Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for USFS KNWR Lower Skilak Lake Drinking Water System, Skilak Lake, Alaska PWSID # 241274.001

DRINKING WATER PROTECTION PROGRAM REPORT # 390
Alaska Department of Environmental Conservation

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By URS Corporation

DRINKING WATER PROTECTION PROGRAM REPORT # 390

CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

Source Water Assessment for USFS KNWR Lower Skilak Lake Source of Public Drinking Water, Skilak Lake, Alaska

By URS Corporation

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The USFS KNWR Lower Skilak Lake is a Class B (transient/non-community) water system consisting of one well located on the northern shore of Skilak Lake at mile 15 Skilak Lake Road. Identified potential and current sources of contaminants for USFS KNWR Lower Skilak Lake public drinking water source include: vaulted 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 USFS KNWR Lower Skilak Lake received a vulnerability rating of **Low** for bacteria and viruses, nitrates and nitrites, and 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. URS Corporation has been contracted to perform these assessments under the supervision of ADEC.

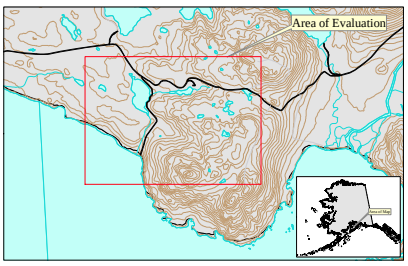
This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE KENAI PENINSULA, ALASKA

Location

The Kenai Peninsula Borough is located directly south of the city of Anchorage. The borough encompasses 25,600 square miles, only 15,700 square miles of which is land (Kenai Peninsula Borough, 2002). The Kenai Peninsula is broken into two distinct geographic areas: the Kenai Mountains and the Kenai Lowland. The Kenai Mountains are located in the southern and eastern part of the peninsula, comprising about 6,500 square miles. Towns located within the Kenai Mountains include Moose Pass, Cooper Landing, Crown Point, and Seward. The Kenai Lowlands are located in the west and comprise about 2,900 square miles and include the towns of Sterling, Soldotna, Kenai, Clam Gulch, Ninilchik and Homer. Two main highways divide the peninsula; the Seward Highway begins in Anchorage and ends in Seward, connecting the Turnagain Arm to the peninsula. The Sterling Highway splits off from the Seward Highway at Tern Lake Junction and runs east and west to Kenai, where it then turns south and ends in Homer. The peninsula is bordered by the Prince William Sound in the east, Gulf of Alaska in the south and the Cook Inlet in the west. The Kenai River, located in the Kenai Mountains, is the largest stream within the peninsula, beginning at Kenai Lake and draining into the Cook Inlet through the Kenai Lowlands. The Kasilof River is the second largest river and is located in the Kenai Lowlands, starting at Tustumena Lake and draining into Cook Inlet at Kasilof (*USGS, 1915*).

Figure 1



Glaciers occupied the Kenai Peninsula during the early Quaternary time, however the exact date is unknown. During that time, the Kenai Lowlands were occupied by a large valley glacier that encompassed most of the Cook Inlet basin. Currently, glaciers are found most extensively in the valleys of the Resurrection River and Skilak Lake and to the east in the valleys of the tributaries to Kachemak Bay and Tustumena Lake. Much of the higher altitudes are covered by snow fields, connecting many valley glaciers (*USDA, 1962*).

Precipitation

The communities of Sterling and Cooper Landing average about 20 inches per year with the most precipitation occurring in the fall.

Topography and Drainage

In the Kenai lowlands, sea level ranges from 50 feet to 200 feet above sea level. The largest lake in the Kenai Peninsula is located within the Kenai Lowlands (Tustumena Lake). Two substantial rivers also flow through the Kenai Lowlands (Kenai River and Kasilof River) (*USGS, 1915*).

Tustumena Lake is the largest lake in the Kenai Peninsula and is located primarily in the Kenai Lowlands, approximately 6.4 miles off the Sterling Highway. It is approximately 6 miles wide and 25 miles long and is open to lake trout and salmon fishing (except king and sockeye fishing) (*Milepost, 2000*).

The ***Kenai River*** watershed covers over 2,200 square miles and runs over 80 miles in length. This watershed includes the towns of Cooper Landing, Sterling, Soldotna and Kenai. Several tributaries flow into the river, including the Snow River, Trail Creek, Killey River and Funny River. Glaciers along the path of the river continually supply the waters with sediment, keeping the waters turbid (*http://www.kenai-watershed.org/ - Kenai River Watershed and USGS, 1915*).

Groundwater

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Kenai River Center, GW Scientific, and Restoration Science and Engineering are currently investigating the interactions that occur between the Kenai River Watershed and groundwater in the Lower Kenai area (Soldotna)(*http://www.kenai-watershed.org/spawning /kenai_river/kenai_river.html, 2002*).

The Kenai Peninsula 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 15 feet below the surface.

Geology and Soils

The Kenai area is situated on proglacial lake deposits. Modern floodplain and associated low-terrace and alluvial fan deposits also exist within fluvial regions. The surficial deposits are underlain by sedimentary rocks of Tertiary age, which are in turn underlain by a thick sequence of Mesozoic rocks containing the Cook Inlet oil and gas reserves.

Thick beds of sand and gravel run along the Kenai and Kasilof Rivers, while the rest of the area is made up of hilly moraines of coarse-textured or compact, fine-grained material. The entire area is buried under loess ranging from a few inches to a several feet. The U.S. Soil Conservation Service and Alaska Agricultural Experiment Station (USDA) have identified twenty-eight different soil series associated with the Kenai Peninsula.

USFS KNWR LOWER SKILAK LAKE PUBLIC DRINKING WATER SYSTEM

USFS KNWR Lower Skilak Lake is a Class B (transient/non-community) water system. The system consists of one well located on the northern shore of Skilak Lake at mile 15 Skilak Lake Road (T4N, R7W, Section 3). This area is at an elevation of approximately 250 feet above sea level.

The most recent Sanitary Survey (7/14/92) completed for the water system indicates, installation of the well occurred on May 1, 1978 to a total depth of approximately 26 feet below ground surface. The size of the well casing is unknown. 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 was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

This system operates seasonally from May to September and serves more than 65 non-residents through one service connection.

USFS KNWR LOWER SKILAK 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. 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, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*). 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 Bs 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 for the 2-yr. TOT
B	Less than the 2 year TOT
C	Less Than the five year TOT
D	Less than the 10 year TOT

As an example, water moving through the aquifer in Zone B will 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 USFS KNWR Lower Skilak 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 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 and B were associated with residential and light industrial type activities. The sources are 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.

VULNERABILITY OF USFS KNWR LOWER SKILAK LAKE 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:

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 USFS KNWR Lower Skilak Lake is completed in an confined or semi-confined aquifer setting. The aquifer that is utilized by the well is protected from surface contamination by a relatively impermeable geological formation. The thickness of the confining layer is unknown. Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of Overall Susceptibility. Table 2 shows the Overall Susceptibility score and rating for USFS KNWR Lower Skilak Lake.

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

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	25	Very High
Natural Susceptibility	25	Medium

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.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	12	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 Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

Table 3 contains the overall vulnerability scores (0 – 10) 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 of USFS KNWR Lower Skilak Lake to Contamination by Category

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

Tables 2 through 5 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.

The vaulted pit toilets, paved highways and roads, and campgrounds and RV parks create a risk increase for the bacteria and viruses, and nitrates and nitrites contaminant categories.

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water

sampling of the system at USFS KNWR Lower Skilak Lake.

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].

Sampling history for USFS KNWR Lower Skilak Lake well indicates that nitrates have not been detected (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Existing nitrate concentration is approximately 0.0 mg/L or 0 %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.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving USFS KNWR Lower Skilak Lake. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, nitrates and 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 USFS KNWR Lower Skilak Lake 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 USFS KNWR Lower Skilak Lake public drinking water source.

REFERENCES CITED

Alaska Department of Community and Economic Development, 2001 [WWW document]. URL http://www.dced.state.ak.us/mra/CF_BLOCK.cfm.

Alaska Department of Labor, State of Alaska 2001 [WWW document]. URL http://146.63.75.45/census2000/.

Balding, G.O. 1976. Water Availability, Quality, and Use in Alaska. U.S Geological Survey Open File Report 76-513.

Brabets, T., 1997, Precipitation map of Alaska, Web extension to the U.S. Geological Survey Water Resources for Alaska GIS datasets. <URL:http://agdc.usgs.gov/data/usgs/water> .

Guide to the Bedrock Geology along the Seward Highway north of Turnagain Arm, 1981

Guide to the Geology of the Kenai Peninsula, Alaska, 1997

Hartman, C.W. and Johnson, P.R., 1978. Environmental Atlas of Alaska. University of Alaska, Institute of Water Resources, Second Edition.

Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.

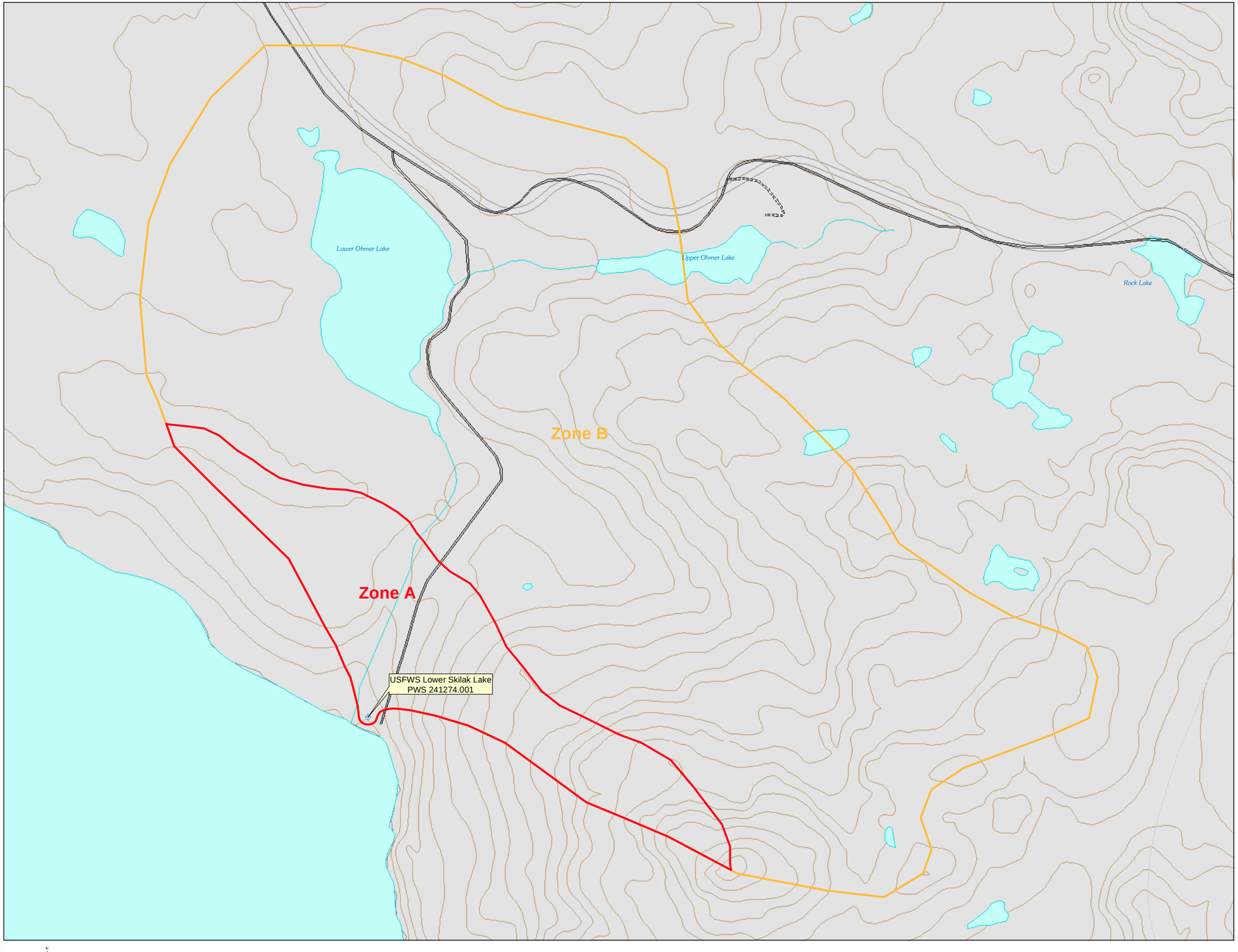
Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?akmatv

Winkler, G.R. 1992. Geologic Map and Summary Geochronology of the Anchorage 1^{o} x 3^{o} Quadrangle, Southern Alaska. Prepared by the U.S. Department of the Interior, Geological Survey in cooperation with the State of Alaska Division of Geological and Geophysical Surveys.

APPENDIX A

USFS KNWR Lower Skilak Lake
Drinking Water Protection Area
(Map 1)

Drinking Water Protection Areas for the Public Water Well System for PWS # 241274.001 Lower Skilak Lake



LEGEND

- Public Water System Well

Groundwater Protection Zones

- Zone A – Several Months Travel Time
- Zone B – Less Than 2 Years Travel Time

Hydrography/Physical

- Parcels
- Stream
- Aqueduct or Pipeline
- Lake or Pond
- Glacier
- Contours (approx. 70 ft.)

Transportation

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

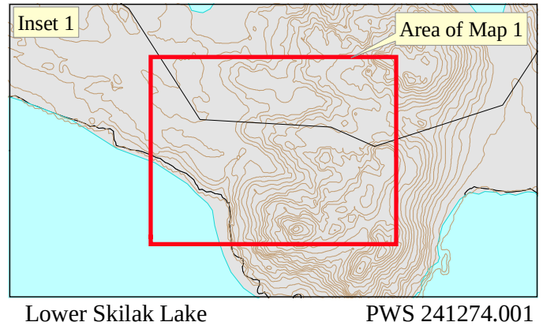
Data Sources:
Contaminant Sources, Public Water System Wells, Contours
Alaska Department of Environmental Conservation (ADEC)

Parcels
Kenai Peninsula Borough

All other data
United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC
Calculation Spreadsheet.

URS Corporation does not guarantee the accuracy or validity of the data provided.



0 1,300 2,600 5,200 7,800 10,400 Feet

Lower Skilak Lake PWS 241274.001

APPENDIX B

Contaminant Source Inventory and Risk Ranking for USFS KNWR Lower Skilak Lake (Tables 1-4)

Table 1 *Contaminant Source Inventory for* ***PWSID 241274.001***

USFWS KNWR Lower Skilak Lake

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-01	A		1	
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-02	A		1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A		1	
Campgrounds and RV Parks	X35	X35-01	A		1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	B		1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	B		1	

Table 2

Contaminant Source Inventory and Risk Ranking for USFWS KNWR Lower Skilak Lake Sources of Bacteria and Viruses

PWSID 241274.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-01	A	Low	1		1	
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-02	A	Low	2		1	
Campgrounds and RV Parks	X35	X35-01	A	Low	3		1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	4		1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	B	Low	5		1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	B	Low	6		1	

Table 3

Contaminant Source Inventory and Risk Ranking for USFWS KNWR Lower Skilak Lake Sources of Nitrates/Nitrites

PWSID 241274.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-01	A	Low	1		1	
Pit toilets (vaulted) nonresidential (one or more)	D17	D17-02	A	Low	2		1	
Campgrounds and RV Parks	X35	X35-01	A	Low	3		1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	4		1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	B	Low	5		1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	B	Low	6		1	

Table 4

Contaminant Source Inventory and Risk Ranking for USFWS KNWR Lower Skilak Lake Sources of Volatile Organic Chemicals

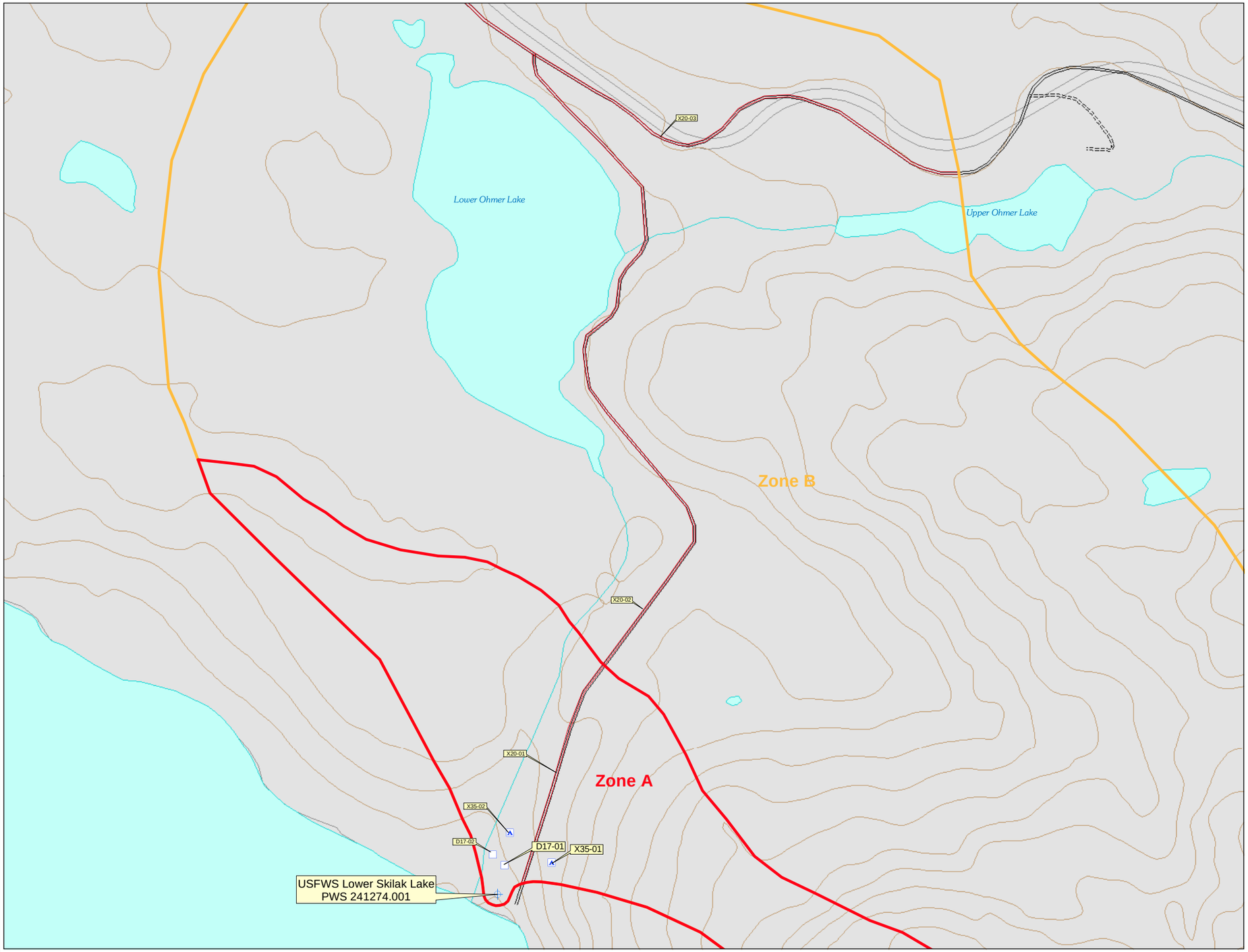
PWSID 241274.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map Number	Comments
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	1		1	
Campgrounds and RV Parks	X35	X35-01	A	Low	2		1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	B	Low	3		1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	B	Low	4		1	

APPENDIX C

USFS KNWR Lower Skilak Lake
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Drinking Water Protection Areas for the Public Water Well System for PWS # 241274.001 Lower Skilak Lake
Showing Potential and Existing Sources of Contamination



LEGEND

Public Water System Well

Groundwater Protection Zones

Zone A – Several Months Travel Time

Zone B – Less Than 2 Years Travel Time

Contaminant Sources

Campgrounds and RV Parks (X35)

Pit Toilets (vaulted) nonresidential (one or more) (D17)

Highways and roads, paved (X20)

Data Sources:
Contaminant Sources, Public Water System Wells, Contours
Alaska Department of Environmental Conservation (ADEC)

Parcels
Kenai Peninsula Borough

All other data
United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC
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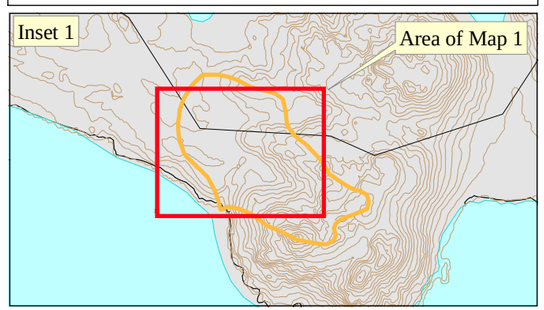


0 900 1,800 3,600 5,400 7,200 Feet

Lower Skilak Lake PWS 241274.001

APPENDIX D

Vulnerability Analysis for
USFS KNWR Lower Skilak Lake
Public Drinking Water Source
(Charts 1-8)

Chart 1. Susceptibility of the wellhead - USFWS KNWR Lower Skilak Lake (241274.001)

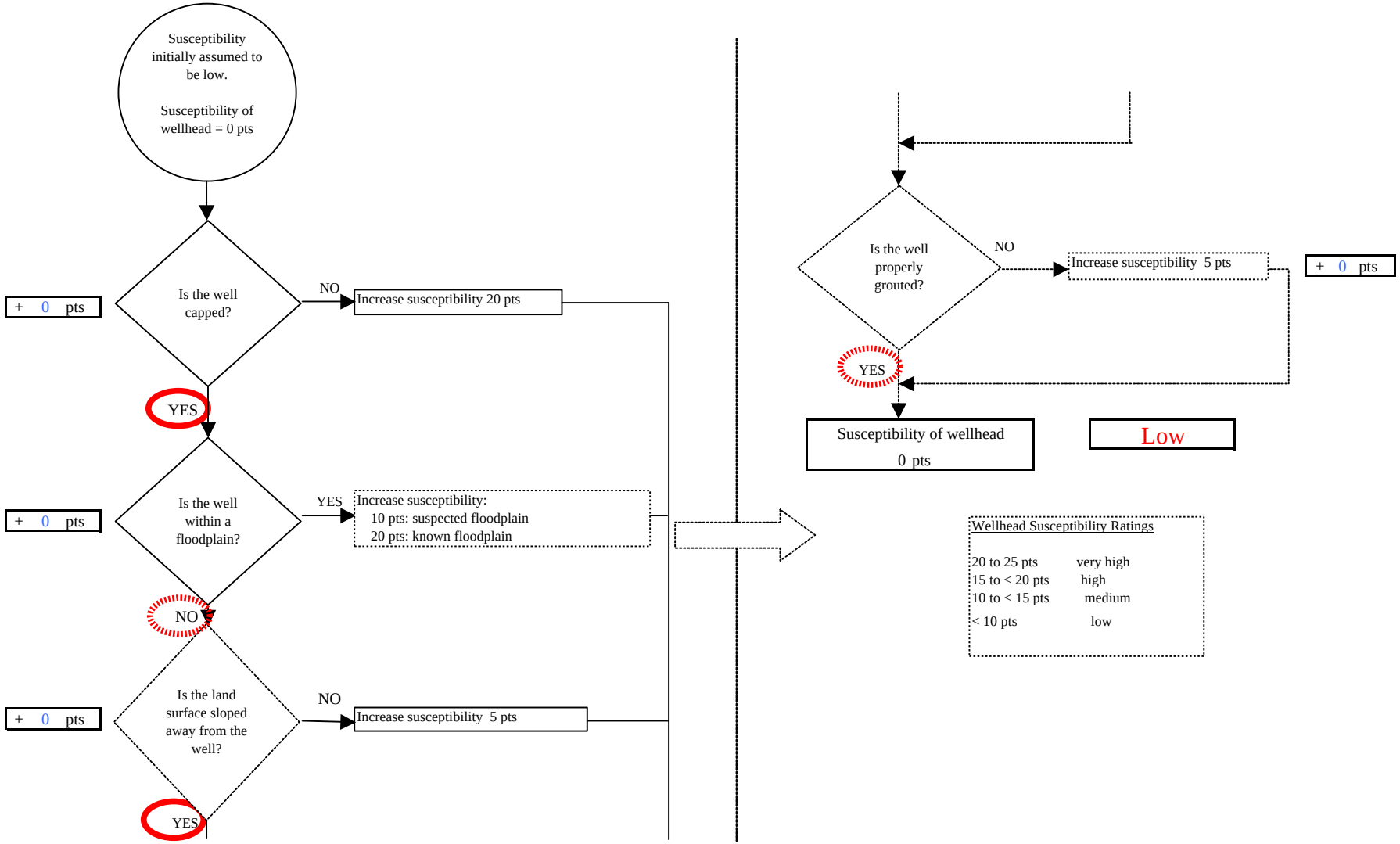


Chart 2. Susceptibility of the aquifer - USFWS KNWR Lower Skilak Lake (241274.001)

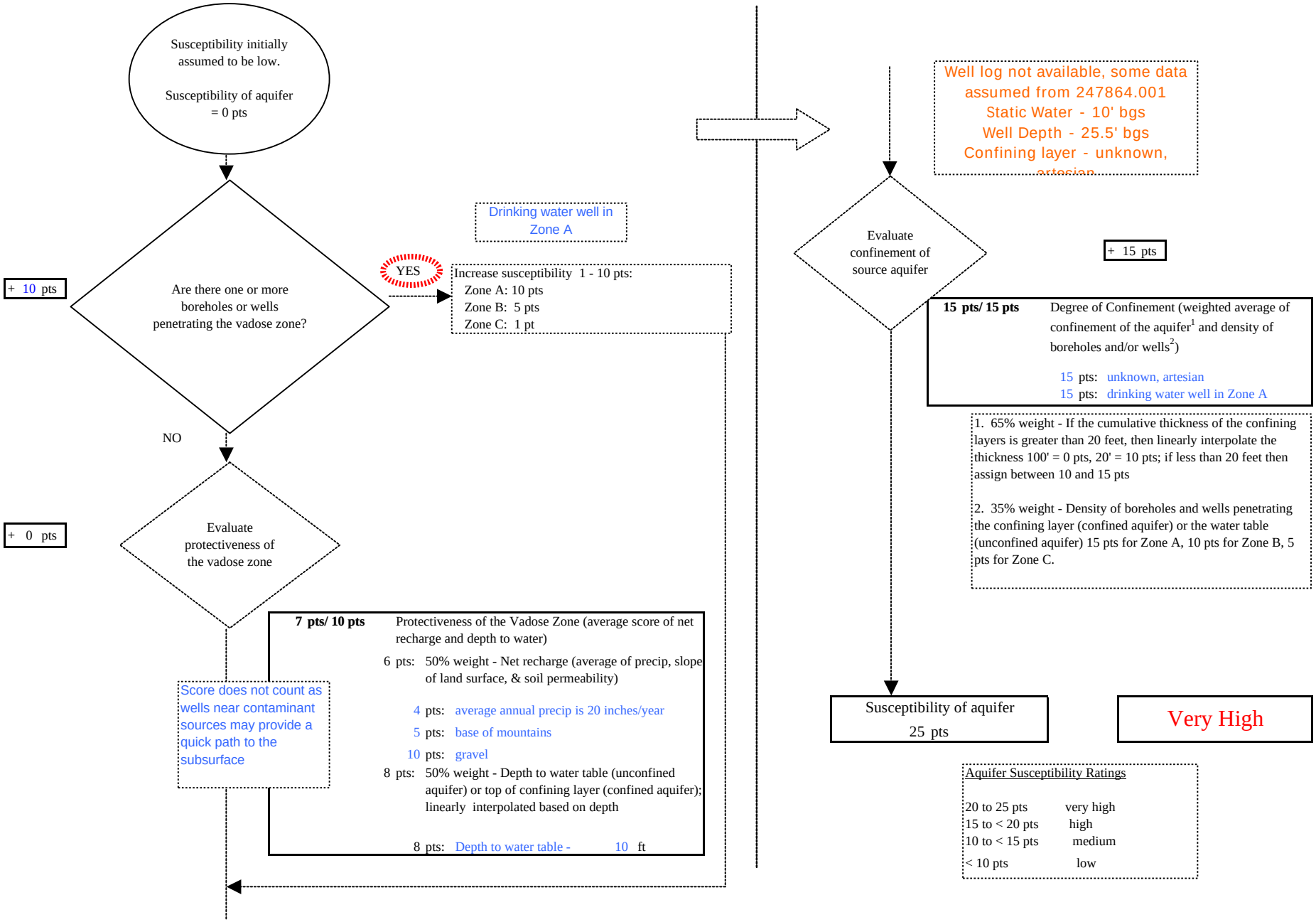
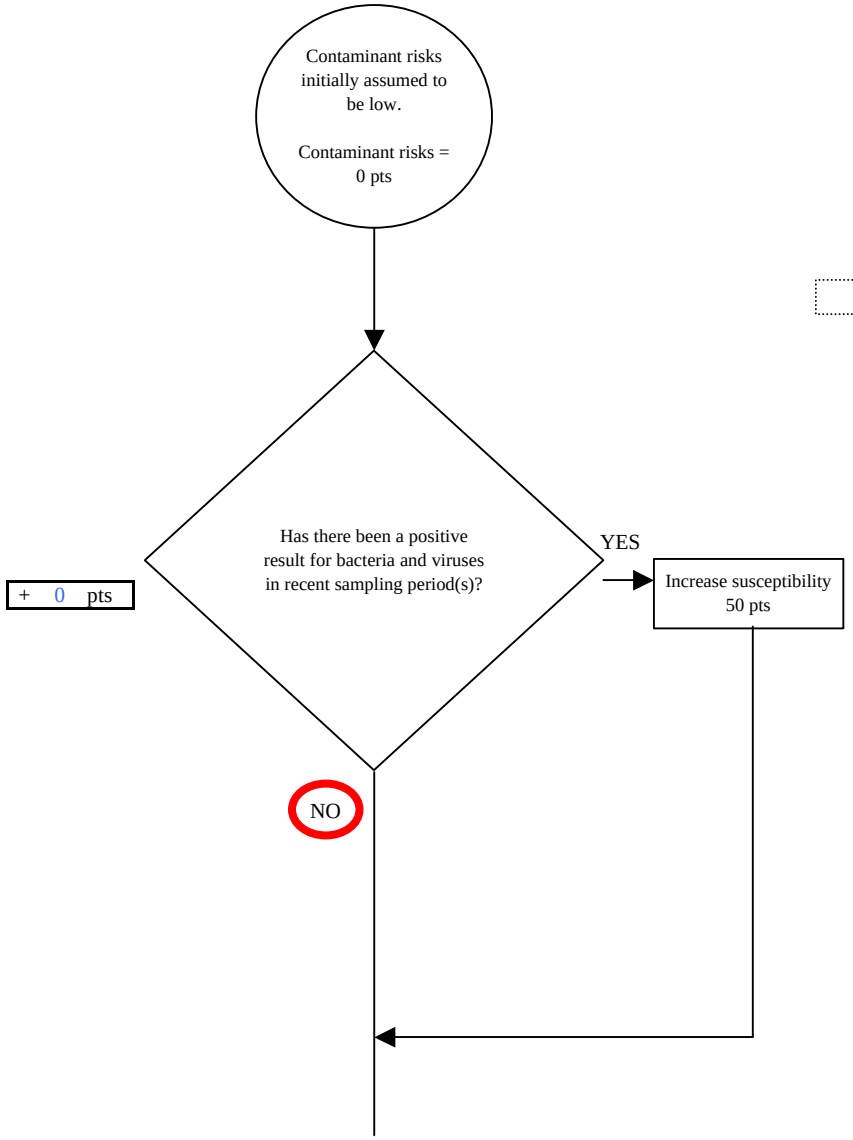
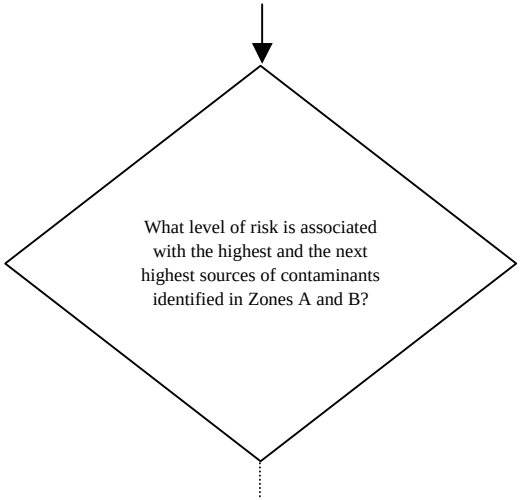


Chart 3. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Bacteria & Viruses





+ 10 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	4	1	5

	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.

Chart 3. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Bacteria & Viruses

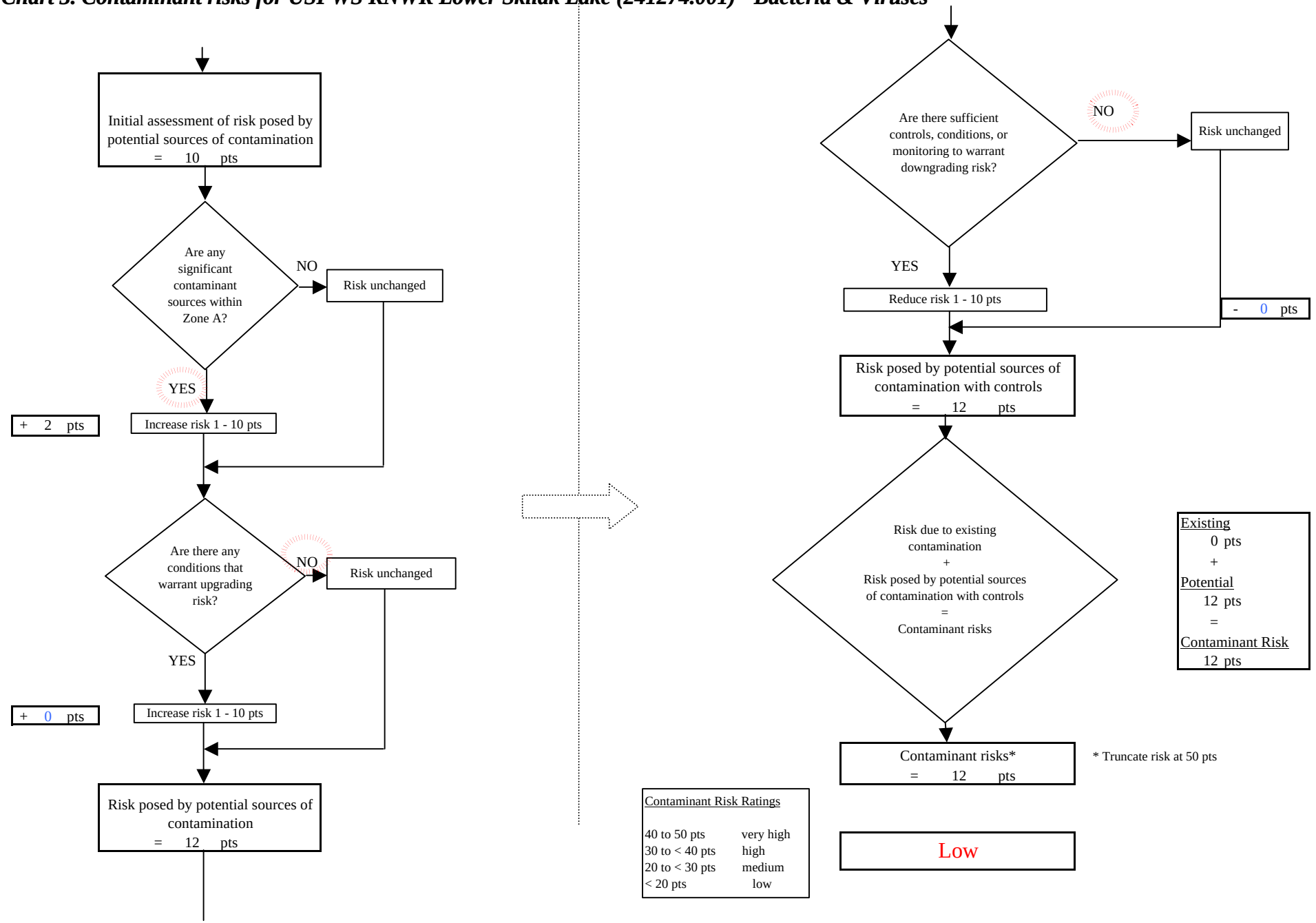


Chart 4. Vulnerability analysis for USFWS KNWR Lower Skilak Lake (241274.001) - Bacteria & Viruses

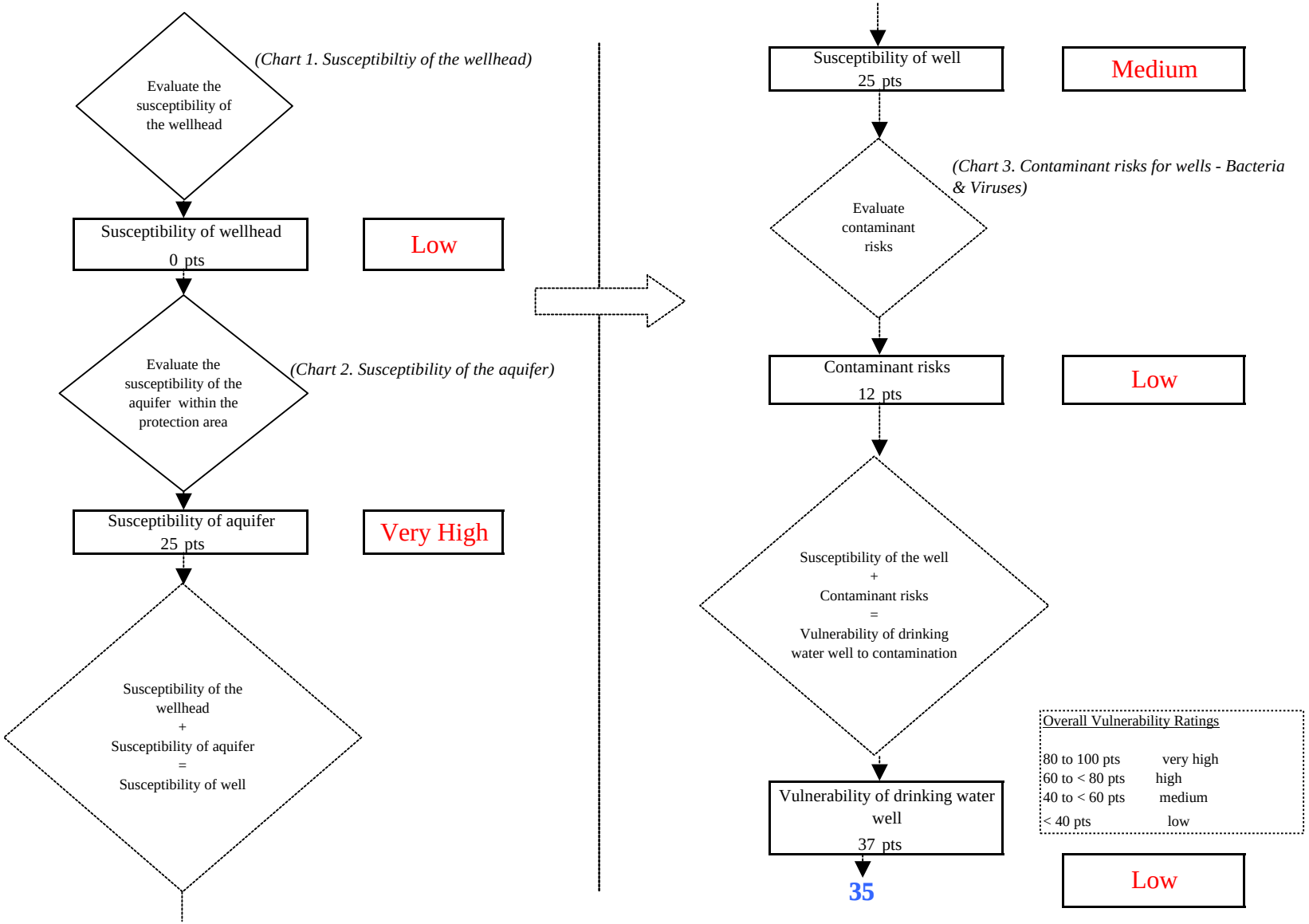


Chart 5. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Nitrates and Nitrites

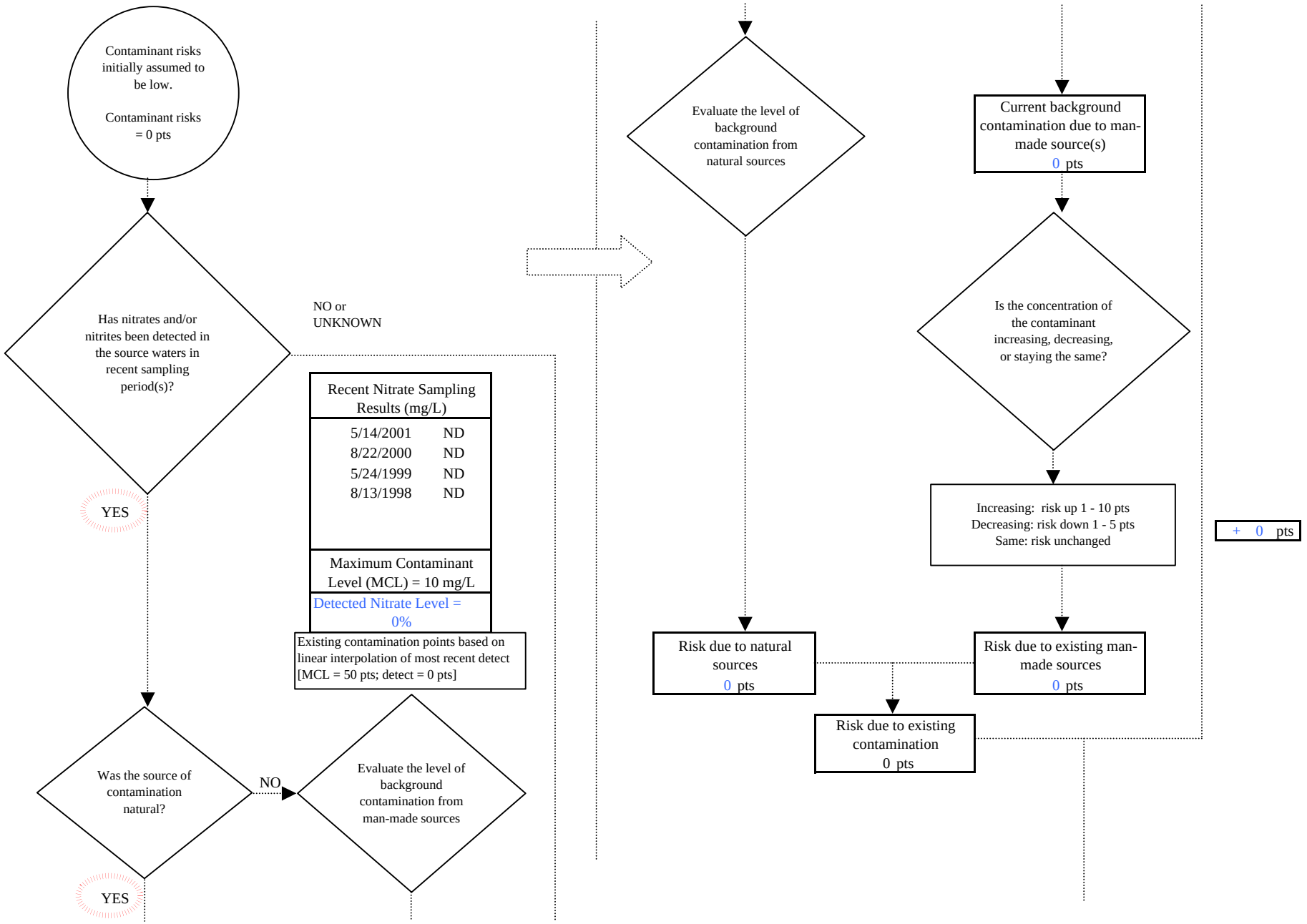


Chart 5. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Nitrates and Nitrites

+ 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)	4	1	5

	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.

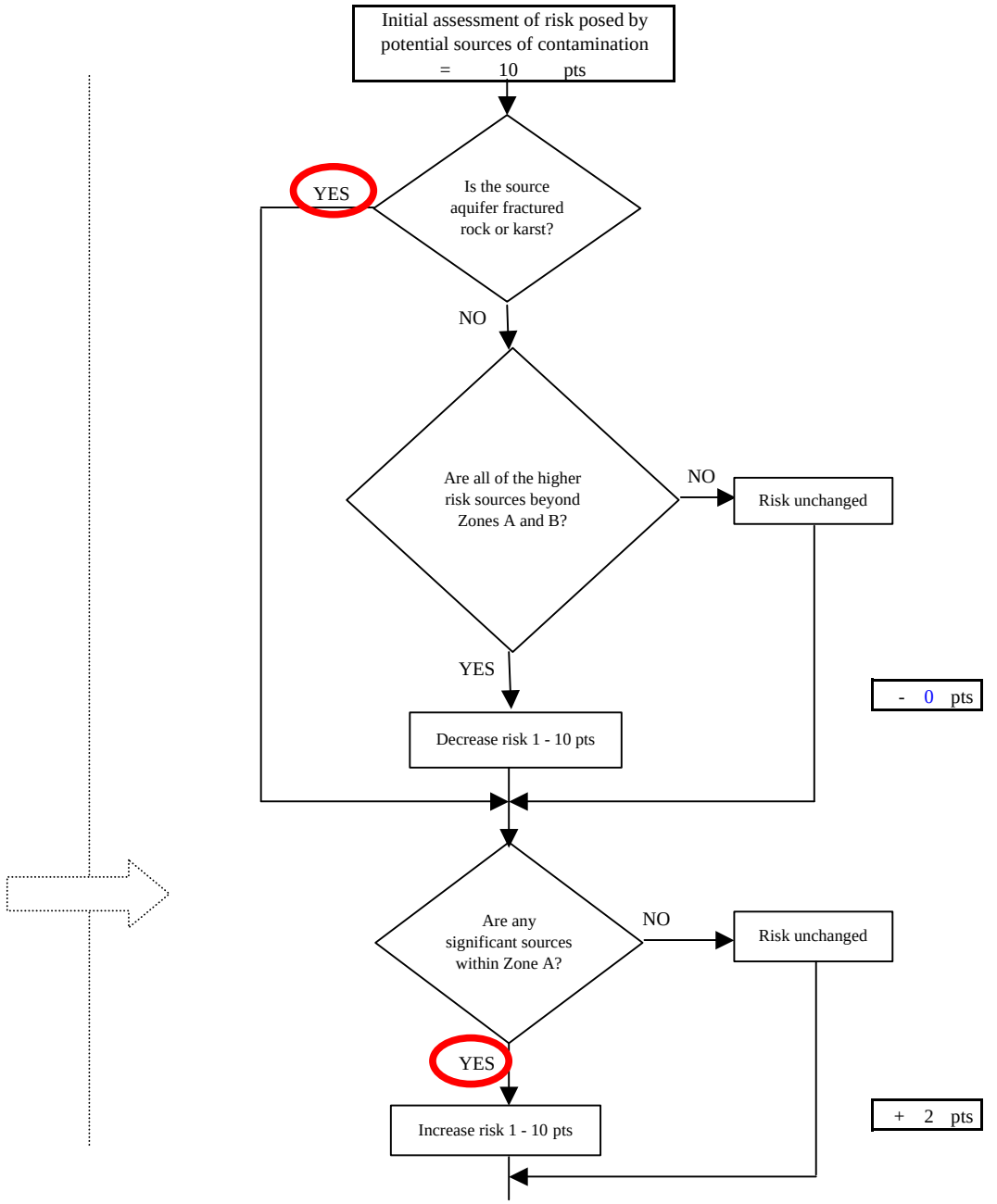


Chart 5. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Nitrates and Nitrites

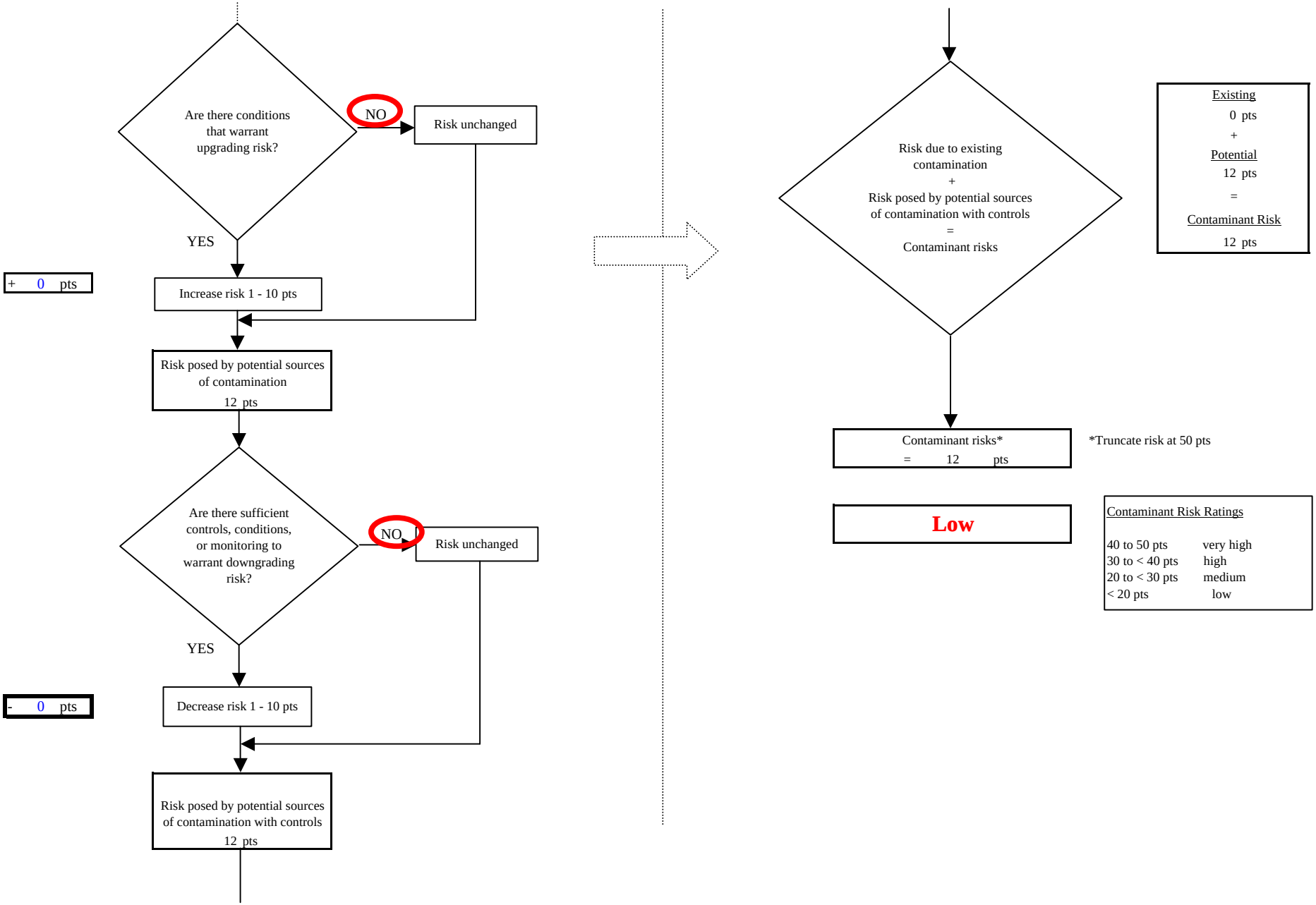


Chart 6. Vulnerability analysis for USFWS KNWR Lower Skilak Lake (241274.001) - Nitrates and Nitrites

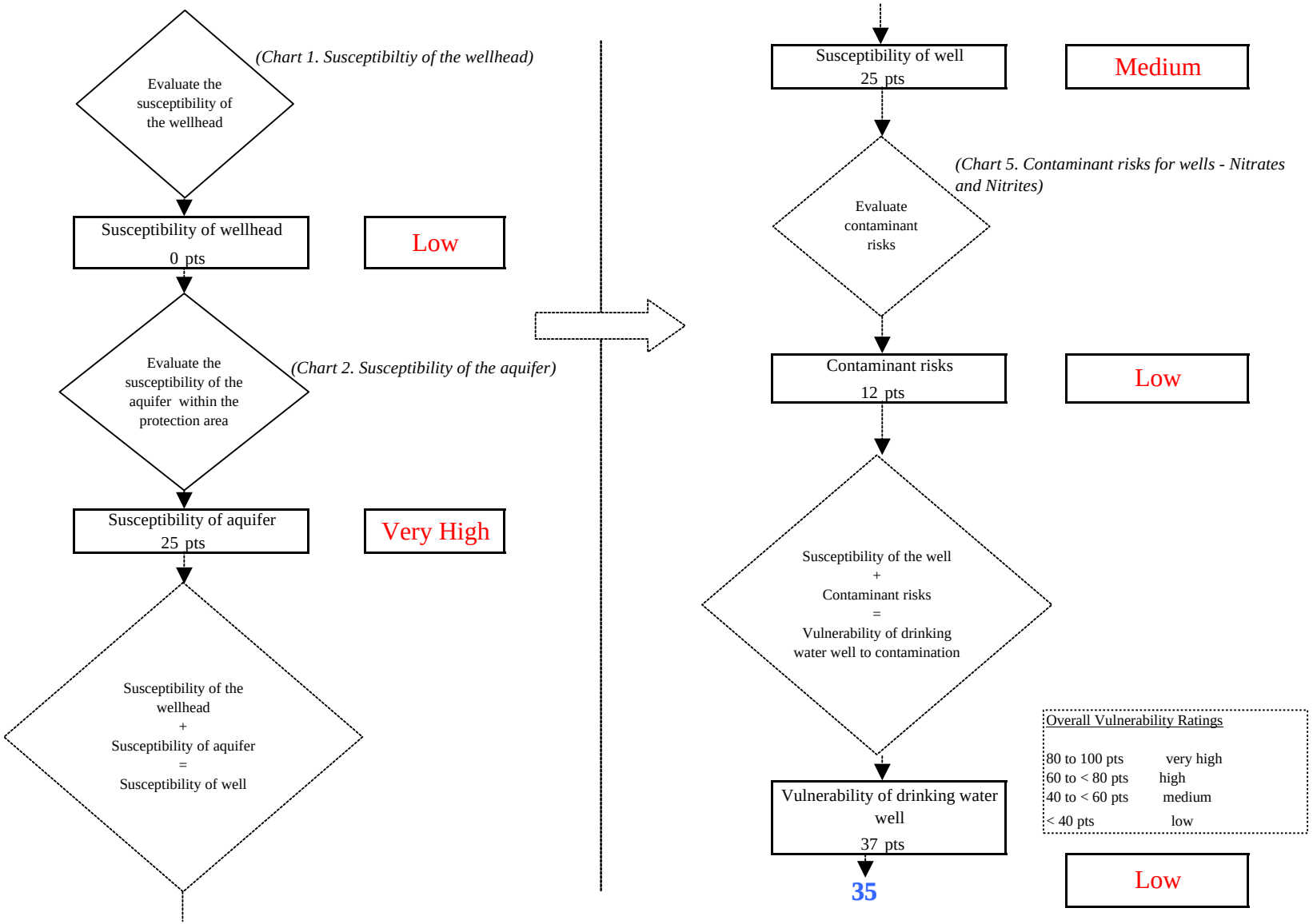


Chart 7. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Volatile Organic Chemicals

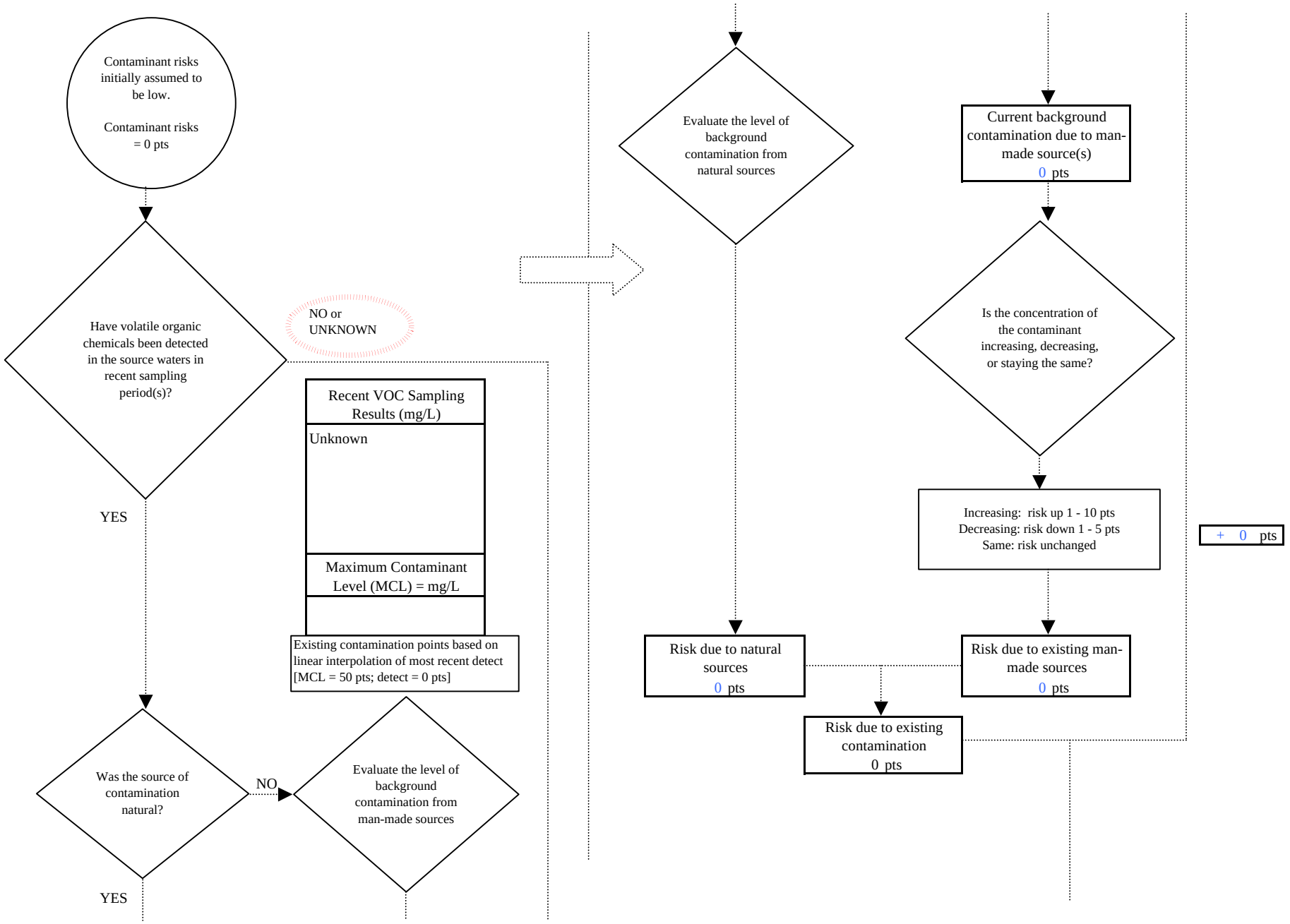
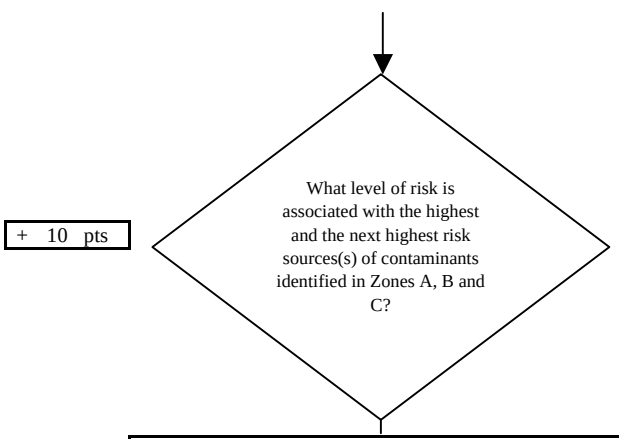


Chart 7. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Volatile Organic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	1	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.

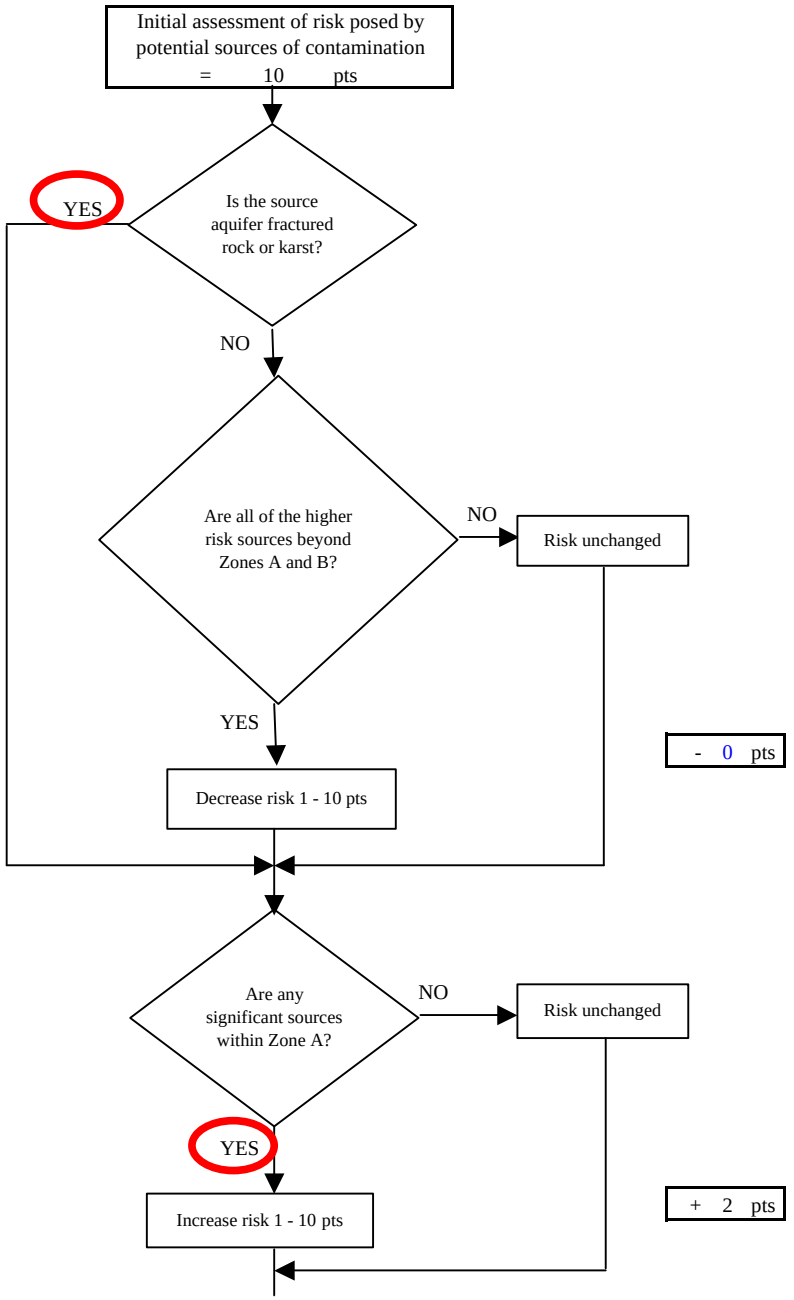


Chart 7. Contaminant risks for USFWS KNWR Lower Skilak Lake (241274.001) - Volatile Organic Chemicals

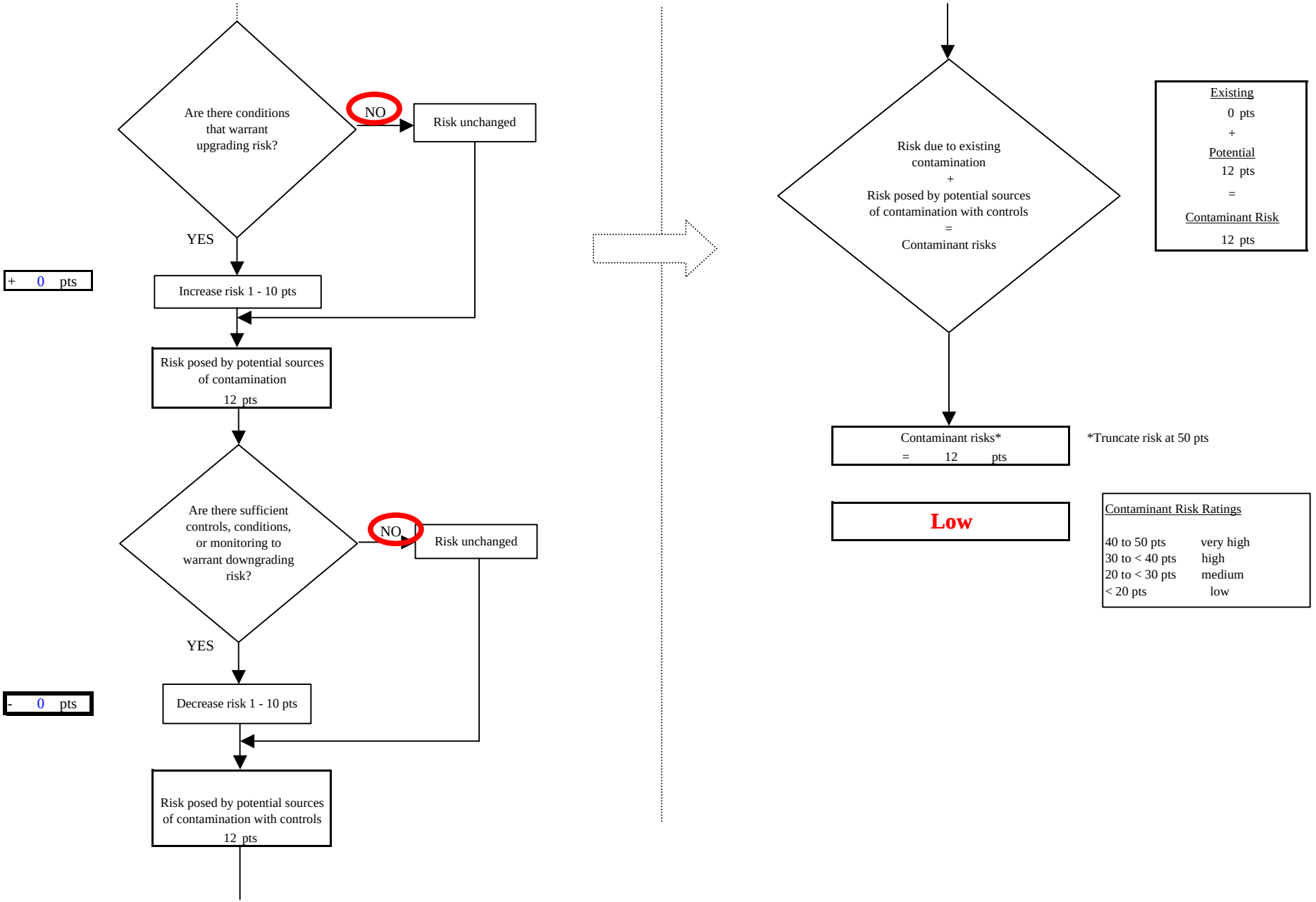


Chart 8. Vulnerability analysis for USFWS KNWR Lower Skilak Lake (241274.001) - Volatile Organic Chemicals