Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Tikchik Narrows Lodge

Tikchik Narrows Lodge, Alaska

PWSID #261648.001

January 2004

Drinking Water Protection Program Report #1189

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 (EPA), the 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 that 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 the Tikchik Narrows Lodge Water System, Tikchik Narrows Lodge, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The water system for Tikchik Narrows Lodge, Alaska, is a Class B surface water system that obtains water from Tikchik and Nuyukuk Lakes. Water from the lakes is chlorinated, filtered, and stored in six plastic 300-gallon storage tanks near the pumphouse. The storage tanks have a combined volume of 1,800 gallons. Water from the storage tanks is piped to the cabins and lodge where it is filtered again before consumption.

The Tikchik Narrows Lodge protection area is approximately 5,000 square miles in size and has received a susceptibility rating of **High**. *A rating of High to Very High is typical for all systems with surface water intakes*. Potential and existing sources of the following contaminants were evaluated for the Source Water Assessment: bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

Known potential contaminant sources are located within the surface water protection area and include motor vehicle repair shops, sewage lagoons, landfills, mines, heating oil tanks, cemeteries, bulk fuel facilities, power generation facilities, ADEC contaminated sites and airports. These sources may affect drinking water at the source and could potentially influence sampling results. Samples were collected from post-treated water. Contaminant sources identified within the surface water protection area for this public water system have been considered in order to provide the most conservative evaluation.

This evaluation included all available water sampling data submitted to the Alaska Department of Environmental Conservation (ADEC) by the system operator. As stated previously, the samples were collected from post-treated water. Vulnerability ratings for the water system have been determined by combining the susceptibility of the surface water source with the contaminant risks. The system received a vulnerability rating of **High** in the nitrates and nitrites contaminant category, and **Very High** in the bacteria and viruses, and volatile organic chemicals categories.

This assessment can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Tikchik Narrows Lodge to protect public health.

DRINKING WATER SYSTEM AND AREA OVERVIEW

Tikchik Narrows Lodge is located on a peninsula separating Tikchik and Nuyukuk Lakes in Tikchik State Park. The lodge is open seasonally from May 15th to October 1st and serves 55 to 60 people on a weekly basis. The lodge was built in 1969 on top of a rocky knoll at the tip of the peninsula, surrounded on three sides by water. The lodge is isolated with the closest community being Koliganek, about 50 miles southeast. In the Tikchik Narrows area, temperatures range from 37 to 66°F in the summer to 4 to 30°F in the winter (ADOT&PF 1979).

The water system is a Class B surface water system that operates seasonally from May 15th to October 1st and obtains water from the Tikchik and Nuyukuk Lakes, which surrounds the lodge. Water is piped from the lakes to the nearby pump house where it is first treated with chlorine and then sent through a 10-micron and a 5-micron filter. The treated water is stored at the pumphouse in six 300-gallon plastic storage tanks. Water is pumped from the storage tanks to lodge and cabins where it is run through a 1-micron filter before consumption.

Information acquired from a June 2003 sanitary survey for the public water system indicated that the surface water intake is adequately constructed. The intake is maintained and screened. The average daily production of the system is unknown.

This area consists of ancient glacial moraines and outwash mantles which extend from the coast of Bristol Bay, north and east towards the Alaska Mountain Range. In the vicinity of the village, the sands and gravels of the ancient moraines are overlain by a thin layer of organic material. The organic layer ranges in depth from 2 to 4 feet thick. Permafrost is

discontinuous in the area, and isolated ice lenses and scattered zones of permafrost are present (B&B 1992).

TIKCHIK NARROWS LODGE DRINKING WATER PROTECTION AREA

Identifying the pathways most likely for surface contamination to reach water intake areas is the first step in determining the water system's risk. These pathways are initially determined by looking at the drainage area contributing overland water flow to a surface water source intake. The entire drainage area is also known as the "drinking water protection area." Please refer to pages 10-11 of the "Guidance Manual for Class B Public Water Systems" for additional information.

The protection area established for surface water sources by the ADEC is usually separated into three zones. These zones correspond to the overland-flow distance that water travels to get to the source. The ADEC Drinking Water Protection Program's Technical Advisory Committee developed guidelines for derivation of these zones in 1998. The following is a summary of the three protection area zones:

Table 1. Definition of Zones

Zone	Definition
A	Areas within 1000-ft of lakes or streams
B	Areas within 1-mile of lakes or streams
C	The watershed boundary

The protection area for the Tikchik Narrows Lodge water intake includes each of these Zones (See Map A 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 Tikchik Narrows Lodge surface water protection area. This inventory was completed through a search of agency records and other publicly available information. There is a wide array of potential contamination sources to surface water. These contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For Class B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

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

Numerous contaminant sources were identified in the Tikchik Narrows Lodge protection area as displayed on Maps C and D of Appendix C and in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

Once potential and existing sources of contamination have been identified, they are assigned a ranking according to what category and level of risk they represent. Ranking of contaminant risks for "potential" or "existing" sources of contamination is a function of the toxicity and the volume of specific contaminants associated with that source. Rankings include:

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

The time-of-travel for contaminants within the water is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zone A because of their short life span. Only "Very High" and "High" rankings are inventoried within Zones B and C due to the probability of contaminant dilution by the time the contaminants reach the water intake.

The remaining tables in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF THE DRINKING WATER SYSTEM

Vulnerability of a drinking water source to contamination is a combination of two factors:

- Surface Water Susceptibility and
- Contaminant risks.

Appendix D contains 7 charts, which together form the 'Vulnerability Analysis' for the public drinking water Source Water Assessment. Chart 1 analyzes the 'Susceptibility of the Surface Water Source' to contamination by looking at the climate, terrain, and intake location. Chart 2 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 intake area. Chart 3 contains the 'Vulnerability Analysis for Bacteria and Viruses,' which is a composite score of the Vulnerability Analysis and the overall Susceptibility. Charts 4 through 7 repeat the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

A score for the Surface Water Susceptibility of the source is reached by considering the properties of the water intake and the surrounding area. The derivation of this information is presented below and the data for this source is shown in Chart 1 of Appendix D.

Susceptibility of the Surface Water Source – always considered to be "high" (30 points)

+

Adequate Construction of the Intake (0 – 5 Points)

+

Runoff Potential Within Zone B (0 – 5 Points)

+

Dilution Capacity of the Surface Water (0 – 10 Points)

=

Natural Susceptibility
(0 – 50 Points)

A ranking is assigned for the Surface Water Susceptibility according to the point score:

Surface Water Source Susceptibility Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High

Table 2. Susceptibility of the Water Source

	Score	Rating
Minimum Allowable Susceptibility	30	
Intake Construction Adequate	0	
Runoff Potential	2	
Dilution Capacity	0	
Overall Susceptibility	***32***	***High***

For contaminants, risks to a drinking water source depend on the type, number or density, and distribution of the contaminant sources. The Contaminant Risk score has been derived from an examination of existing, and historical contamination sources that have been detected in the protection area 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 the 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. Tikchik Narrows Lodge Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	46	Very High
Volatile Organic Chemicals	50	Very High

Finally, an overall vulnerability score is assigned for each contaminant type by combining each of the contaminant risk scores with the susceptibility score:

Susceptibility of the Surface Water Source

(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 and ratings for each of the six categories of drinking water

contaminants. Note: scores are rounded off to the nearest five.

Table 4. Tikchik Narrows Lodge Water System Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	80	Very High
Nitrates and Nitrites	75	High
Volatile Organic Chemicals	80	Very High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High**. The contaminant risk for bacteria and viruses is primarily attributed to the presence of bacteria in recent sampling results and the presence of the wastewater lagoon and landfill in Zone A (see Table 2 – Appendix B).

Coliforms (a bacteria) are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli, which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2003). Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination. Typically, coliform detection in raw water samples collected from surface water sources is normal. (See Chart 2 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Positive bacteria counts were reported in recent (previous 5 years) sampling events and were confirmed with follow-up samples in 2001.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the source, the overall vulnerability of the source to bacteria and virus contamination is **Very High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High** (See Chart 4 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Several potential contaminant risk sources for nitrates were identified in the protection area for this public water system. The contaminate risk is primary attributed to the presence of the landfill and wastewater treatment lagoon in Zone A (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately the same rate as water. The Maximum Contaminant Level (MCL) for nitrates is 10 milligrams per liter (mg/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 (EPA, 2003).

Although low concentrations of nitrates have been reported in recent sampling history, none of the concentrations exceed the MCL of 10 mg/L.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the source, the overall vulnerability of the source to contamination remains **High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Very High** (see Chart 6 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). Numerous potential contaminant sources for volatile organic chemicals were identified in the protection area for this public water system. The contaminate risk is primary attributed to the presence of three bulk fuel terminals in Zone A and partially attributed to numerous other contaminant sources in Zones A and B (see Table 4 – Appendix B).

Review of the historical sampling data found no recent sampling results for volatile organic chemicals.

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the source, the overall vulnerability of the source to contamination remains **Very High**.

Using the Source Water Assessment

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 Tikchik Narrows Lodge 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 drinking water source.

REFERENCES

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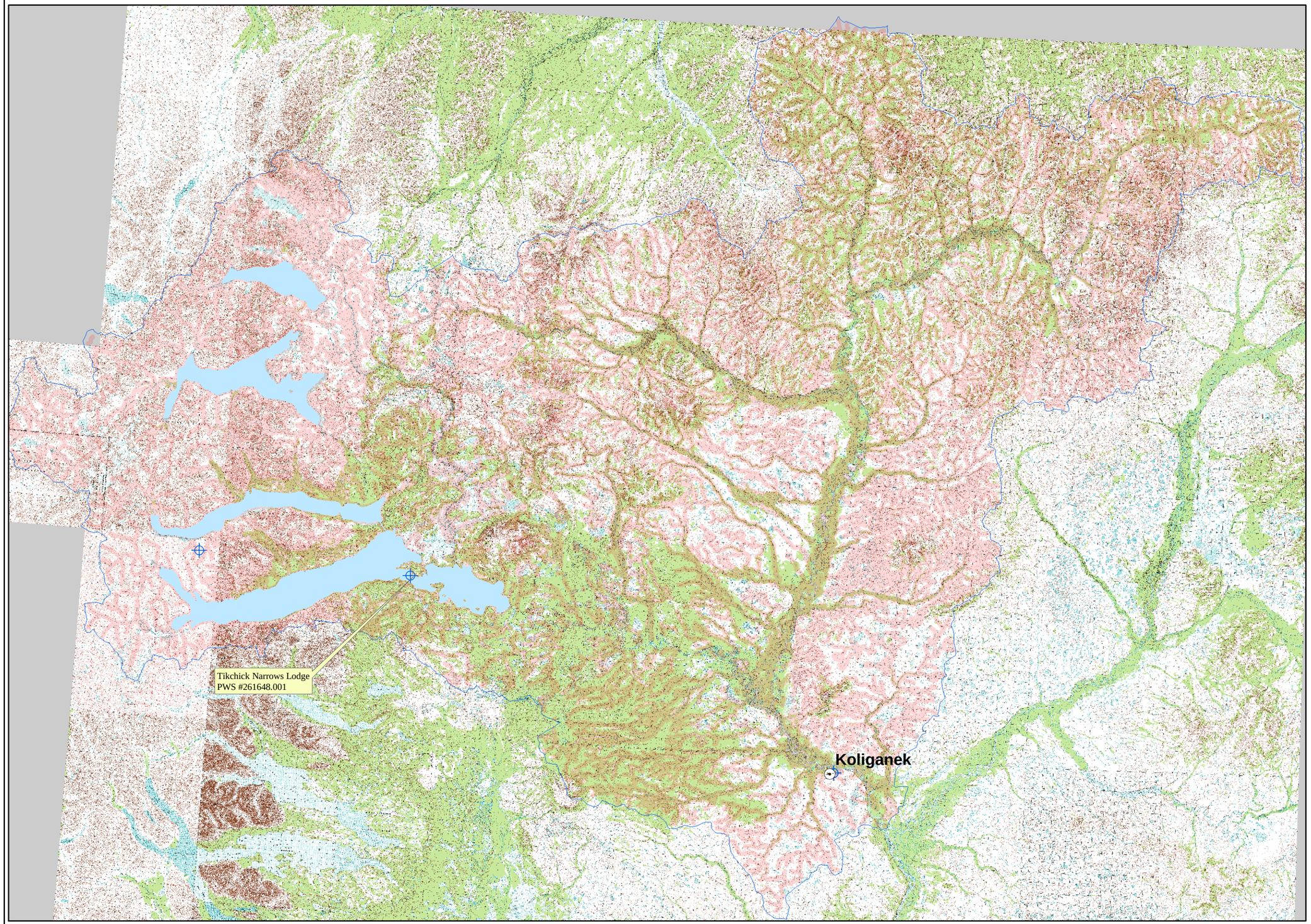
APPENDIX A

Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #261648.001 Tikchick Narrows Lodge



LEGEND

- Public Water System Well

Surface Water Protection Zones

- Zone A – 1000 Feet from Surface Water
- Zone C – Watershed Boundary

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours (approx. 50 ft. or as indicated)

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)

Critical Facilities
Federal Emergency Management Agency (FEMA)

All other data
United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC published document:
"Alaska Drinking Water Protection Progarm - Guidance Manual for
Class A Public Water Systems"

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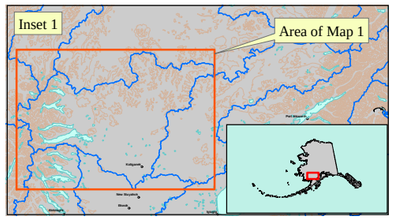


0 3.75 7.5 15 22.5 30 Miles

APPENDIX B

Contaminant Source Inventory and Risk Rankings (Tables 1-4)

Table 1

Contaminant Source Inventory for ***Tikchik Narrows Lodge***

PWSID 261648.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Motor /motor vehicle repair shops	C31	C31-01	A	C	Village Shop
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	C	Sewage Lagoon
Landfills (municipal; Class III)	D51	D51-01	A	C	Koliganek Landfill (municipal, Class III)
Metals mining, placer (active or inactive?)	E04	E04-01	A	C	Caribou Creek
Metals mining, placer (active or inactive?)	E04	E04-02	A	C	King Salmon River
Metals mining, placer (active or inactive?)	E04	E04-03	A	C	McGeary Creek
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	Power Generation Facility
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	Koliganek Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	C	Bristol Bay Telephone Company
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	C	Village Council Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-09	A	C	Police Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-10	A	C	Post Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-11	A	C	ATT
Tanks, heating oil, nonresidential (aboveground)	T14	T14-12	A	C	GCI
Tanks, heating oil, nonresidential (aboveground)	T14	T14-13	A	C	School
Water supply wells	W09	W09-01	A	C	Resevoir/Water Supply
Cemeteries	X01	X01-01	A	C	Cemetery #1
Cemeteries	X01	X01-02	A	C	Cemetery #2

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Municipal or city parks (with green areas)	X04	X04-01	A	C	School Playground
Petroleum product bulk station/terminals	X11	X11-01	A	C	Electric Utility
Petroleum product bulk station/terminals	X11	X11-02	A	C	School
Petroleum product bulk station/terminals	X11	X11-03	A	C	Village Council
Electric power generation (fossil fuels)	X36	X36-01	A	C	Power Generation Facility
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	C	Koliganek Clinic
Metals mining, placer (active or inactive?)	E04	E04-04	B	C	Tickchick Mt.
Quarries (sand, gravel, rock, other?)	E10	E10-03	B	C	
Quarries (sand, gravel, rock, other?)	E10	E10-04	B	C	
Quarries (sand, gravel, rock, other?)	E10	E10-05	B	C	
Quarries (sand, gravel, rock, other?)	E10	E10-10	B	C	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-01	B	C	Koliganek Village Council Office Building
Water supply wells	W09	W09-02	B	C	Koligenak Water System
Municipal or city parks (with green areas)	X04	X04-02	B	C	Wood-Tikchik State Park
Airports	X14	X14-01	B	C	Koliganek Landing Strip

Table 2

Contaminant Source Inventory and Risk Ranking for Tikchik Narrows Lodge Sources of Bacteria and Viruses

PWSID 261648.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	Sewage Lagoon
Landfills (municipal; Class III)	D51	D51-01	A	High	C	Koliganek Landfill (municipal, Class III)
Municipal or city parks (with green areas)	X04	X04-01	A	Medium	C	School Playground
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Medium	C	Koliganek Clinic

Table 3

Contaminant Source Inventory and Risk Ranking for Tikchik Narrows Lodge Sources of Nitrates/Nitrites

PWSID 261648.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	Sewage Lagoon
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	Koliganek Landfill (municipal, Class III)
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	Low	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	Low	C	
Cemeteries	X01	X01-01	A	Medium	C	Cemetery #1
Cemeteries	X01	X01-02	A	Medium	C	Cemetery #2
Municipal or city parks (with green areas)	X04	X04-01	A	Medium	C	School Playground
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Koliganek Clinic

Table 4

Contaminant Source Inventory and Risk Ranking for Tikchik Narrows Lodge
Sources of Volatile Organic Chemicals

PWSID 261648.001

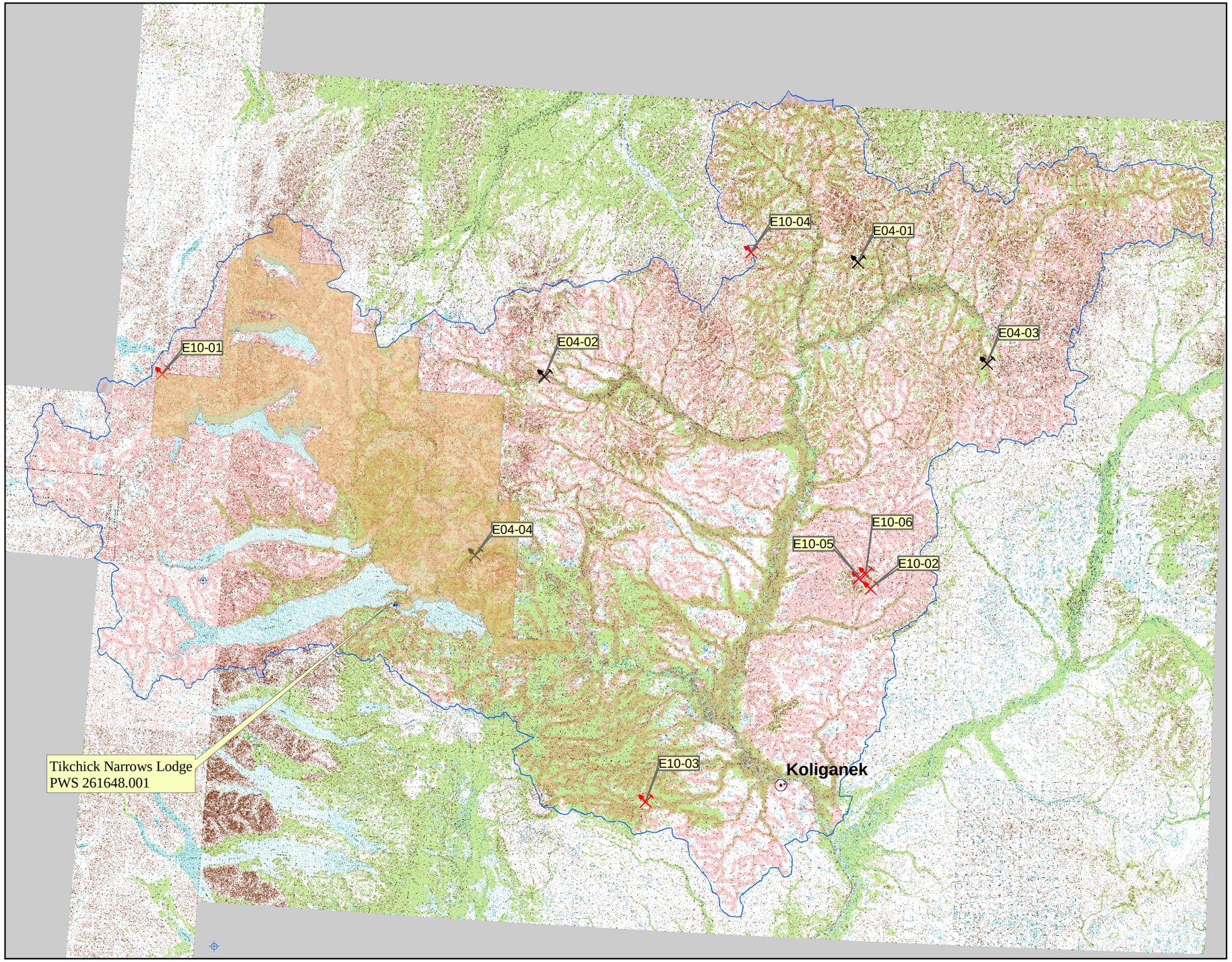
Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	Village Shop
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	Sewage Lagoon
Landfills (municipal; Class III)	D51	D51-01	A	High	C	Koliganek Landfill (municipal, Class III)
Quarries (sand, gravel, rock, other?)	E10	E10-01	A	Low	C	
Quarries (sand, gravel, rock, other?)	E10	E10-02	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	Power Generation Facility
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Koliganek Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	Low	C	Bristol Bay Telephone Company
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	Low	C	Village Council Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-09	A	Low	C	Police Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-10	A	Low	C	Post Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-11	A	Low	C	ATT
Tanks, heating oil, nonresidential (aboveground)	T14	T14-12	A	Low	C	GCI
Tanks, heating oil, nonresidential (aboveground)	T14	T14-13	A	Low	C	School
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	Electric Utility
Petroleum product bulk station/terminals	X11	X11-02	A	Very High	C	School
Petroleum product bulk station/terminals	X11	X11-03	A	Very High	C	Village Council
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	Power Generation Facility
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Koliganek Clinic

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Quarries (sand, gravel, rock, other?)	E10	E10-04	B	High	C	
Quarries (sand, gravel, rock, other?)	E10	E10-05	B	High	C	
Quarries (sand, gravel, rock, other?)	E10	E10-10	B	High	C	
Airports	X14	X14-01	B	High	C	Koliganek Landing Strip

APPENDIX C

Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps C and D)

Public Water Well System for PWS #261648.001 Tikchick Narrows Lodge
Showing Potential and Existing Sources of Contamination



LEGEND

Public Water System Well

Surface Water Protection Zones

- Zone A – 1000 Feet from Lake Boundary
- Zone C – Entire Watershed

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours (approx. 50 ft. or as indicated)

Transportation

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

Potential Contaminant Sources

- Placer Mine (E04)
- Other Mine (E10)
- Parks (with green areas) (X04)

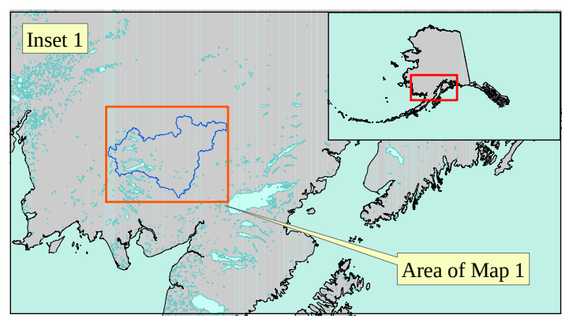
Data Sources:
Contaminant Sources, Public Water System Wells, Contours
Alaska Department of Environmental Conservation (ADEC)

Critical Facilities
Federal Emergency Management Agency (FEMA)

All other data
United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC published document:
"Alaska Drinking Water Protection Progarm - Guidance Manual for
Class A Public Water Systems"

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

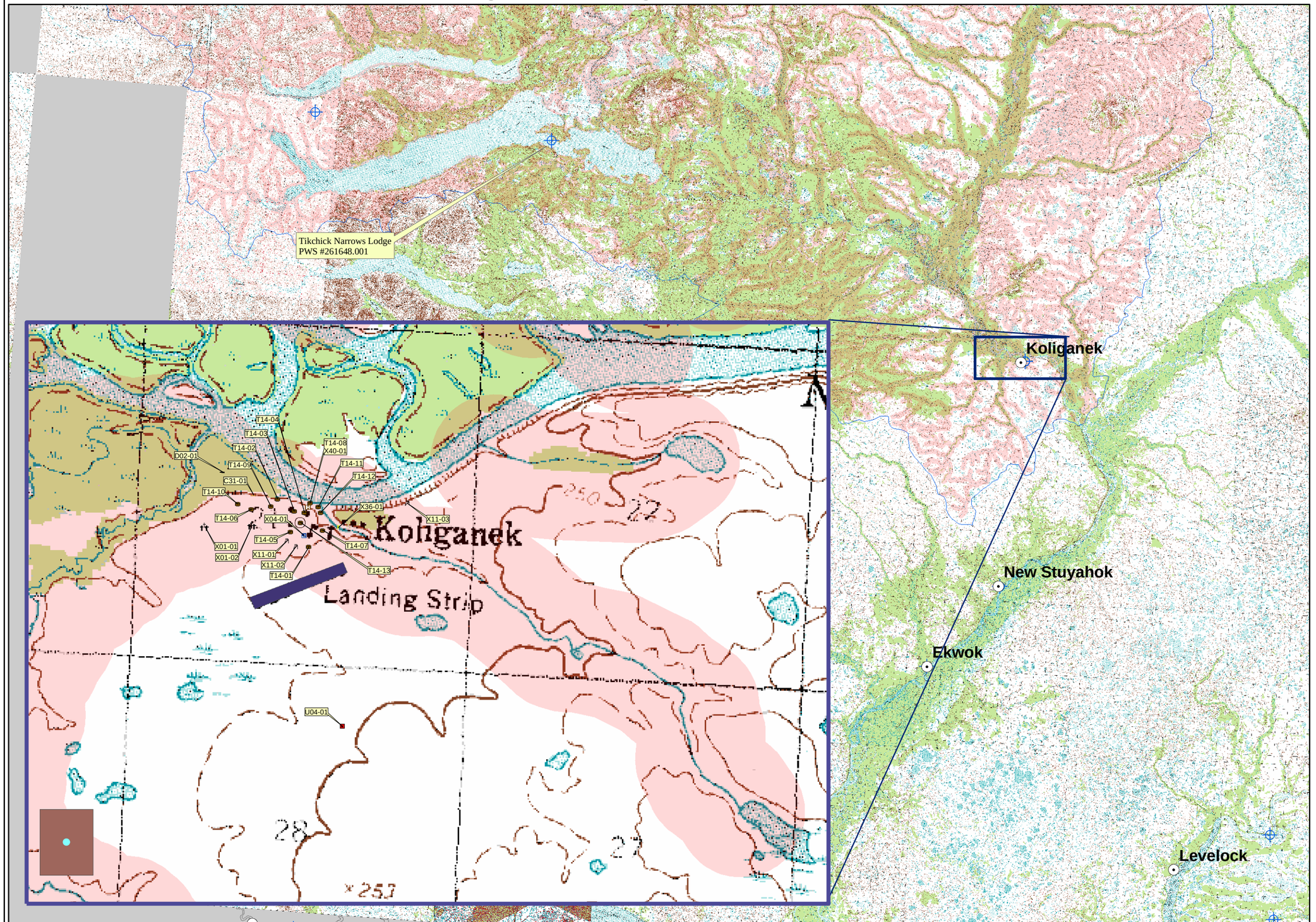


N
W E
S

0 5 10 20 30 40 Miles

Tikchick Narrows Lodge PWS 261648.001
Appendix C MAP C

Public Water Well System for PWS #261648.001 Tikchick Narrows Lodge
Showing Potential and Existing Sources of Contamination



LEGEND

- Public Water System Well

Surface Water Protection Zones

- Zone A – 1000 Feet from Surface Water
- Zone C – Watershed Boundary

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours (approx. 50 ft. or as indicated)

Transportation

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

Potential Contaminant Sources

- Service/Maintenance Shop (C31)
- Sewage Lagoon (D02)
- Aboveground fuel storage tank (non-residential) (T14)
- Contaminated sites, DEC recognized, non-Superfund, non-RCRA (U04)
- Cemetery (X01)
- Parks (with green areas) (X04)
- Fuel Storage >500 gallons (X11)
- Power Generation Facility (X36)
- Hospital/Clinic/ER (X40)
- Landfill (Municipal, Class III) (D51)
- Airports/Landing Strip (X14)

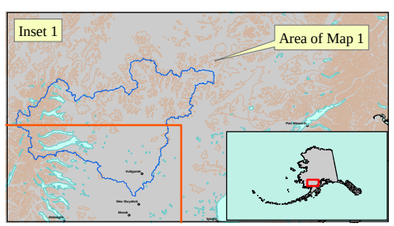
Data Sources:
Contaminant Sources, Public Water System Wells, Contours
Alaska Department of Environmental Conservation (ADEC)

Critical Facilities
Federal Emergency Management Agency (FEMA)

All other data
United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC published document:
"Alaska Drinking Water Protection Progarm - Guidance Manual for
Class A Public Water Systems"

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



0 3.5 7 14 21 28 Miles

Tikchick Narrows Lodge PWS 261648.001
Appendix C Map D

APPENDIX D

Vulnerability Analysis and Contaminant Risks
(Charts 1-7)

Chart 1. Susceptibility of the Surface Water Source - Tikchick Narrows Lodge (PWS No. 261648.001)

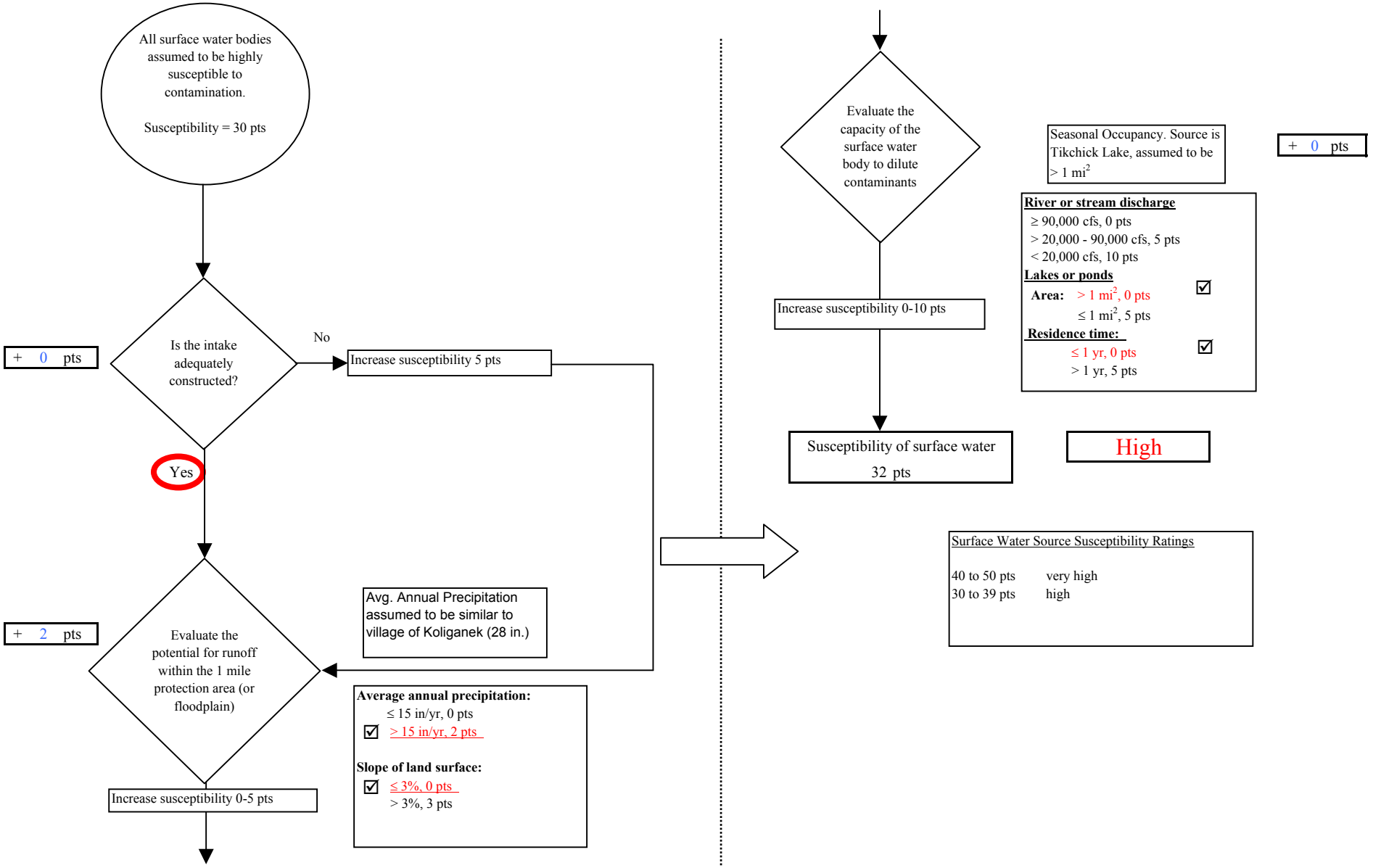
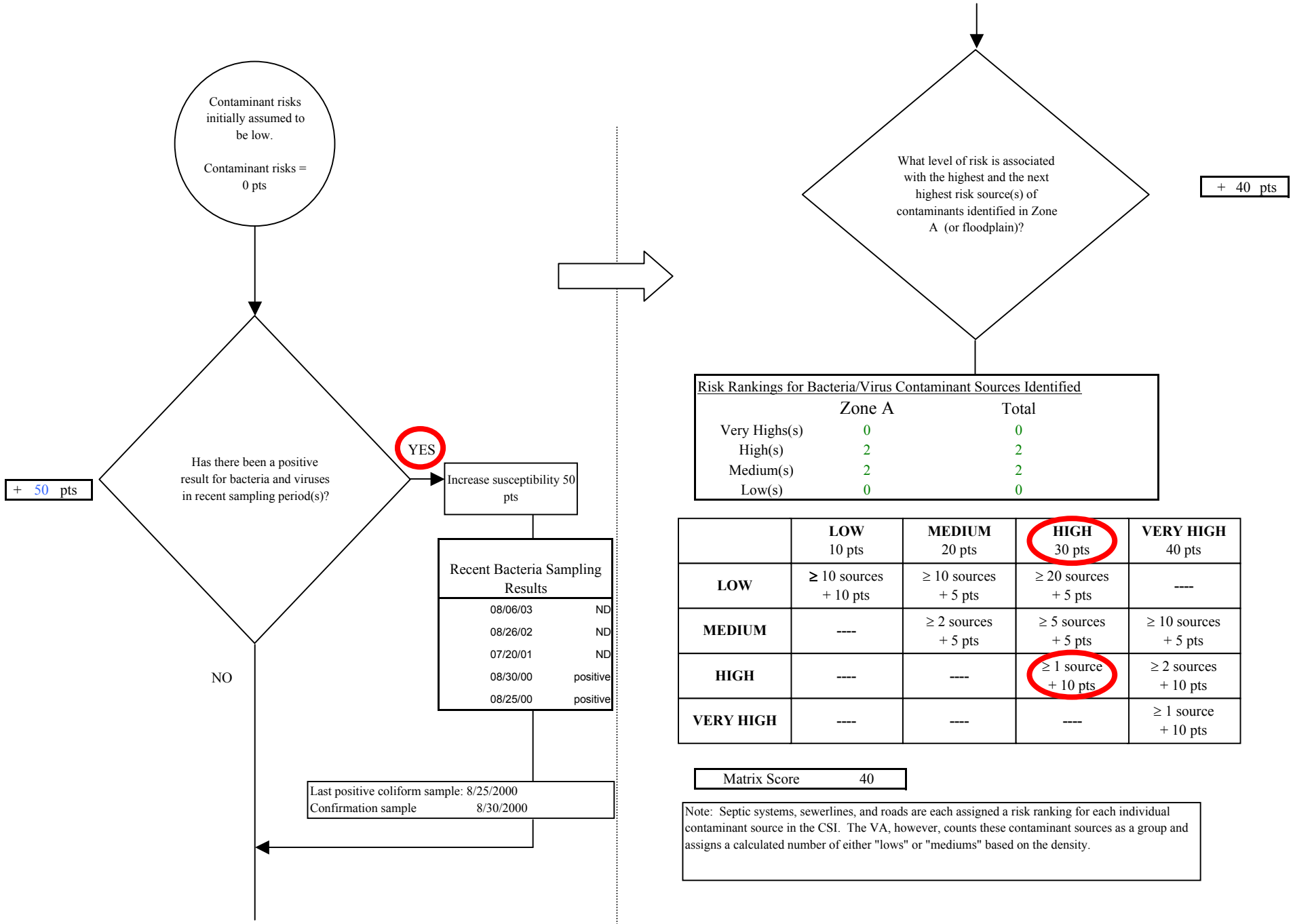


Chart 2. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Bacteria & Viruses



Risk Rankings for Bacteria/Virus Contaminant Sources Identified

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

	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

Matrix Score 40

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 2. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Bacteria & Viruses

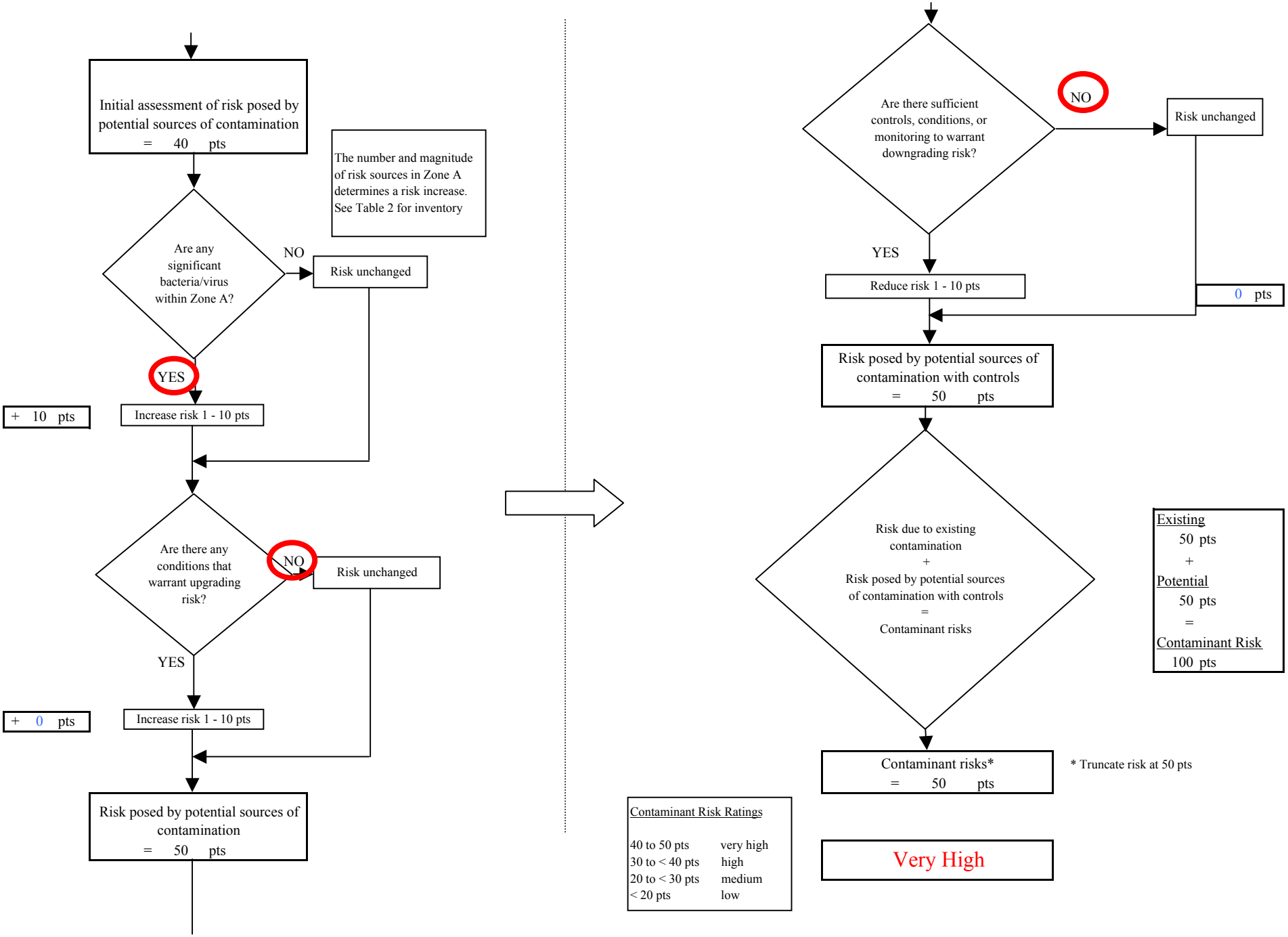


Chart 3. Vulnerability analysis for Tikchick Narrows Lodge (PWS No. 261648.001) - Bacteria & Viruses

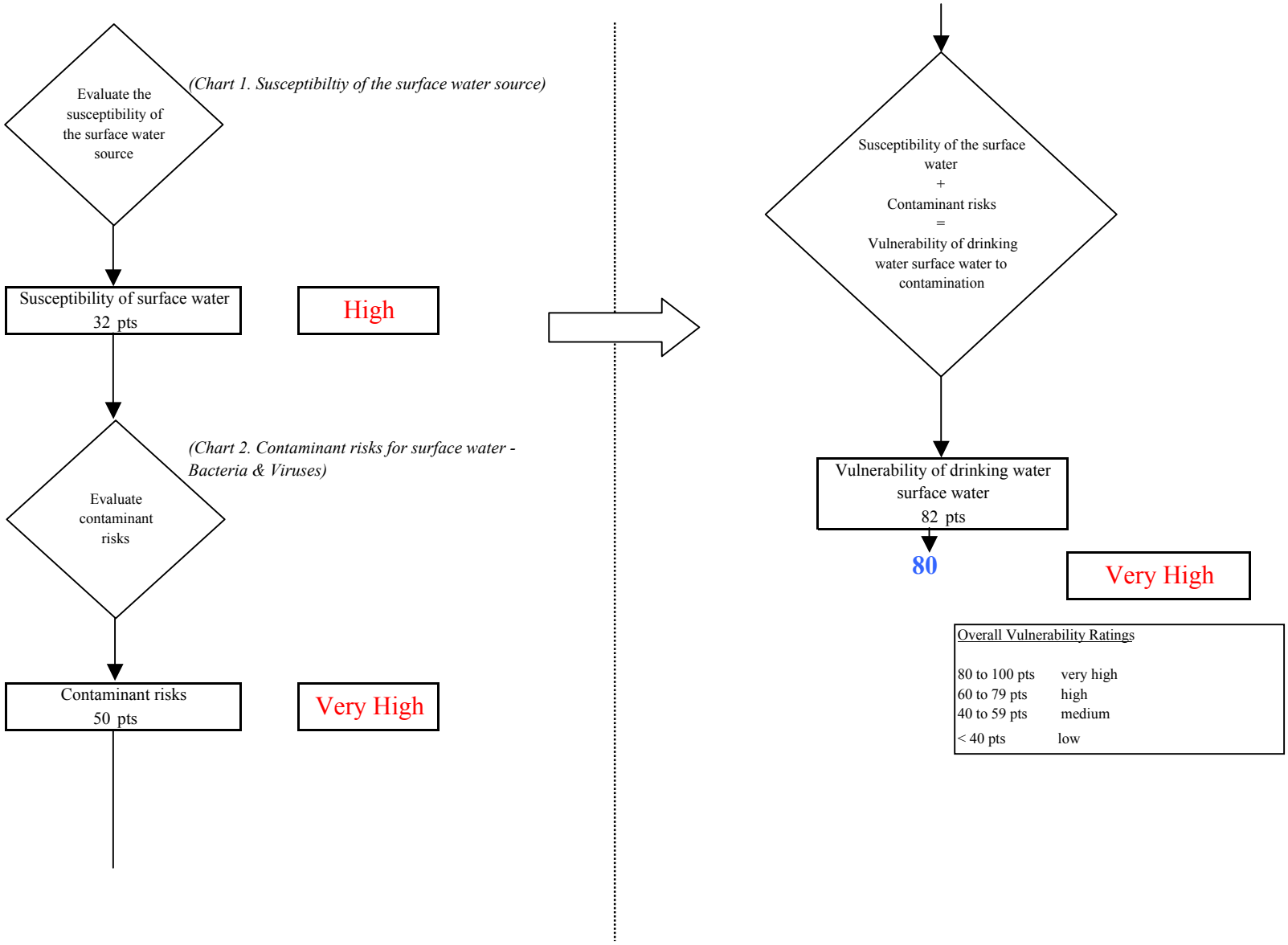


Chart 4. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Nitrates and Nitrites

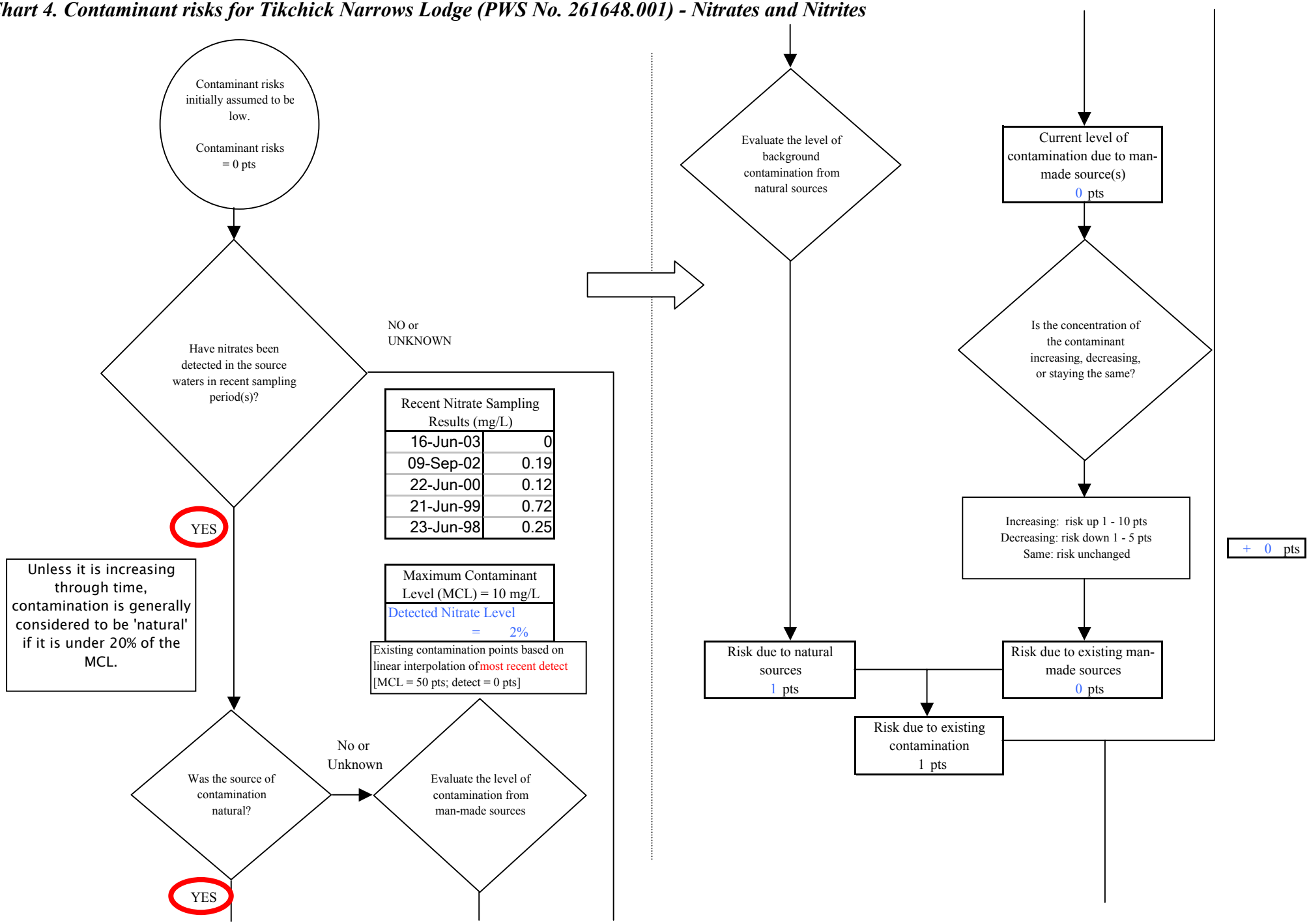


Chart 4. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Nitrates and Nitrites

+ 40 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A and B? (see Risk Matrix below)

Initial assessment of risk posed by potential sources of contamination = 40 pts

Are any significant nitrate/nitrite sources in Zone A?

NO → Risk unchanged → + 10 pts

YES → Increase risk 1 - 10 pts

The number and magnitude of risk sources in Zone A determines a risk increase. See Table 3 for inventory

Risk Levels for Nitrate/Nitrite Sources identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	1	0	1
High(s)	1	0	1
Medium(s)	3		3
Low(s)	3		3

	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

Matrix Score 40

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 4. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Nitrates and Nitrites

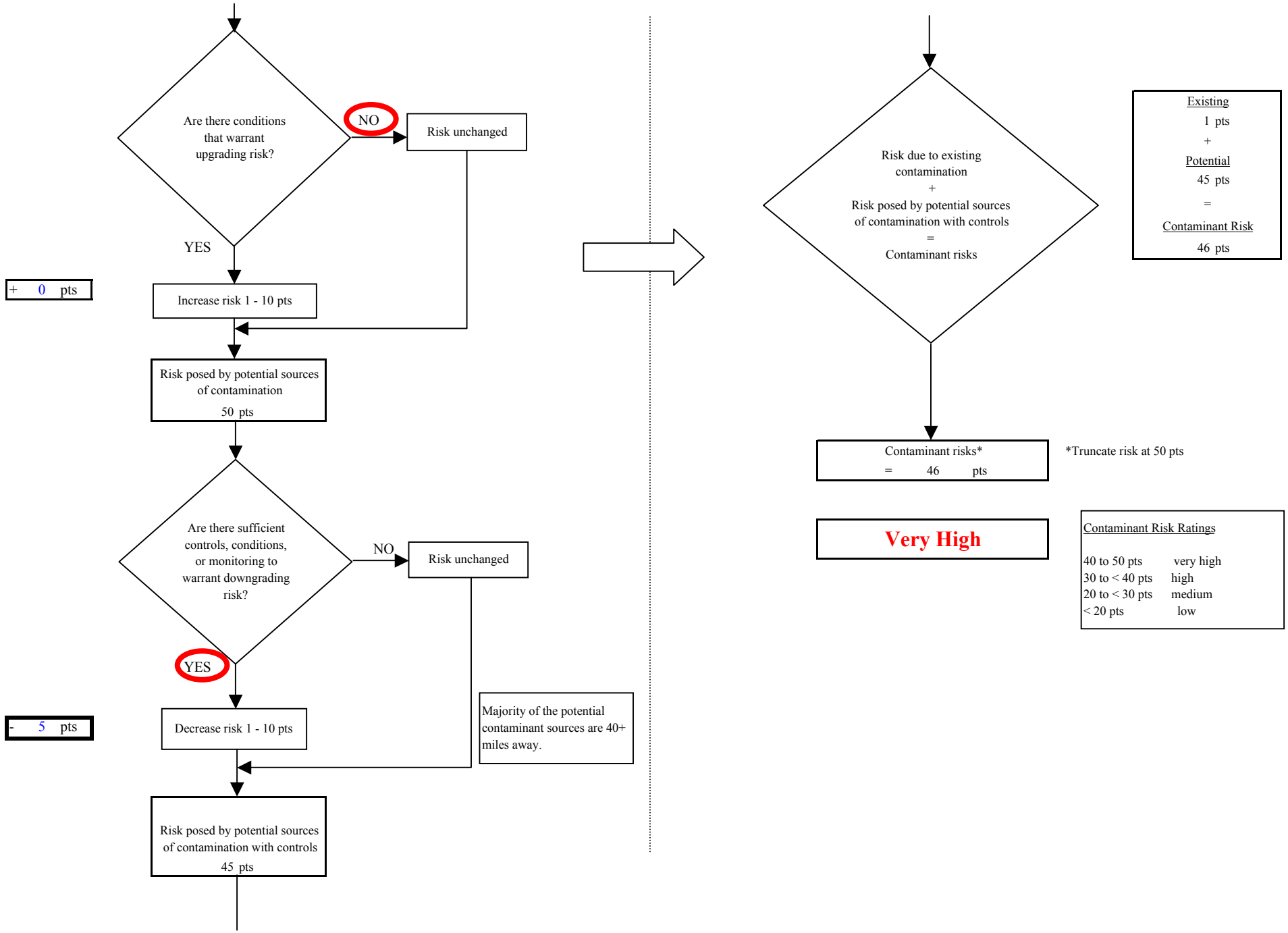


Chart 5. Vulnerability analysis for Tikchick Narrows Lodge (PWS No. 261648.001) - Nitrates and Nitrites

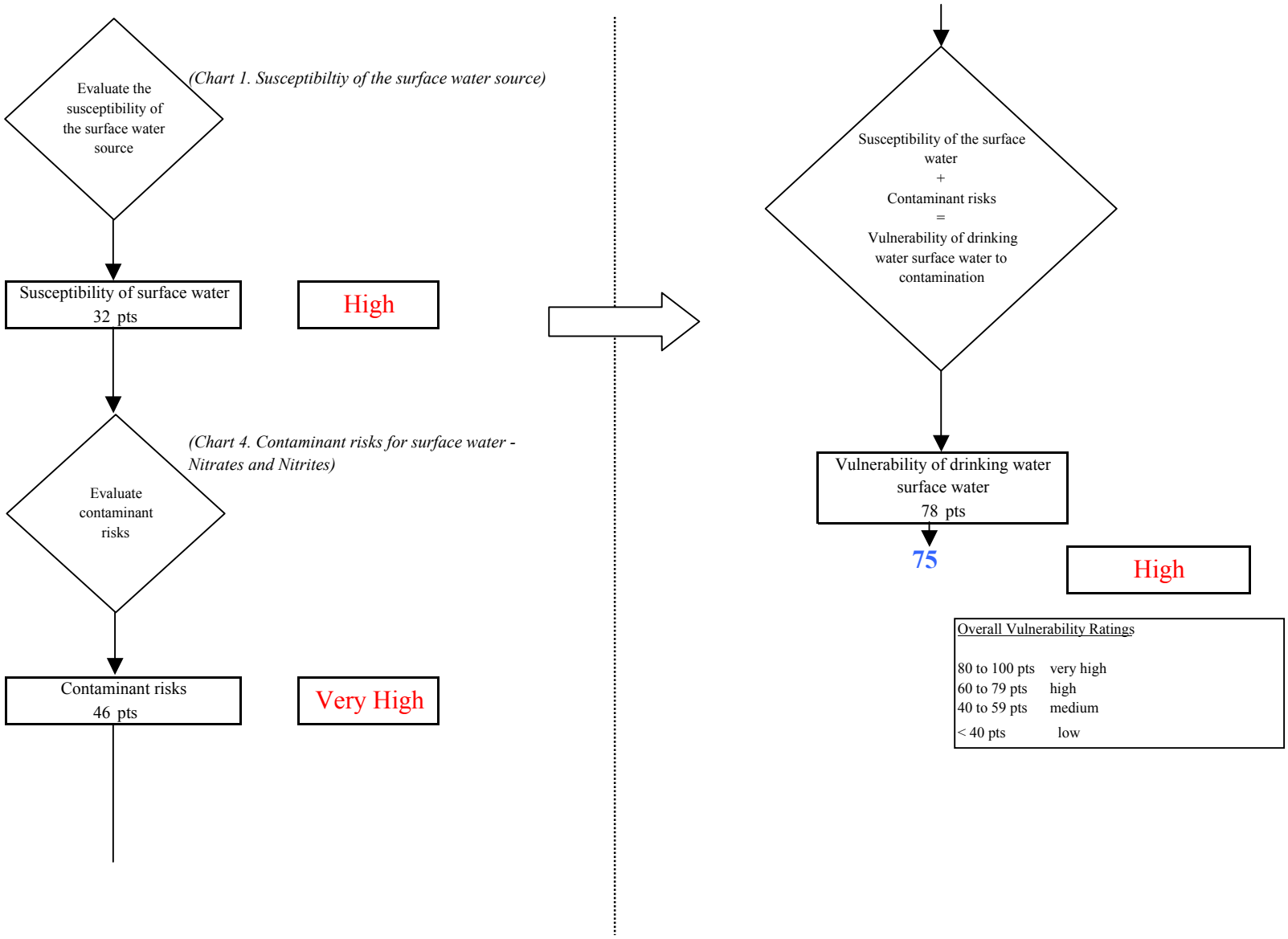


Chart 6. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Volatile Organic Chemicals

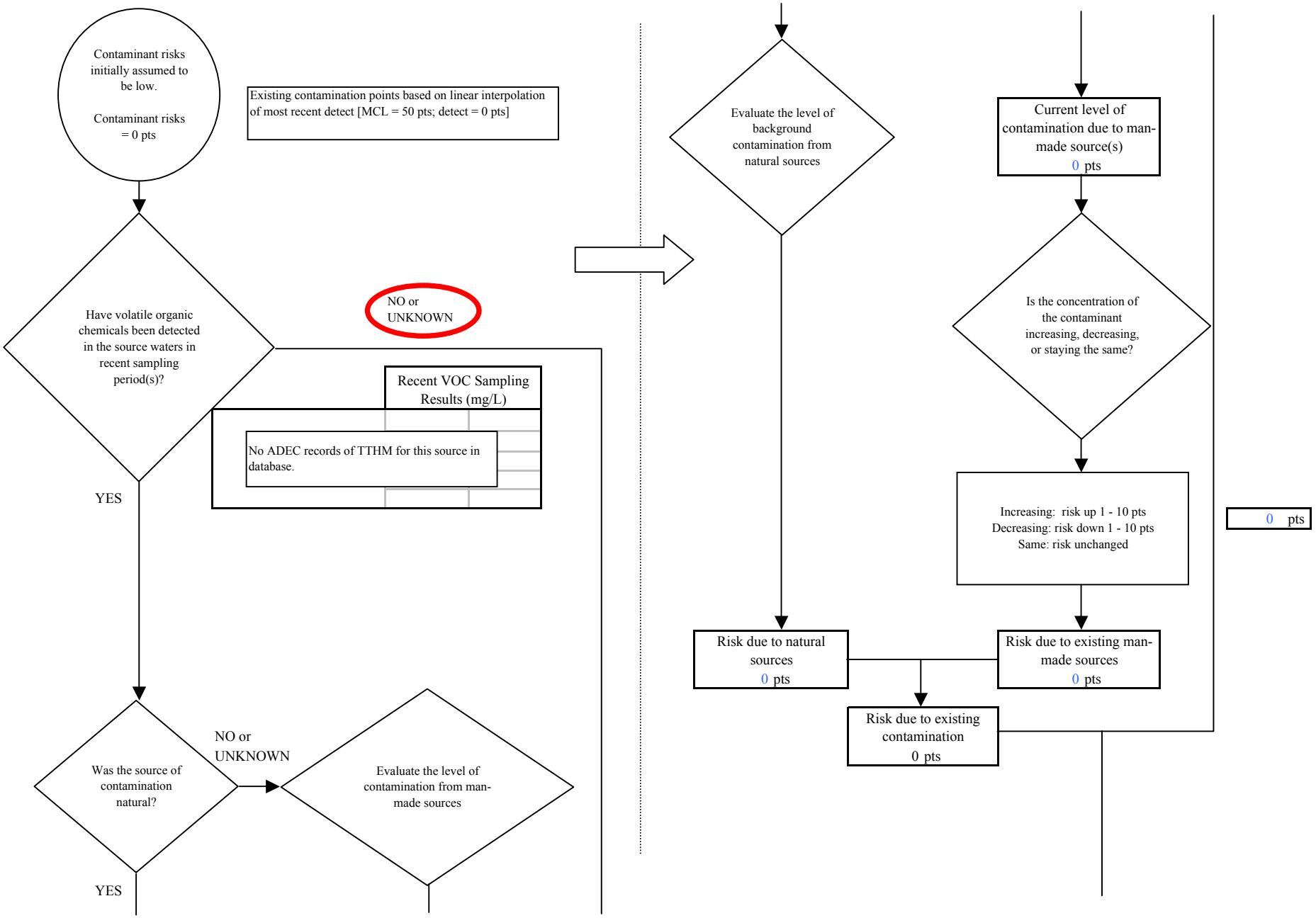


Chart 6. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Volatile Organic Chemicals

+ 50 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A and B? (see Risk Matrix below)

Risk Levels for VOC Sources identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	3	0	3
High(s)	1	4	5
Medium(s)	2		2
Low(s)	17		17

	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

Matrix Score 50

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 = 50 pts

Are any significant VOC sources in Zone A?

NO → Risk unchanged → + 10 pts

YES

The number and magnitude of risk sources in Zone A determines a risk increase. See Table 3 for inventory

Increase risk 1 - 10 pts

Chart 6. Contaminant risks for Tikchick Narrows Lodge (PWS No. 261648.001) - Volatile Organic Chemicals

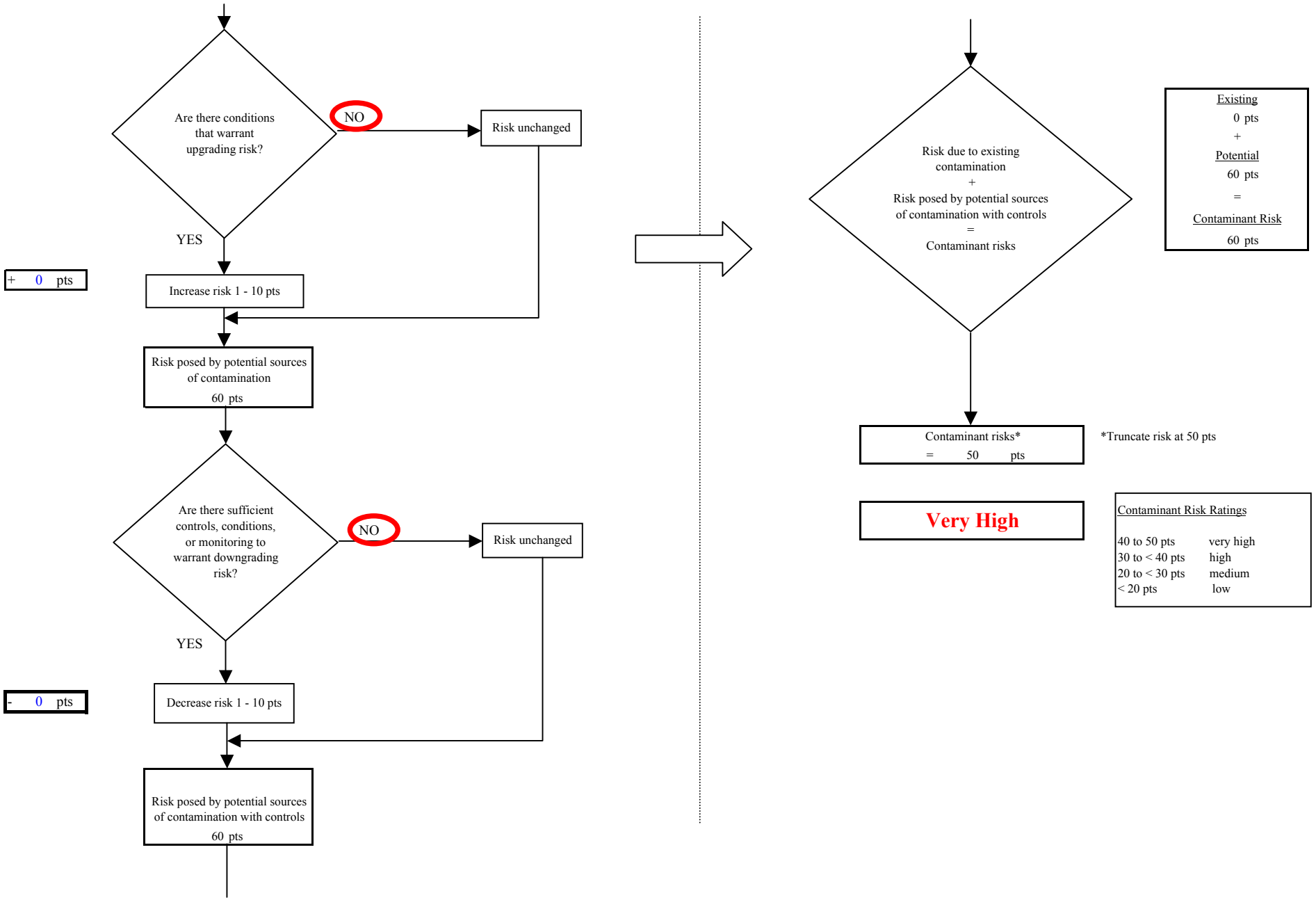


Chart 7. Vulnerability analysis for Tikchick Narrows Lodge (PWS No. 261648.001) - Volatile Organic Chemicals