Source Water Assessment:

Hydrogeologic Susceptibility and Vulnerability Assessment for Museum of Alaska Drinking Water Well, Wasilla, Alaska

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DRINKING WATER PROTECTION PROGRAM REPORT *84*

October 2001

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By Shannon & Wilson, Inc.

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: OCTOBER 2001

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By Shannon & Wilson, Inc.

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Museum of Alaska well is a Class B drinking water source consisting of one well. Identified potential and current sources of contaminants for the Museum of Alaska include: highways and roads, a railroad corridor, and approximately 12 acres of residential area. 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 Museum of Alaska public water source received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and/or nitrites, and **Low** for volatile organic chemicals.

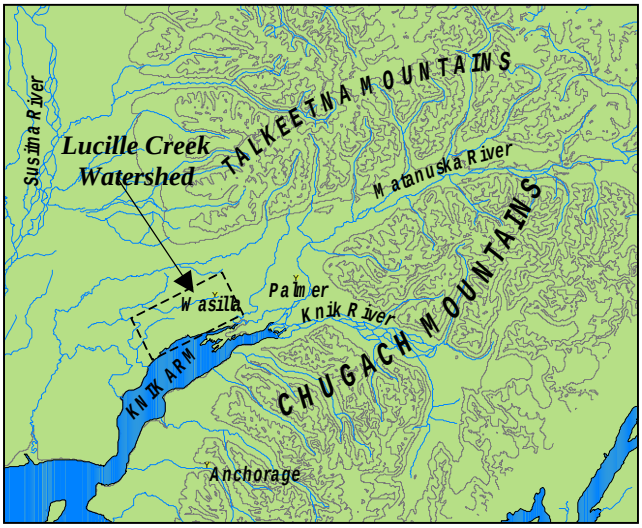

Figure 1. Index Map showing the location of the Matanuska-Susitna Valley and the Lucille Creek Watershed.

INTRODUCTION

The purpose of this environmental assessment is to provide public water system owners/operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. This assessment was completed for the Museum of Alaska source of public drinking water. This source consists of one well in the Lucille Creek Watershed (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined a review of the natural hydrogeologic sensitivity with potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

DESCRIPTION OF THE WASILLA-AREA, ALASKA

Location

Wasilla is located near the center of the Matanuska Susitna (Mat-Su) Borough in south central Alaska. The Mat-Su Borough encompasses approximately 23,00 square miles, including the majority of the drainage of the Susitna and Matanuska Rivers. Wasilla is located south of the Talkeetna Mountains, about 12 miles north of Knik Arm on Cook Inlet. Wasilla is 30 air miles north/northeast of Anchorage, adjacent to the Alaska Railroad main line and the George Parks Highway.

The Wasilla area was shaped by glacial forces during the end of the last ice age. Several glacial advances and retreats left a complex system of hills, ridges, lake, and lowlands that define the topography of today. Landforms in and around Wasilla consist of undulating ridges of glacial till and flat benches of sand and gravel out-wash.

Climate

The climate in Wasilla is transitional between the extremes of Interior Alaska and the wet conditions found along the coastal areas.

Wasilla is less than 15 miles from Knik Arm and about 75 miles from Prince William Sound. Summer temperatures are more moderate than those in the Interior due to the proximity to the coast. The Chugach and Talkeetna Mountains and the Alaska Range also protect Wasilla from the frigid cold of the interior winter and act to break up strong storm fronts.

Wasilla averages about 18 inches of precipitation per year, including about 59 inches of snowfall. Winter thaws can decrease snow cover to a few inches.

Mean monthly high temperatures in Wasilla range from about 22 degrees Fahrenheit in December and January to 69 degrees Fahrenheit in July. The frost-free period in spring and summer averages 115 days, with the first frost usually arriving by September 1st.

The record low for Wasilla was –50 degrees Fahrenheit in January 1947. The highest recorded temperature was 90 degrees Fahrenheit in 1969.

Topography and Drainage

The Wasilla area topography varies from about 300 feet to 500 feet above sea level. The surrounding terrain gradually rises from south to north. The Wasilla area has hundreds of small lakes, several large lakes, and two substantial streams. At 387 acres, ***Wasilla Lake*** is one of the largest lakes in South-central Alaska.

The Cottonwood Creek drainage system, of which Wasilla Lake is part, begins northeast of Wasilla and discharges into Knik Arm about 15 miles to the south.

Cottonwood Creek is a popular salmon fishing stream (outside city limits), and has an average rate of flow of about 16 cubic feet per second near the outfall from Wasilla Lake.

At 362 acres, ***Lake Lucille*** is slightly smaller than Wasilla Lake. However, although within close proximity, they are part of two separate drainages and have significantly different characteristics. Lake Lucille is shallow with an average depth of five and a half feet. Its primary water sources are springs in the lakebed. No significant creek leads into it and Lucille Creek is a low flow stream that drains it into Big Lake. Water circulation and flushing action through the lake are slow.

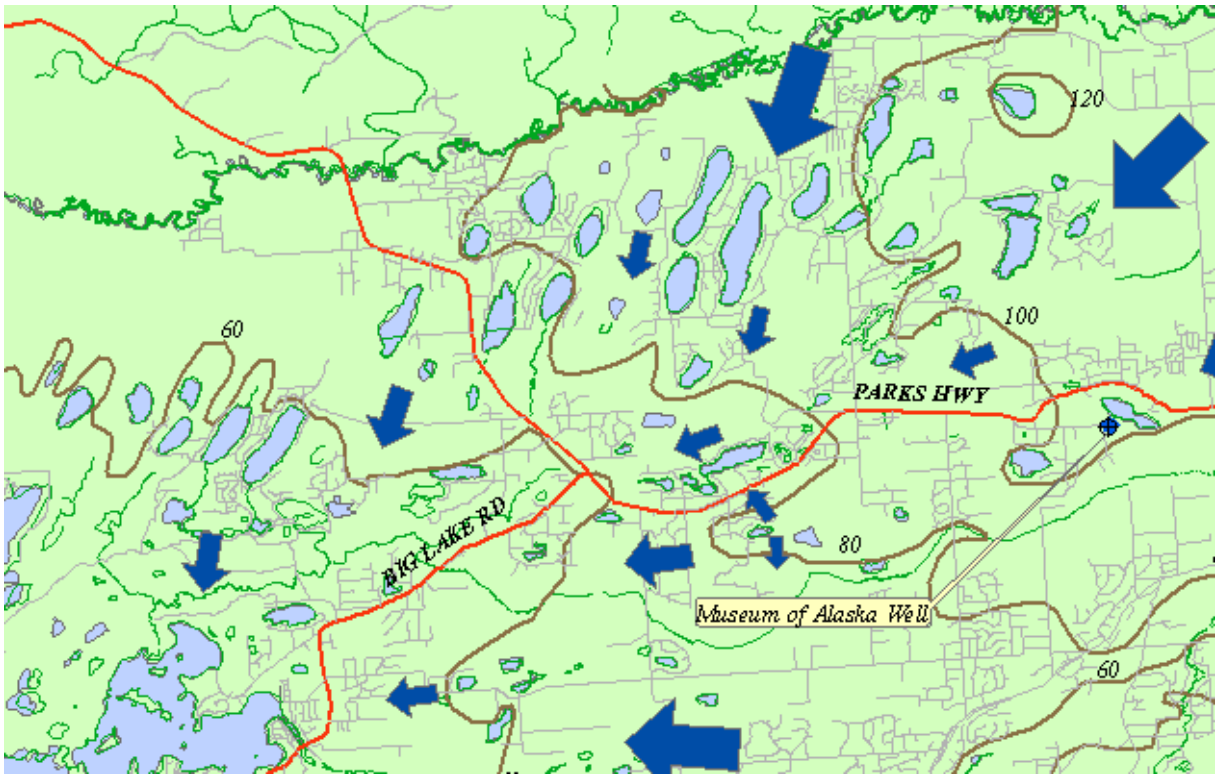

Figure 2. Map showing regional ground-water flow in Matanuska-Susitna Valley. ***(Jokela, Munter and Evans, 1991)***

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Wasilla area has a central water system, and several subdivisions have private water systems. Many homes and businesses in the area, however, rely on individual wells for their water supply. Most of these wells are shallow with depths of less than 100 feet. Static water levels in many of these wells are around 30 feet below the surface. The coarse gravel underlying the Wasilla area provides a large aquifer even in the winter when infiltration is low.

Geology and Soils

The Susitna River valley lowland was covered by a lake during glacial times. The deposition of glacial silts and clays played an important part in the make up of the soils of the area.

Most of the soils in the area provide good sources of sand, gravel, and topsoil. The deposition of silt, clay, and organic muck in old lakes and depressions means that some areas have soil conditions which vary over relatively short distances. Seven soil associations in and around the Wasilla area have been mapped by the U.S. Soil Conservation Service.

The Homestead and Knik soil types predominate the Wasilla area with smaller areas of Coal Creek, Jacobsen, Salamatof, and Slikok soil types.

The ***Homestead*** series is common in the Wasilla area especially north of the Parks Highway from the west end of Lake Lucille. Homestead soils are shallow, well-drained silty soils over loose sand and gravel. They have formed on broad out-wash plains and gravel moraines and run from nearly flat terrain to steep areas.

Homestead series is prevalent along Church Road north of the Parks Highway and throughout the Mission Hills subdivision.

The ***Knik*** series is the other major soil type in the area. It includes most of the downtown area, north and south of Lake Lucille and Wasilla Lake.

Knik soils are shallow, well-drained and silty, overlaying coarse, gravelly material, although scattered areas of poorly drained soils are also included. The soils are extensive over a broad range of slopes from flat to steep escarpments.

The ***Coal Creek*** series consists of dark-colored, poorly drained soils that formed in moderately deep silty material over compacted, fine-textured sediments. These soils occur in nearly level to gently sloping stream valleys, on the border of muskegs, and in small depressions. They are sometimes characterized by hillside seeps. This soil unit is found in small areas north and west of the downtown area.

The ***Jacobsen*** series is a very poorly drained, very stony silt loam found in broad depressions. The type is found west of Lake Lucille, south of the railroad, and even with Church Road.

The ***Salamatof*** and ***Slikok*** series are found within low areas and consist of poorly drained, peat, muck and silty sediments in shallow depressions throughout the eastern side of the city. High water tables, often at or just below the surface, are characteristic of these soils. The banks of Cottonwood Creek south of Wasilla Lake have the greatest concentration of these soils.

Finally, the ***Wasilla*** series consists of somewhat poorly drained soils with layers of sand and compacted finer material. They do not have the high organic content of the Slikok series. These soils are not extensive in the local area and are most commonly found southeast of Lake Lucille along the Knik-Goose Bay Road.

MUSEUM OF ALASKA PUBLIC WATER SOURCE

Museum of Alaska public water source is a Class B water source, which is operated by Harry Yost. The source consists of one well located on the southwest side of Jacobsen Lake at an elevation of approximately 320 feet above sea level. The well is located southeast of the intersection of Neuser Street and Beacon Street. (See Map 1 in Appendix A). The well is inferred to be completed in the underlying unconfined aquifer. According to the well log, the Museum of Alaska's well is screened from 75 to 80 feet below the land surface and had a static water level of 35 feet below land surface at the time of drilling (7/13/93). The well has been capped, and grouted, and is not located in a floodplain. This water system operates year round and serves approximately 25 non-residents through a single connection to the business.

ASSESSMENT AND PROTECTION AREA FOR MUSEUM OF ALASKA DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for the Museum of Alaska is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of the drinking water source to contamination. This zone around the drinking water source is the most critical area for the preservation of the quality of the drinking water for this source. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the area of focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems along the front range of the Chugach Mountains and flows toward Cook Inlet. An analytical calculation was used to determine the size and shape of the area that

contributed water to the well. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (Patrick, Brabets, and Glass 1989), and State of Alaska Department of Water Resources (*Jokela, Munter and Evans, 1991).* This analytical calculation was used as a guide as the first step in establishing the protection area for the Museum of Alaska. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful and conservative protection area with respect to public health (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Areas for Museum of Alaska contain four zones: Zone A, Zone B, Zone C and Zone D (See Map 1 in Appendix B). Zone A corresponds to the area between the well and the distance equal to ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be on the order of several days to several hours.

The Zone B protection area for the Museum of Alaska corresponds to a time-of-travel of less than two years and extends northeast..

The Zone C protection area extends from Zone B northeast and corresponds to a time-of-travel of less than five years. Lastly, the Zone D protection area, which corresponds to a time-of-travel less than ten years, extends from Zone C to the northwest.

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 Museum of Alaska's Drinking Water Protection Area. This survey was completed through a search of agency records and other publicly available information.

Potential sources of contamination to drinking water supplies cover 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 this assessment and all Class B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

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

Inventoried potential sources of contamination within Zone A through Zone D were associated with residential and light industrial type activities (see Table 1 in Appendix C). Below is a summary of the contaminant sources inventoried within the Museum of Alaska protection area:

- A railroad corridor;
- Approximately 12 acres of residential area; and
- Activities associated with 5 highways and roads.

These potential contaminant sources present risks for all three categories of drinking water contaminants for the Museum of Alaska drinking water source.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been identified, 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 MUSEUM OF ALASKA DRINKING WATER SOURCES

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:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

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

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

The well for the Museum of Alaska is completed in an unconfined aquifer setting. Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of Overall Susceptibility (See Appendix D). Table 1 shows the Overall Susceptibility score and rating for the Museum of Alaska.

Table 1. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	15	High
Natural Susceptibility	15	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. The residential area and the railroad corridor contribute the highest risk for potential contamination to the Museum of Alaska source of public drinking water.

A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (Appendix B - Table 1 – Table 4). This portion of the analysis examines any existing or historical contamination that has been detected at the drinking water source through routine sampling. It also reviews contamination that has or may have occurred but has not arrived or been detected at the well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	13	Low
Volatile Organic Chemicals	12	Low

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 Analysis for nitrates and nitrites and volatile organic chemicals, respectively.

Vulnerability of the drinking water source to contamination is the combination of susceptibility of the aquifer and the well with contaminant risks. Table 3 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of Museum of Alaska Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and Nitrites	30	Low
Volatile Organic Chemicals	25	Low

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

The activities associated with the road in Zone A are the principal driving factors in determining the contaminant risks for bacteria and viruses, and nitrates

and nitrites; the rail corridor in Zone A is the driving factor in determining contaminant risks for volatile organic chemicals (see "Overall Rank after Analysis" in Table 2 – 4 of Appendix C).

The contaminant risks for the bacteria and viruses category are low with the activities associated with a road driving the score. Combining this potential bacteria and viruses risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water. Contaminant risks for the nitrate/nitrite category are low with the activities associated with a road driving the score. Combining this potential nitrate/nitrite risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

Overall, contaminant risks for the volatile organic chemicals category are low with the rail corridor and roads driving the score. Combining these potential volatile organic chemicals contamination risks with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

SUMMARY

A *Source Water Assessment* has been completed for the Museum of Alaska source of public drinking water. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, nitrates and/or nitrites, and 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 the Alaska Department of Environmental Conservation 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 public drinking water source.

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APPENDIX A

Museum of Alaska
Drinking Water Protection Area

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Museum of Alaska

APPENDIX C

Museum of Alaska
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

APPENDIX D

Vulnerability Analysis for Museum of Alaska Public Drinking Water Source

Chart 1. Susceptibility of the Wellhead – Museum of Alaska

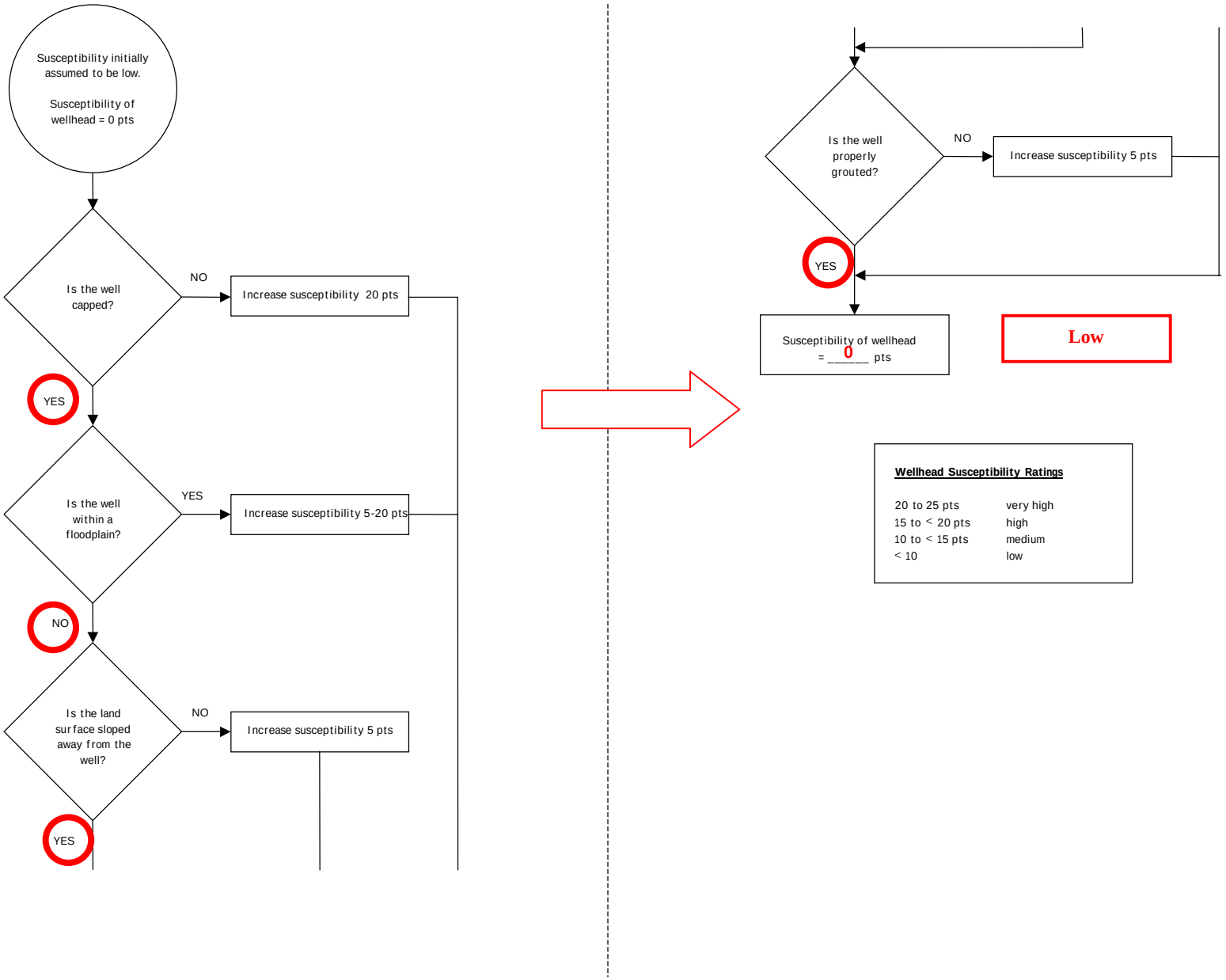
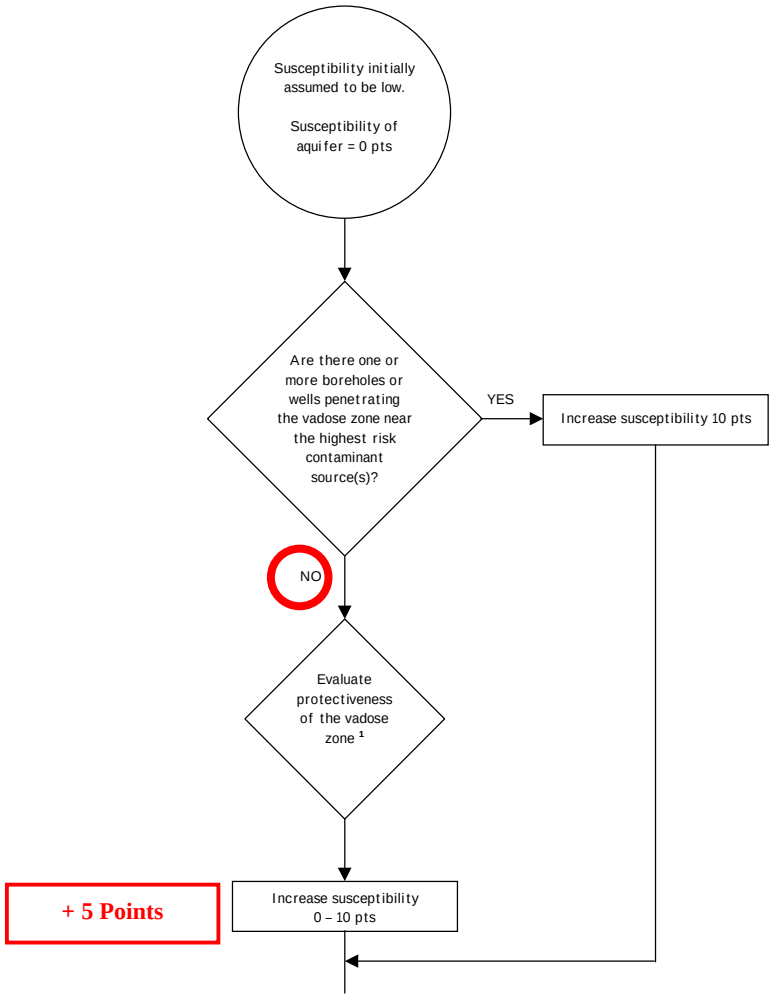
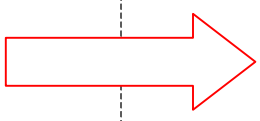
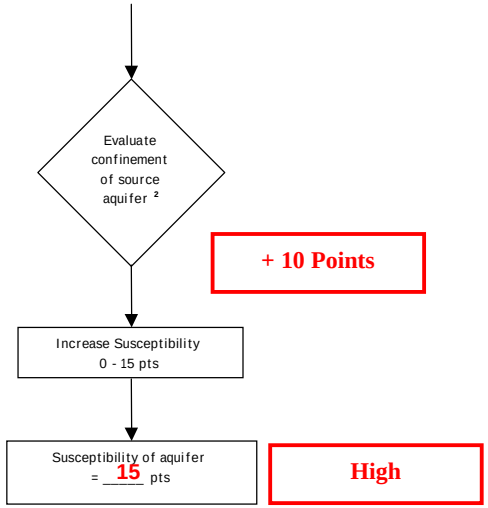


Chart 2. Susceptibility of the aquifer – Museum of Alaska







1. Protectiveness of the Vadose Zone

- net recharge (function of precipitation, slope of land surface, & permeability of soils)
  [0 – 10 pts; 50% weight]
- depth to water table (unconfined aquifer) or top of confining layer (confined aquifer)
  [interpolate linearly: 100' – 20', 0 – 5 pts; 20' – 0', 5 – 10 pts; 50% weight]

Precipitation=20"/Yr.= 4 pts.
Soil = Silt/Loam = 4 pts.
Slope = 0-5% = 10 pts.
18 pts./3 = 6 pts.
6 pts. X 50% = **3 pts.**

Depth to water table = 34 feet
Interpolate linearly = 4 pts.
4 pts. X 50% = **2 pts.**

Total = 5 of 10 Points

2. Degree of Confinement

- confined verses unconfined aquifer
  [confined: K ≤ 10^{-6} cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' – 20', 0 – 10 pts; unconfined = 10 - 15 pts; 65% weight]
- density of boreholes and wells penetrating the confining layer (confined aquifer) or the water table (unconfined aquifer)
  [confined: 0 – 15 pts; unconfined = 10-15 pts; 35% weight]

Unconfined Aquifer

Well depth 101 feet = 10 pts.
Few wells/boreholes in proximity = 10 pts.

10(65%) + 10(35%) =**10 pts.**

Total = 10 of 15 Points

Aquifer Susceptibility Ratings

20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10	low

High

Chart 3. Contaminant risks for Museum of Alaska – Bacteria & Viruses

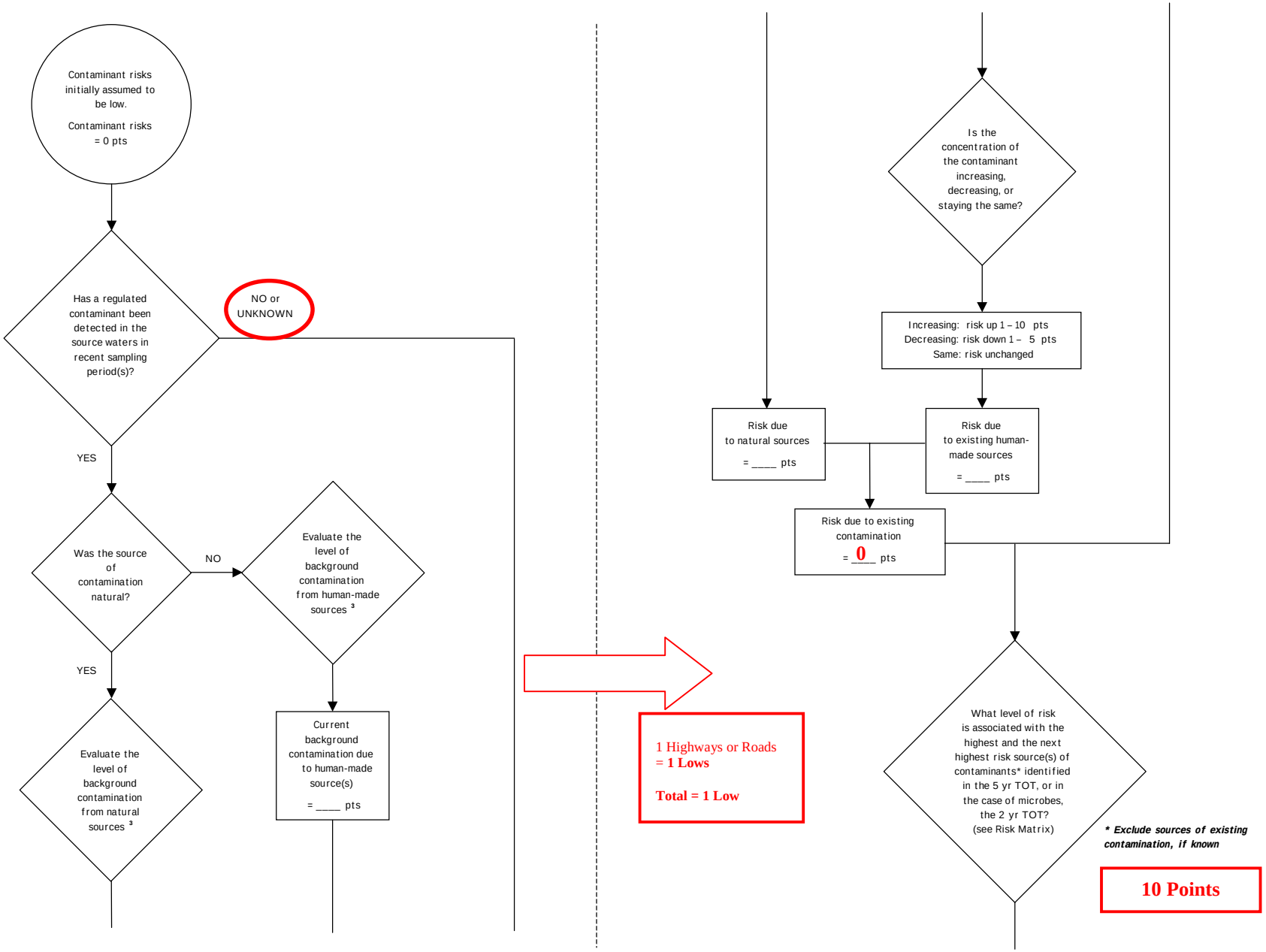


Chart 3. Contaminant risks for Museum of Alaska – Bacteria & Viruses (Continued)

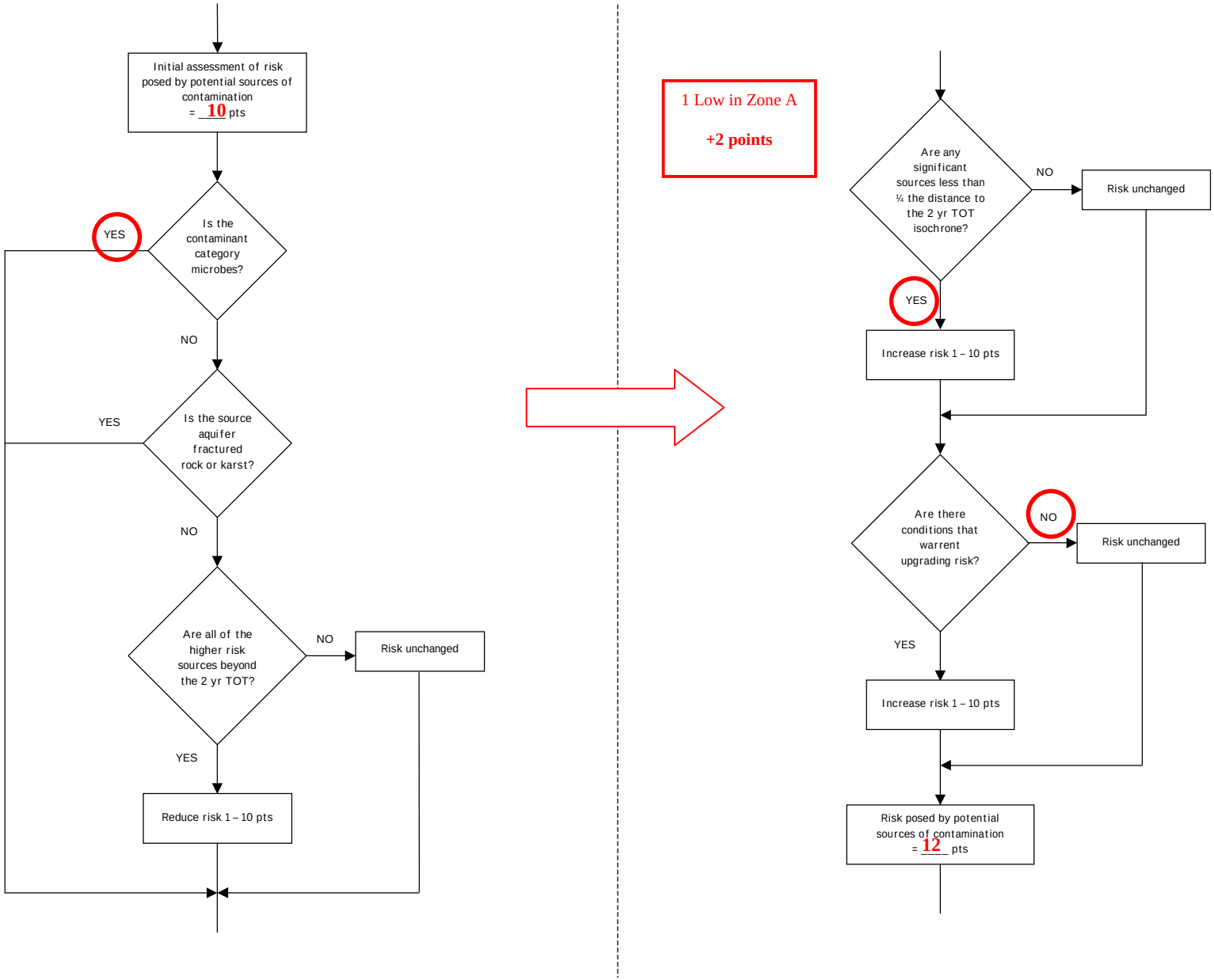
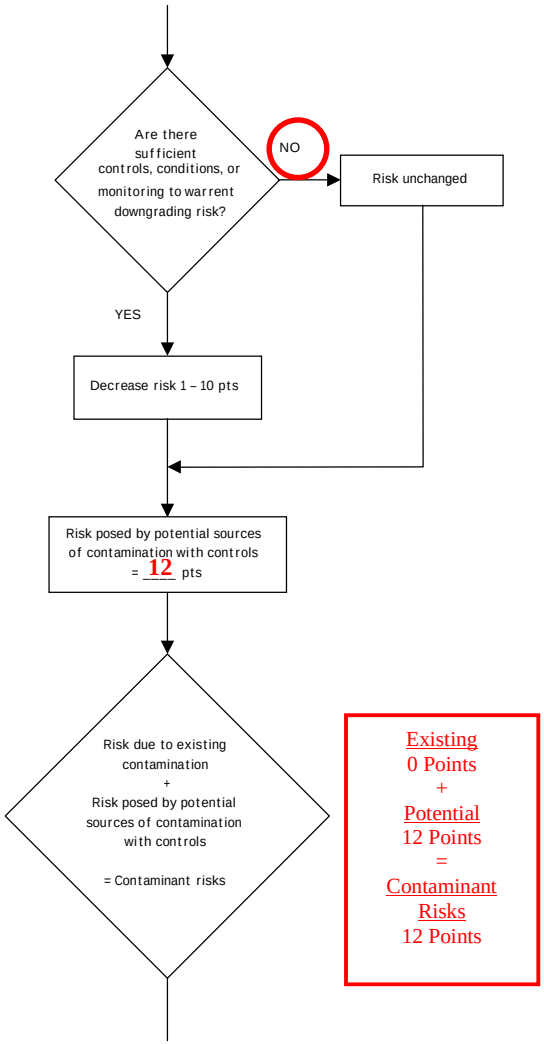


Chart 3. Contaminant risks for Museum of Alaska – Bacteria & Viruses (Continued)



Existing
0 Points
+
Potential
12 Points
=
Contaminant Risks
12 Points

**** Truncate risk at 50 pts***

Contaminant risks*
= 12 pts

Low

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20	low

Table 1. Risk Matrix for Contaminant Sources for Museum of Alaska – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Source(s)	**Total = 1 Low**	**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

Chart 4. Vulnerability analysis for Museum of Alaska – Bacteria & Viruses

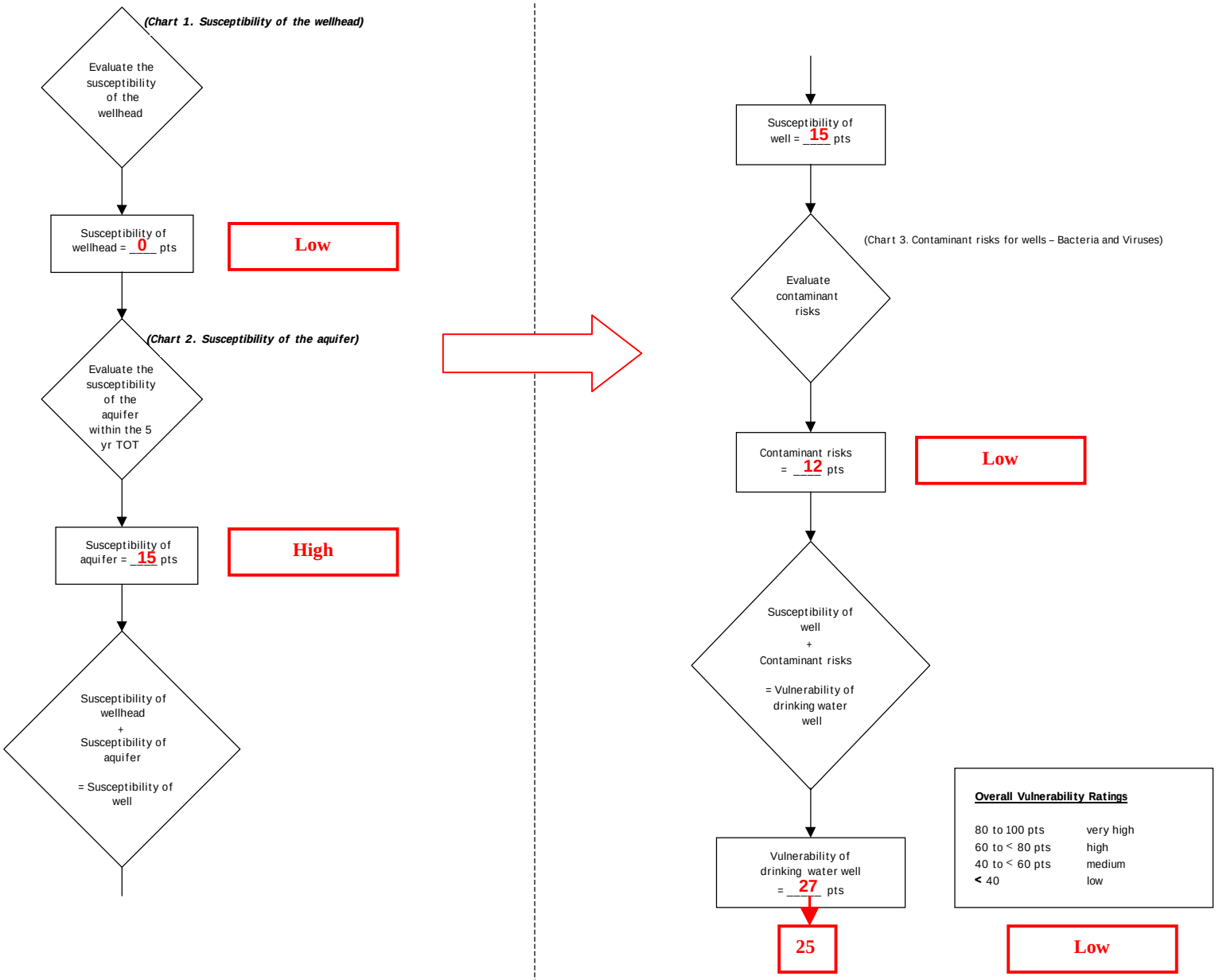


Chart 5. Contaminant risks for Museum of Alaska - Nitrates and Nitrites

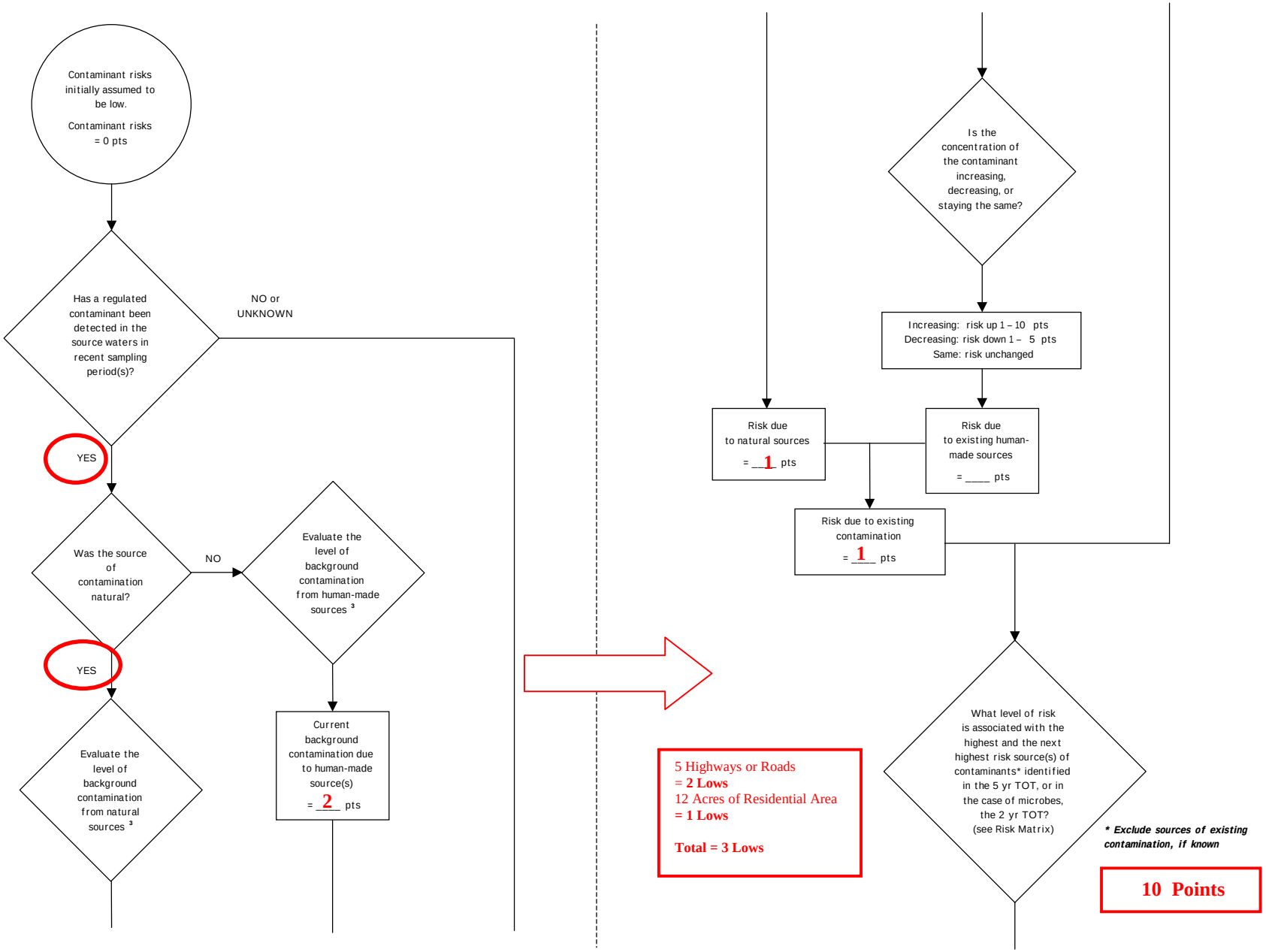


Chart 5. Contaminant risks for Museum of Alaska – Nitrates and Nitrites (Continued)

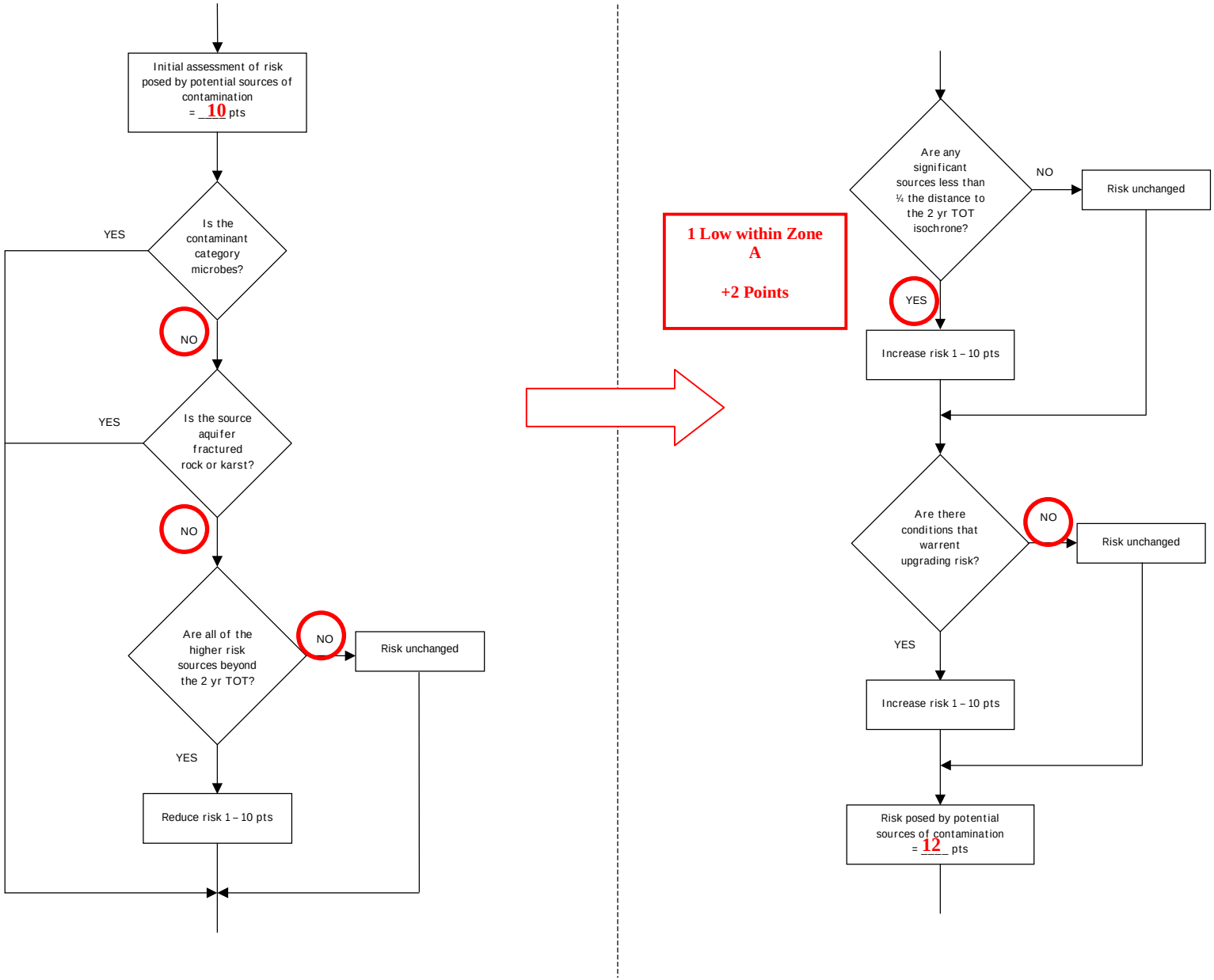
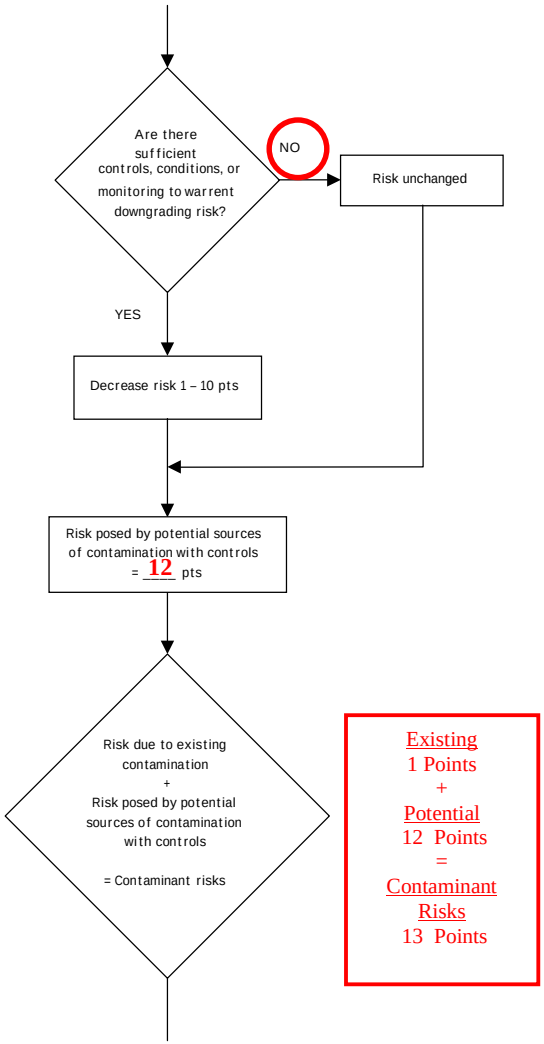


Chart 5. Contaminant risks for Museum of Alaska – Nitrates and Nitrites (Continued)



Existing
1 Points
+
Potential
12 Points
=
Contaminant Risks
13 Points

* Truncate risk at 50 pts

Contaminant risks*
= 13 pts

Low

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20	low

Sample Date	Concentration
12/11/00	Not Detected (ND)
12/14/99	0.11 mg/L
12/09/98	ND
12/29/97	ND
12/11/96	ND

Maximum Contaminant Level (MCL)= 10mg/L
(0.11 mg/L)/(10 mg/L) = 0.011 of MCL

Interpolated Linearly = **1 Point**

Table 2. Risk Matrix for Contaminant Sources for Museum of Alaska Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Total = 3 Lows	**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

Chart 6. Vulnerability analysis for Museum of Alaska – Nitrates and Nitrites

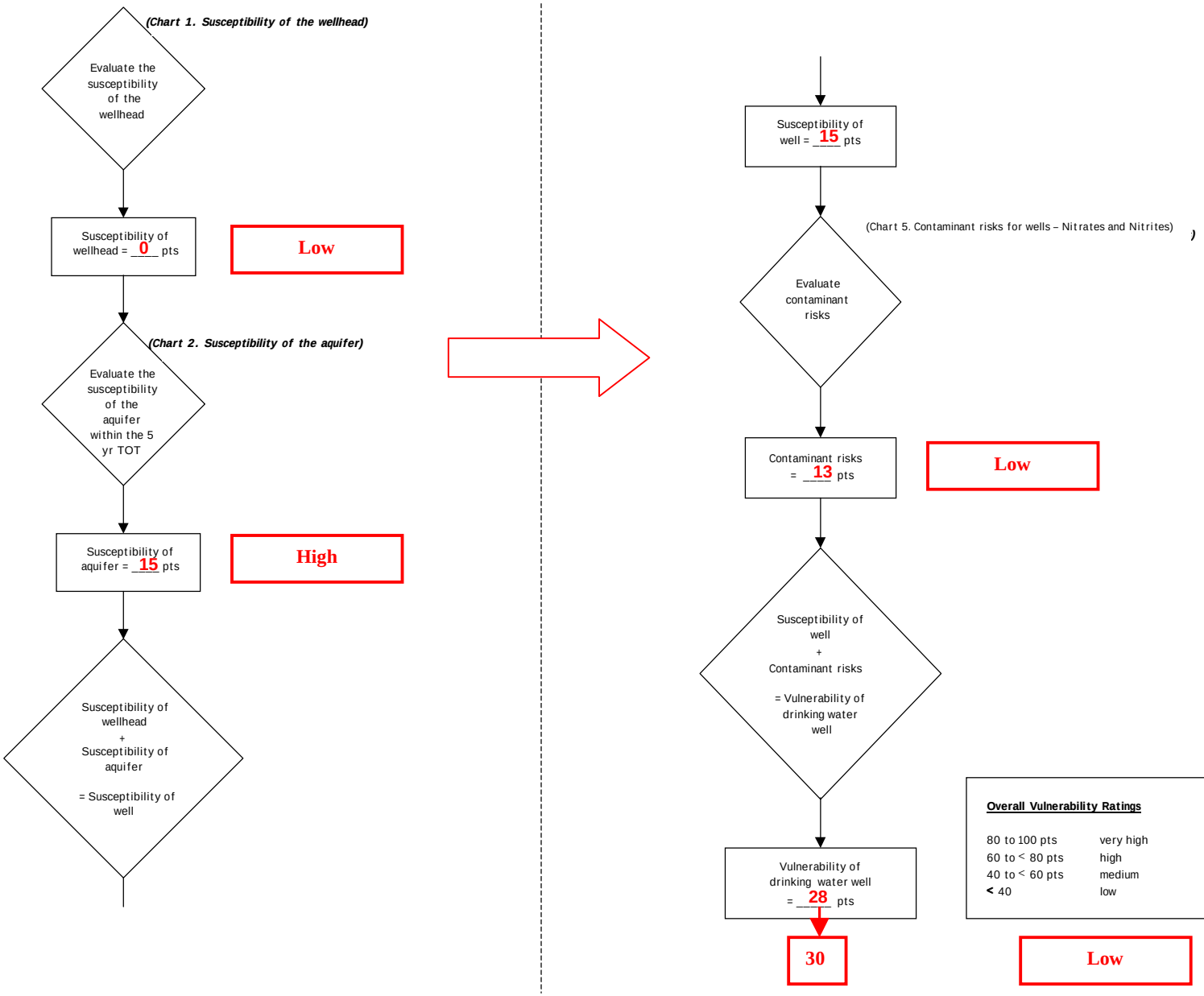


Chart 7. Contaminant risks for Museum of Alaska – Volatile Organic Chemicals

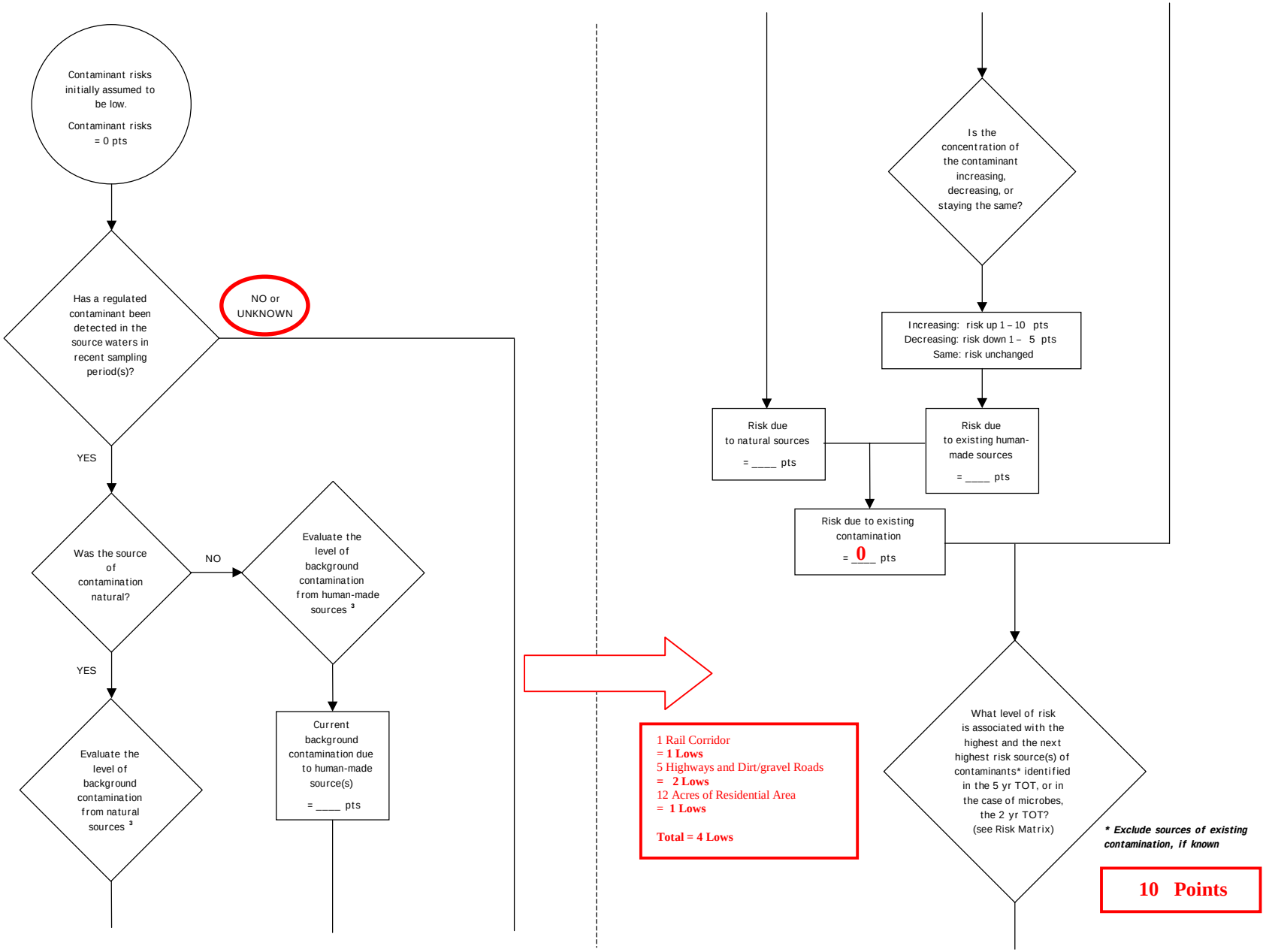


Chart 7. Contaminant risks for Museum of Alaska– Volatile Organic Chemicals (Continued)

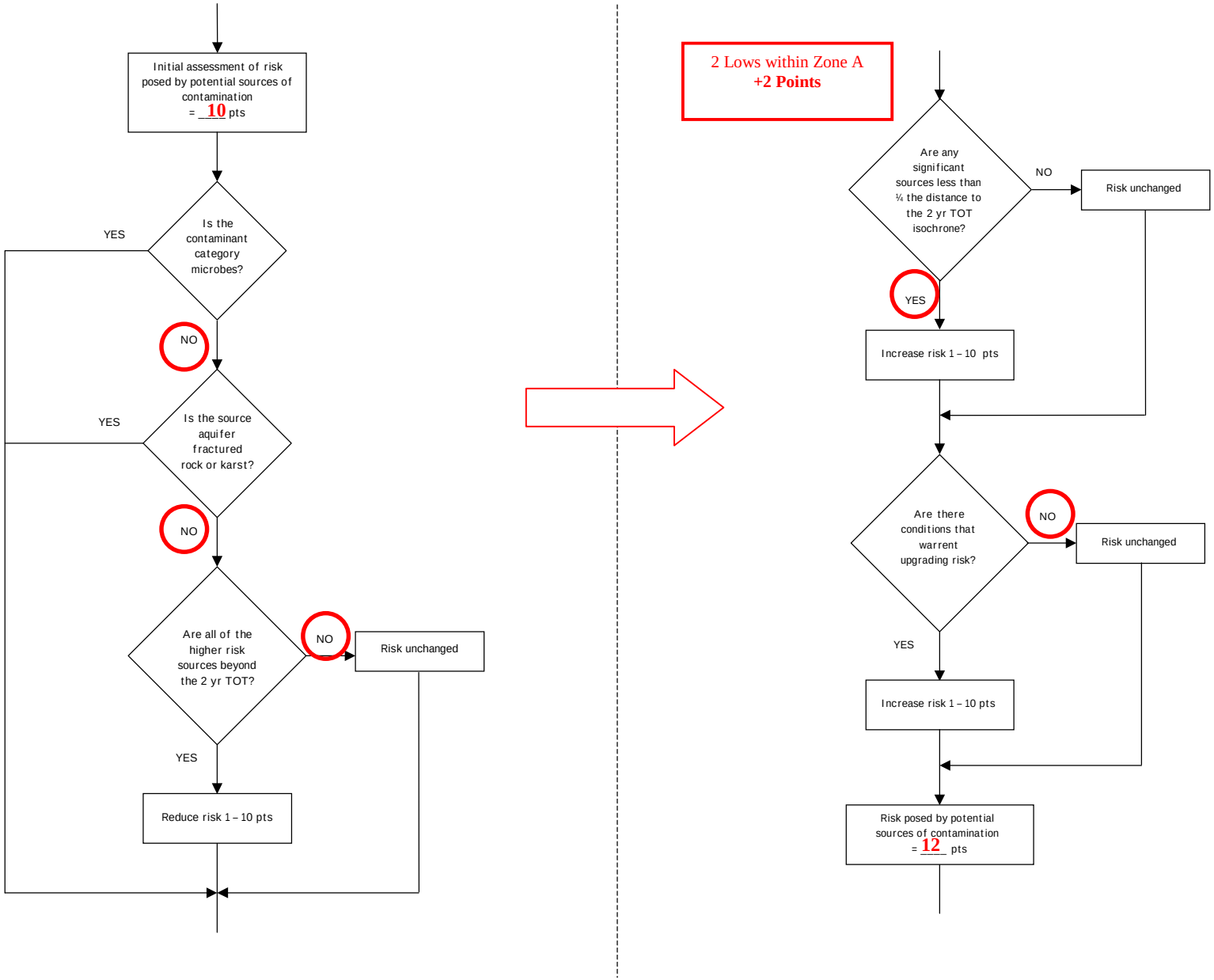
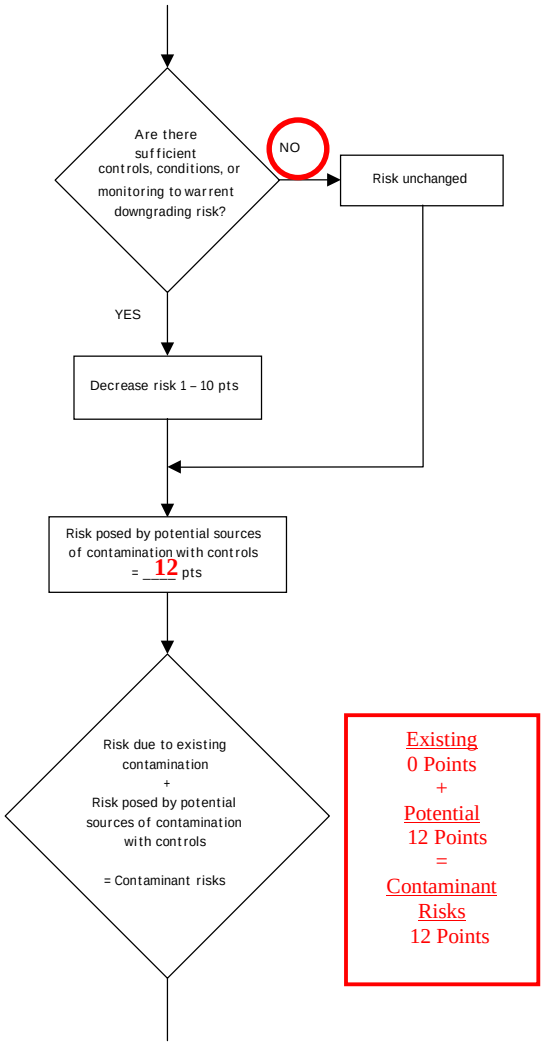


Chart 7. Contaminant risks for Museum of Alaska – Volatile Organic Chemicals (Continued)



Existing
0 Points
+
Potential
12 Points
=
Contaminant Risks
12 Points

Contaminant risks*
= 12 pts

** Truncate risk at 50 pts*

Low

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

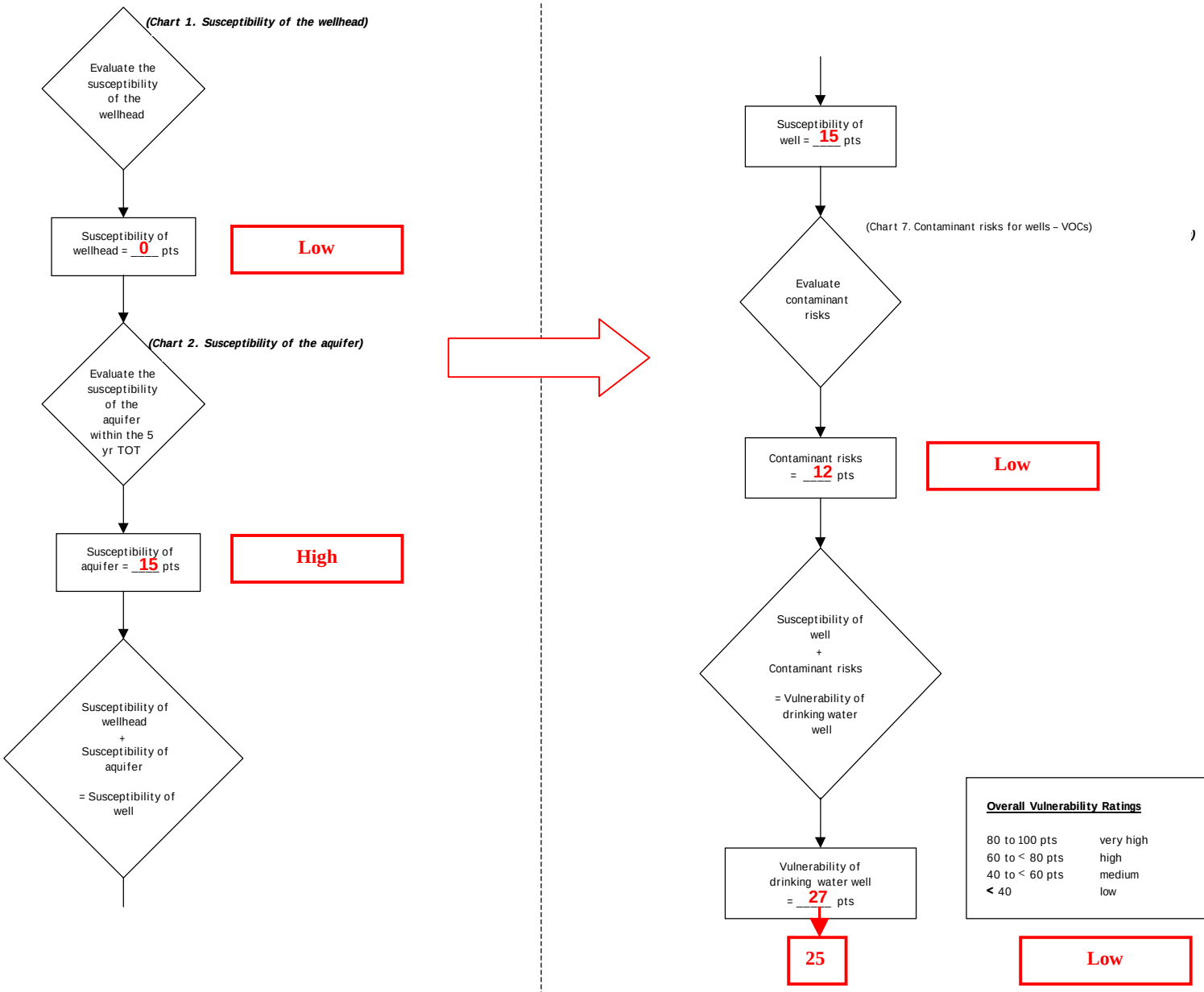
40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20	low

Table 3. Risk Matrix for Contaminant Sources for Museum of Alaska – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Total = 4 Lows	**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

Chart 8. Vulnerability analysis for Museum of Alaska – Volatile Organic Chemicals



Drinking Water Protection Areas for Museum of Alaska

990 0 990 Feet

- Museum of Alaska Well
- MSB roads
- Railroad
- Buildings
- Lakes
- MSB parcel core

Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less Than 2-Years Travel Time

Zone C Protection Area
Less Than 5-Years Travel Time

Zone D Protection Area
Less Than 10-Years Travel Time

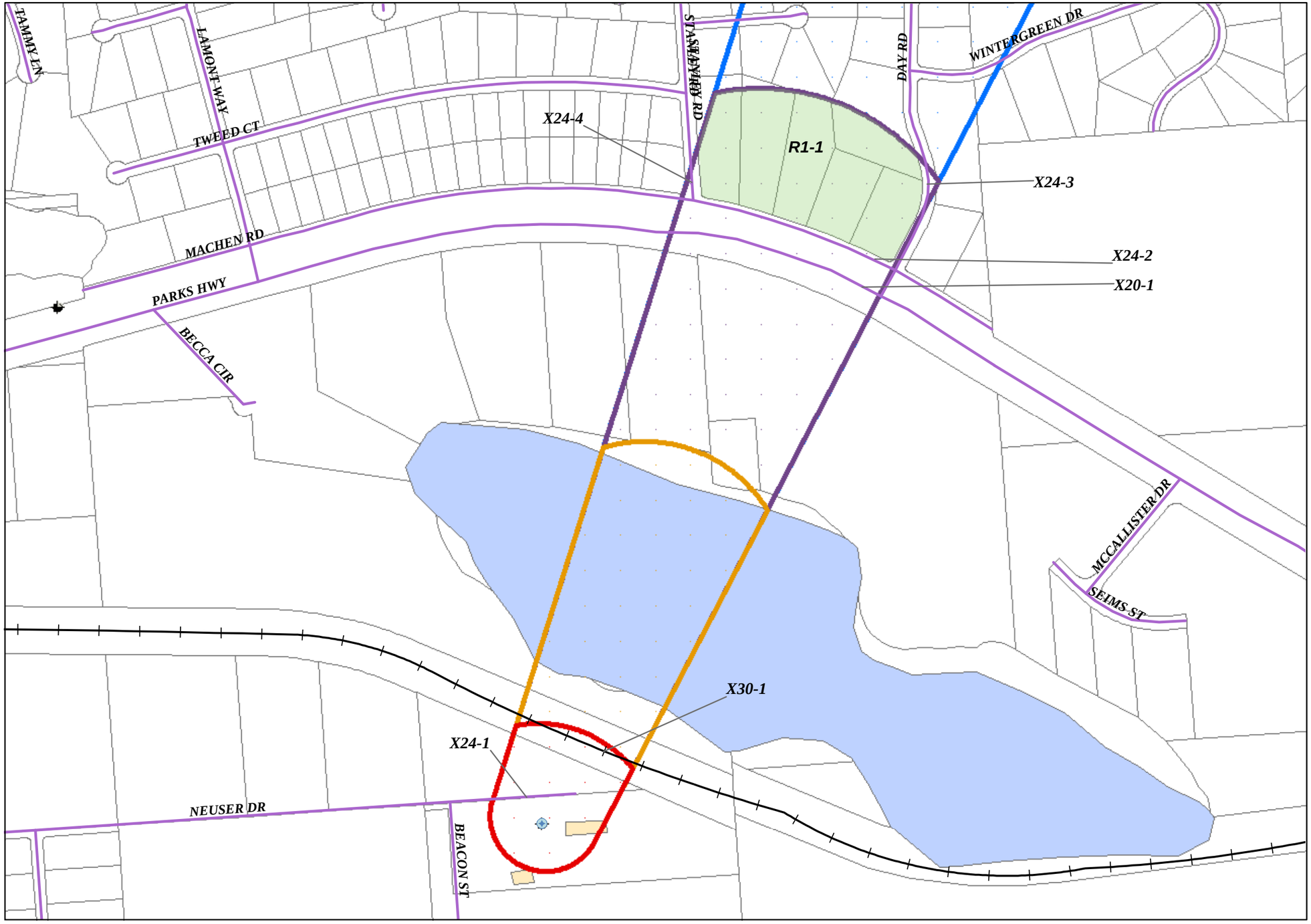
Location of Map

N W E S

PWSID 225241.001

Map 1

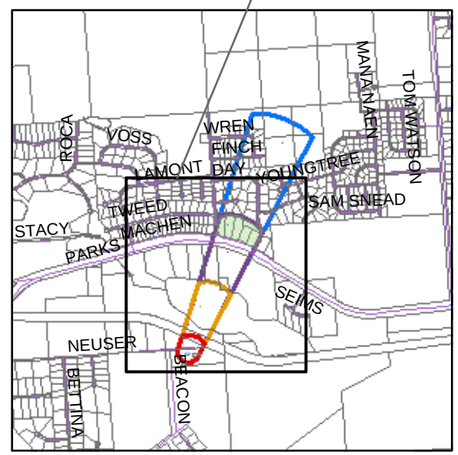
Drinking Water Protection Areas for Museum of Alaska and Potential and Existing Sources of Contamination



490 0 490 Feet

Museum of Alaska Well
MSB roads
Railroad
Residential Area
Lakes
MSB parcel core
Buildings
Zone A Protection Area
Several Months Travel Time
Zone B Protection Area
Less Than 2-Years Travel Time
Zone C Protection Area
Less Than 5-Years Travel Time
Zone D Protection Area
Less Than 10-Years Travel Time

Location of Map



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PWSID 225241.001

Map 2

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-1*	*A*	*Neuser Drive*	*2*	
Rail corridors	*X30*	*X30-1*	*A*	*North of Neuser Dr*	*2*	
Residential Areas	*R1*	*R1-1*	*C*	*North of Parks Hwy.*	*2*	*12 Acres*
Highways and roads, paved (cement or asphalt)	*X20*	*X20-1*	*C*	*Parks Hwy.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-2*	*C*	*Machen Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-3*	*C*	*Day Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-4*	*C*	*Stanley Rd*	*2*	

Potential and Existing Sources of Contamination for
Museum of Alaska
Bacteria and Viruses

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank After Analysis*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-1*	*A*	*Very Low*	*2*	*Neuser Drive*	*2*	
Residential Areas	*R1*	*R1-1*	*C*	*Low*	*1*	*North of Parks Hwy.*	*2*	*12 Acres*
Highways and roads, paved (cement or asphalt)	*X20*	*X20-1*	*C*	*Very Low*	*3*	*Parks Hwy.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-2*	*C*	*Very Low*	*4*	*Machen Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-3*	*C*	*Very Low*	*5*	*Day Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-4*	*C*	*Very Low*		*Stanley Rd*	*2*	

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank After Analysis*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-1*	*A*	*Very Low*	*2*	*Neuser Drive*	*2*	
Residential Areas	*R1*	*R1-1*	*C*	*Low*	*1*	*North of Parks Hwy.*	*2*	*12 Acres*
Highways and roads, paved (cement or asphalt)	*X20*	*X20-1*	*C*	*Very Low*	*3*	*Parks Hwy.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-2*	*C*	*Very Low*	*4*	*Machen Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-3*	*C*	*Very Low*	*5*	*Day Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-4*	*C*	*Very Low*		*Stanley Rd*	*2*	

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank After Analysis*	*Location*	*Map*	*Comments*
Rail corridors	*X30*	*X30-1*	*A*	*Low*	*1*	*North of Neuser Dr*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-1*	*A*	*Very Low*	*3*	*Neuser Drive*	*2*	
Residential Areas	*R1*	*R1-1*	*C*	*Low*	*2*	*North of Parks Hwy.*	*2*	*12 Acres*
Highways and roads, paved (cement or asphalt)	*X20*	*X20-1*	*C*	*Very Low*	*4*	*Parks Hwy.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-2*	*C*	*Very Low*	*5*	*Machen Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-3*	*C*	*Very Low*		*Day Rd*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-4*	*C*	*Very Low*		*Stanley Rd*	*2*	