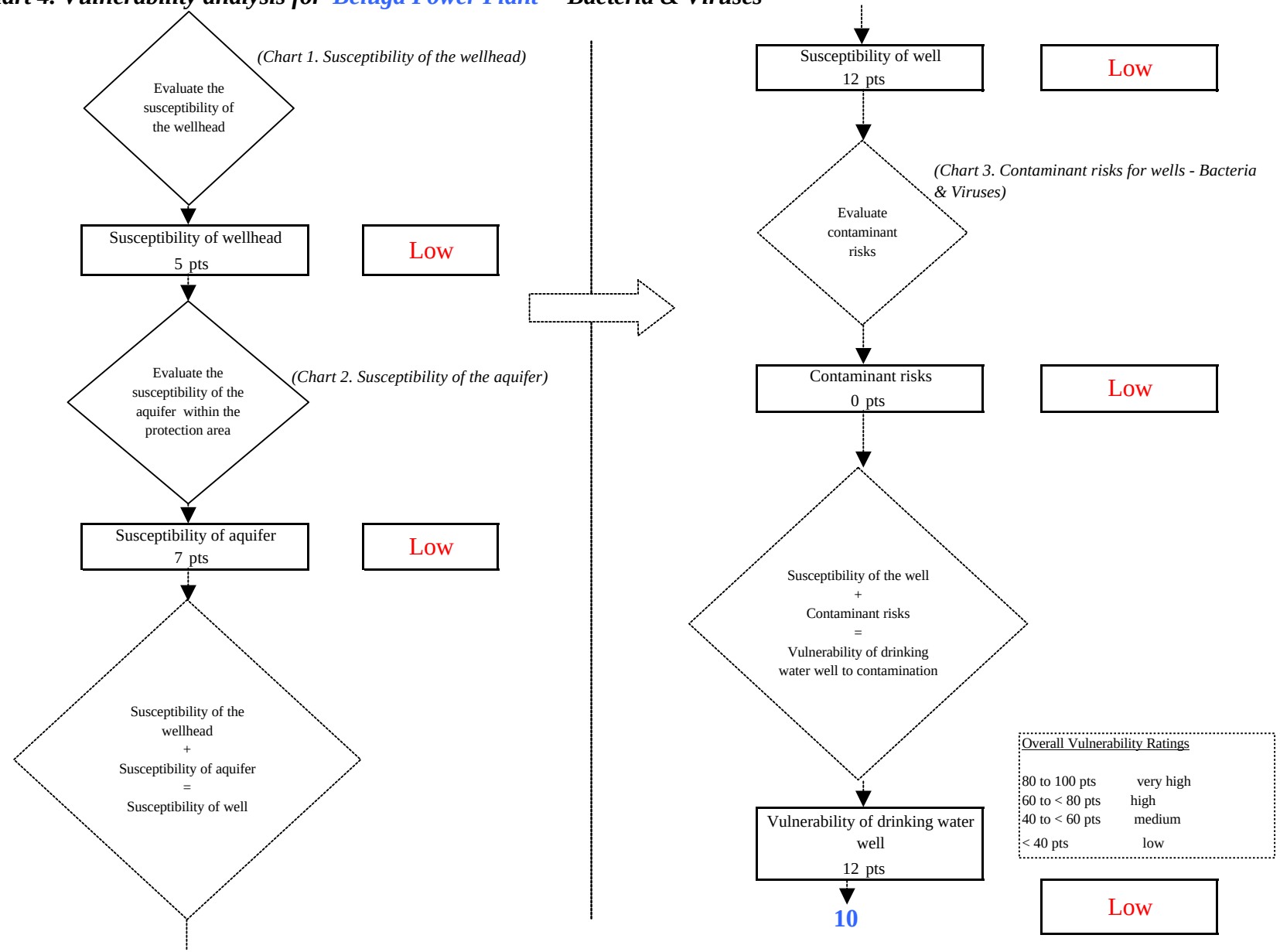


Chart 5. Contaminant risks for Beluga Power Plant - Nitrates and Nitrites

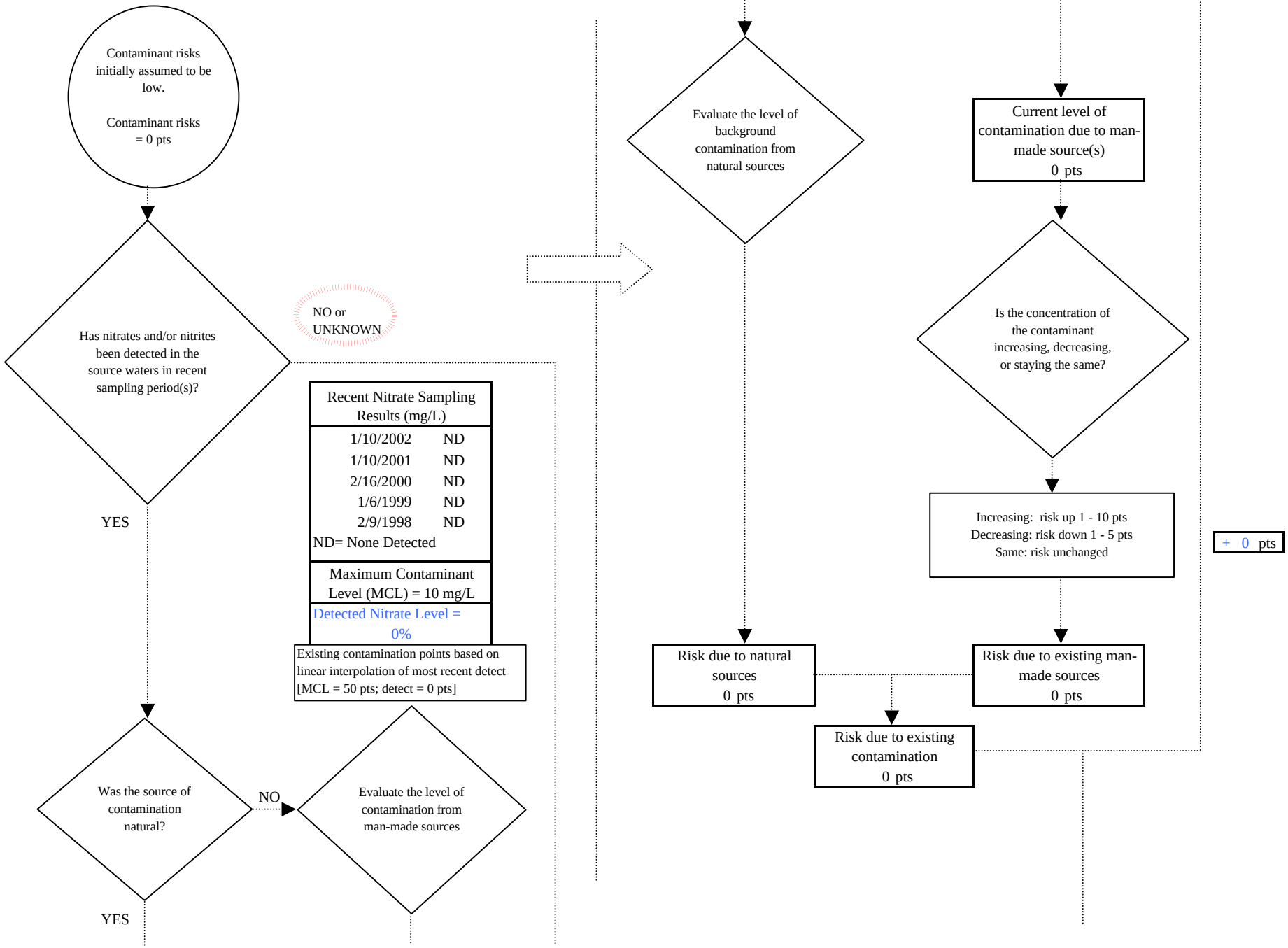


Chart 5. Contaminant risks for Beluga Power Plant - Nitrates and Nitrites

+ 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	[3] 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.

Initial assessment of risk posed by potential sources of contamination = 0 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 Beluga Power Plant - Nitrates and Nitrites

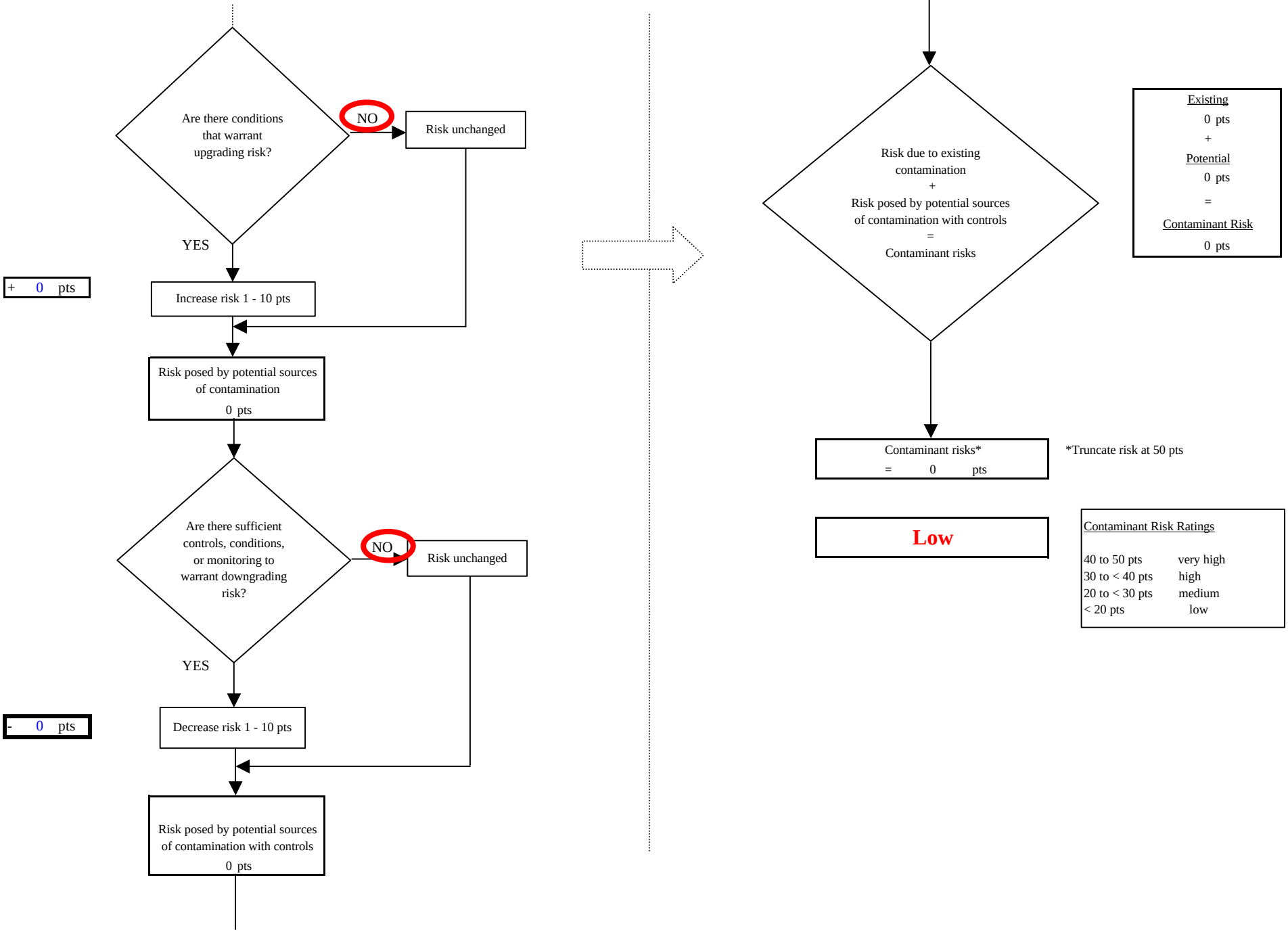


Chart 6. Vulnerability analysis for Beluga Power Plant - Nitrates and Nitrites

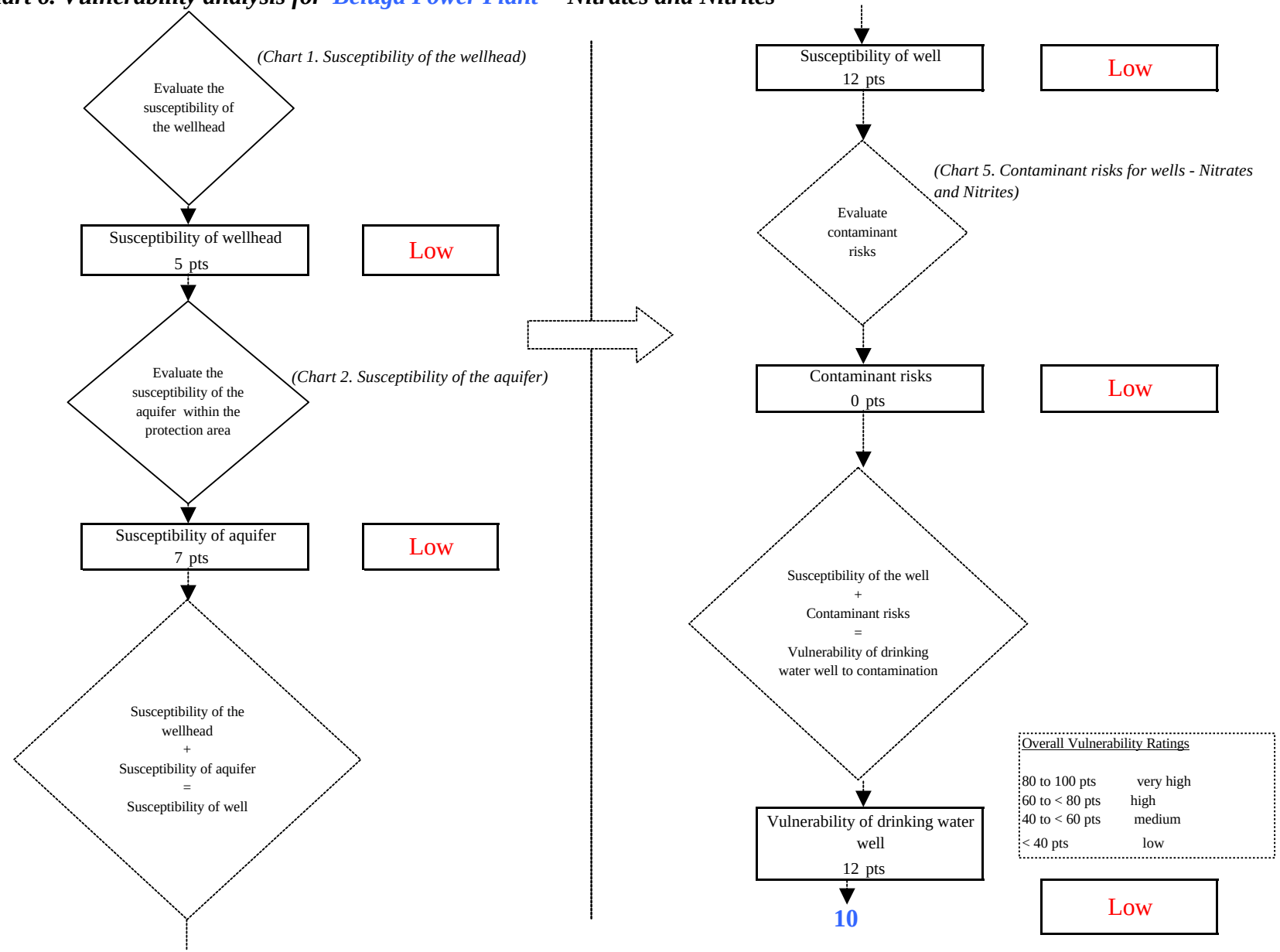


Chart 7. Contaminant risks for Beluga Power Plant - Volatile Organic Chemicals

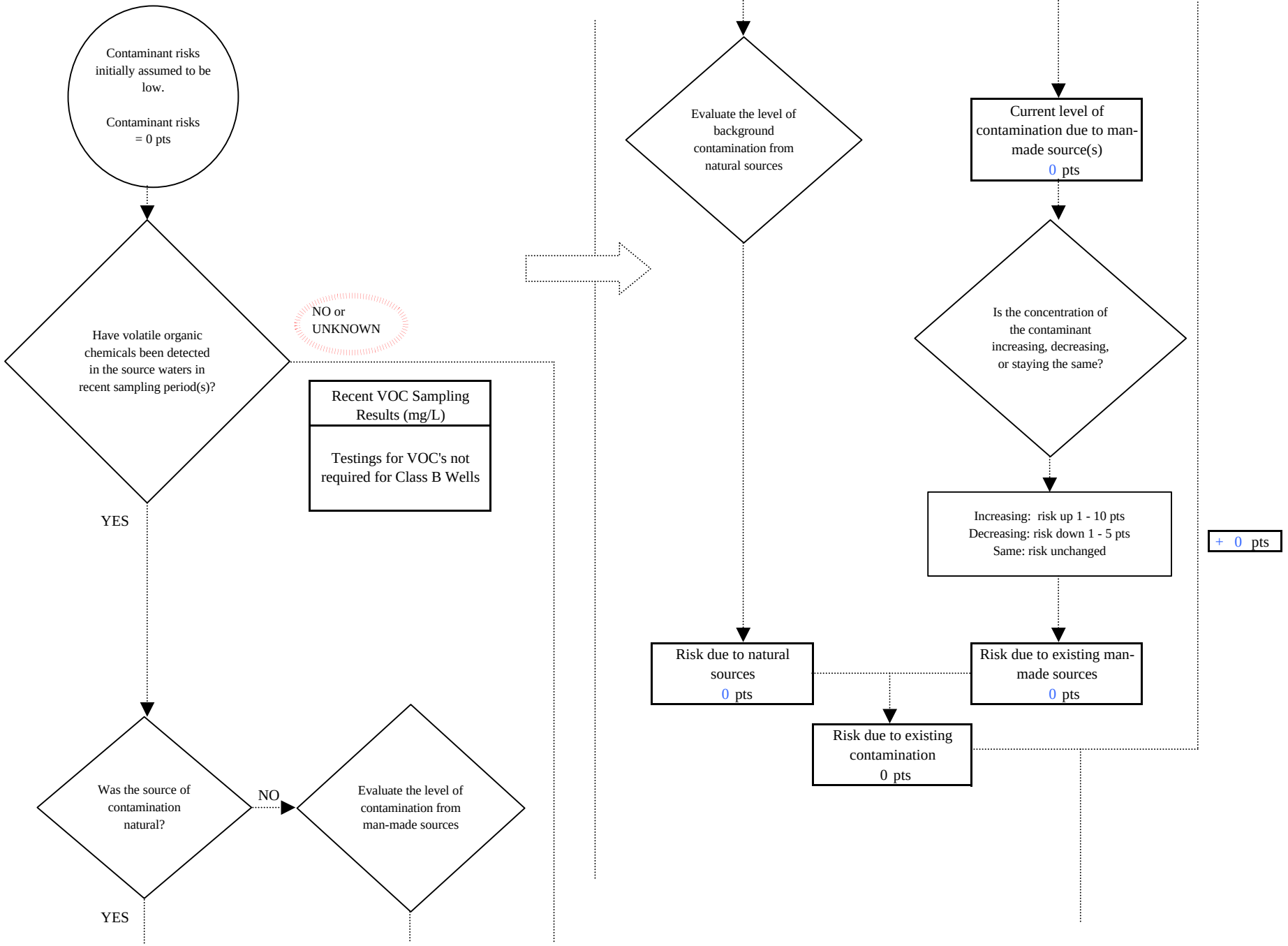


Chart 7. Contaminant risks for Beluga Power Plant - Volatile Organic Chemicals

+ 20 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

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

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

	LOW 10 pts	**MEDIUM** 20 pts	**HIGH** 30 pts	**VERY HIGH** 40 pts
LOW	[3] 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

Potential sources of volatile organic chemical contamination in Zone A can be found in Table 4 of Appendix B.

Chart 7. Contaminant risks for Beluga Power Plant - Volatile Organic Chemicals

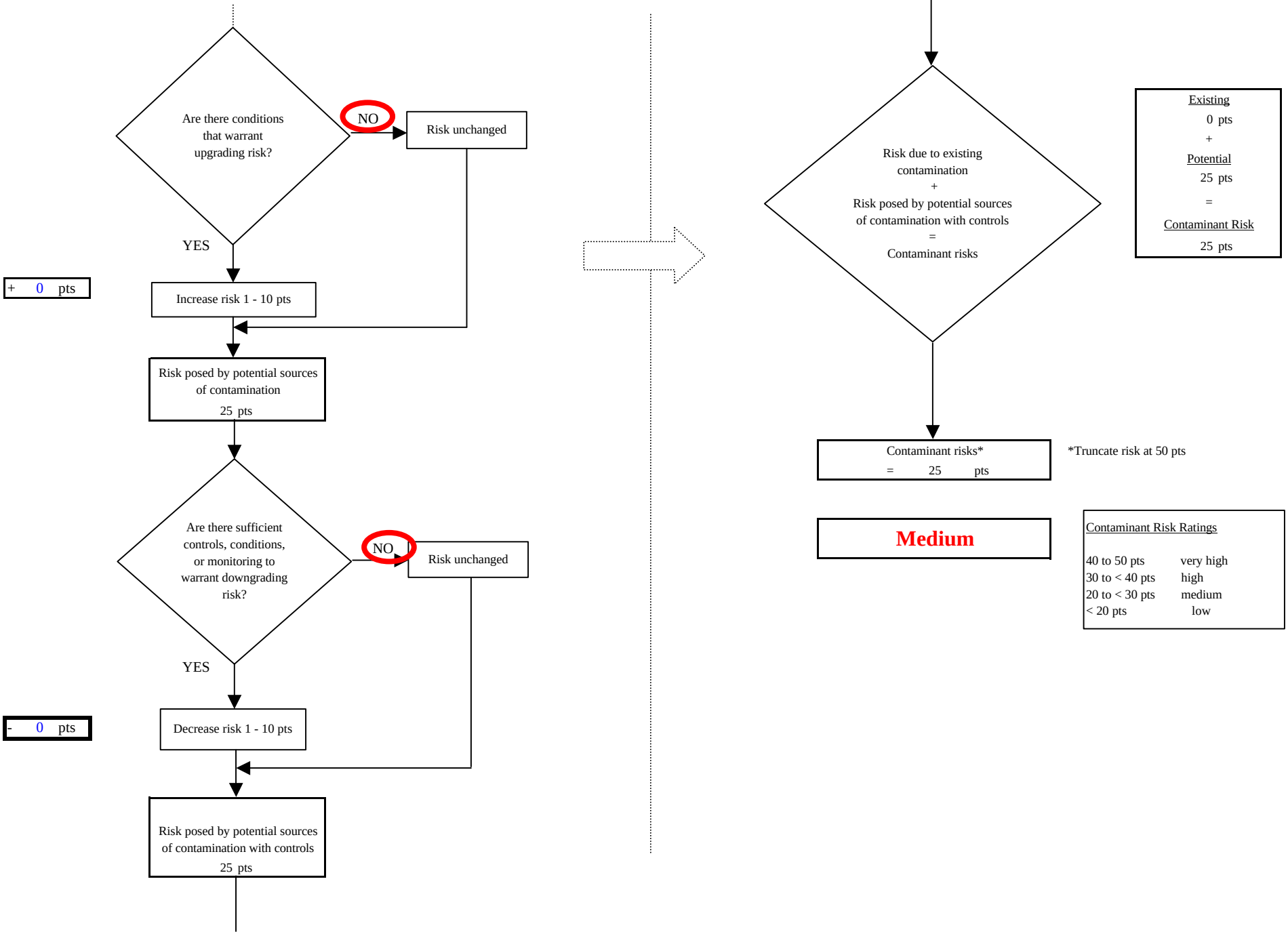


Chart 8. Vulnerability analysis for Beluga Power Plant - Volatile Organic Chemicals