Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Bettles Lodge Drinking Water System, Bettles, Alaska

PWSID # 300581.001

June 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1320
Alaska Department of Environmental Conservation

Source Water Assessment for
Bettles Lodge
Drinking Water System
Bettles, Alaska

PWSID # 300581.001

DRINKING WATER PROTECTION PROGRAM REPORT 1320

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.

CONTENTS

TABLES

APPENDICES

Source Water Assessment for Bettles Lodge Source of Public Drinking Water, Bettles, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Bettles Lodge has one Public Water System (PWS) well. It is assumed that the well (PWSID# 300581.001) has been used as a drinking water source since it was drilled in approximately 1988.

The well is a Class B (transient/non-community) water system located in Bettles Lodge, in Bettles, Alaska. Available records did not reveal any information regarding secondary storage of drinking water nor treatment of drinking water. This system operates year round and serves approximately 25 non-residents and 4 residents through five service connections. The wellhead received a susceptibility rating of **Very High** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produce a **Very High** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for the primary public drinking water source include, but are not limited to: gasoline stations, laundromats without dry cleaning, motor vehicle repair shops, underground gasoline and diesel tanks, aboveground heating oil tanks, and roads. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the water well received a vulnerability rating of **Very High** for the bacteria and viruses, a vulnerability rating of **Very High** for nitrates and nitrites, and a vulnerability rating of **Very High** for volatile organic chemicals contaminant categories.

BETTLES LODGE PUBLIC DRINKING WATER SYSTEM

The Bettles Lodge well is a Class B (transient/non-community) public water system. The well is located in Bettles Lodge, in Bettles, Alaska (Sec. 16, T024N, R019W, Fairbanks Meridian; see Map A of Appendix A). Bettles is located about 180 air miles and 250 road miles northwest of Fairbanks, adjacent to Evansville and just north of the Kanuti National Wildlife Refuge. The community has a population of 33 (ADCED, 2003). Average annual precipitation in Bettles is 13.4 inches, with 77 inches of snow. Temperatures range from an average low of below 0°F in winter and an average high of 70°F in summer.

The community of Bettles obtains most of their water supply from individual wells. Most households have individual septic tanks and the remaining households utilize outhouses (ADCED, 2003). Bettles receives electrical power from Alaska Power Company, which is operated privately. Power generating facilities are fueled by diesel sources. Refuse is collected by individuals and transported to the landfill located in and operated by the community of Bettles (ADCED, 2003).

According to information supplied by ADEC for the Bettles Lodge PWS, the depth of the primary water well is 40 feet below the ground surface. The well is not screened and based on well construction details for surrounding wells in the area, it is assumed that the well is unconfined. Unconfined aquifers are more susceptible to groundwater impacts resulting from the downward migration of surface contaminants. The well is located within a floodplain.

Information acquired from a September 2001 sanitary survey for the public water system indicated that the land surface was sloped away from the well. Generally, land surfaces that slope away from the wellhead promote surface water drainage, which reduces potential of contaminant migration down the well casing annulus. It is unknown if the well is grouted according to ADEC regulations, but is assumed not to be. Proper grouting provides added protection against contaminants traveling along the well casing annulus and into source waters.

Bettles is separated from the Brooks Range to the north by a major east-trending fault. It is near the limit of the Pleistocene glaciation by Brooks Range glaciers. Alluvial and glacial-fluvial sediments in the Koyukuk River Valley and surrounding lowlands characterize the surficial geology. Discontinuous permafrost occurs in the alluvial sediments of the Koyukuk River Valley and may be absent in close proximity to large water bodies. Soils are classified

as inceptisols Lowland soils are derived from the silty alluvium and loess of the Koyukuk River Valley. A thick, peaty surface mat is present above the saturated active layer. Freezing and thawing of the active layer produces an irregular land surface. Where present, the underlying permafrost is usually ice-rich. Similar soils and found in the uplands, but are usually more gravelly and loamy in texture (Cowan, 1995).

BETTLES LODGE 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 protection area 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 for the Bettles Lodge PWS. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (Freeze and Cherry, 1979). Available geology and groundwater contours were also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

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 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 the Bettles Lodge PWS was determined using an analytical calculation and includes Zones A, B, C, and D (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 Bettles Lodge 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 C 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 time-of-travel 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 THE BETTLES LODGE 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

The Bettles Lodge's water well is completed in an unconfined aquifer. Unconfined aquifers are more susceptible to potential groundwater quality impacts posed by the migration of surface water contaminants downward from the surface. Table 2 shows the susceptibility scores and ratings for this PWS.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	25	Very High
Susceptibility of the Aquifer	15	High
Natural Susceptibility	40	Very 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	40	Very High
Nitrates and/or Nitrites	50	Very High
Volatile Organic Chemicals	50	Very High

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	90	Very High
Nitrates and Nitrites	90	Very High
Volatile Organic Chemicals	90	Very High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High**. The risk is primarily attributed to the presence of a landfill located 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.

No positive bacteria counts have been reported in recent (within five years) sampling events (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.

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

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High**. The risk to this source of public drinking water is primarily attributed to the presence a landfill in Zone A (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately the same rate as water. The sampling history for this well indicates that nitrates have not been detected in recent sampling events. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L; therefore, nitrate concentrations above 2 mg/L may be indicative of man-made sources (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Nitrate levels are often derived from the decomposition of organic matter in soils. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to nitrate and nitrite contamination is **Very High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the presence of aboveground heating oil tanks, a landfill, and a gasoline station located in Zone A. Other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

No recent sampling data was available in ADEC records for Bettles Lodge (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **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 Bettles Lodge and the community of Bettles 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

Alaska Department of Community and Economic Development (ADCED), 2003 [WWW document]. URL: http://www.dced.state.ak.us/cbd/commdb/CF_COMDB.htm

Alaska Department of Environmental Conservation, Contaminated Sites Database, 2003 [WWW database], URL http://www.state.ak.us/dec/dspar/csites/cs_search.htm

Alaska Department of Environmental Conservation, Leaking Underground Storage Tank Database, 2003 [WWW database], URL http://www.dec.state.ak.us/spar/stp/ust/search/fac_search.asp

Cowan, James R. Overview of Environmental and Hydrogeologic Conditions at Bettles Field, Alaska. 1995. U.S. Geological Survey Open File Report 95-343 (prepared in cooperation with the FAA)

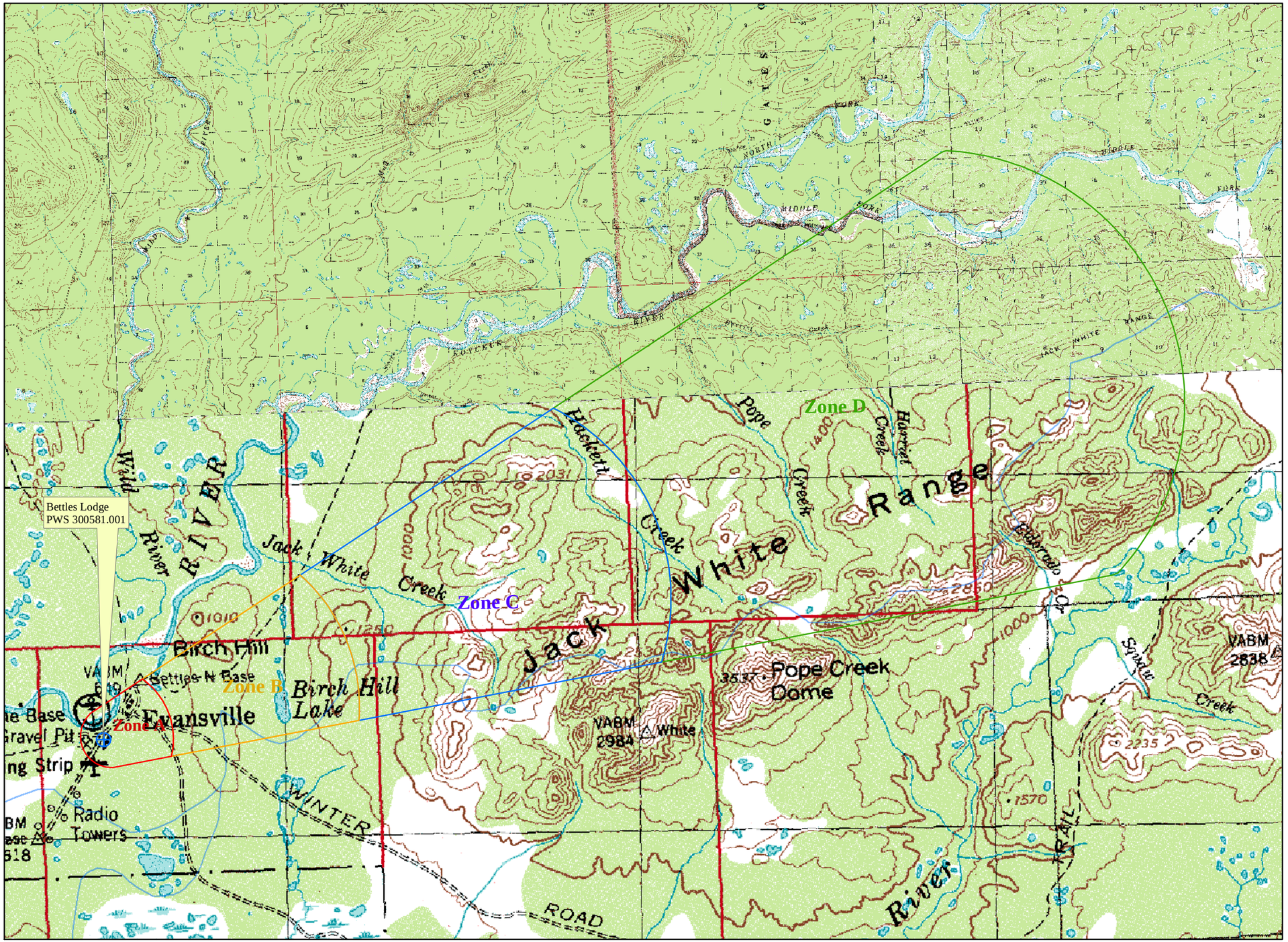
Freeze, R. A., and Cherry, J.A. 1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey

United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL http://www.epa.gov/safewater/mcl.html.

APPENDIX A

Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #300581.001 Bettles Lodge



LEGEND

- Public Water System Well

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours

Transportation

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

Groundwater Protection Zones

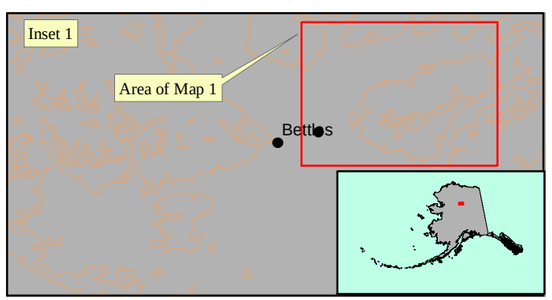
- Zone A Protection Area– Several Months Travel Time
- Zone B Protection Area– 2 Years Travel Time
- Zone C Protection Area– 5 Years Travel Time
- Zone D Protection Area– 10 Years Travel Time

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

All other data:
United States Geological Survey (USGS)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC

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



0 0.5 1 2 3 4 Miles

Bettles Lodge
PWS 300581.001

Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking (Tables 1-7)

Table 1

Contaminant Source Inventory for

Bettles Lodge

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Gasoline stations (without repair shop)	C15	C15-01	A	C	BETTLES LODGE, INC
Laundromats without dry cleaning	C22	C22-01	A	C	Washeteria
Motor /motor vehicle repair shops	C31	C31-01	A	C	Service/Maintenance Shop
Landfills (municipal; Class III)	D51	D51-01	A	C	Landfill/Incinerator
Tanks, diesel (underground)	T08	T08-01	A	C	BETTLES LODGE, INC
Tanks, gasoline (underground)	T12	T12-01	A	C	BETTLES LODGE, INC
Tanks, gasoline (underground)	T12	T12-02	A	C	BETTLES LODGE, INC
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	Power Generation Facility
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	Hospital/Clinic/ER
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	Radio Transmitter
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	C	Telephone
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	C	Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-09	A	C	Emergency Operations Center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-10	A	C	Emergency Shelter(s)
Tanks, heating oil, nonresidential (aboveground)	T14	T14-11	A	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-12	A	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-13	A	C	Museum
Tanks, heating oil, nonresidential (aboveground)	T14	T14-14	A	C	Offices

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Tanks, heating oil, nonresidential (aboveground)	T14	T14-15	A	C	Post Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-16	A	C	Satellite
Tanks, heating oil, nonresidential (aboveground)	T14	T14-17	A	C	School
Tanks, heating oil, nonresidential (aboveground)	T14	T14-18	A	C	Senior Center
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	C	BETTLES LODGE, INC
Cemeteries	X01	X01-01	A	C	Cemetery
Municipal or city parks (with green areas)	X04	X04-01	A	C	Park
Petroleum product bulk station/terminals	X11	X11-01	A	C	Fuel Storage Tanks (>500gal)
Petroleum product bulk station/terminals	X11	X11-02	A	C	Fuel Storage Tanks (>500gal)
Airports	X14	X14-01	A	C	Airport
Boat yards and marinas	X15	X15-01	A	C	Harbor/Dock/Port
Highways and roads, dirt/gravel	X24	X24-01	A	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	C	Power Generation Facility
Firehouses	X38	X38-01	A	C	Fire Station
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	C	Hospital/Clinic/ER
Highways and roads, dirt/gravel	X24	X24-02	B	C	Assume 1-20 roads in Zone B

Table 2

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

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Landfills (municipal; Class III)	D51	D51-01	A	High	C	Landfill/Incinerator
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	Low	C	BETTLES LODGE, INC
Municipal or city parks (with green areas)	X04	X04-01	A	Medium	C	Park
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Medium	C	Hospital/Clinic/ER
Highways and roads, dirt/gravel	X24	X24-02	B	Low	C	Assume 1-20 roads in Zone B

Table 3

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

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	Landfill/Incinerator
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	Low	C	BETTLES LODGE, INC
Cemeteries	X01	X01-01	A	Medium	C	Cemetery
Municipal or city parks (with green areas)	X04	X04-01	A	Medium	C	Park
Airports	X14	X14-01	A	Low	C	Airport
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Hospital/Clinic/ER
Highways and roads, dirt/gravel	X24	X24-02	B	Low	C	Assume 1-20 roads in Zone B

Table 4

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

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Gasoline stations (without repair shop)	C15	C15-01	A	High	C	BETTLES LODGE, INC
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	Service/Maintenance Shop
Landfills (municipal; Class III)	D51	D51-01	A	High	C	Landfill/Incinerator
Tanks, diesel (underground)	T08	T08-01	A	High	C	BETTLES LODGE, INC
Tanks, gasoline (underground)	T12	T12-01	A	High	C	BETTLES LODGE, INC
Tanks, gasoline (underground)	T12	T12-02	A	High	C	BETTLES LODGE, INC
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	Hospital/Clinic/ER
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Radio Transmitter
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Telephone
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	Low	C	Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	Low	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-09	A	Low	C	Emergency Operations Center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-10	A	Low	C	Emergency Shelter(s)
Tanks, heating oil, nonresidential (aboveground)	T14	T14-11	A	Low	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-12	A	Low	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-13	A	Low	C	Museum

Table 4 (continued)

Contaminant Source Inventory and Risk Ranking for Bettles Lodge

Sources of Volatile Organic Chemicals

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Tanks, heating oil, nonresidential (aboveground)	T14	T14-14	A	Low	C	Offices
Tanks, heating oil, nonresidential (aboveground)	T14	T14-15	A	Low	C	Post Office
Tanks, heating oil, nonresidential (aboveground)	T14	T14-16	A	Low	C	Satellite
Tanks, heating oil, nonresidential (aboveground)	T14	T14-17	A	Low	C	School
Tanks, heating oil, nonresidential (aboveground)	T14	T14-18	A	Low	C	Senior Center
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	High	C	BETTLES LODGE, INC
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	Fuel Storage Tanks (>500gal)
Petroleum product bulk station/terminals	X11	X11-02	A	Very High	C	Fuel Storage Tanks (>500gal)
Airports	X14	X14-01	A	High	C	Airport
Boat yards and marinas	X15	X15-01	A	Low	C	Harbor/Dock/Port
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	Power Generation Facility
Firehouses	X38	X38-01	A	Low	C	Fire Station
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Hospital/Clinic/ER
Highways and roads, dirt/gravel	X24	X24-02	B	Low	C	Assume 1-20 roads in Zone B

Table 5

Contaminant Source Inventory and Risk Ranking for Bettles Lodge

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Gasoline stations (without repair shop)	C15	C15-01	A	Low	C	BETTLES LODGE, INC
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	Service/Maintenance Shop
Landfills (municipal; Class III)	D51	D51-01	A	High	C	Landfill/Incinerator
Tanks, gasoline (underground)	T12	T12-01	A	Medium	C	BETTLES LODGE, INC
Tanks, gasoline (underground)	T12	T12-02	A	Medium	C	BETTLES LODGE, INC
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	Hospital/Clinic/ER
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Radio Transmitter
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Telephone
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	Low	C	Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	Low	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-09	A	Low	C	Emergency Operations Center
Tanks, heating oil, nonresidential (aboveground)	T14	T14-10	A	Low	C	Emergency Shelter(s)
Tanks, heating oil, nonresidential (aboveground)	T14	T14-11	A	Low	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-12	A	Low	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-13	A	Low	C	Museum
Tanks, heating oil, nonresidential (aboveground)	T14	T14-14	A	Low	C	Offices
Tanks, heating oil, nonresidential (aboveground)	T14	T14-15	A	Low	C	Post Office

Table 5 (continued)

Contaminant Source Inventory and Risk Ranking for Bettles Lodge

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Tanks, heating oil, nonresidential (aboveground)	T14	T14-16	A	Low	C	Satellite
Tanks, heating oil, nonresidential (aboveground)	T14	T14-17	A	Low	C	School
Tanks, heating oil, nonresidential (aboveground)	T14	T14-18	A	Low	C	Senior Center
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	Low	C	BETTLES LODGE, INC
Cemeteries	X01	X01-01	A	Low	C	Cemetery
Municipal or city parks (with green areas)	X04	X04-01	A	Low	C	Park
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	Fuel Storage Tanks (>500gal)
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Fuel Storage Tanks (>500gal)
Airports	X14	X14-01	A	Low	C	Airport
Boat yards and marinas	X15	X15-01	A	Low	C	Harbor/Dock/Port
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	Power Generation Facility
Firehouses	X38	X38-01	A	Low	C	Fire Station
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Hospital/Clinic/ER
Highways and roads, dirt/gravel	X24	X24-02	B	Low	C	Assume 1-20 roads in Zone B

Table 6

Contaminant Source Inventory and Risk Ranking for Bettles Lodge
Sources of Synthetic Organic Chemicals

PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	Landfill/Incinerator
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	Low	C	BETTLES LODGE, INC
Cemeteries	X01	X01-01	A	Medium	C	Cemetery
Municipal or city parks (with green areas)	X04	X04-01	A	Low	C	Park
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	Fuel Storage Tanks (>500gal)
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Fuel Storage Tanks (>500gal)
Airports	X14	X14-01	A	Medium	C	Airport
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Hospital/Clinic/ER

Table 7

Contaminant Source Inventory and Risk Ranking for Bettles Lodge

Sources of Other Organic Chemicals

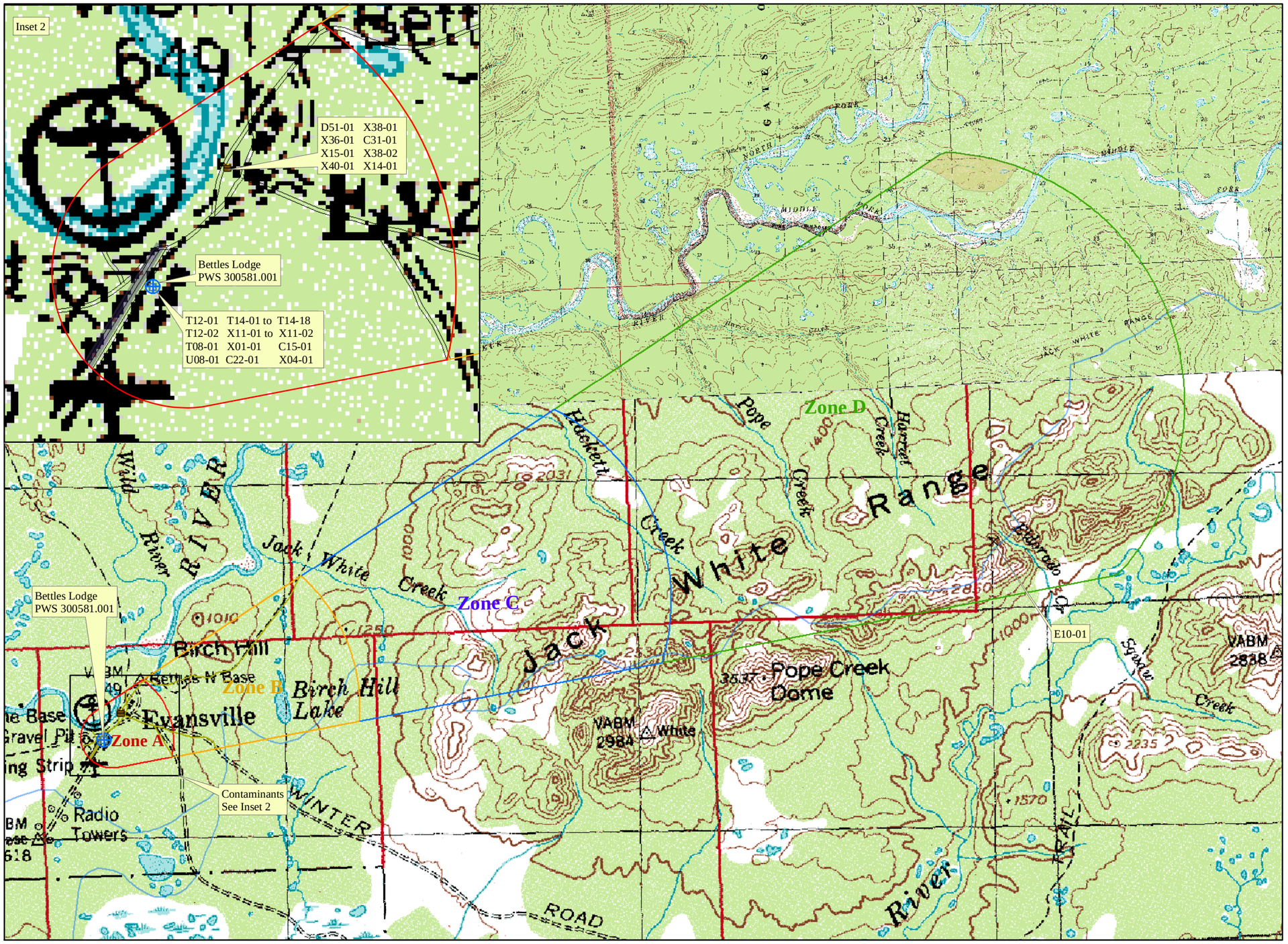
PWSID 300581.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Gasoline stations (without repair shop)	C15	C15-01	A	Low	C	BETTLES LODGE, INC
Motor /motor vehicle repair shops	C31	C31-01	A	Medium	C	Service/Maintenance Shop
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	Landfill/Incinerator
Closed Leaking Underground Fuel Storage Tank (LUST) Sites	U08	U08-01	A	Low	C	BETTLES LODGE, INC
Petroleum product bulk station/terminals	X11	X11-01	A	High	C	Fuel Storage Tanks (>500gal)
Petroleum product bulk station/terminals	X11	X11-02	A	High	C	Fuel Storage Tanks (>500gal)
Airports	X14	X14-01	A	Medium	C	Airport
Boat yards and marinas	X15	X15-01	A	Low	C	Harbor/Dock/Port
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	High	C	Power Generation Facility
Highways and roads, dirt/gravel	X24	X24-02	B	Low	C	Assume 1-20 roads in Zone B

APPENDIX C

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

Public Water Well System for PWS #300581.001 Bettles Lodge
Showing Existing & Potential Sources of Contamination



LEGEND

Public Water System Well

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours

Transportation

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

Groundwater Protection Zones

- Zone A Protection Area– Several Months Travel Time
- Zone B Protection Area– 2 Years Travel Time
- Zone C Protection Area– 5 Years Travel Time
- Zone D Protection Area– 10 Years Travel Time

Existing or Potential Contaminant Sources

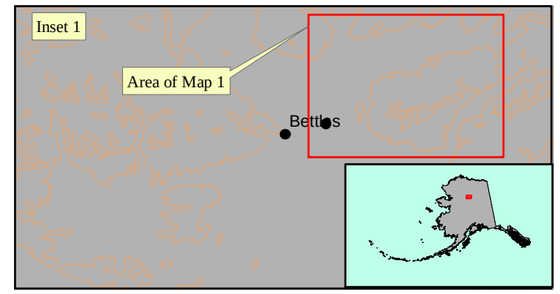
- Gasoline stations (without repair shop) (C15)
- Laundromats without dry cleaning (C22)
- Motor/motor vehicle repair shops (C31)
- Quarries (E10)
- Tanks, diesel (underground) (T8)
- Tanks, gasoline (underground) (T12)
- Tanks, heating oil, nonresidential (aboveground) (T14)
- Closed Leaking Underground Fuel Storage Tank (LUST) (heating oil) (U08)
- Cemetaries (X01)
- Petroleum product bulk station/terminals (X11)
- Boat yards and marinas (X15)
- Electric power generation (fossil fuels) (X36)
- Firehouses (X38)
- Medical/veterinary facilities (doctor or dentis offices, hospitals, nursing homes) (X40)
- Landfills (municipal; Class III) (D51)
- Municipal or city parks (X4)
- Airports (X14)

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

All other data:
United States Geological Survey (USGS)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC

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



0 0.5 1 2 3 4 Miles

Bettles Lodge
PWS 300581.001

Appendix C Map C

APPENDIX D

Vulnerability Analysis for Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - Bettles Lodge (PWS No. 300581.001)

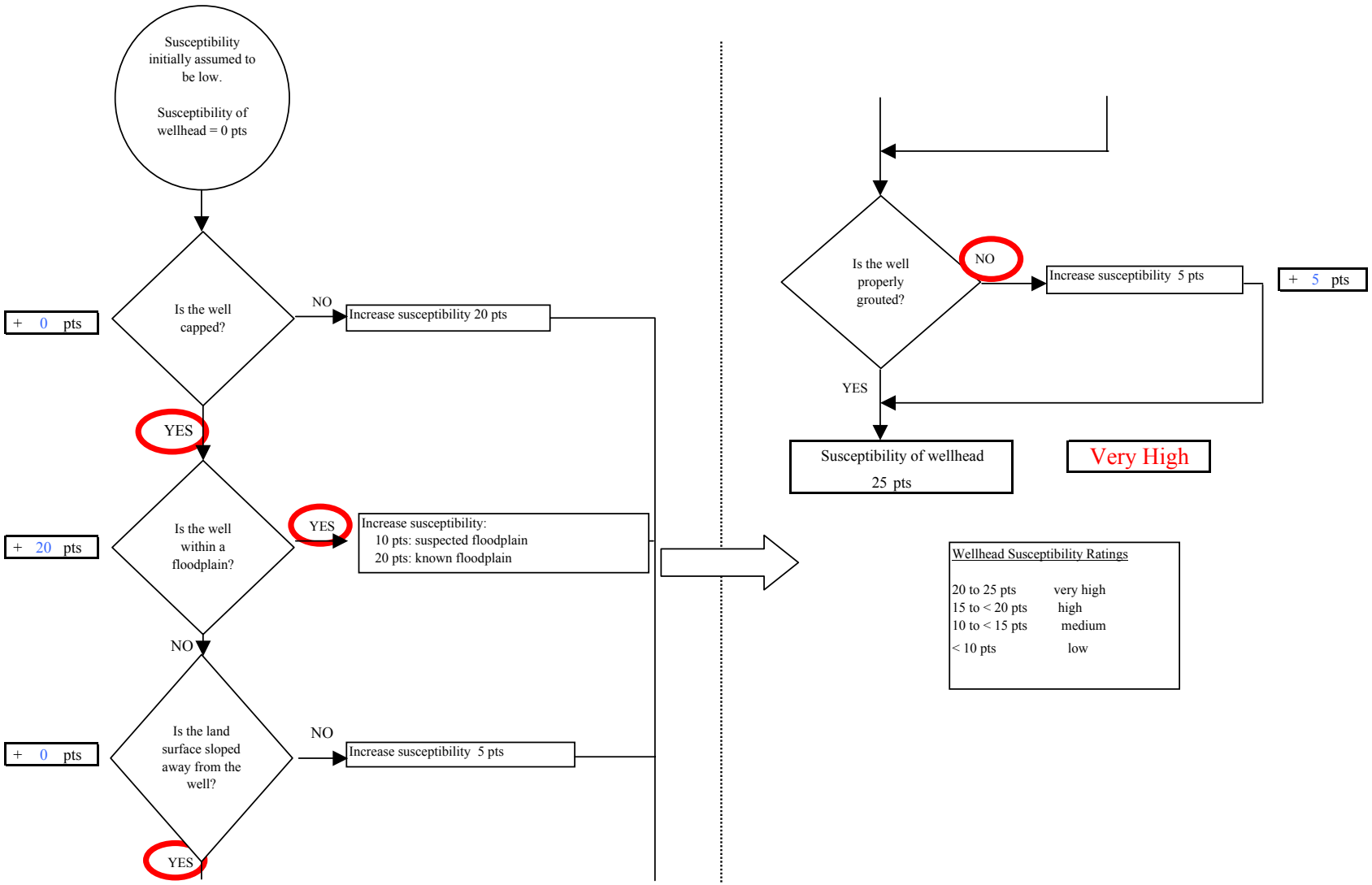


Chart 2. Susceptibility of the aquifer Bettles Lodge (PWS No. 300581.001)

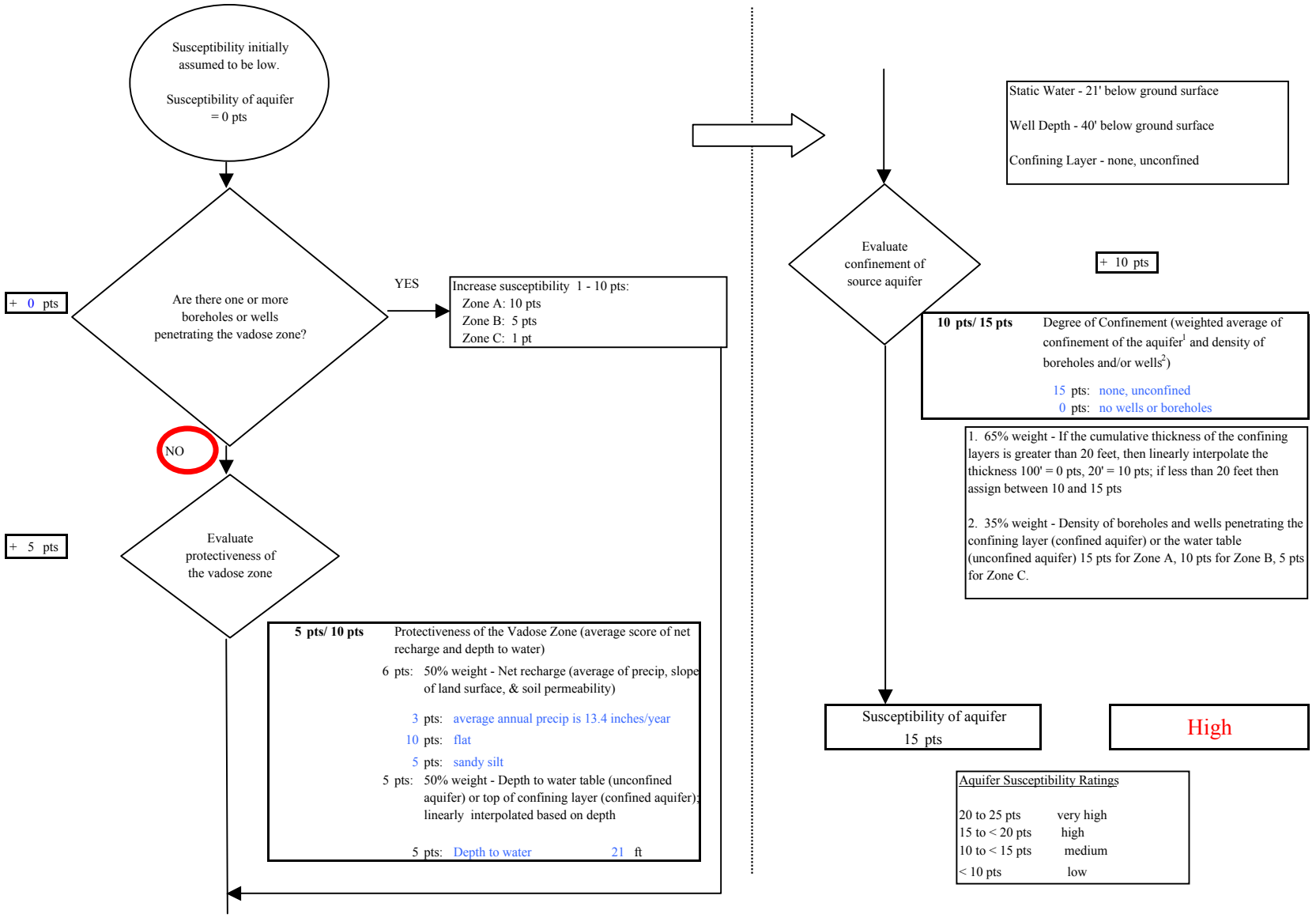
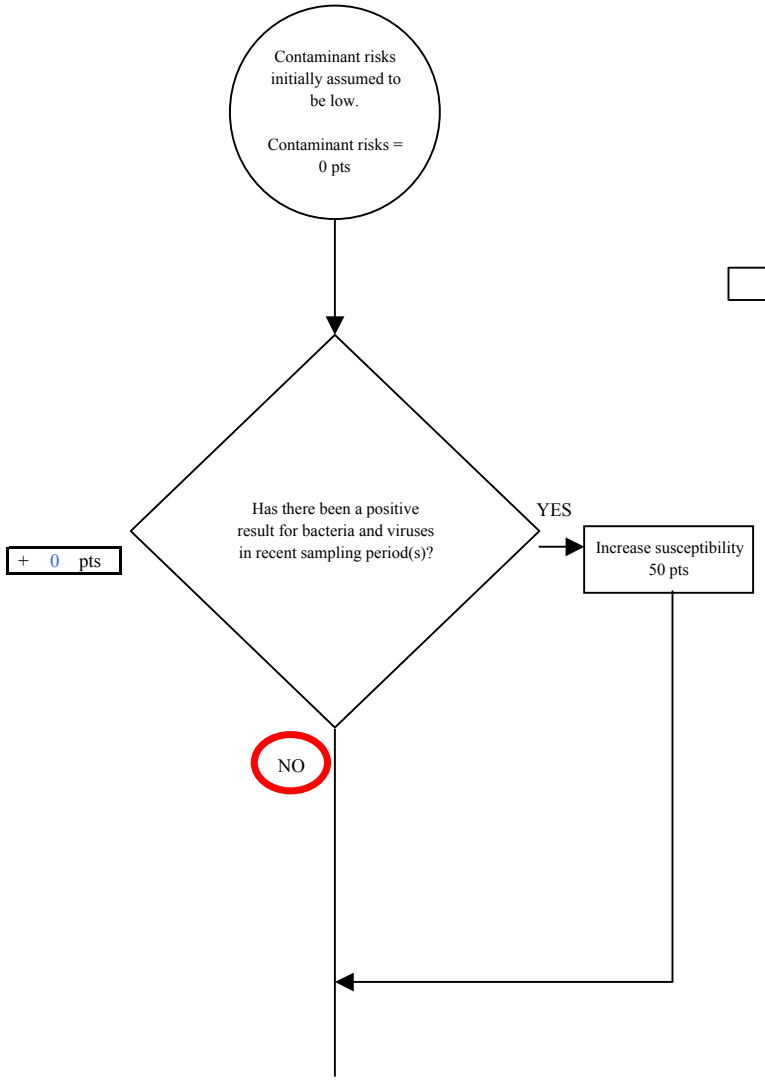
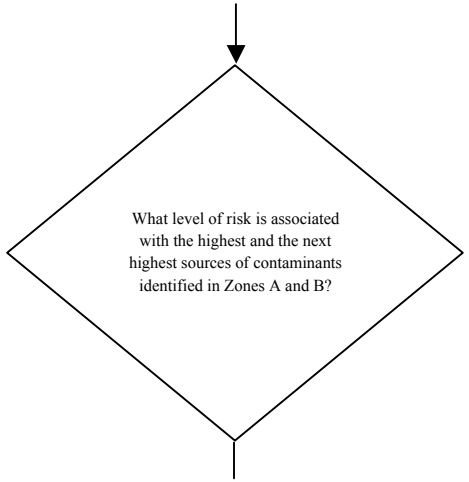


Chart 3. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Bacteria & Viruses





+ 30 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)	1	0	1
Medium(s)	2	0	2
Low(s)	3	1	4

	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 30

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 Bettles Lodge (PWS No. 300581.001) - Bacteria & Viruses

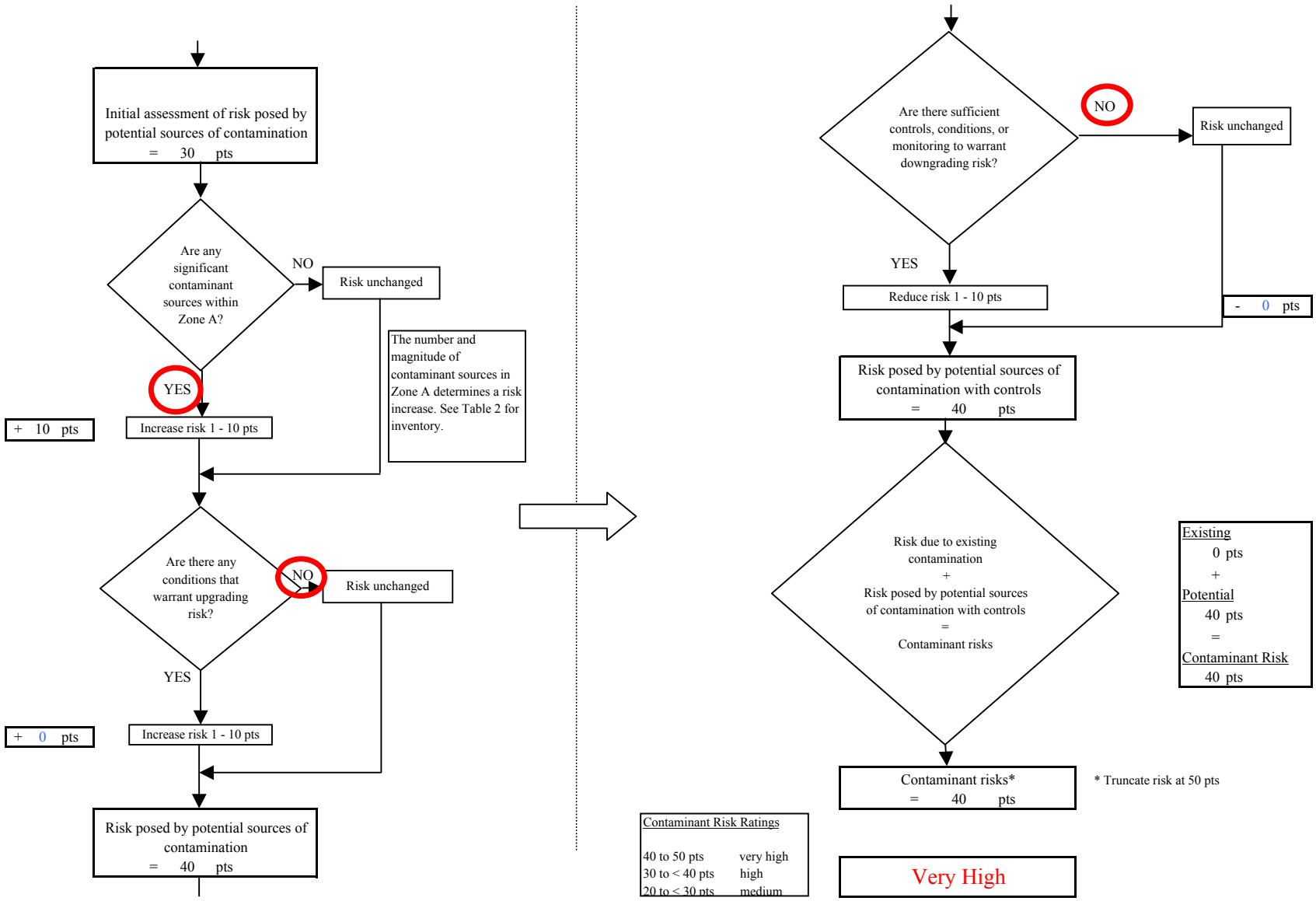


Chart 4. Vulnerability analysis for Bettles Lodge (PWS No. 300581.001) - Bacteria & Viruses

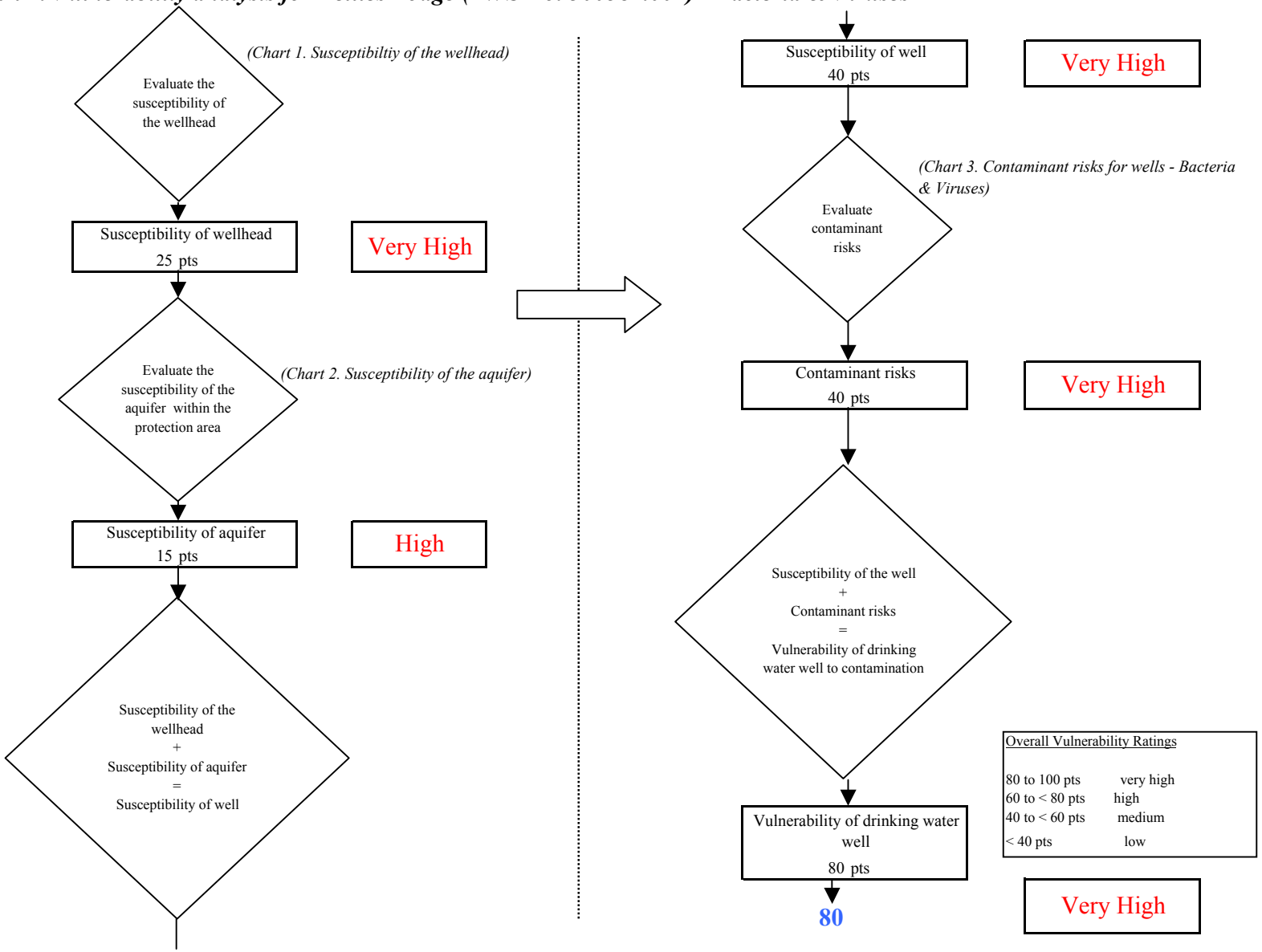


Chart 5. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Nitrates and Nitrites

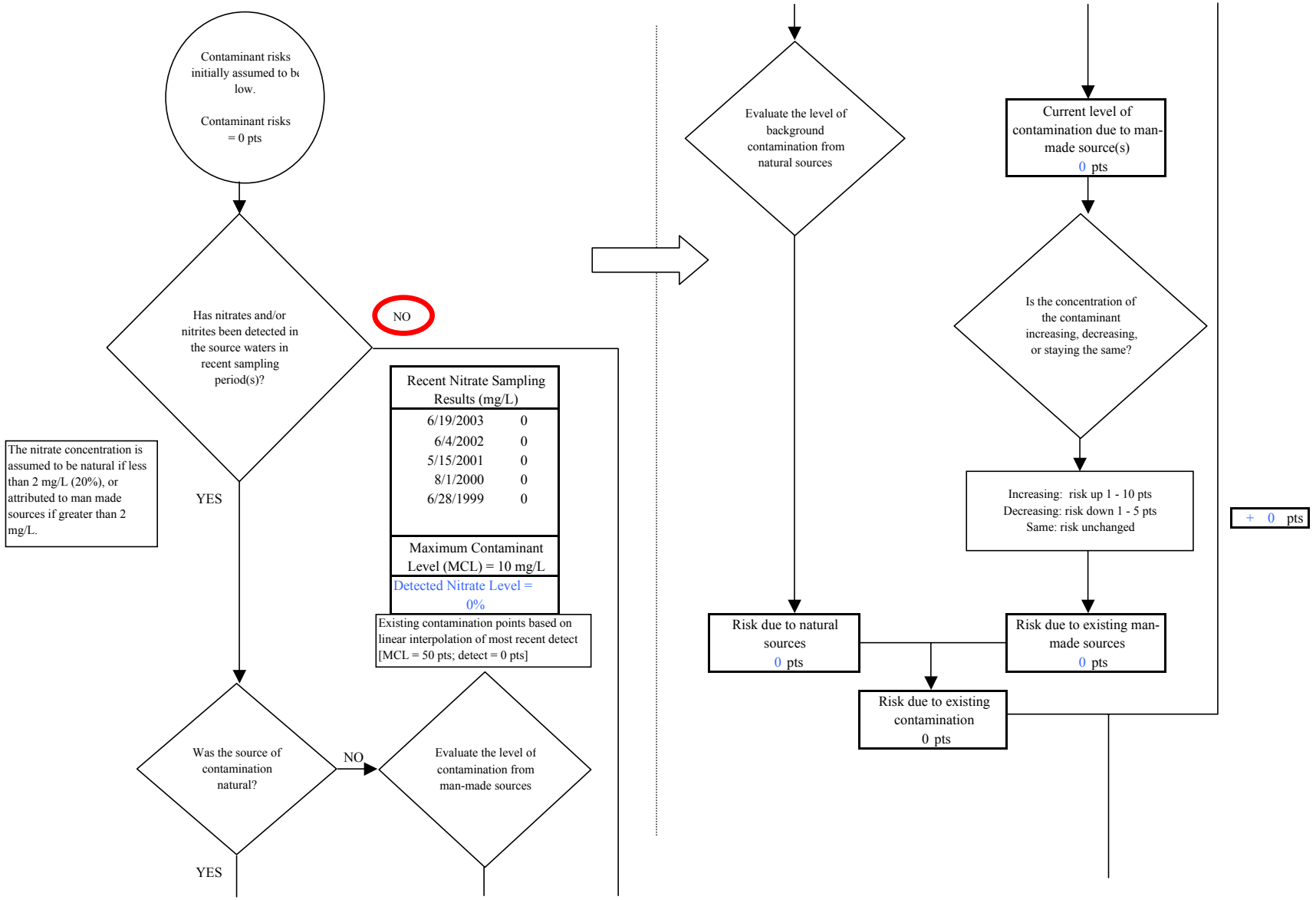


Chart 5. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Nitrates and Nitrites

+ 40 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	1	0	1
High(s)	0	0	0
Medium(s)	2	0	2
Low(s)	10	1	11

	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 individua 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 = 40 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 → Increase risk 1 - 10 pts

+ 10 pts

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

Chart 5. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Nitrates and Nitrites

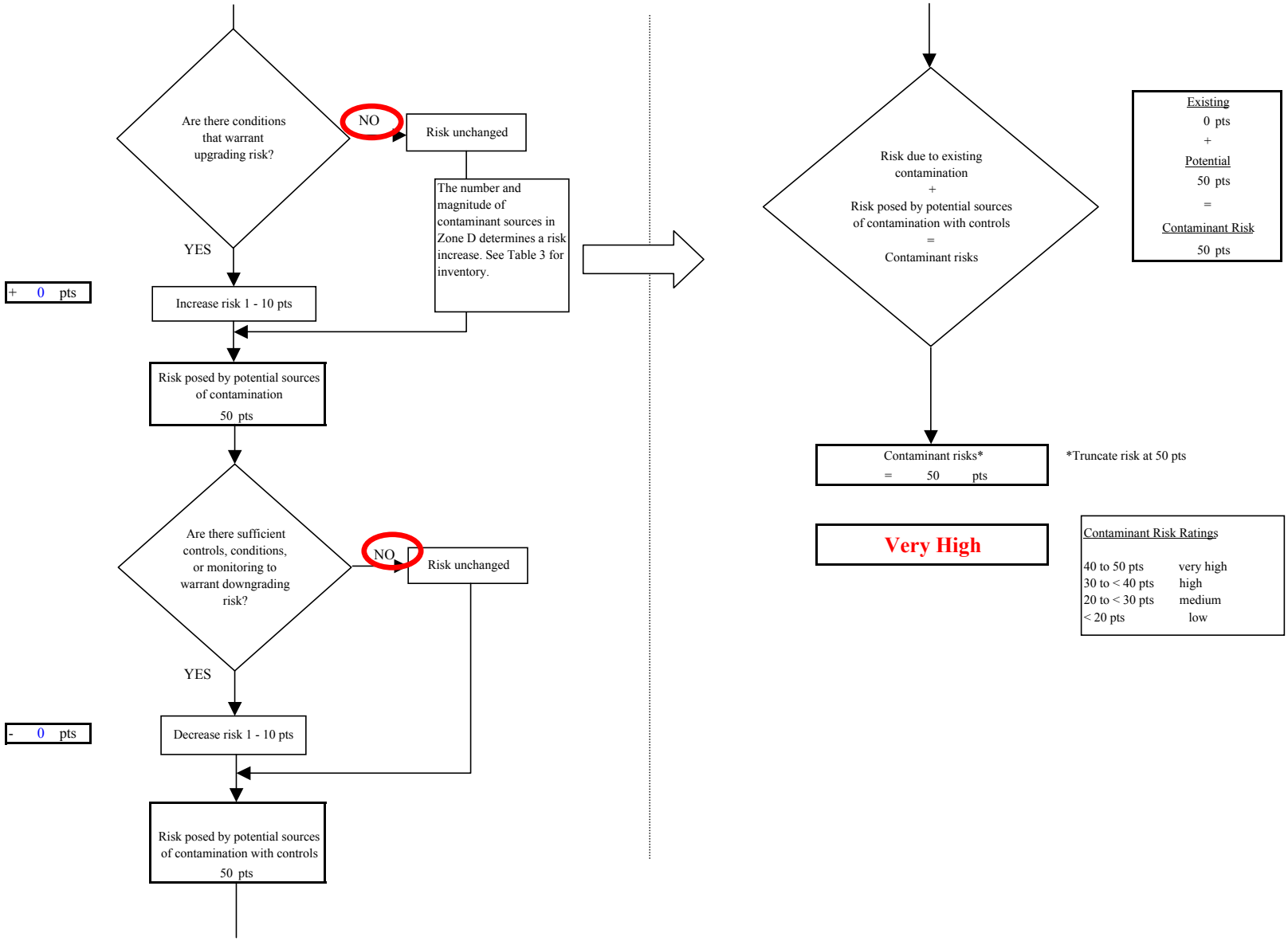


Chart 6. Vulnerability analysis for Bettles Lodge (PWS No. 300581.001) - Nitrates and Nitrites

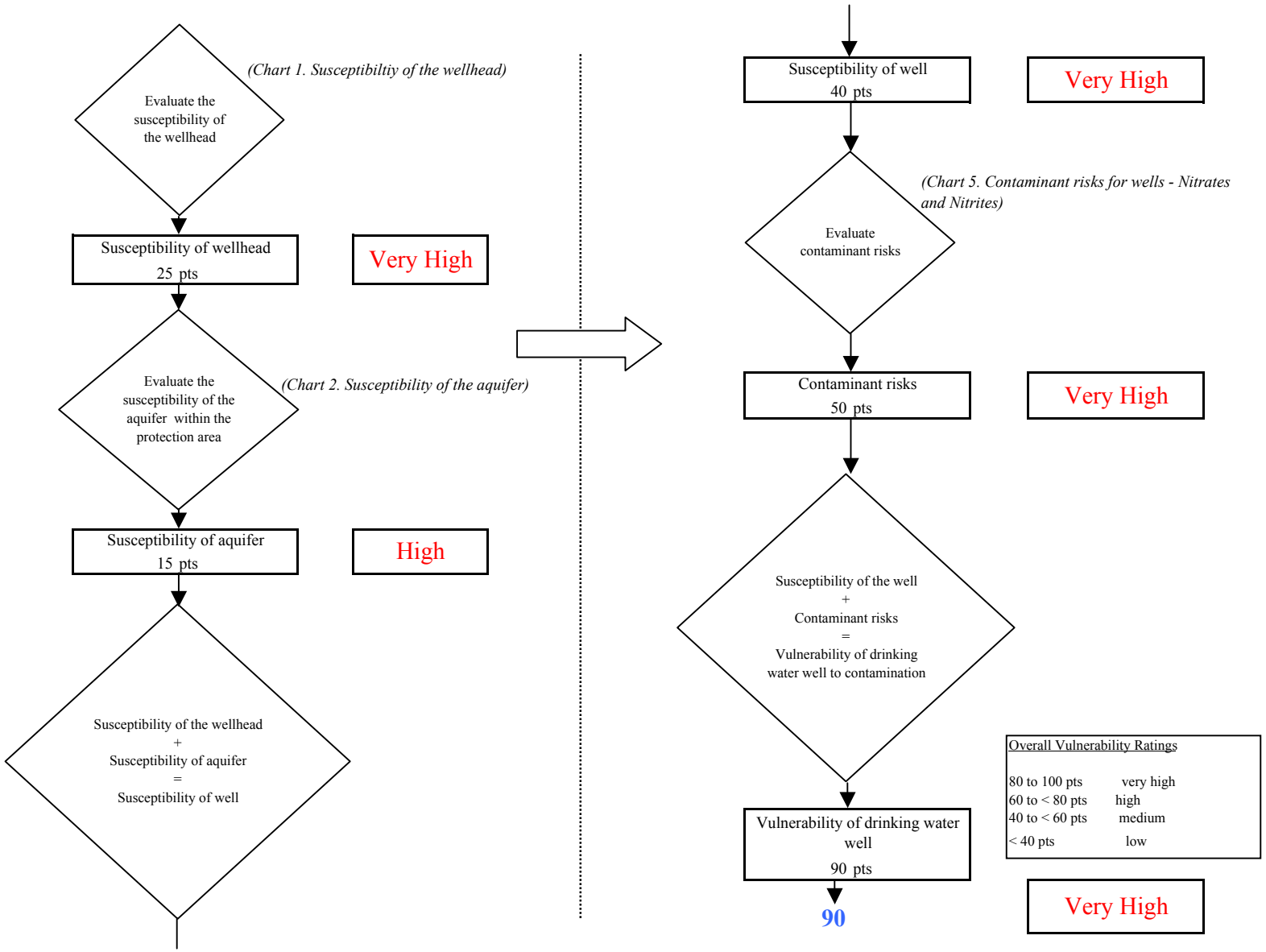


Chart 7. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Volatile Organic Chemicals

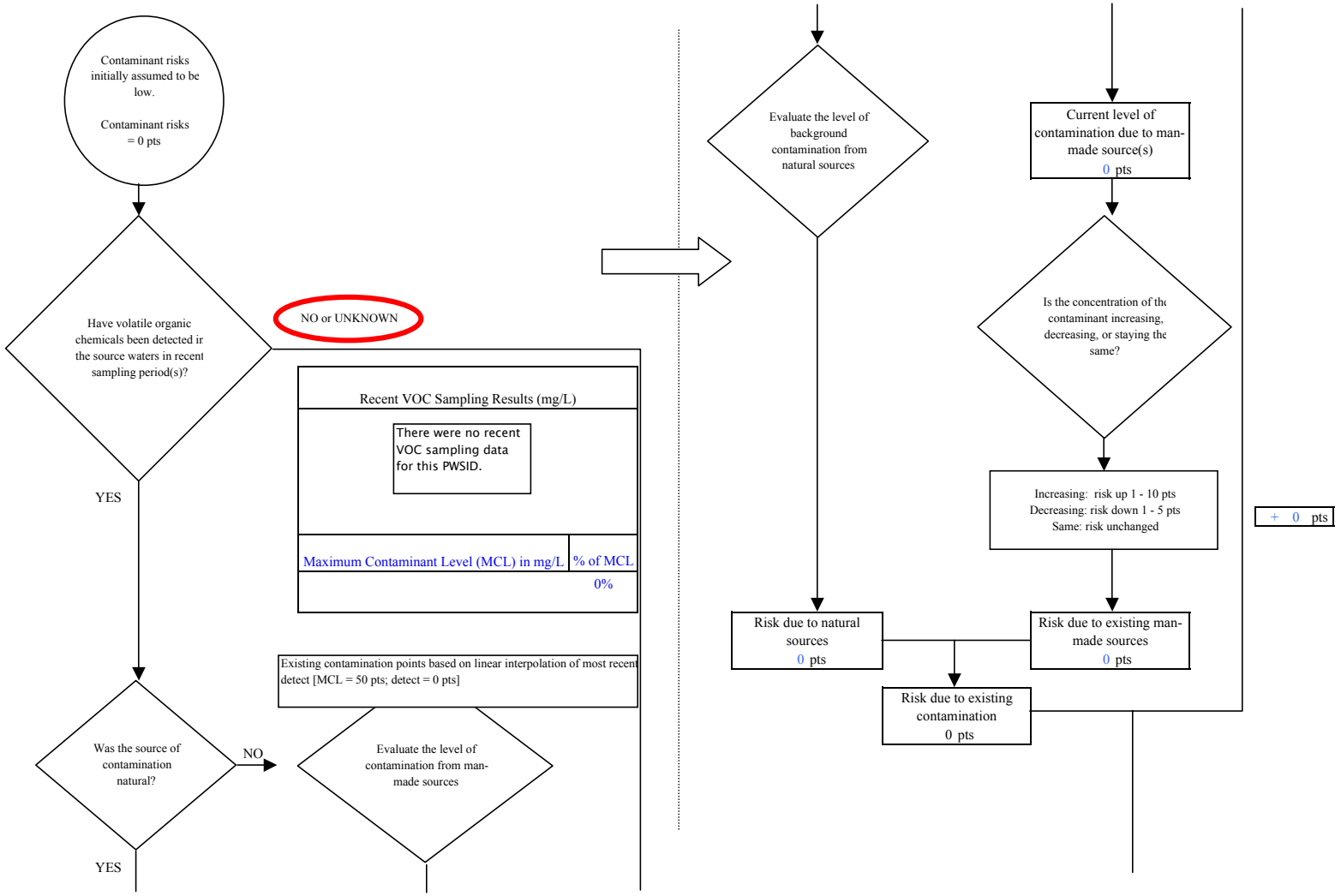
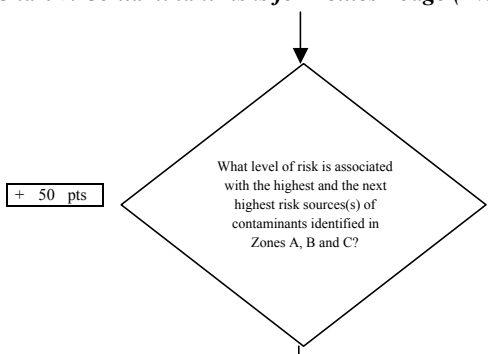


Chart 7. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Volatile Organic Chemicals



+ 50 pts

Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	2	0	2
High(s)	7	0	7
Medium(s)	2	0	2
Low(s)	47	1	48

	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 tl 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.

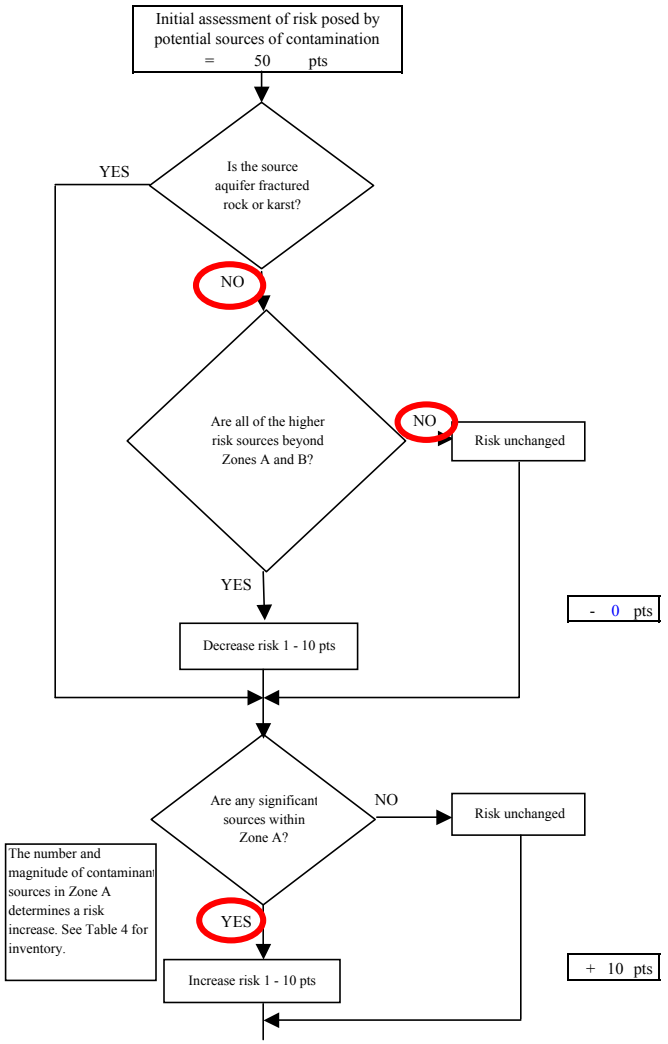


Chart 7. Contaminant risks for Bettles Lodge (PWS No. 300581.001) - Volatile Organic Chemicals

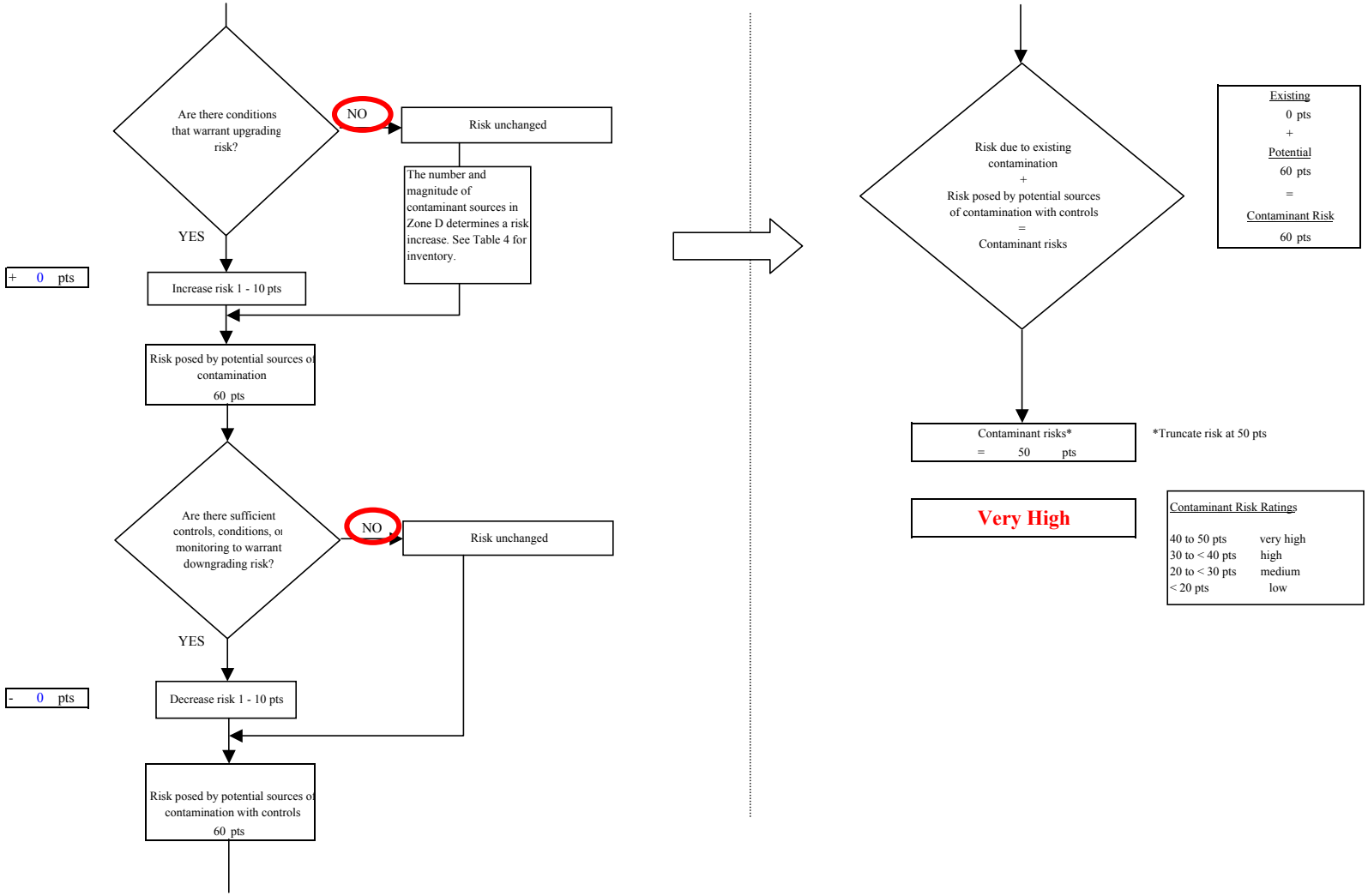


Chart 8. Vulnerability analysis for Bettles Lodge (PWS No. 300581.001) - Volatile Organic Chemicals