

Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Northern Lights Theatre & Gift Shop
Drinking Water System,
McKinley Park, Alaska
PWSID # 391419

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By Ecology & Environment, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT # 307

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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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Source Water Assessment for Northern Lights Theatre & Gift Shop Source of Public Drinking Water, McKinley Park, Alaska

By Ecology & Environment, Inc.

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Northern Lights Theatre & Gift Shop is a Class B (transient/non-community) water system consisting of one well in McKinley Park, Alaska. No potential and current sources of contaminants for Northern Lights Theatre & Gift Shop's public drinking water source were identified. The vulnerability of the public water source identifies a risk of contamination from any future, or unidentified, sources of contaminants. Overall, the public water source for Northern Lights Theatre & Gift Shop 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 MCKINLEY PARK AND MCKINLEY VILLAGE AREA

Location

The McKinley Park area is located at the junction of the George Parks Highway and McKinley Park Road at mile 231 of the highway, at the entrance of Denali National Park. McKinley Village is located to the south, near the confluence of the Yanert Fork and the Nenana River (Figure 1).



Figure 1

Precipitation

The McKinley Park/McKinley Village area averages about 15 inches of precipitation per year, with approximately 81 inches of snowfall (ACRC 2002).

Topography and Drainage

McKinley Park and McKinley Village lie in the Nenana River valley, which cuts through the steeply rising peaks of the Alaska Range. Most of the businesses are located along the river or on the gentler slopes at the base of the mountains.

Groundwater Use

There is no municipal water supply. Most of the seasonally-used private homes in the area haul their drinking water. The lodges and other businesses which cater to tourists generally have their own wells and septic systems (ADCED 2002).

Geology and Soils

The geology of the McKinley Park and McKinley Village area is characterized by glacial sediments overlying bedrock. The glacial till has been reworked by rivers in some areas, and may consist of well-rounded to angular rock fragments mixed with sand and silt. Local fractures in the bedrock can provide pathways for the migration of groundwater (Lanning 1994).

NORTHERN LIGHTS THEATRE & GIFT SHOP PUBLIC DRINKING WATER SYSTEM

Northern Lights Theatre & Gift Shop is a Class B (transient/non-community) water system. The system consists of one well near the Parks Highway at milepost 230.

According to the well log completed for the water system, installation of the well occurred on June 26, 1992 to a total depth of approximately 220 feet below ground surface. The most recent Sanitary Survey (69/18/98) 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 well providing adequate surface water drainage. The well apparently was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters. The aquifer is assumed to be confined based on the depth of the well, and the static water level and lithologies encountered during drilling.

This system operates from May 15 to September 15 and serves approximately 200 non-residents.

NORTHERN LIGHTS THEATRE & GIFT SHOP 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 are 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 the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick et al. 1989*). 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 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 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 Northern Lights Theatre &

Gift Shop DWPA. This inventory was completed through a search of agency records and other publicly available information. In addition, Ecology & Environment, Inc. staff conducted a site visit as a quality control measure. 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 Zones A through Zone D were associated with residential and light industrial type activities. The sources are summarized in the tables in Appendix B of the Guidance Manual.

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.

VULNERABILITY OF NORTHERN LIGHTS THEATRE & GIFT SHOP 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 three categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

$$\begin{array}{r} \text{Natural Susceptibility (0 – 50 points)} \\ + \\ \text{Contaminant Risks (0 – 50 points)} \end{array}$$

$$\begin{array}{r} = \\ \text{Vulnerability of the} \\ \text{Drinking Water Source to Contamination (0 – 100).} \end{array}$$

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

$$\begin{array}{r} \text{Susceptibility of the Wellhead (0 – 25 Points)} \\ + \\ \text{Susceptibility of the Aquifer (0 – 25 Points)} \\ = \\ \text{Natural Susceptibility (Susceptibility of the Well)} \\ \text{(0 – 50 Points)} \end{array}$$

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.

Table 2 shows the Overall Susceptibility score and rating for Northern Lights Theatre & Gift Shop (see Charts 1 and 2).

Table 2. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellhead	0	Loe
Susceptibility of the Aquifer	4	Low
Natural Susceptibility	4	Low

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

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	0	Low
Nitrates and/or Nitrites	6	Low
Volatile Organic Chemicals	0	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 of Northern Lights Theatre & Gift Shop to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	5	Low
Nitrates and Nitrites	10	Low
Volatile Organic Chemicals	5	Low

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

Only a small amount of bacteria and viruses are required to endanger public health. If bacteria and viruses have been detected during recent water sampling of the system at Northern Lights Theatre & Gift Shop, the result is a maximum score on Chart 3.

The sampling history for the Northern Lights Theatre & Gift Shop well indicates that nitrates and/or nitrites are found in natural background concentration at this site, as elsewhere throughout Alaska. 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]. Existing nitrate concentration in the Northern Lights Theatre & Gift Shop well is approximately 1.3 mg/L or 13% 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. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Though existing nitrate contamination was detected at the site, concentrations remain at safe levels

with respect to human health (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Class B Public Water systems are not required to test for volatile organic chemicals (VOCs); therefore, no score for pre-existing contamination has been assigned. The vulnerability score for VOCs reflects the potential for contamination from the sources indicated on Table 4 in Appendix B.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Northern Lights Theatre & Gift Shop. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, **Low** for nitrates and nitrites, and **Low** for volatile organic chemicals. 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 Northern Lights Theatre & Gift Shop 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 Northern Lights Theatre & Gift Shop public drinking water source.

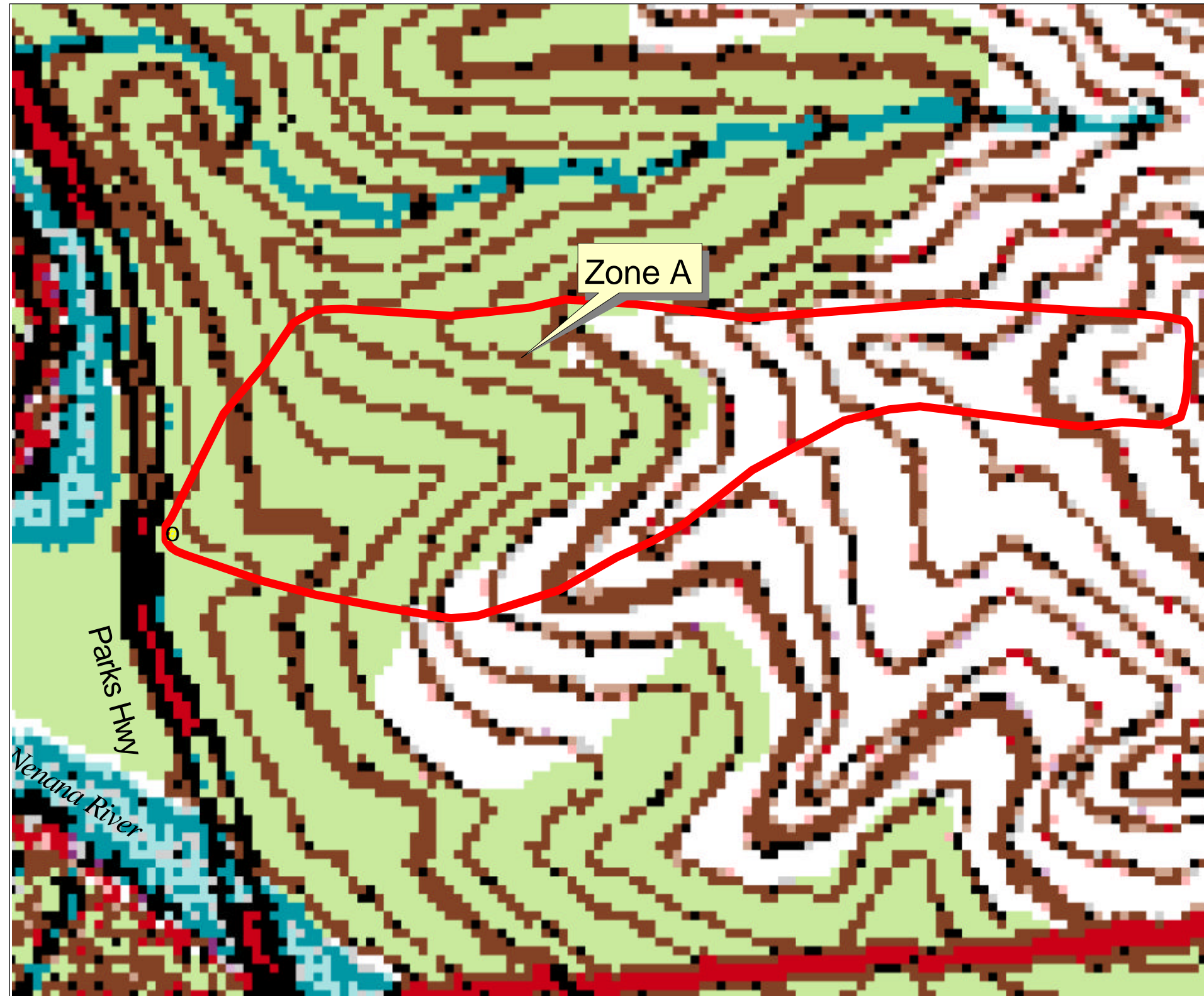
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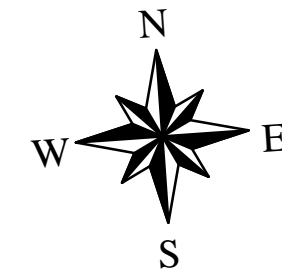
APPENDIX A

Northern Lights Theatre & Gift Shop Drinking Water Protection Area (Map 1)

Drinking Water Protection Area for Northern Lights Theatre Lights & Gift



- Northern Lights Theatre and Gft Well
- Zone A (Few Months Travel Time)



APPENDIX B

Contaminant Source Inventory and Risk Ranking for Northern Lights Theatre & Gift Shop (Tables 1-4)

Not Applicable – No Contaminant Sources Identified

APPENDIX C

Northern Lights Theatre & Gift Shop Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)

Not Applicable – No Contaminant Sources Identified

APPENDIX D

Vulnerability Analysis for Northern Lights Theatre & Gift Shop Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - Northern Lights Theatre & Gift

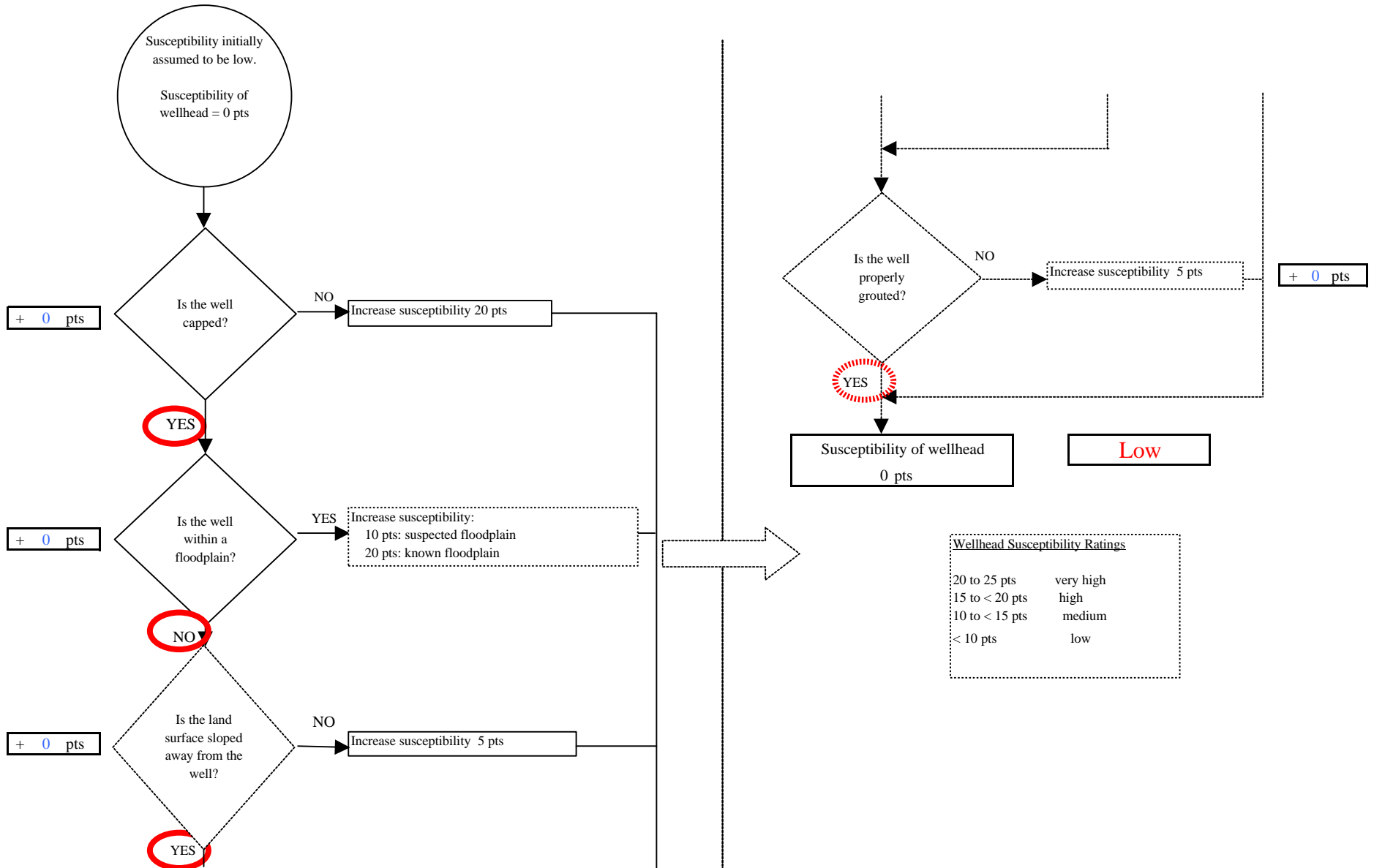


Chart 2. Susceptibility of the aquifer - Northern Lights Theatre & Gift

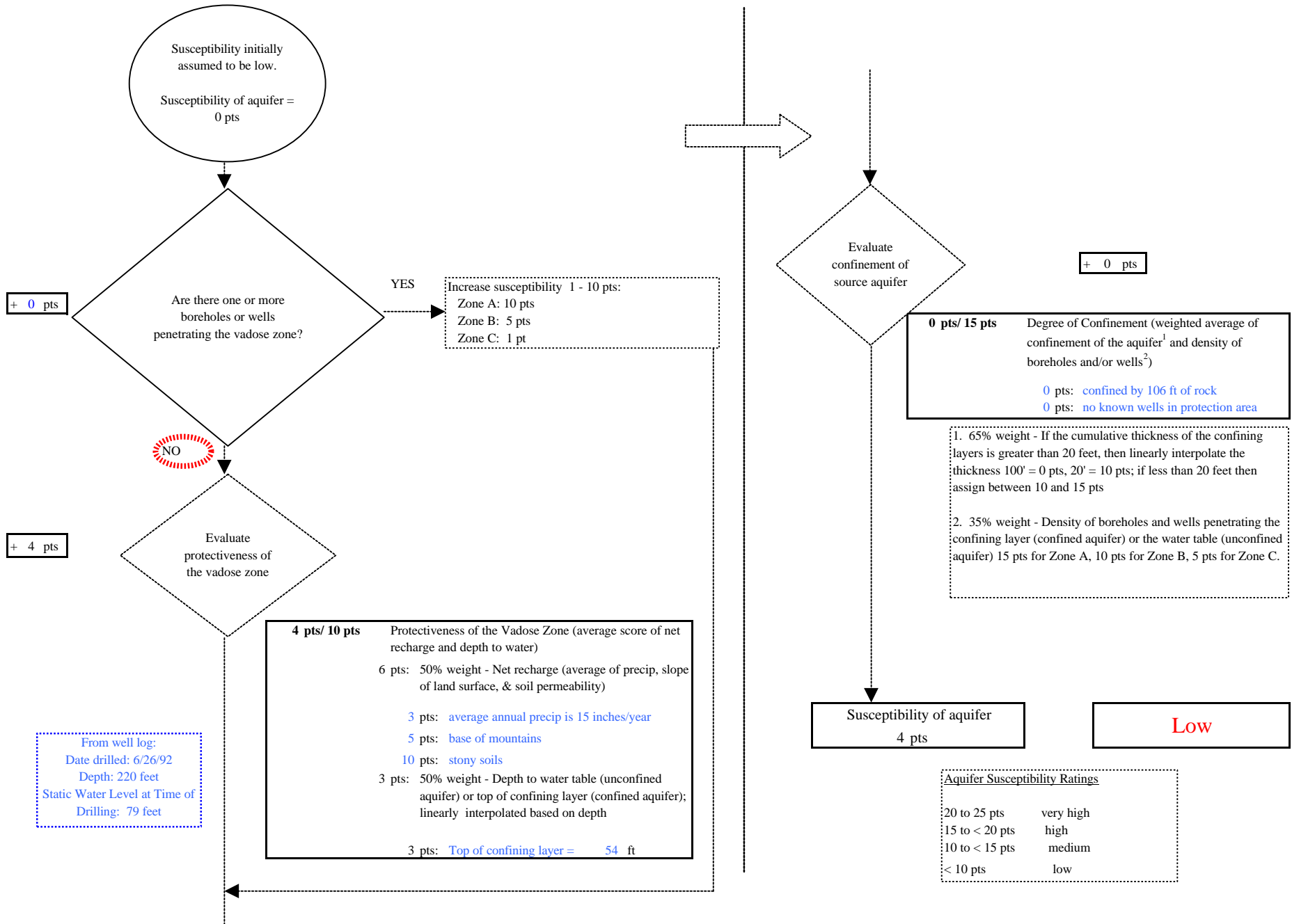
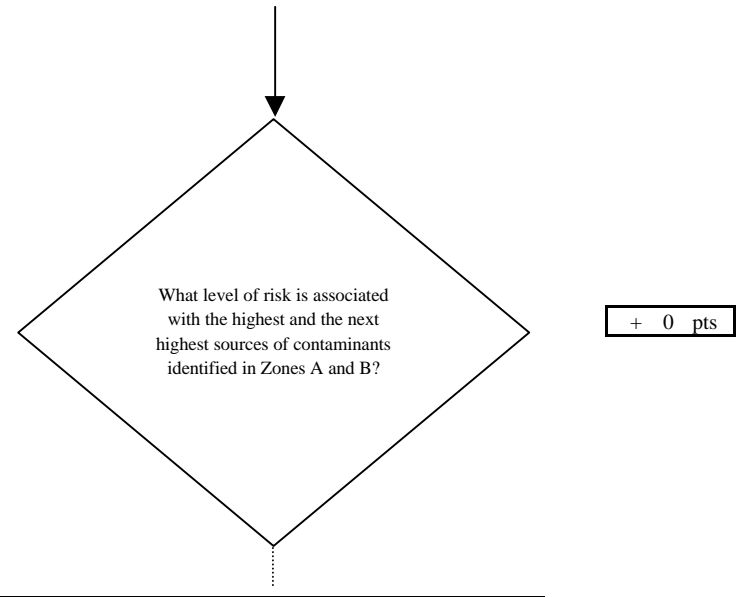
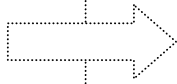
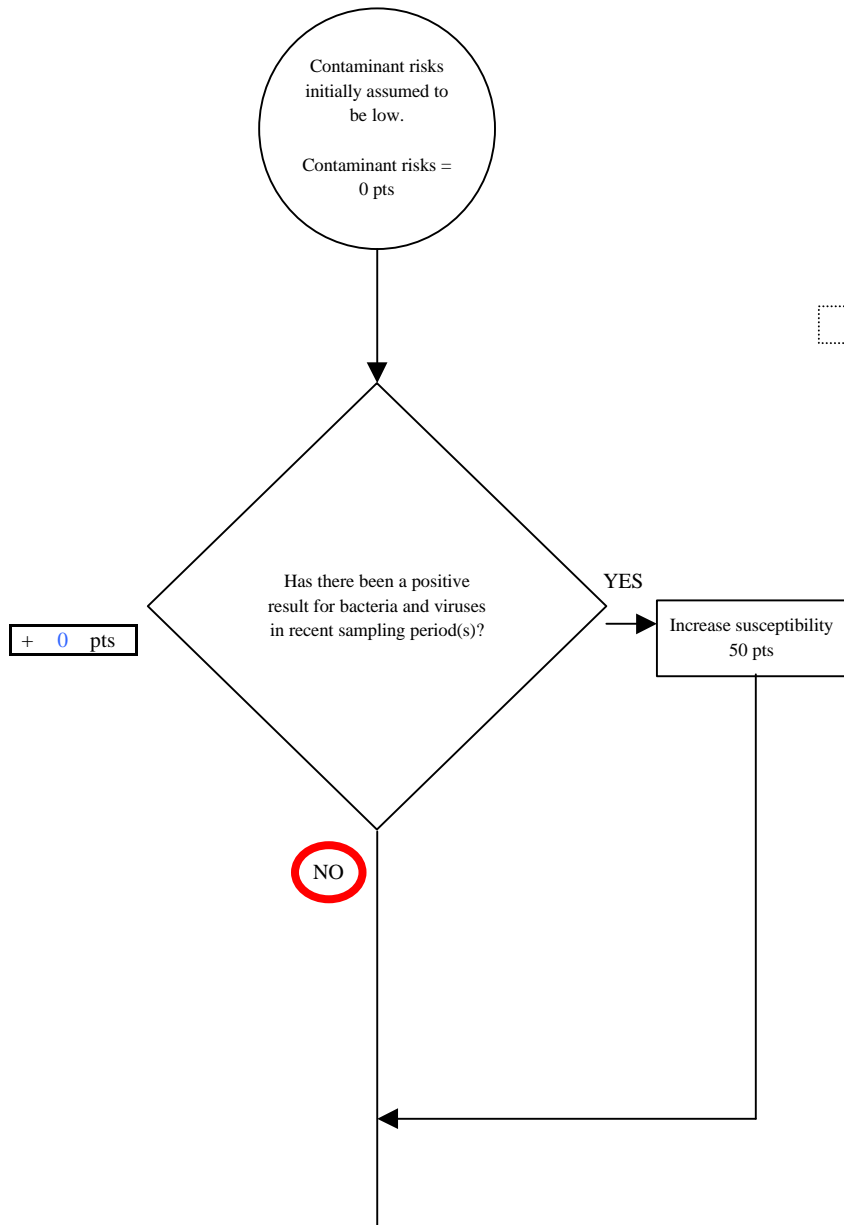


Chart 3. Contaminant risks for Northern Lights Theatre & Gift - Bacteria & Viruses



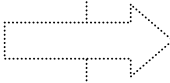
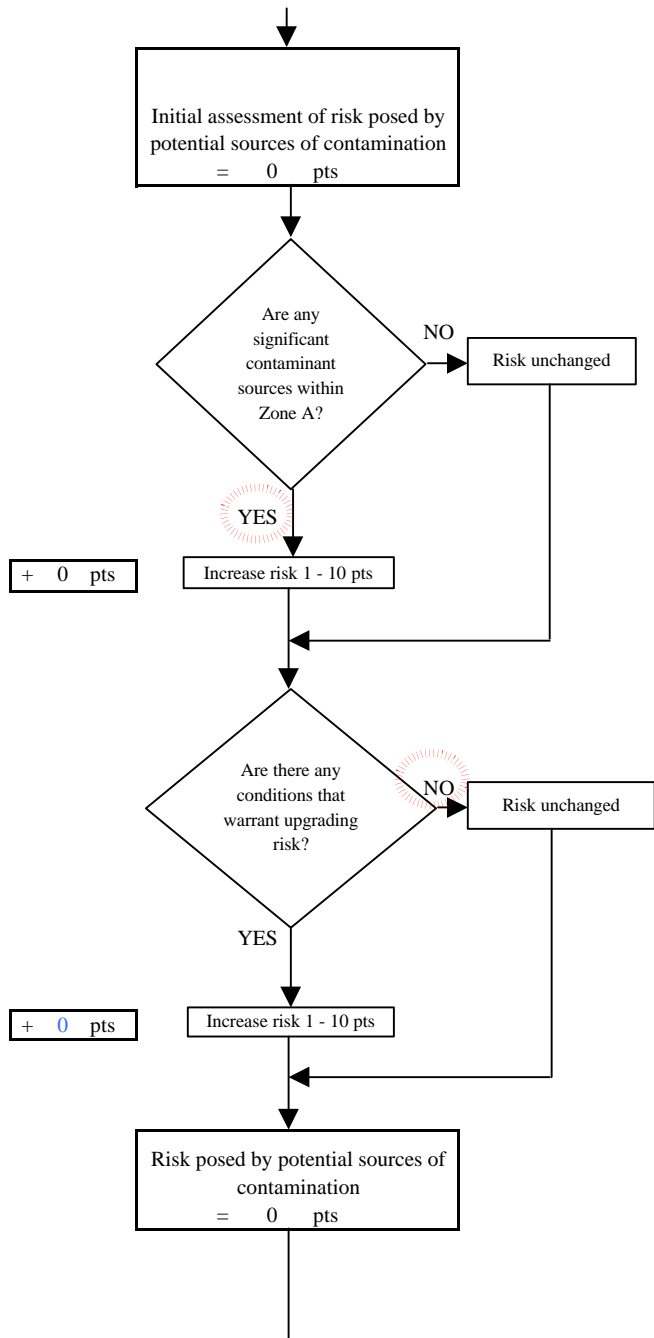
Risk Rankings for Contaminant Sources Identified in Zones A and B			
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	0	0

	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 Northern Lights Theatre & Gift - Bacteria & Viruses



Contaminant Risk Ratings	
40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

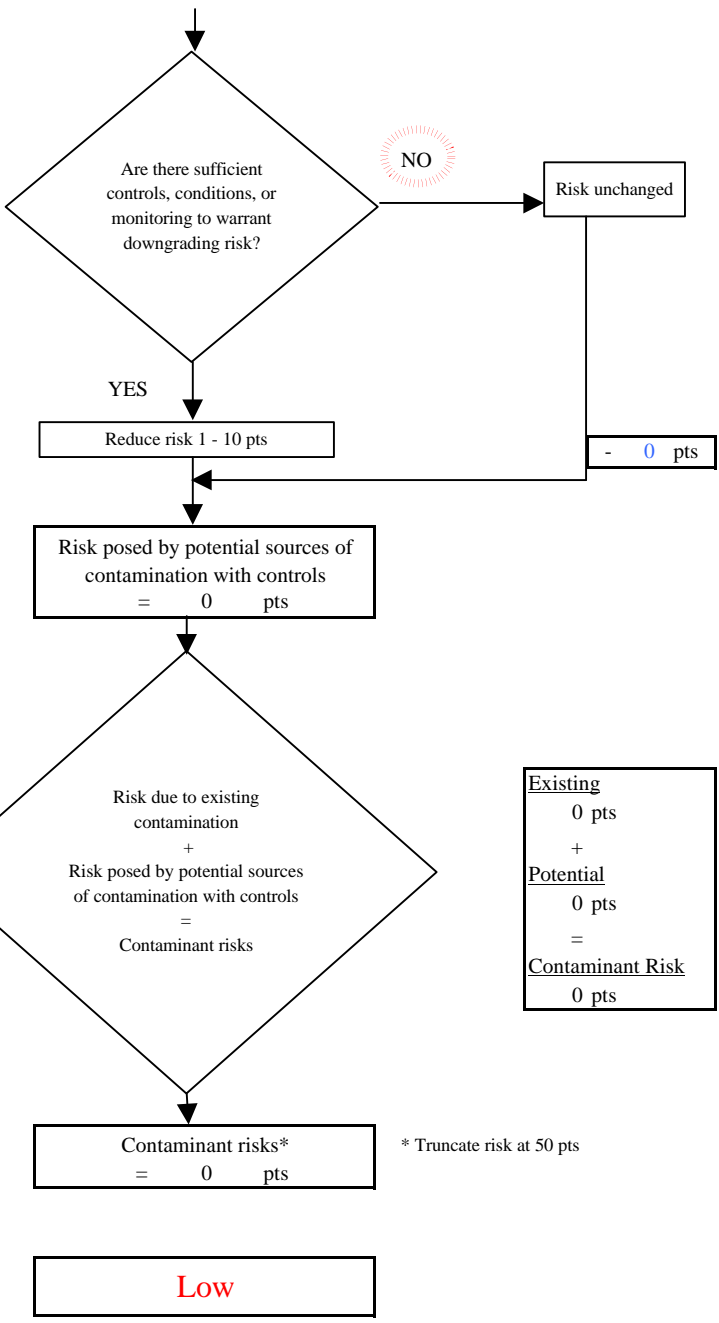


Chart 4. Vulnerability analysis for Northern Lights Theatre & Gift - Bacteria & Viruses

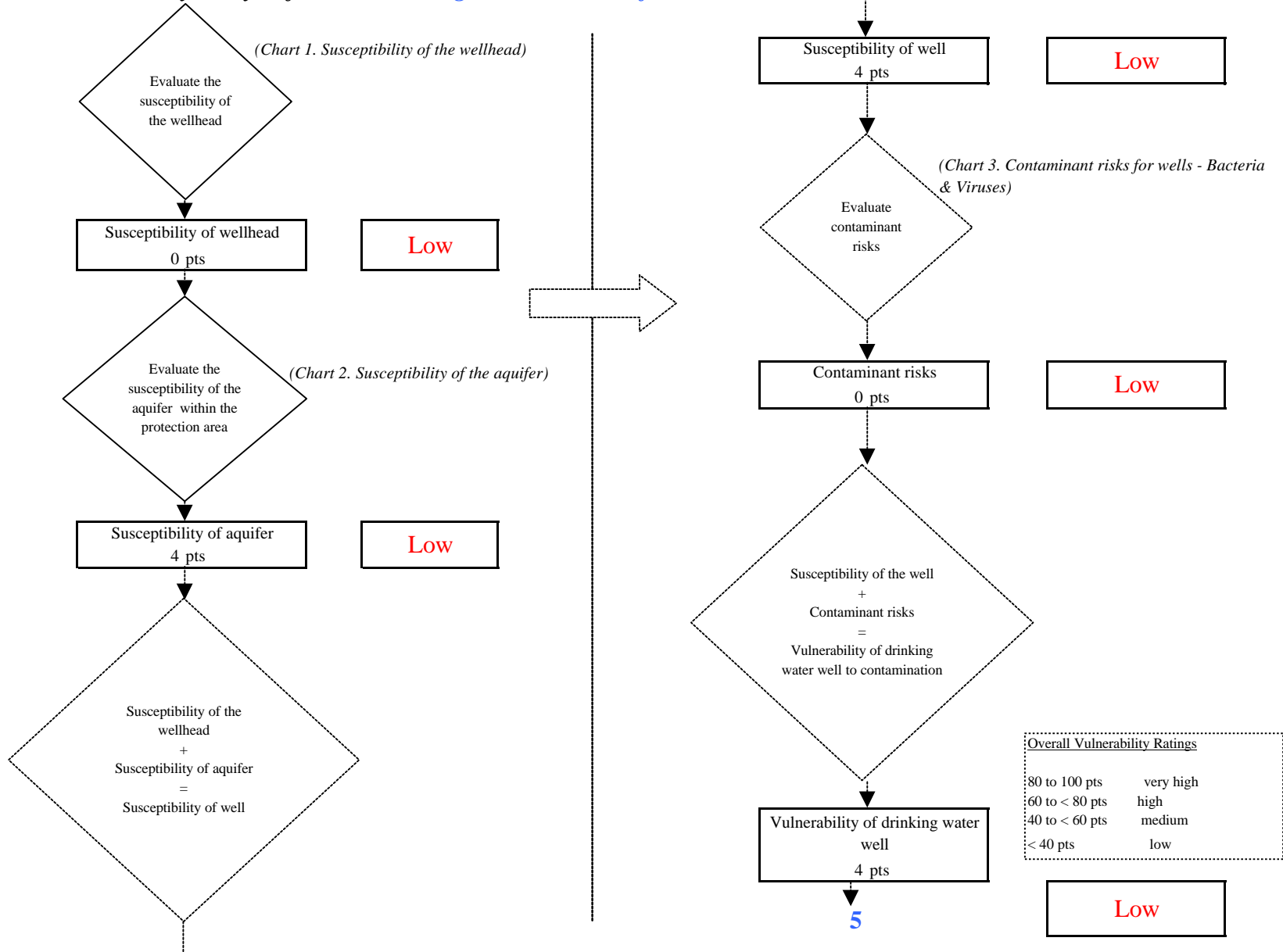


Chart 5. Contaminant risks for *Northern Lights Theatre & Gift* - Nitrates and Nitrites

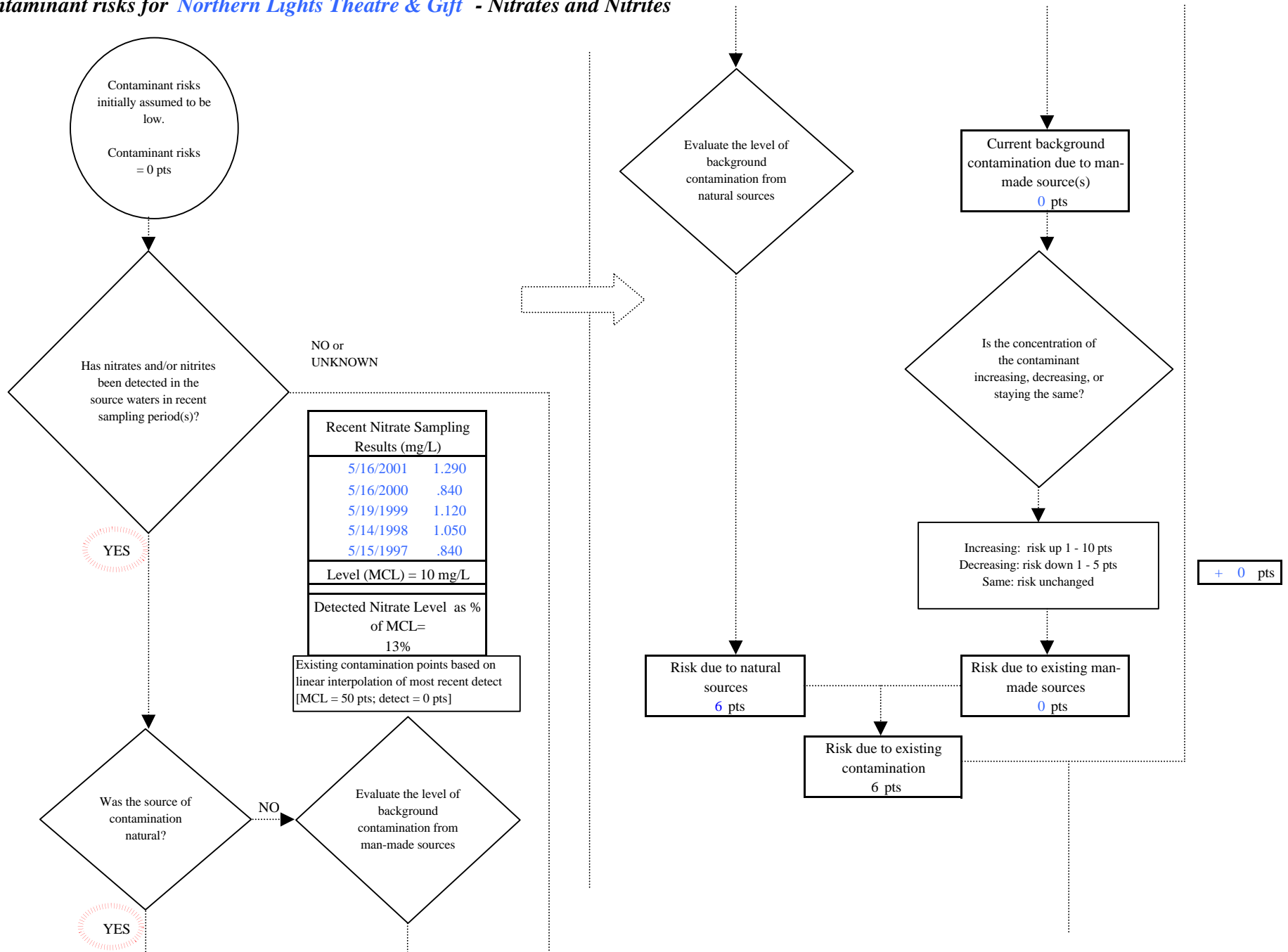


Chart 5. Contaminant risks for Northern Lights Theatre & Gift - Nitrates and Nitrites

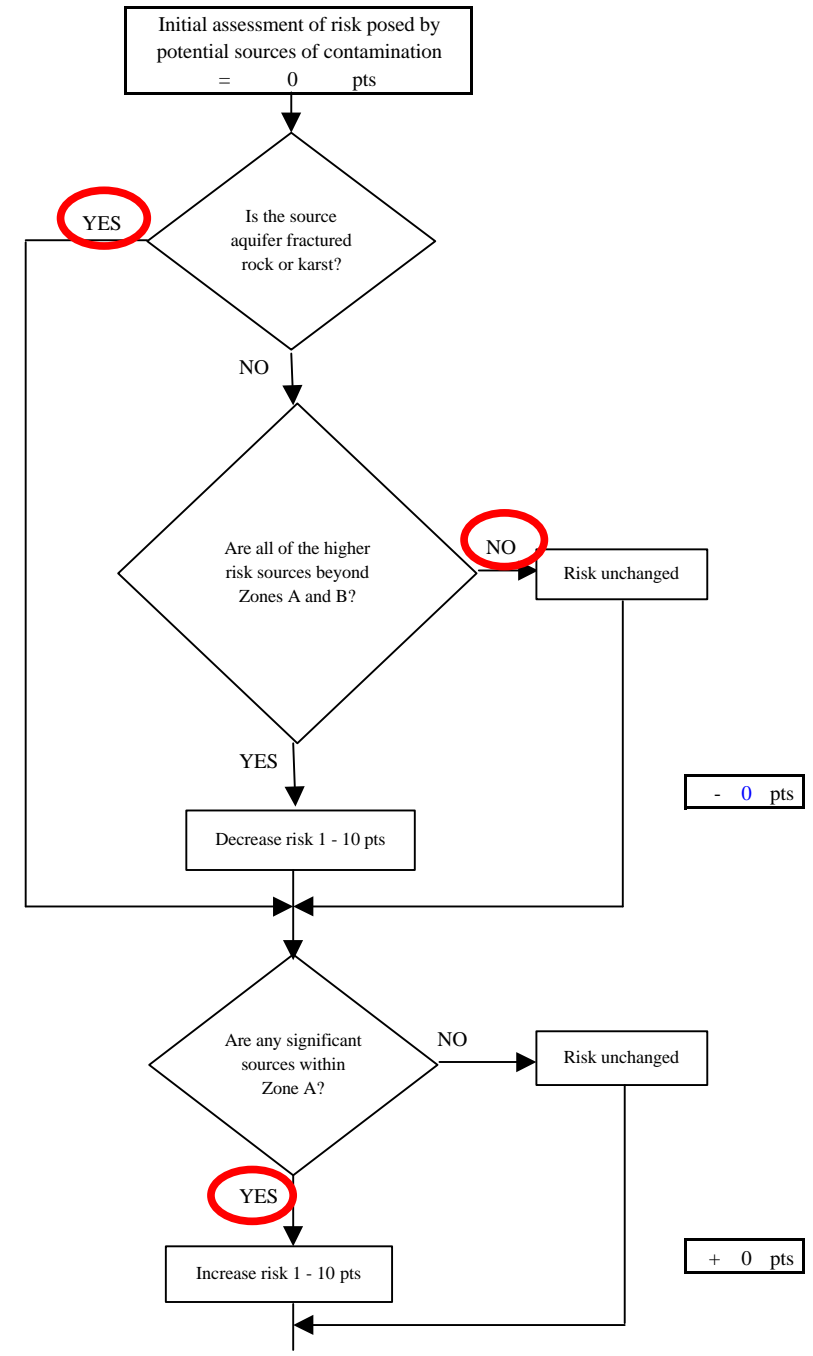
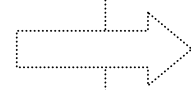
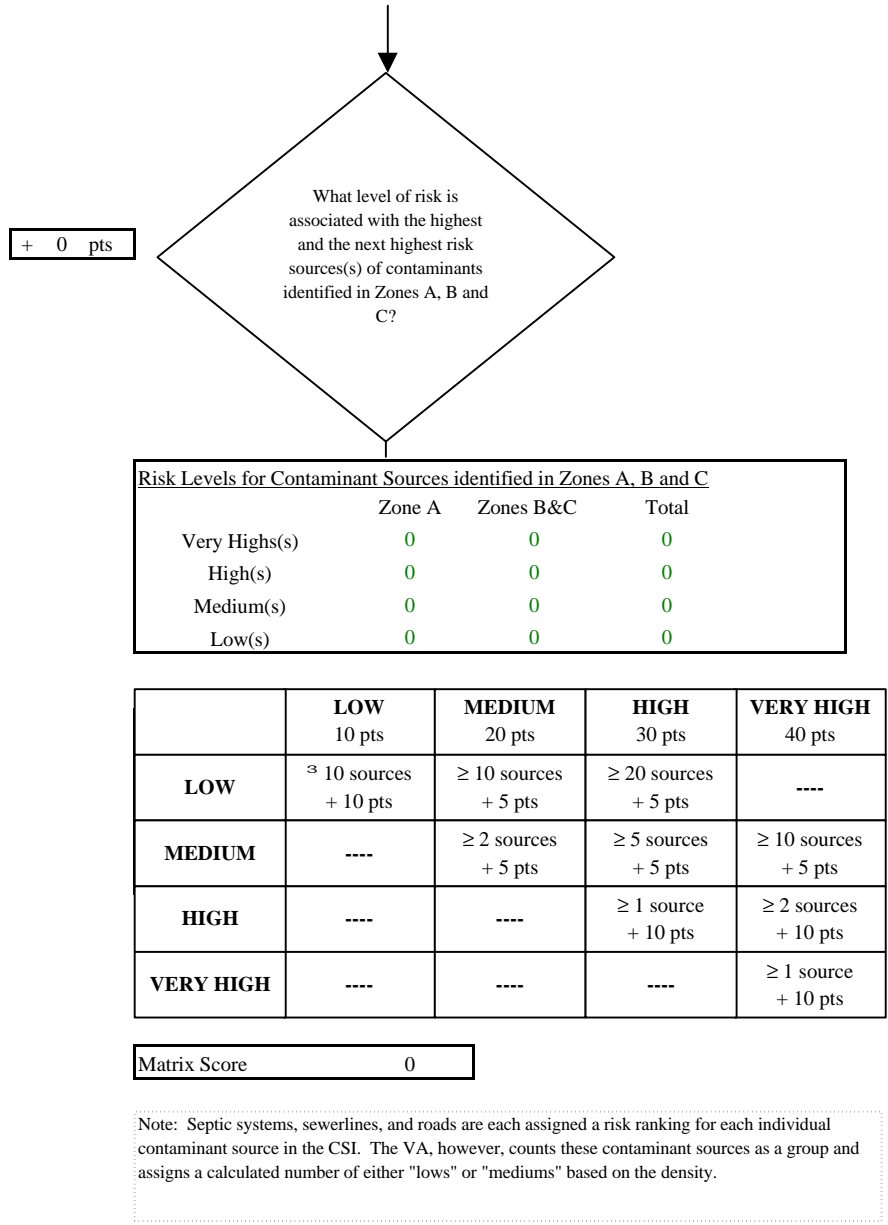


Chart 5. Contaminant risks for Northern Lights Theatre & Gift - Nitrates and Nitrites

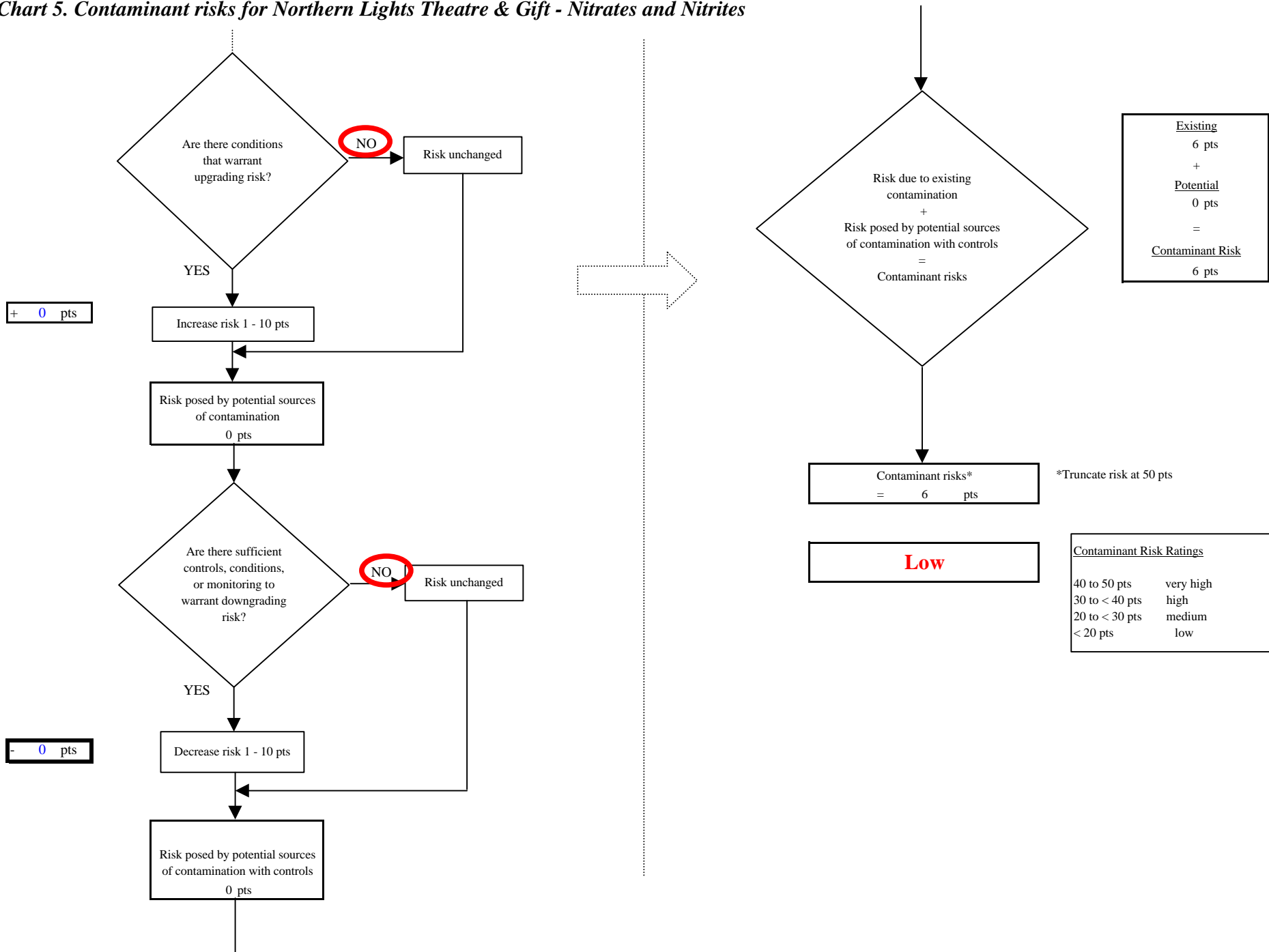


Chart 6. Vulnerability analysis for Northern Lights Theatre & Gift - Nitrates and Nitrites

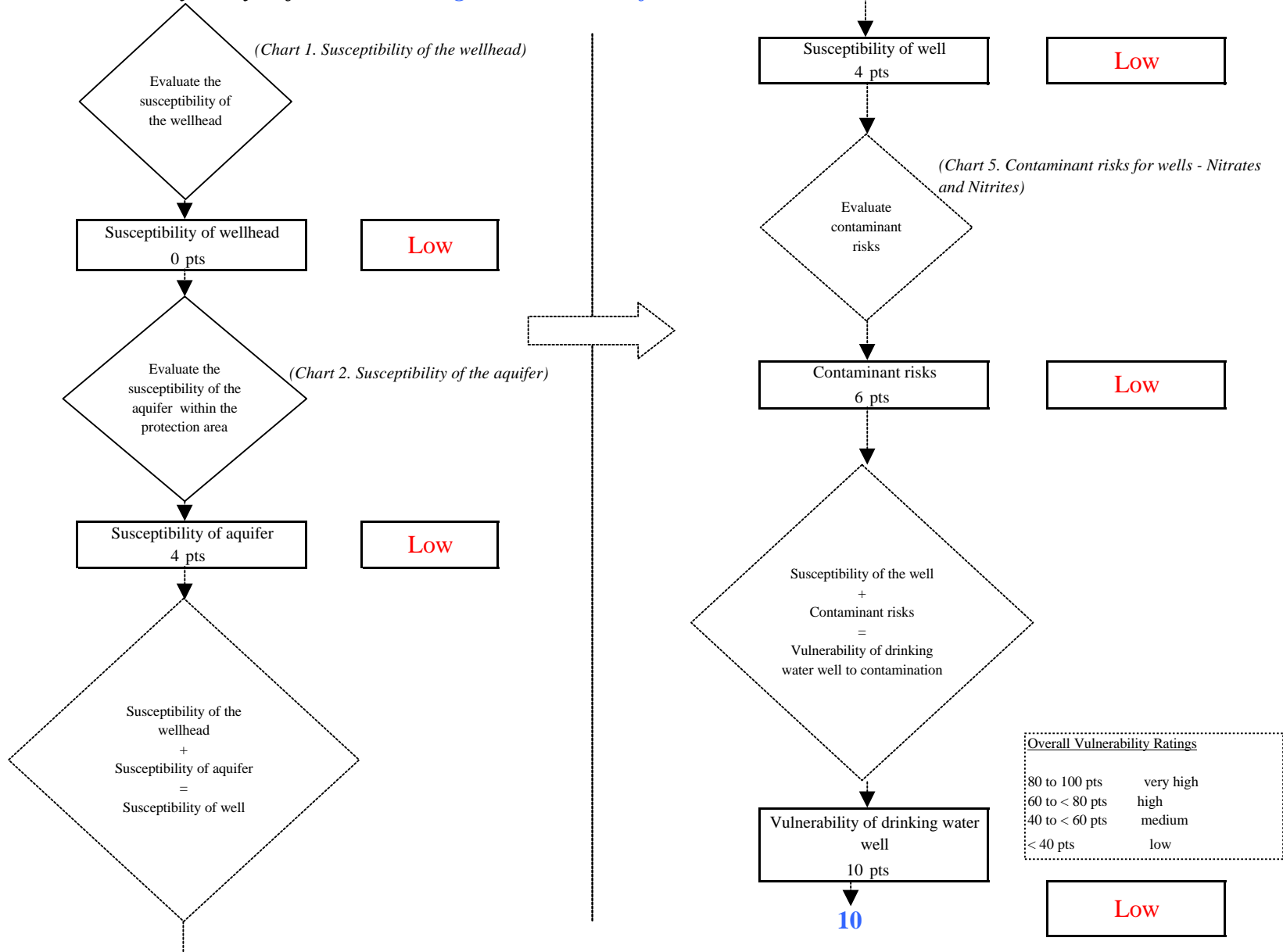


Chart 7. Contaminant risks for Northern Lights Theatre & Gift - Volatile Organic Chemicals

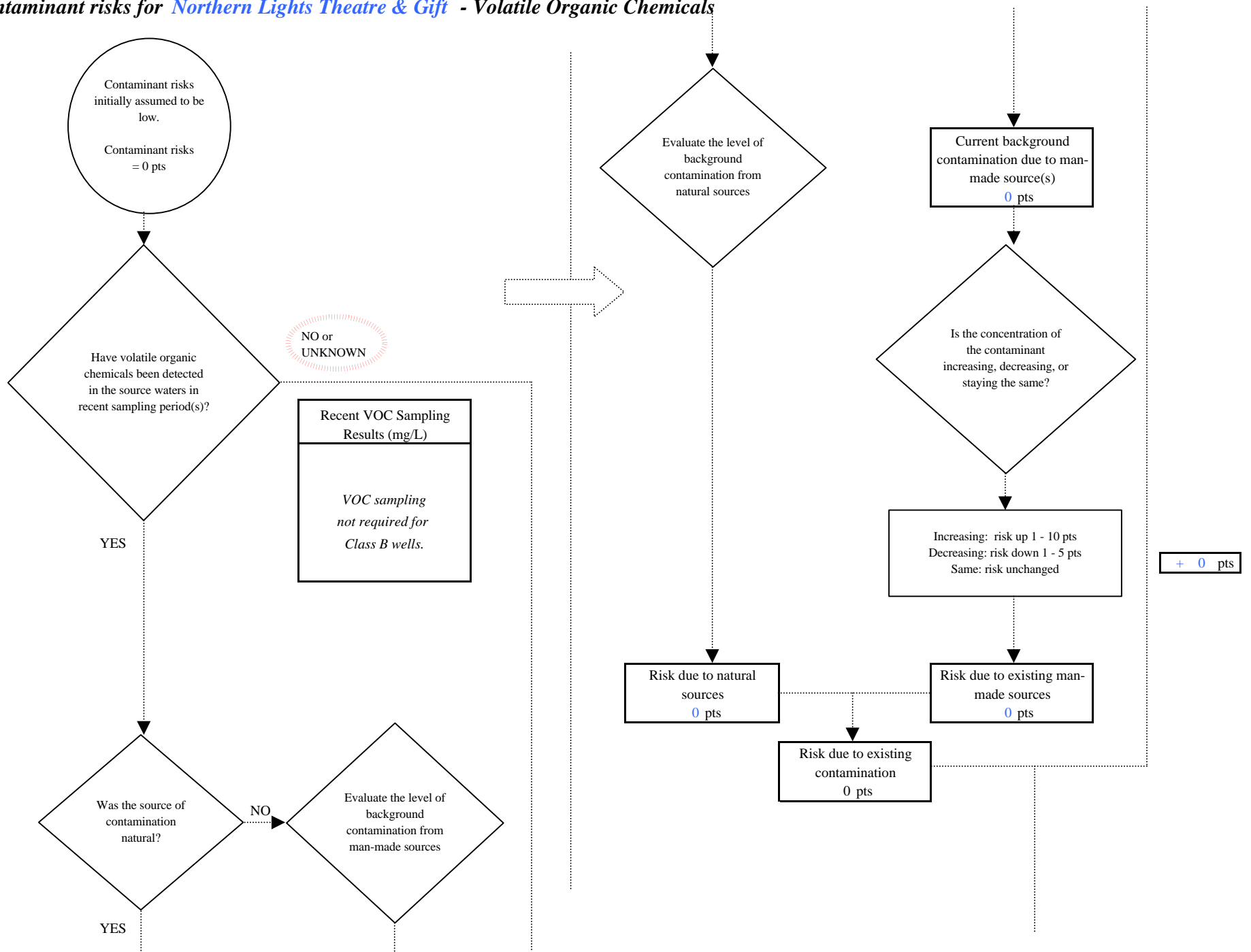


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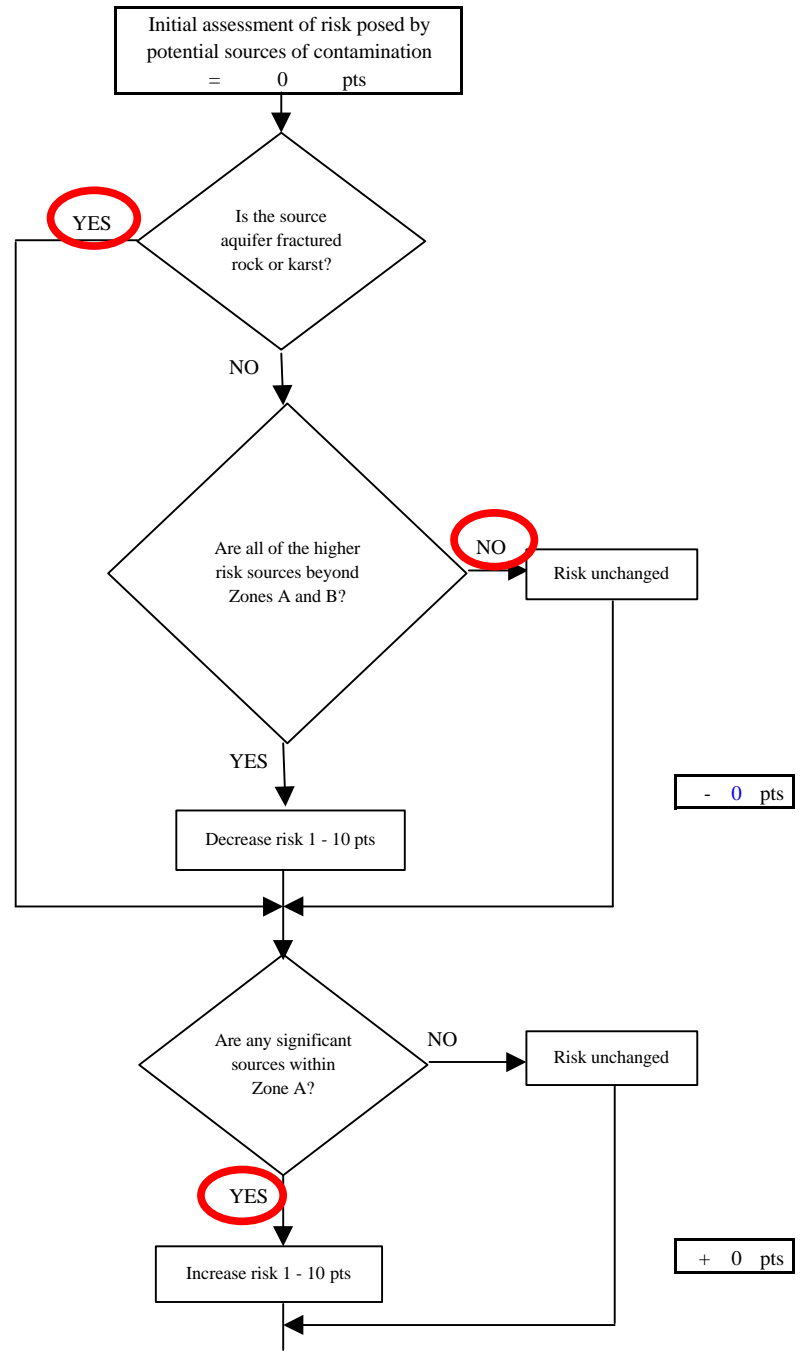
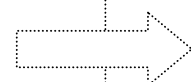
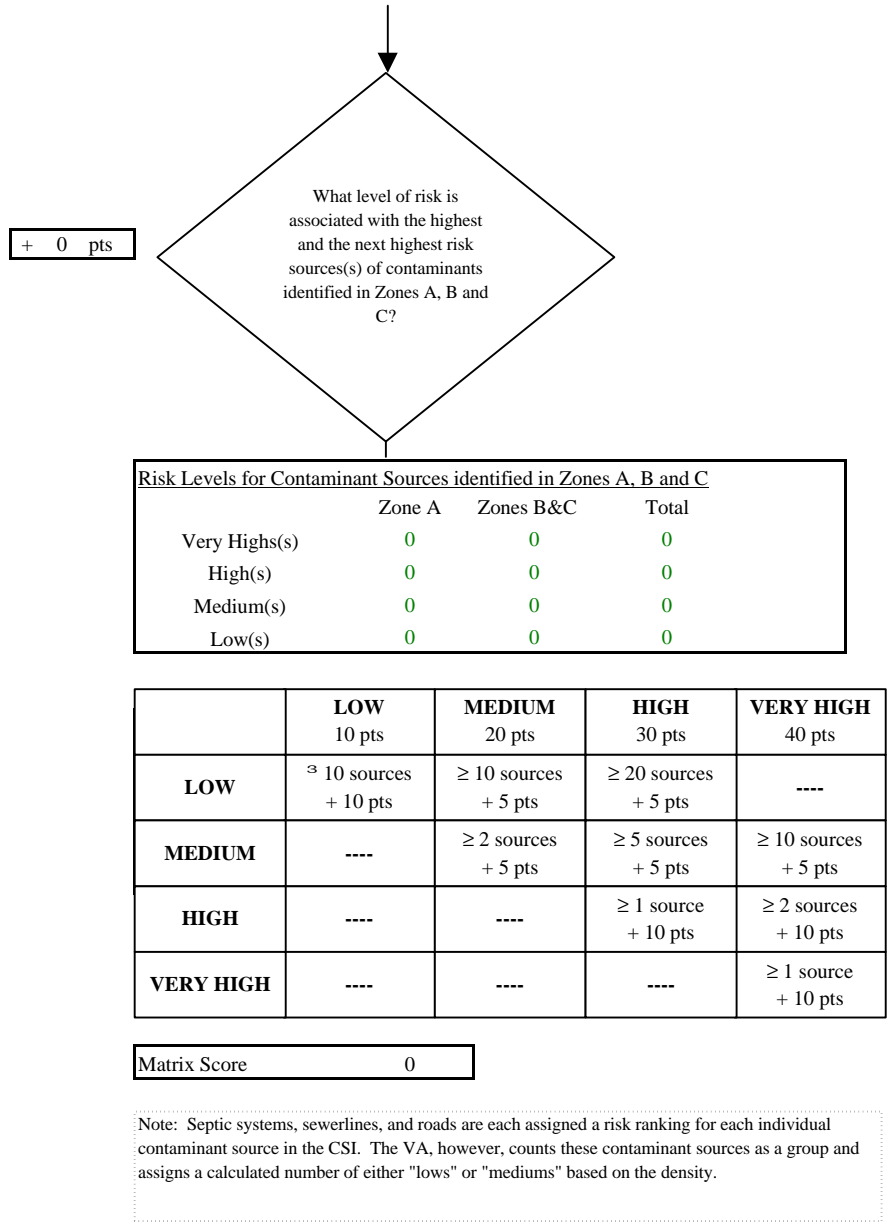


Chart 7. Contaminant risks for Northern Lights Theatre & Gift - Volatile Organic Chemicals

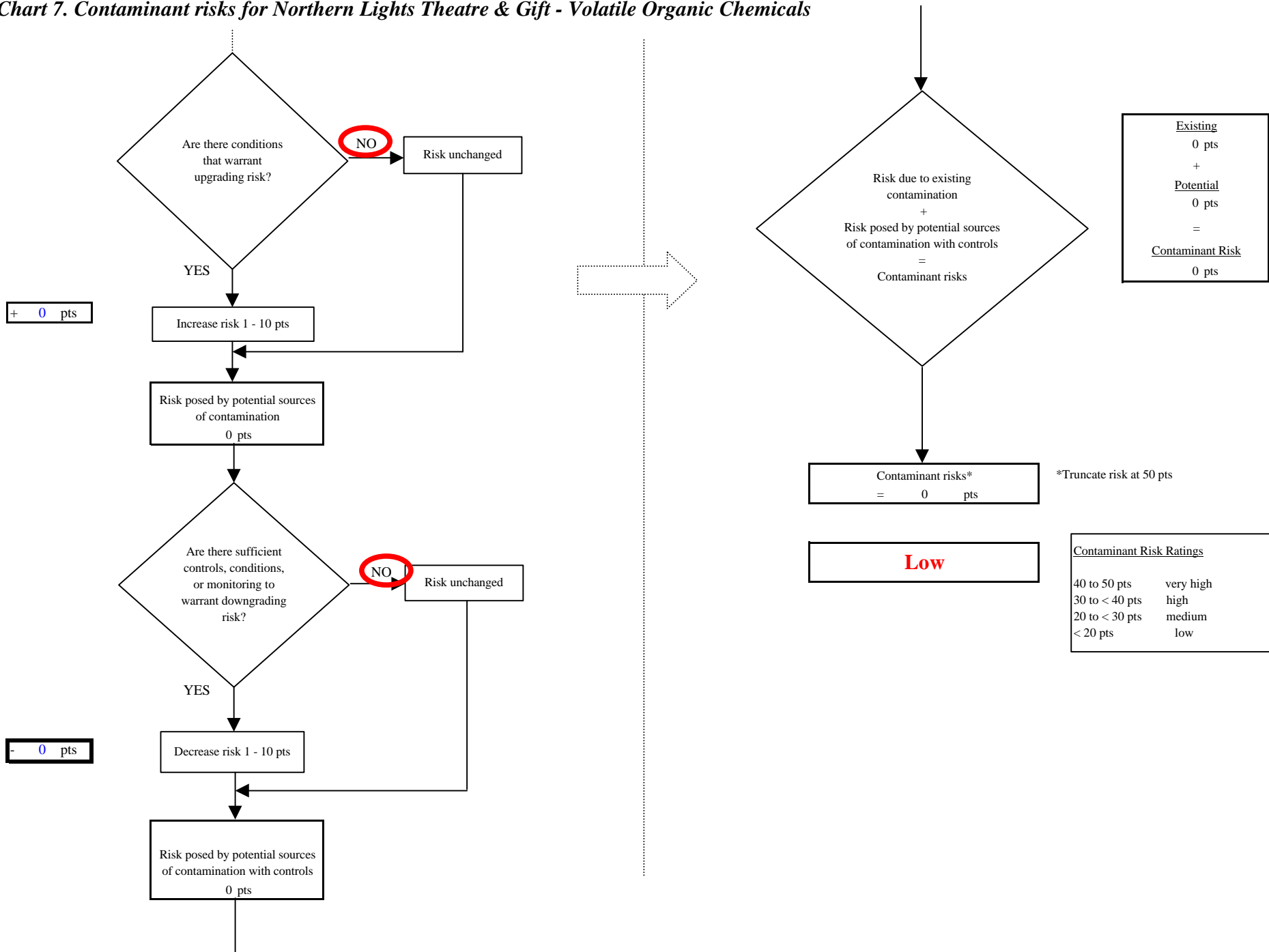


Chart 8. Vulnerability analysis for Northern Lights Theatre & Gift - Volatile Organic Chemicals

