Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Moon Lake State Recreation Site, Tok, Alaska PWSID #381058

DRINKING WATER PROTECTION PROGRAM REPORT NO. 914

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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Source Water Assessment for Moon Lake State Recreation Site, Tok, Alaska

Drinking Water Protection Program
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EXECUTIVE SUMMARY

The public water system for Moon Lake State Recreation Site (Moon Lake) is a Class B (transient/non-community) water system consisting of one well. The Moon Lake is located at Mile 1332 of the Alaska Highway, near Tok, Alaska. The wellhead received a susceptibility rating of **High** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **High** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Moon Lake State Recreation Site public drinking water source include pit toilets; paved highways and roads; and campgrounds and RV parks. 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 sources for Moon Lake State Recreation Site received a vulnerability rating of **Medium** for bacteria and viruses, nitrates and nitrites, and volatile organic chemicals.

MOON LAKE PUBLIC DRINKING WATER SYSTEM

Moon Lake public water system is a Class B (transient/non-community) water system. The system consists of one well at Mile 1332 of the Alaska Highway, near Tok, Alaska (See Map 1 of Appendix A). Tok is located at the junction of the Alaska Highway and the Tok cutoff to the Glenn Highway, 200 miles southeast of Fairbanks. Tok is called the "Gateway to Alaska" as it is the first major community upon entering Alaska, 93 miles from the Canadian border. The population of Tok is approximately 1,400.

Tok averages about 15 inches of precipitation per year, including 33 inches of snow. Although the quality of the groundwater can vary significantly in a short distance, groundwater supplies are generally abundant in the area. Static water levels in these wells are generally 50 to 80 feet below the surface. The coarse, alluvial, sandy gravel aquifer generally provides sufficient water, even in the winter when infiltration is low.

The Tok area topography varies from about 1,275 feet along the Tanana River to over 5,000 feet in the Alaska Range. Drainages along the Alaska Highway in this area generally flow northwest toward the Tanana River.

According to a Sanitary Survey dated August 26, 1999, the existing well was installed in 1985 with 6-inch diameter casing to a depth of 35 feet below the ground surface. It is assumed that the length of the well screen is 10 feet. The Survey indicates that the land surface is sloped away from the well, providing adequate surface water drainage. Because the well was installed prior to 1992, it is assumed that it is not grouted according to ADEC standards. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

This system operates seasonally and serves approximately 25 non-residents through one service connection.

MOON LAKE 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 (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

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 estimated from information contained in the well logs and/or the Sanitary Survey. 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 Public Water Systems for additional information).

The DWPAs established for wells by the ADEC are usually 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 TOT 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 protection area zones for wells and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. 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

The DWPA for Moon Lake extends over 2 miles south of the well, and includes only Zone A. Because the upland groundwater system may include fractured bedrock, the TOT may be more rapid than predicted. For this reason, the zones related to TOT have been expanded at the upland base. Development in the vicinity of the well is limited to only Zone A (See Map 1 of Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Moon Lake 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 public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile 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 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 MOON LAKE DRINKING WATER SYSTEM

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 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

We assume the well for the Moon Lake is completed in an unconfined aquifer. Because unconfined aquifers are recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer. Table 2 shows the Susceptibility scores and ratings for the Moon Lake.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	15	High
Susceptibility of the Aquifer	18	High
Natural Susceptibility	33	High

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	25	Medium
Nitrates and/or Nitrites	25	Medium
Volatile 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 three categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	55	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	45	Medium

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Medium** with pit toilets, paved highways and roads, and campgrounds and RV parks representing the risk to the drinking water well (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. Recent sampling events indicated no recent positive results were detected for bacteria and viruses. However, after combining the contaminant risks with the overall natural susceptibility of the well, the vulnerability of the well to contamination by bacteria and viruses is **Medium**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Medium** with pit toilets, paved highways and roads, and campgrounds and RV parks representing the risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Sampling history for The Moon Lake indicates that nitrates have been detected in the water, but only in very low concentrations (at 1.010 mg/L on 5/15/01) or 10% of the Maximum Contaminant Level (MCL). 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.

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 **Medium**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Low** with pit toilets, paved highways and roads, and campgrounds and RV parks creating the only known risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

There are no recent sample data available for the drinking water at Moon Lake for volatile organic chemicals. However, after combining the 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 **Medium**.

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King, P.B., compiler, 1969, Tectonic map of North America: US Geological Survey Map (Scale 1:5,000,000) 2 sheets.

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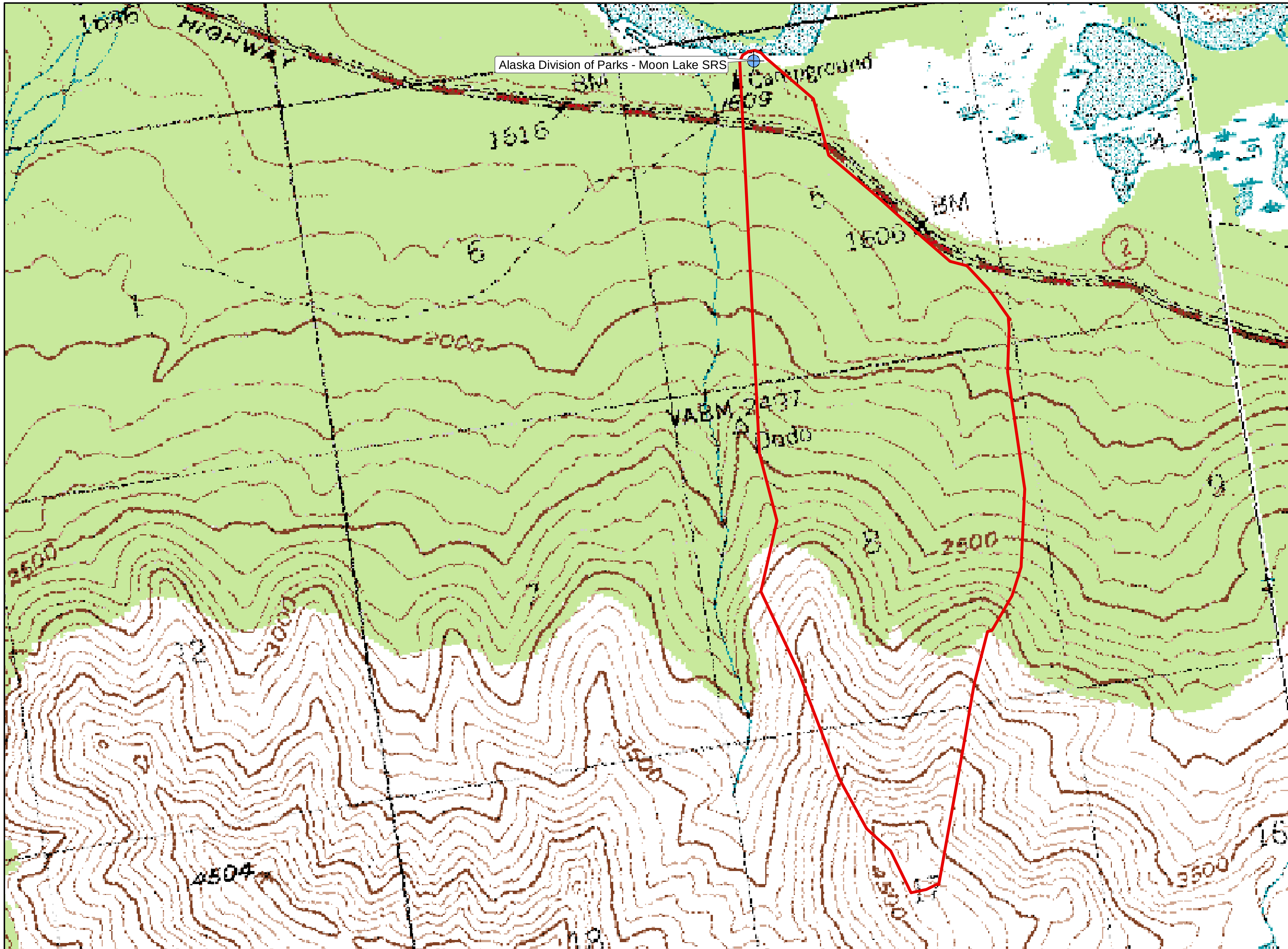
APPENDIX A

Moon Lake State Recreation Site
Drinking Water Protection Area Location Map
(Map 1)



Map 1: Alaska Division of Parks - Moon Lake SRS Drinking Water Protection Areas

PWSID: 381058.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 700 1,400 2,800 4,200 5,600 Feet

1:19,790

Data Sources:

Background image - USGS 1:63,000 mapping

Legend

Public Drinking Water Systems

DWPA Zone A

Several Months Travel Time

DWPA Zone B

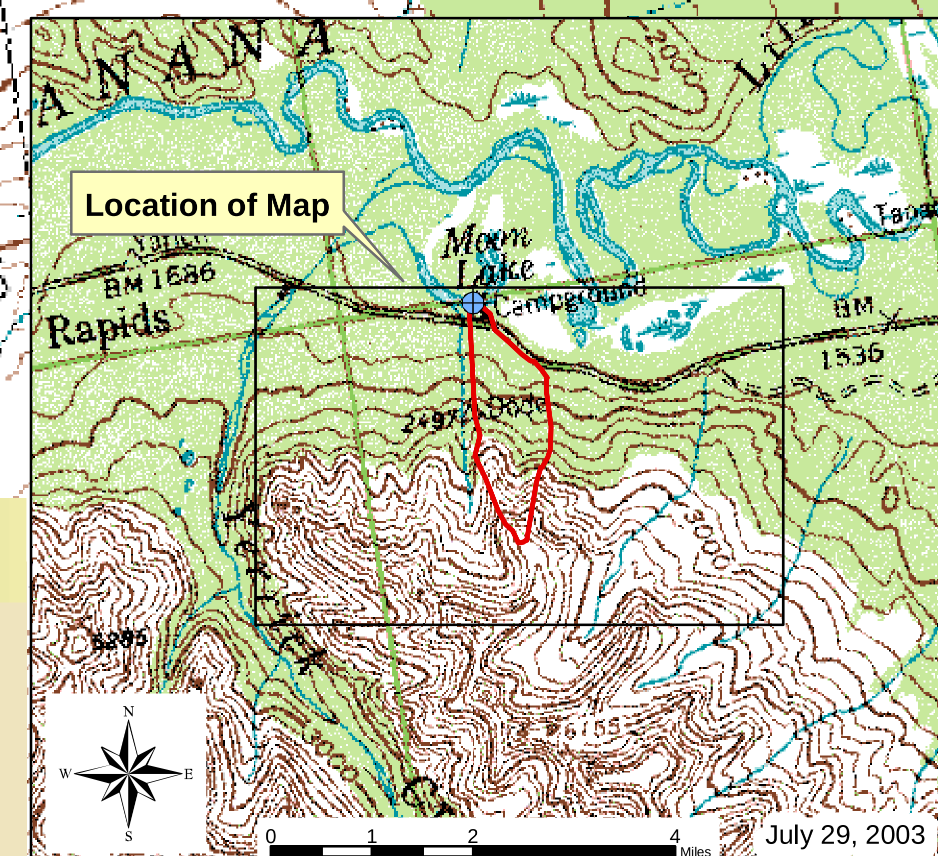
Less than 2 Years Travel Time

DWPA Zone C

Less than 5 Years Travel Time

DWPA Zone D

Less than 10 Years Travel Time



July 29, 2003

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Moon Lake State Recreation Site (Tables 1-4)

Table 1

Contaminant Source Inventory for Alaska Division of Parks - Moon Lake SRS

PWSID 381058.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Map Number	Comments
Pit toilets (open hole), nonresidential (one or more)	D16	D16-1	A	2	Nonresidential Pit Toilets for Moon Lake
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	2	Road Past Moon Lake
Campgrounds and RV Parks	X35	X35-1	A	2	Moon Lake Campground

Table 2

Contaminant Source Inventory and Risk Ranking for Alaska Division of Parks - Moon Lake SRS Sources of Bacteria and Viruses

PWSID 381058.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Map Number	Comments
Pit toilets (open hole), nonresidential (one or more)	D16	D16-1	A	Medium	2	Nonresidential Pit Toilets for Moon Lake
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	Road Past Moon Lake
Campgrounds and RV Parks	X35	X35-1	A	Low	2	Moon Lake Campground

Table 3

Contaminant Source Inventory and Risk Ranking for Alaska Division of Parks - Moon Lake SRS Sources of Nitrates/Nitrites

PWSID 381058.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Map Number	Comments
Pit toilets (open hole), nonresidential (one or more)	D16	D16-1	A	Medium	2	Nonresidential Pit Toilets for Moon Lake
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	Road Past Moon Lake
Campgrounds and RV Parks	X35	X35-1	A	Low	2	Moon Lake Campground

Table 4

Contaminant Source Inventory and Risk Ranking for Alaska Division of Parks - Moon Lake SRS Sources of Volatile Organic Chemicals

PWSID 381058.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Map Number	Comments
Pit toilets (open hole), nonresidential (one or more)	D16	D16-1	A	Low	2	Nonresidential Pit Toilets for Moon Lake
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	Road Past Moon Lake
Campgrounds and RV Parks	X35	X35-1	A	Low	2	Moon Lake Campground

APPENDIX C

Moon Lake State Recreation Site
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

D16-1

Alaska Division of Parks - Moon Lake SRS

X35-1

X20-1

Moon Lake

T 19 N

T 18 N

Map 2: Drinking Water Protection Areas for Alaska Division of Parks - Moon Lake SRS and Potential and Existing Sources of Contamination

PWSID: 381058.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 650 1,300 2,600 3,900 5,200 Feet

1:18,939

Data Sources:

Background image - USGS 1:63,000 mapping

Legend

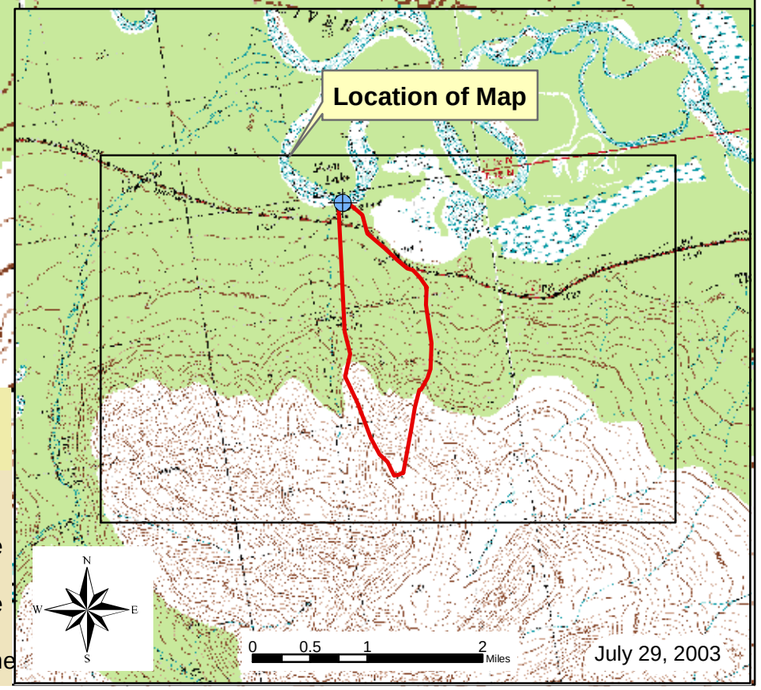
- Public Drinking Water Systems
- Nonresidential Pit Toilets (D16)
- Campground (X35)

DWPA Zone A
Several Months Travel Time

DWPA Zone B
Less than 2 Years Travel Time

DWPA Zone C
Less than 5 Years Travel Time

DWPA Zone D
Less than 10 Years Travel Time



July 29, 2003

APPENDIX D

Vulnerability Analysis for Moon Lake State Recreation Site Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - AK Division of Parks - Moon Lake SRS

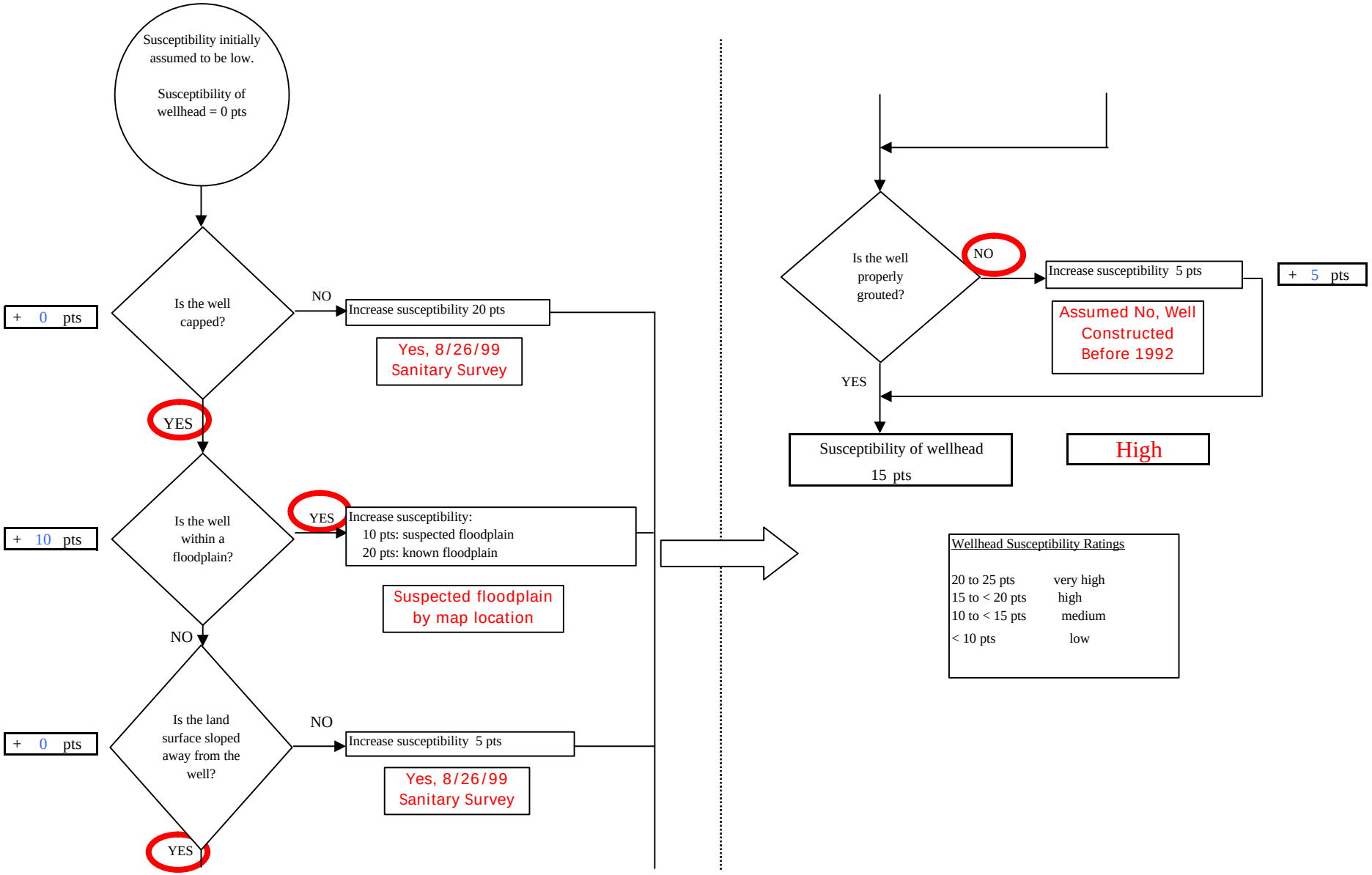


Chart 2. Susceptibility of the aquifer - AK Division of Parks - Moon Lake SRS

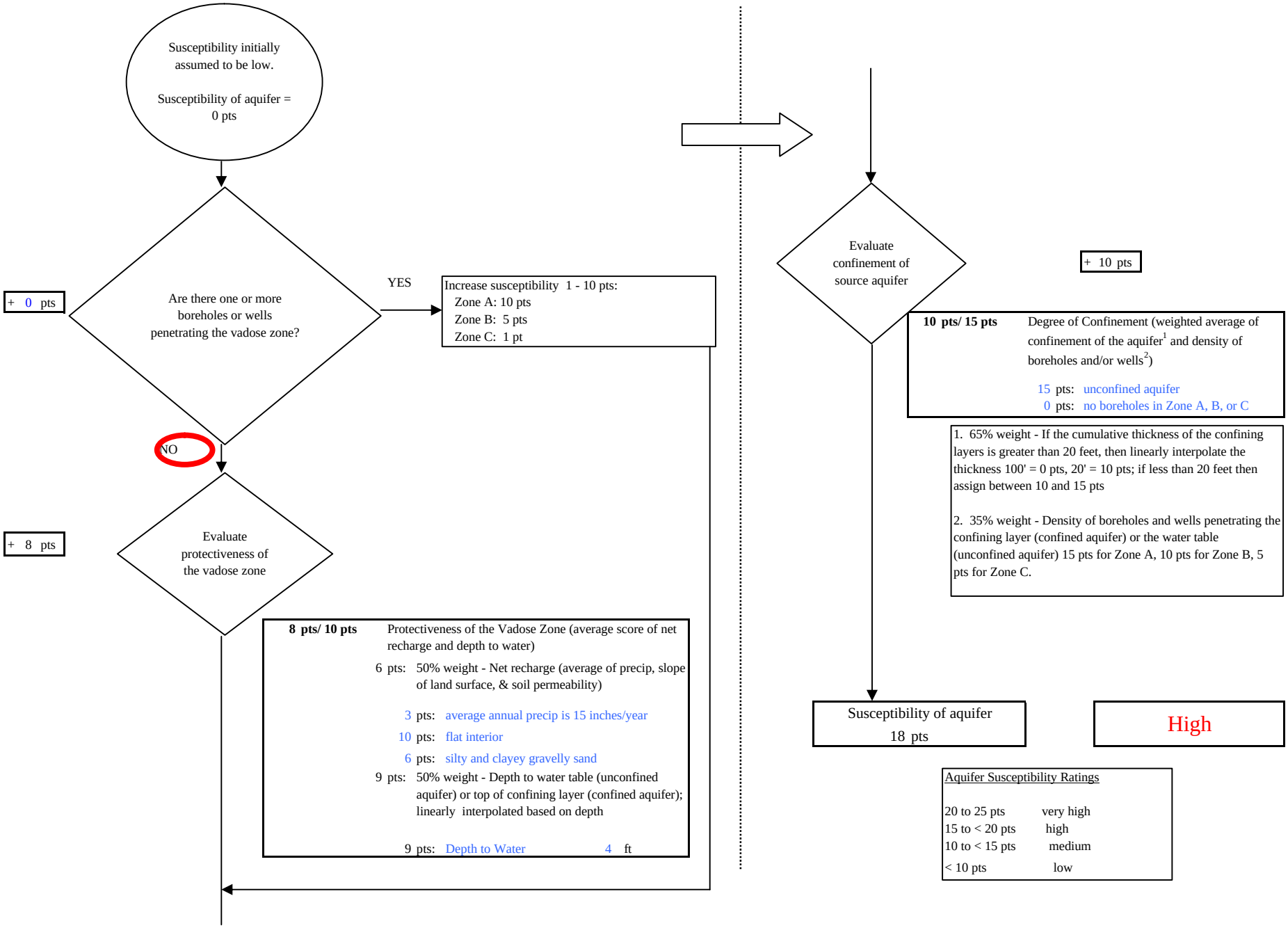
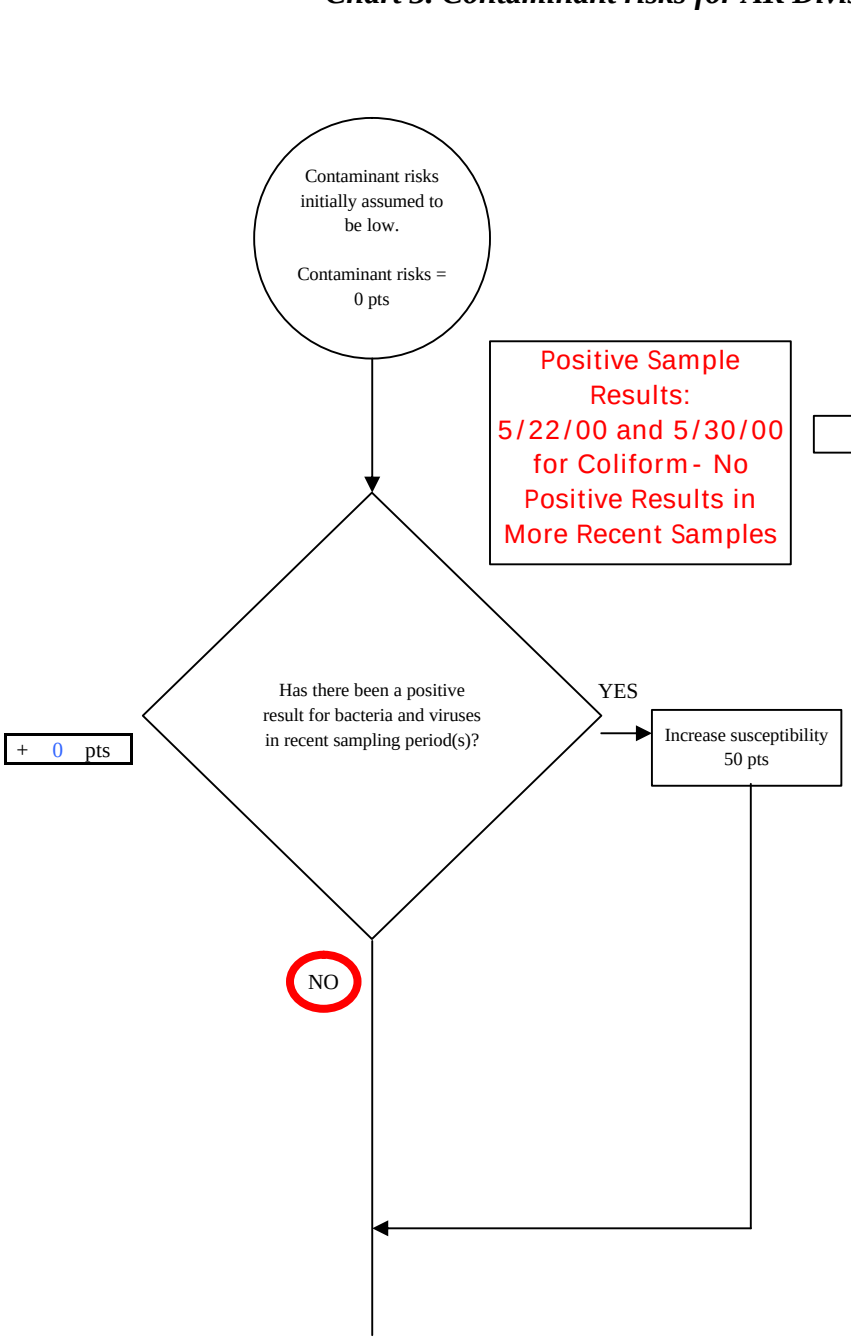
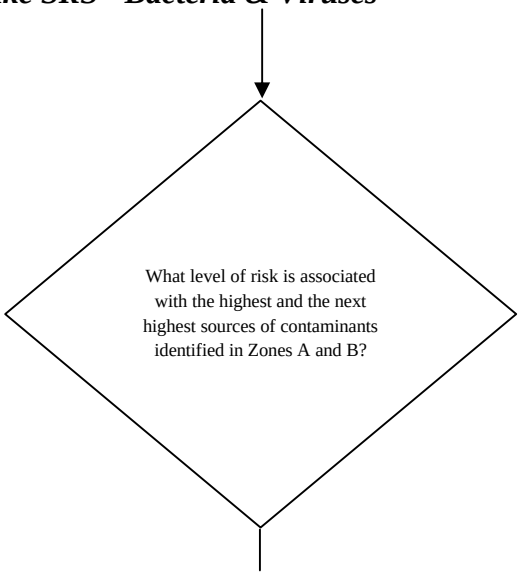


Chart 3. Contaminant risks for AK Division of Parks - Moon Lake SRS - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	2	0	2

	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.

Chart 3. Contaminant risks for AK Division of Parks - Moon Lake SRS - Bacteria & Viruses

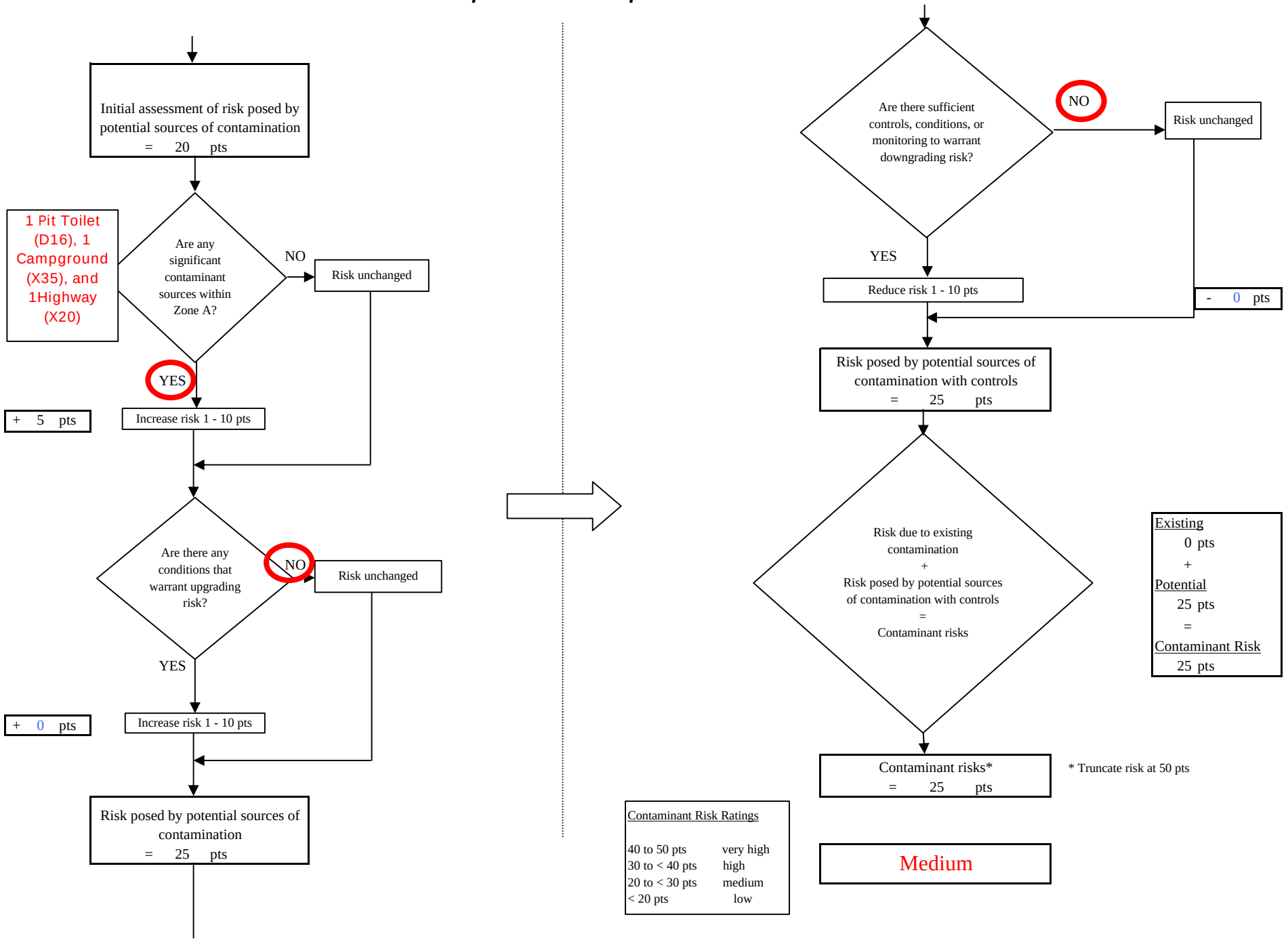


Chart 4. Vulnerability analysis for AK Division of Parks - Moon Lake SRS - Bacteria & Viruses

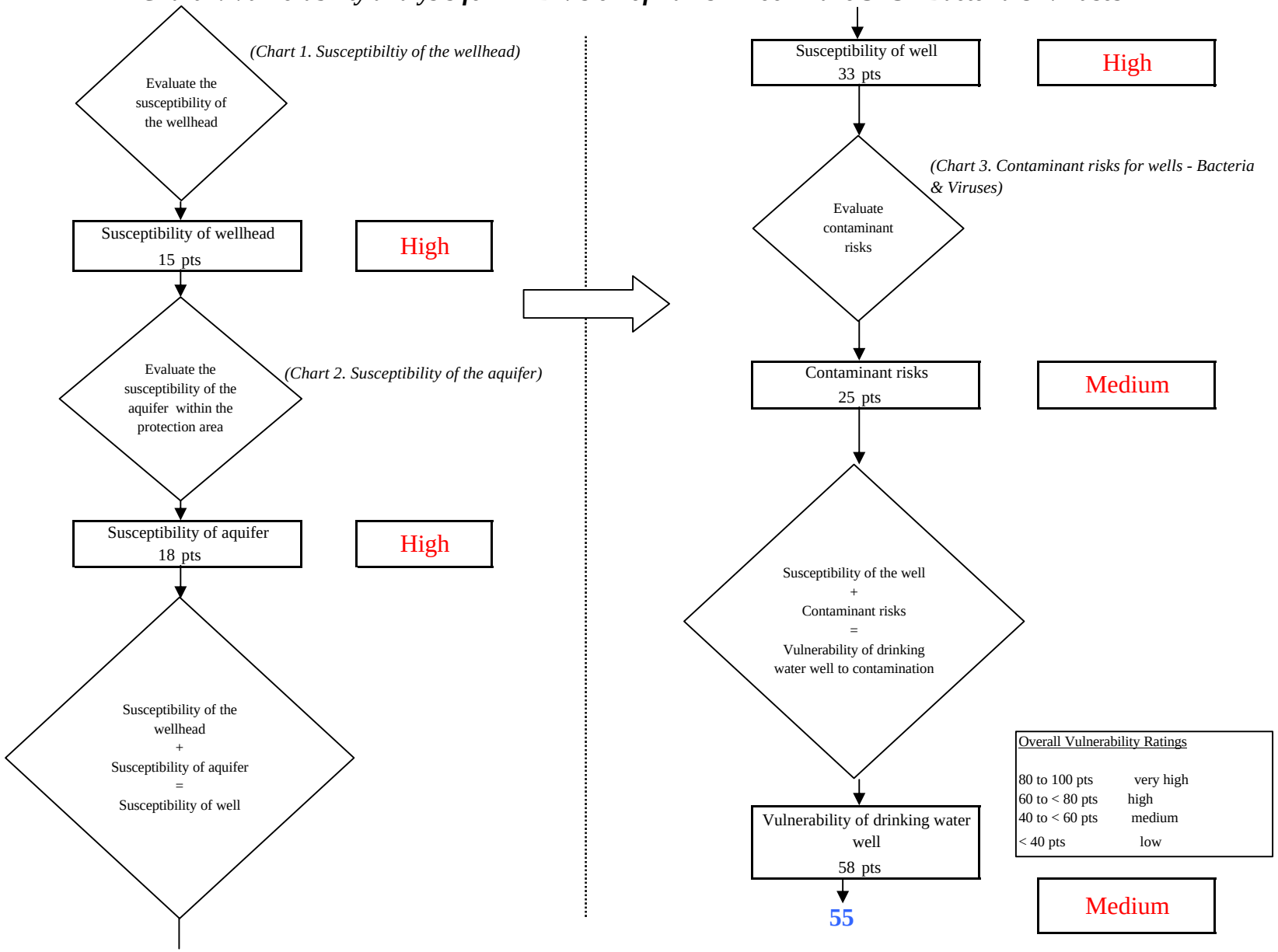


Chart 5. Contaminant risks for AK Division of Parks - Moon Lake SRS - Nitrates and Nitrites

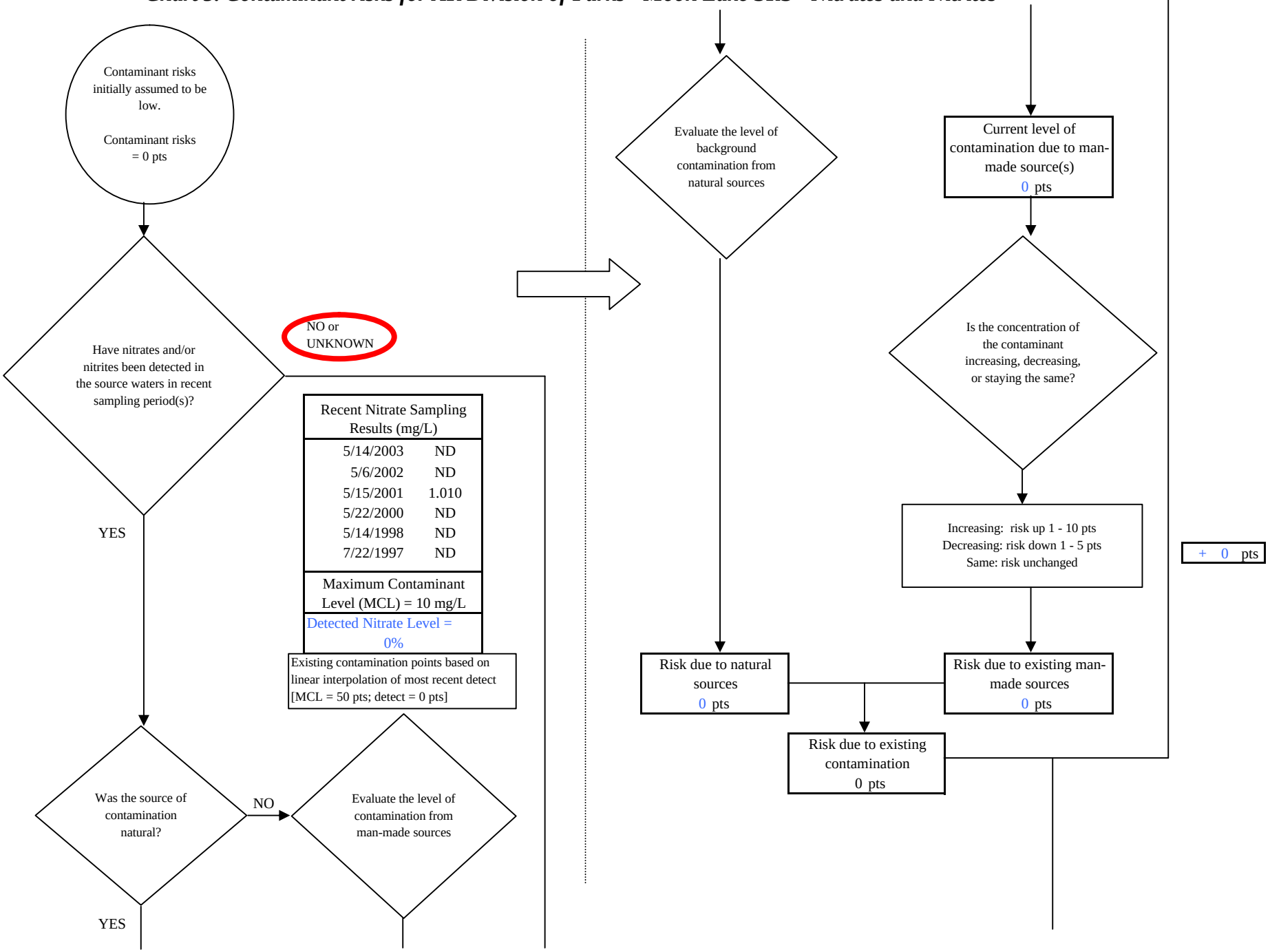


Chart 5. Contaminant risks for AK Division of Parks - Moon Lake SRS - Nitrates and Nitrites

+ 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)	2	0	2

	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

- 0 pts

Decrease risk 1 - 10 pts

Are any significant sources within Zone A?

NO

Risk unchanged

1 Pit Toilet (D16), 1 Campground (X35), and 1Highway (X20)

YES

+ 5 pts

Increase risk 1 - 10 pts

Chart 5. Contaminant risks for AK Division of Parks - Moon Lake SRS - Nitrates and Nitrites

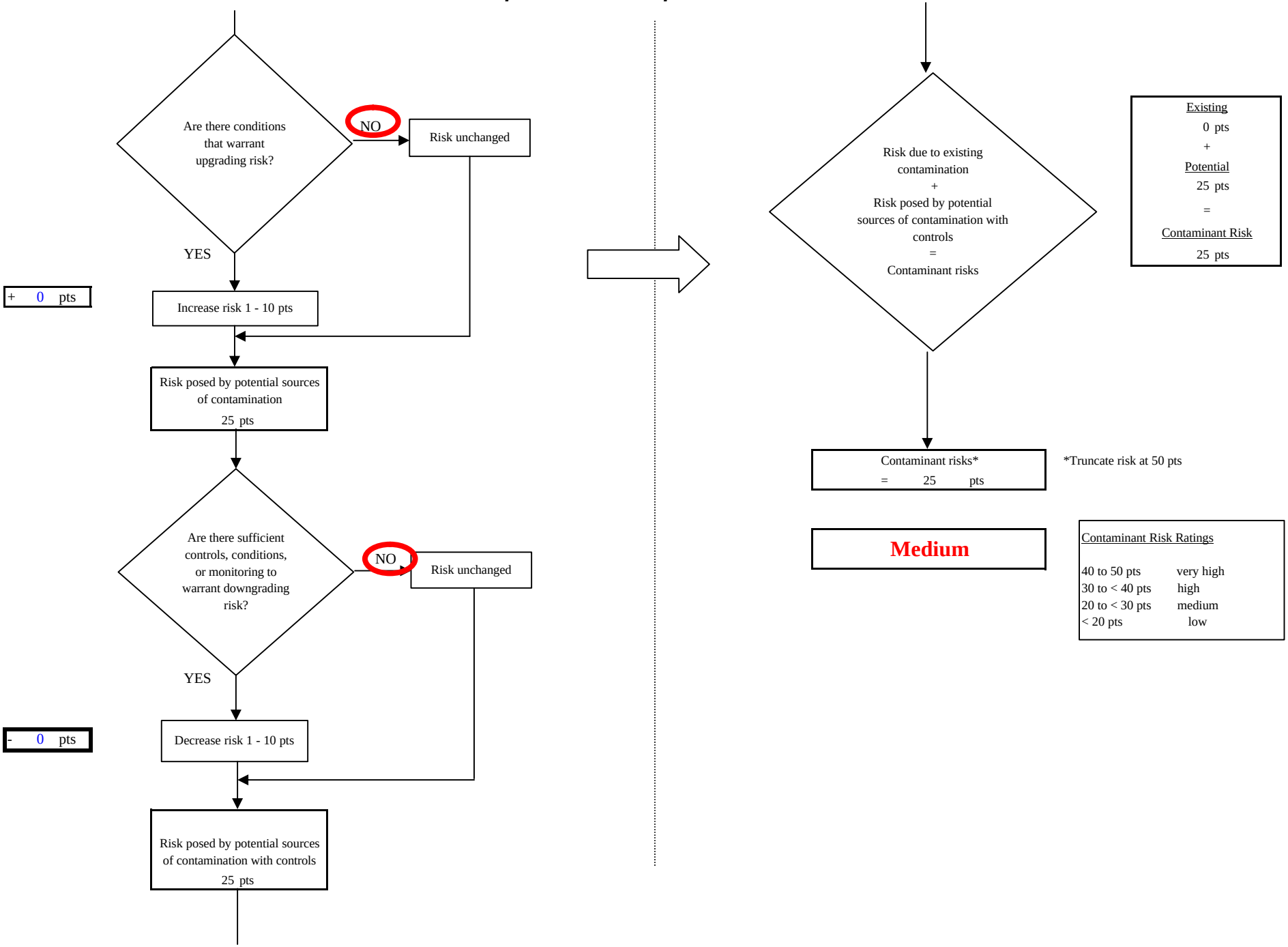


Chart 6. Vulnerability analysis for AK Division of Parks - Moon Lake SRS - Nitrates and Nitrites

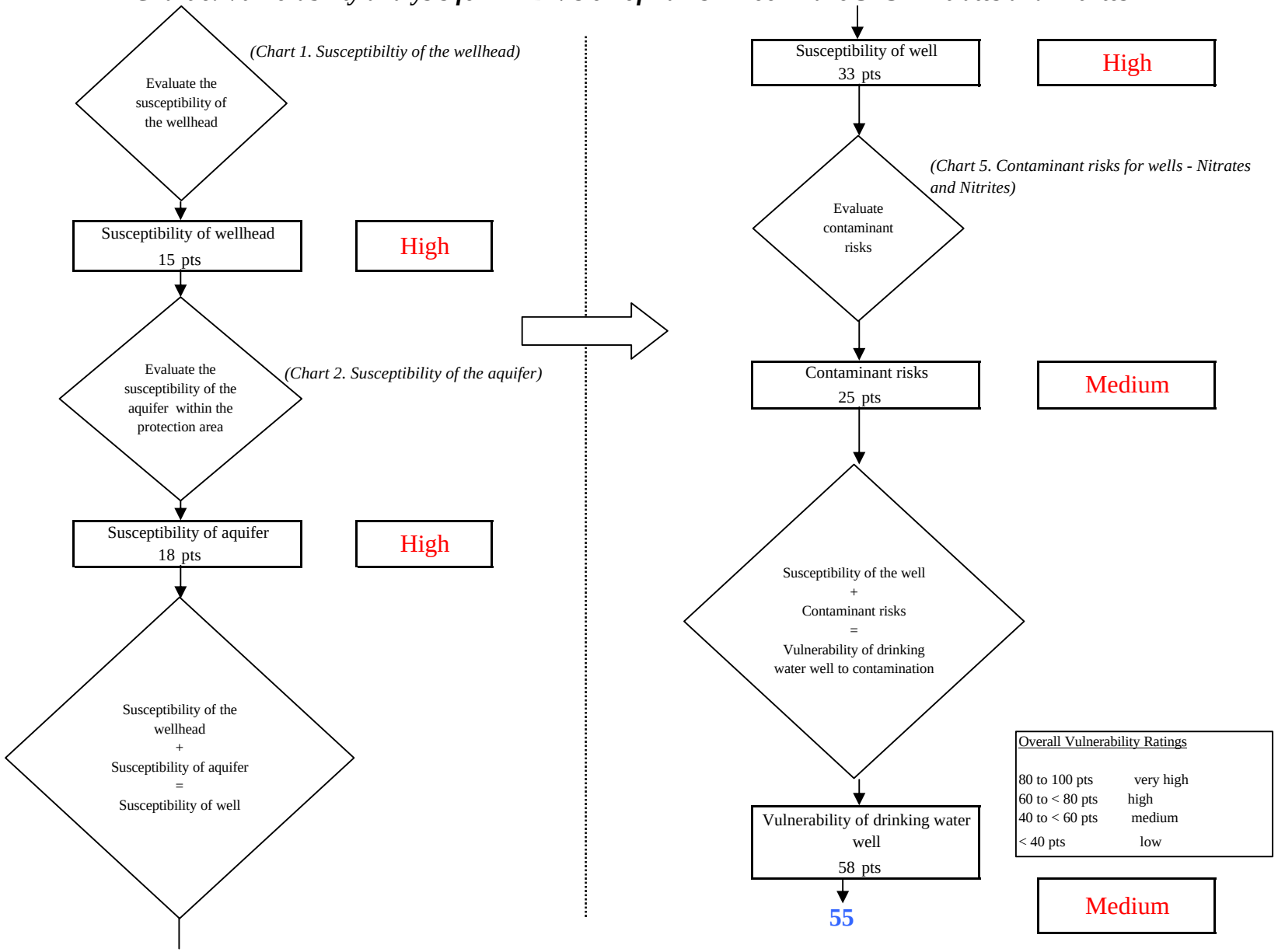


Chart 7. Contaminant risks for AK Division of Parks - Moon Lake SRS - Volatile Organic Chemicals

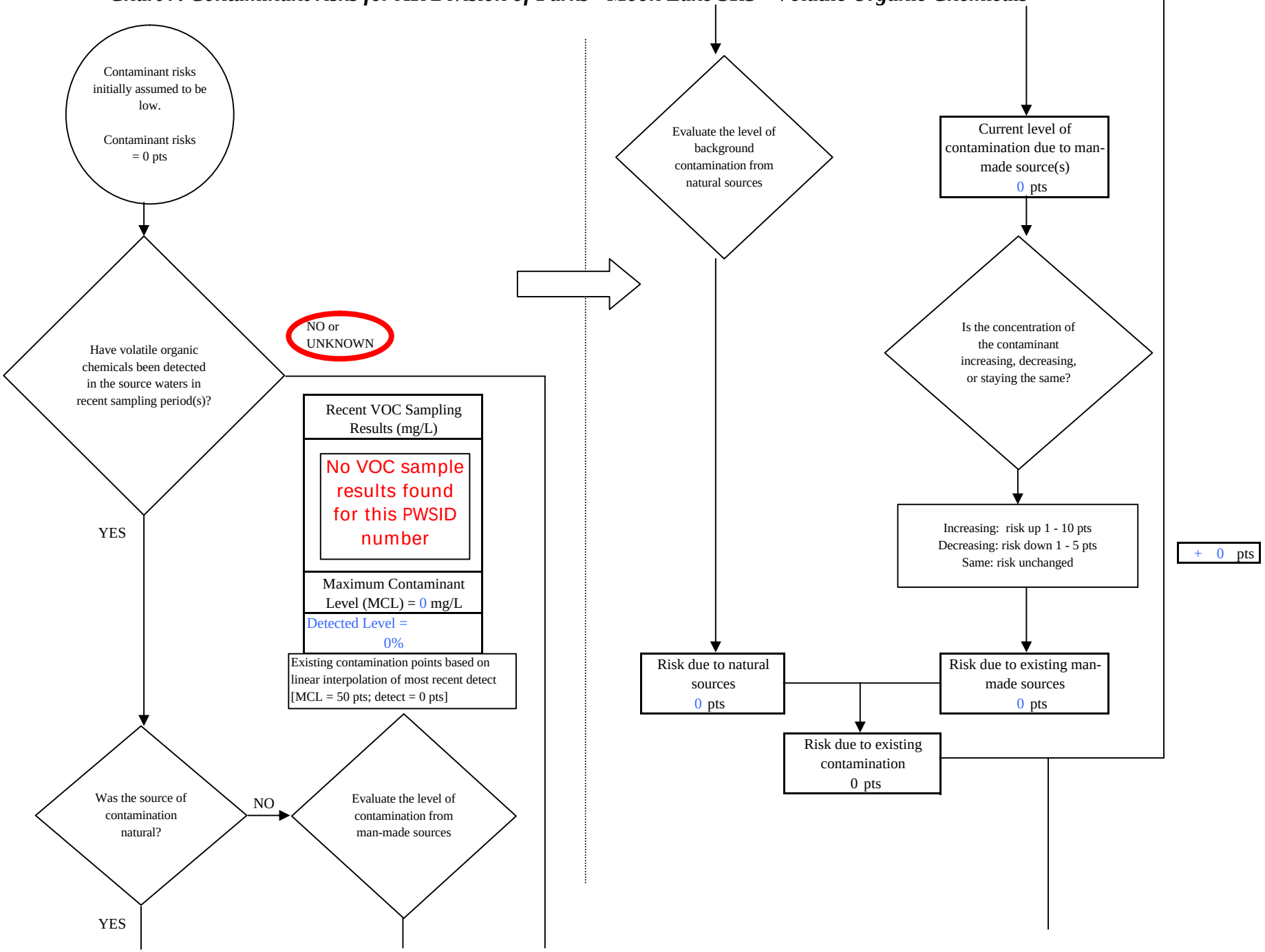


Chart 7. Contaminant risks for AK Division of Parks - Moon Lake SRS - Volatile Organic Chemicals

+ 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)	3	0	3

	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 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

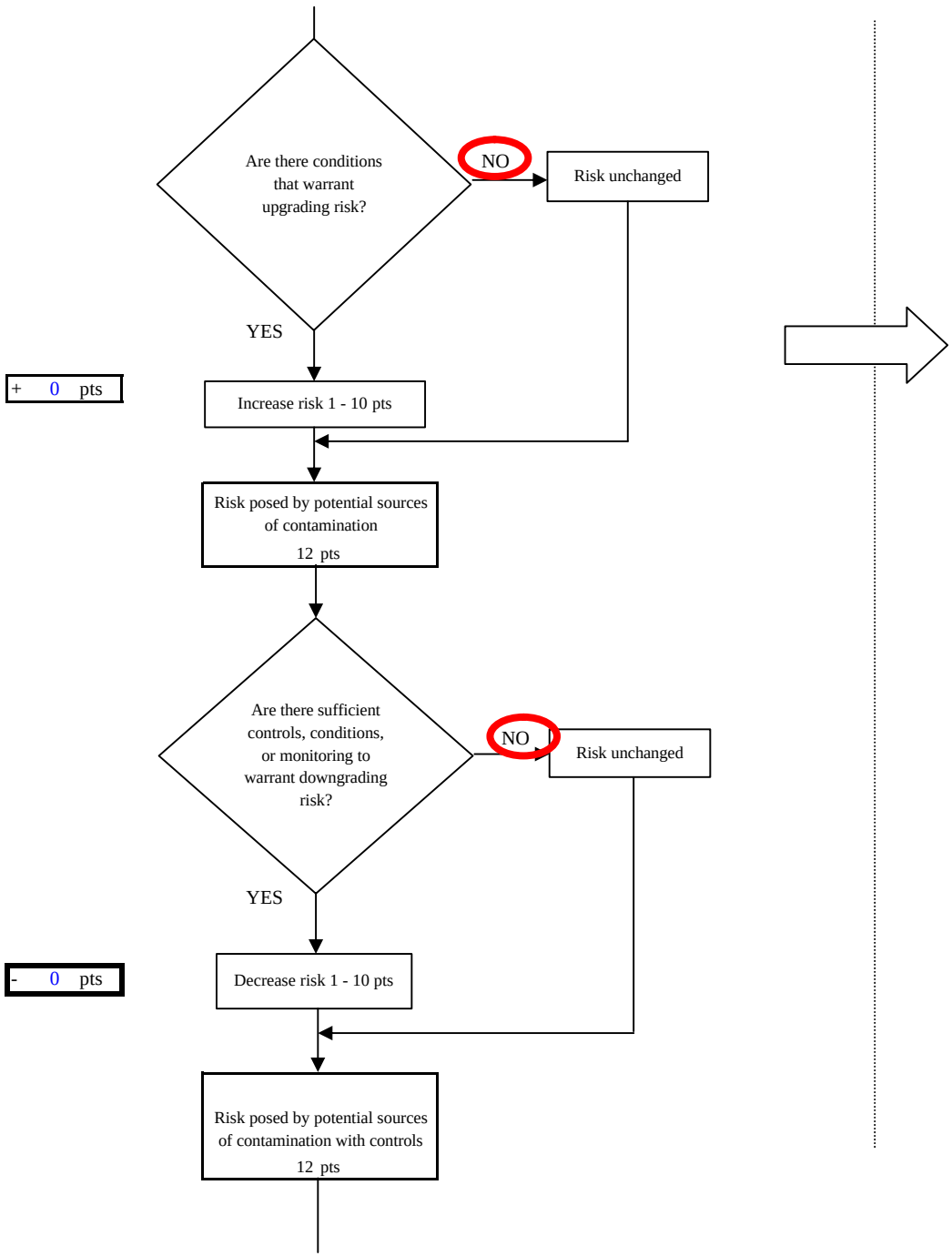
YES

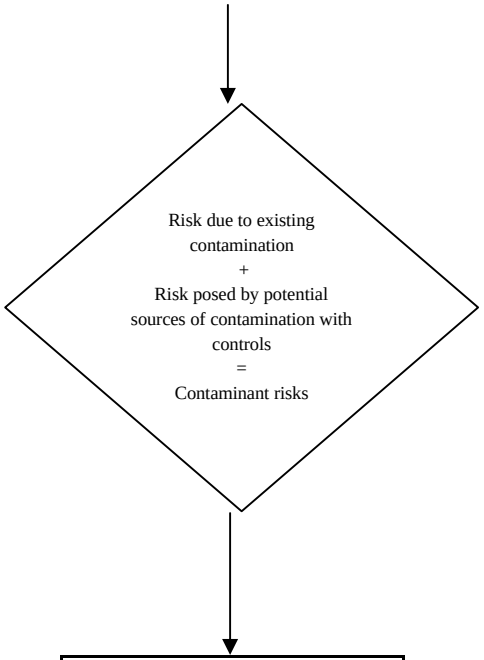
1 Pit Toilet (D16), 1 Campground (X35), and 1Highway (X20)

Increase risk 1 - 10 pts

+ 2 pts

Chart 7. Contaminant risks for AK Division of Parks - Moon Lake SRS - Volatile Organic Chemicals





Existing
0 pts
+
Potential
12 pts
=
Contaminant Risk
12 pts

Contaminant risks*
= 12 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 8. Vulnerability analysis for AK Division of Parks - Moon Lake SRS - Volatile Organic Chemicals