Hydrogeologic Susceptibility and Vulnerability Assessment for Alyeska Chalet Condo HOA Public Drinking Water Well, Girdwood, Alaska

DRINKING WATER PROTECTION PROGRAM REPORT 4

August 2000

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By MICHAEL. J. CROTTEAU

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2000

CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

Hydrogeologic Susceptibility and Vulnerability Assessment for Alyeska Chalet Condo HOA Public Drinking Water Well, Girdwood, Alaska

By Michael J. Crotteau

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Alyeska Chalet Condo HOA Public Water System is a Class A (community) water system consisting of one well. No potential of existing sources of contaminants were inventoried within Alyeska Chalet Condo Home Owners Association (HOA)'s Drinking Water Protection/Assessment Area. However, this public water system has historical contamination from bacteria and viruses as well as nitrates. This existing contamination has lead to an overall rating of high vulnerability for bacteria and viruses and low for nitrates/nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals.

INTRODUCTION

An environmental assessment has been performed for Alyeska Chalet Condo HOA's public drinking water source consisting of one well in the Glacier Creek Valley (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined a review of the natural hydrogeologic sensitivity with contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been performed as a basis for voluntary local protection efforts and to assist agencies in their efforts to reduce risk to public drinking water supplies.

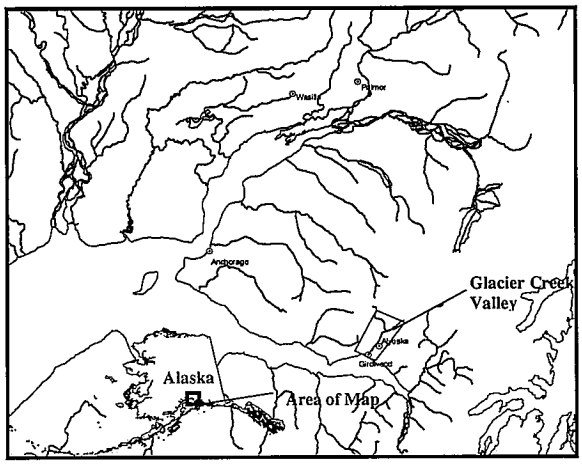


Figure 1. Index map showing the location of the Glacier Creek Valley, Alaska.

PHYSIOGRAPHY OF THE GLACIER CREEK VALEY, ALASKA

Glacier Creek Valley, drained primarily by Glacier Creek, is located near the head of Turnagain Arm of Cook Inlet, approximately 45 miles south of Anchorage, Alaska (see Figure 1). Widened by glaciers and surrounded by steep mountain slopes, the valley is approximately six miles in length and trends northeast-southwest. The valley floor is roughly four miles wide. Elevations within the valley increase inland, from sea level at Turnagain Arm to approximately 6500 feet at the head of the valley. Development comprising the community of Girdwood is present along the lower four miles of the valley.

The floor of the Girdwood Valley is covered primarily by coniferous forests. Bedrock outcrops and wetlands occur intermittently in the valley floor. Bedrock also outcrops at elevation in the mountains. Glacier Creek originates in uplands at the head of the valley, drains an area of approximately 58.2 square miles and is roughly centrally located. A mean annual discharge of 265 cubic feet per second was recorded in Glacier Creek (USGS gaging station near the mouth) from 1965-78. California Creek and Alyeska Creek flow into Glacier Creek. California Creek drains an area of roughly 6.96 square miles. Virgin Creek flows directly into the Turnagain Arm and drains an area of about 3.5 square miles in the valley [*Glass and Brabets*, 1988].

Mean annual precipitation of roughly 40 inches per year was recorded near the mouth of the valley from 1955-66 and 1977-78. At the base of the Alyeska Ski Resort, annual precipitation in excess of 65 inches year has been recorded (1985-86) [*Glass and Brabets*, 1988]. Mean daily temperature ranges from 65.1° F during cool rainy summers to 13.9° F in snowy winters, which average total snow depths of 197.4 inches [*Western Regional Climate Center*, 2000].

Groundwater in the Glacier Creek Valley generally flows from bedrock highlands, including steep valley walls, toward sediments in the center of the valley. Flow through valley sediments, or unconsolidated deposits, is generally to the southwest toward Turnagain Arm.

ALYESKA CHALET CONDO HOA PUBLIC WATER SYSTEM

Alyeska Chalet Condo HOA Public Water System is a Class A (community) water system, which is owned and operated by Alyeska Chalet Condo HOA. The system consists of one well, which is located a mile and a half up the Alyeska Highway from the junction with the Seward Highway. The well is situated at approximately 200 feet above sea level (see Figure 2) and penetrates silty gravel to a total depth of 100 feet below land surface. The well has a perforated open end in sandy gravel at 81 feet below land surface. The well log had no static water level measurement at the time of drilling (March 14, 1975). However, a well drilled on the same property on July 12, 1971 had a static water level measurement of 55 feet below land surface. The land is drained properly away from the well. However, no information is available on whether the well is grouted. This system operates year round and serves approximately 60 residents and 25 non-residents through 21 service connections.

ASSESSMENT/PROTECTION AREA FOR ALYESKA CHALET CONDO HOA'S DRINKING WATER SOURCE

The Drinking Water Protection/Assessment Area that has been established for Alyeska Chalet Condo HOA's public drinking water well is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of the drinking water source to contamination. This zone around the drinking water source is the most critical area to the preservation of the quality of the drinking water. Therefore, this area will also serve as the area of focus for voluntary protection efforts.

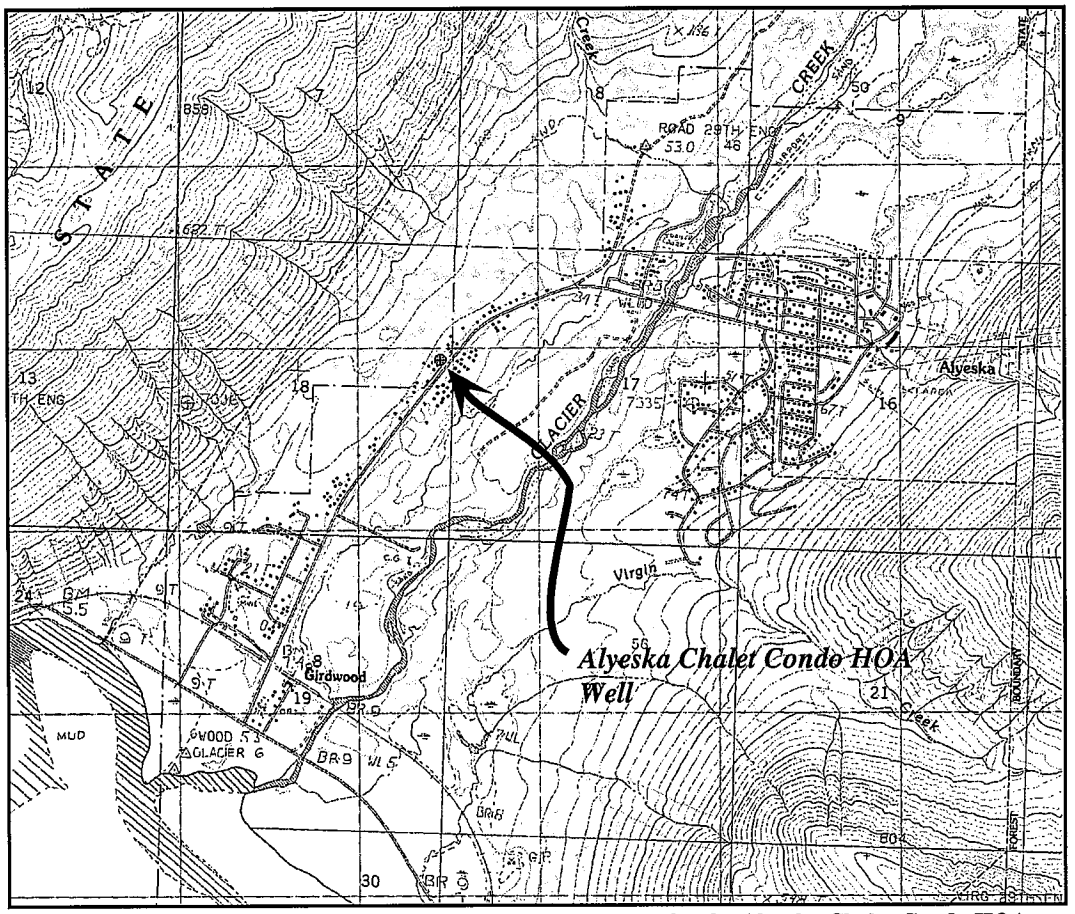


Figure 2. Map showing the location of the drinking water source for the Alyeska Chalet Condo HOA.

Conceptually, surface water and groundwater flow is from steep bedrock slopes toward the unconsolidated stream and glacial deposits in the valley (see Figure 3). A 2-dimensional groundwater flow model was built to simulate groundwater flow in the saturated valley sediments (unconfined or water-table aquifer). This model was used as a guide in the first step in establishing the protection/assessment area for the Alyeska Chalet Condo HOA's source of public drinking water. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful and conservative protection/assessment area with respect to public health (Please refer to the Guidance Manual for additional information).

The Drinking Water Protection/Assessment Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the aquifer from a specific point to the well. The Drinking Water Protection/Assessment Area for the Alyeska Chalet Condo HOA contains two zones, Zone A and Zone B (See Map 1 - Map 4 in Appendix A). Zone A corresponds to ¼ of the distance to the 2-year time-of-travel. Depending on where a contaminant source is located, travel time for a contaminant to the well may be on the order of several days to several hours. The Zone B protection/assessment area for Alyeska Chalet Condo HOA corresponds to a time-of-travel of less than two years. Zone B extends up-slope to the top of the watershed divide to take into account contaminants that may flow overland and enter valley sediments.

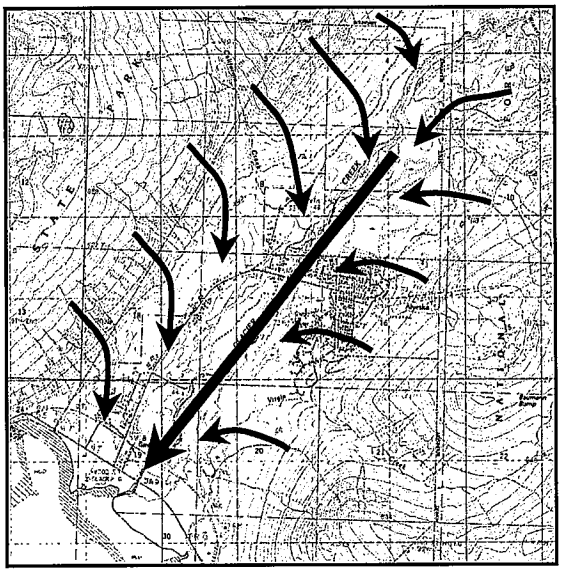


Figure 3. Map showing the conceptual groundwater flow in the Glacier Creek Valley.

INVENTORY OF CONTAMINANT SOURCES

The Drinking Water Protection Program has conducted an inventory of potential and existing sources of contamination within Alyeska Chalet Condo HOA's Drinking Water Assessment/Protection Area. This survey was conducted through a search of agency records and other publicly available information. The initial survey, conducted by the Drinking Water Protection Program, was passed on to the operator of Alyeska Chalet Condo HOA to verify and expand on these preliminary findings.

Potential sources of contamination to drinking water supplies cover a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of this assessment, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates/nitrites;
- Volatile organic chemicals;
- Heavy metals and cyanide;
- Synthetic organic chemicals (pesticides and herbicides); and
- Other synthetic organic chemicals.

The Drinking Water Protection Program's preliminary contaminant source inventory as well as the local survey yielded no potential or existing sources of contamination.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been identified, sorted, and ranked according to what type and level of risk they represent. Ranking of contaminant risks for a potential or existing source of contamination is a function of toxicity and volumes of specific contaminants associated with that source. Contaminant risks are further a function of the number/density of those types of contaminant sources as well as the proximity of those sources to the well.

VULNERABILITY OF ALYESKA CHALET CONDO HOA'S DRIKING WATER SOURCE

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

- natural susceptibility; and
- contaminant risks.

Appendix D contains four charts, which together form the 'Vulnerability Analysis'. Chart 1 contains the 'Vulnerability Analysis'. Chart 2 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 3 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. Lastly, Chart 4 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. This portion of the analysis examines any existing or historical contamination that has been detected at the drinking water source through routine sampling. It also reviews contamination that has or may have occurred but has not arrived at the well. The 'Contaminant Risks' portion of the analysis also considers potential sources of contaminants. Chart 5 through Chart 10 contains the Vulnerability Analysis for nitrates/nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals, respectively.

Each of the three categories of drinking water-regulated 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 susceptibility of the aquifer and the well to contamination is achieved by analyzing the properties of the aquifer and the well. The Alyeska Chalet Condo HOA well penetrates only gravel layers, which provide little if any protective barrier for the movement of contaminants in the subsurface. The well appears not to be properly grouted, which can lead to contaminant movement along the well casing. Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility. Table 1 shows the overall Susceptibility score and rating for Alyeska Chalet Condo HOA.

Table 1. Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility	19	Medium

Contaminant Risks to a drinking water source depends on the type, number/density, and distribution of contaminant sources. No existing or potential sources of contamination were inventoried for this system. However, water quality sampling may suggest the presence of human or animal waste discharges within the area contributing water to the well.

A score (0 – 50 points) and rating of Contaminant Risks is assigned based on the findings of the Contaminant Source Inventory and the historical aspects of water quality monitoring for this system. Table 2 below summarizes the Contaminant Risks for Alyeska Chalet Condo HOA for each category of drinking regulated contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria & Viruses	50 0	Very High
Nitrates/Nitrites	5	Low
Volatile Organic Chemicals	0	Low
Heavy Metals	0	Low
Synthetic Organic Chemicals	0	Low
Other Synthetic Organic Chemicals	0	Low

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

Table 3. Overall Vulnerability of Alyeska Chalet Condo HOA Public Drinking Water System to Contamination by Category

Category	Score	Rating
Bacteria & Viruses	~~20~~ ~~20~~ 15	~~High~~ Low
Nitrates/Nitrites	25 ~~20~~	Low
Volatile Organic Chemicals	~~20~~ 15	Low
Heavy Metals	~~20~~ 15	Low
Synthetic Organic Chemicals	20 15	Low
Other Synthetic Organic Chemicals	~~20~~ 15	Low

SUMMARY

A *Source Water Assessment* has been performed for the for Alyeska Chalet Condo HOA's source of public drinking water. The overall vulnerability of this source to contamination is high by bacteria and viruses, and low for nitrates/nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic 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 agencies to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes.

REFERENCES CITED

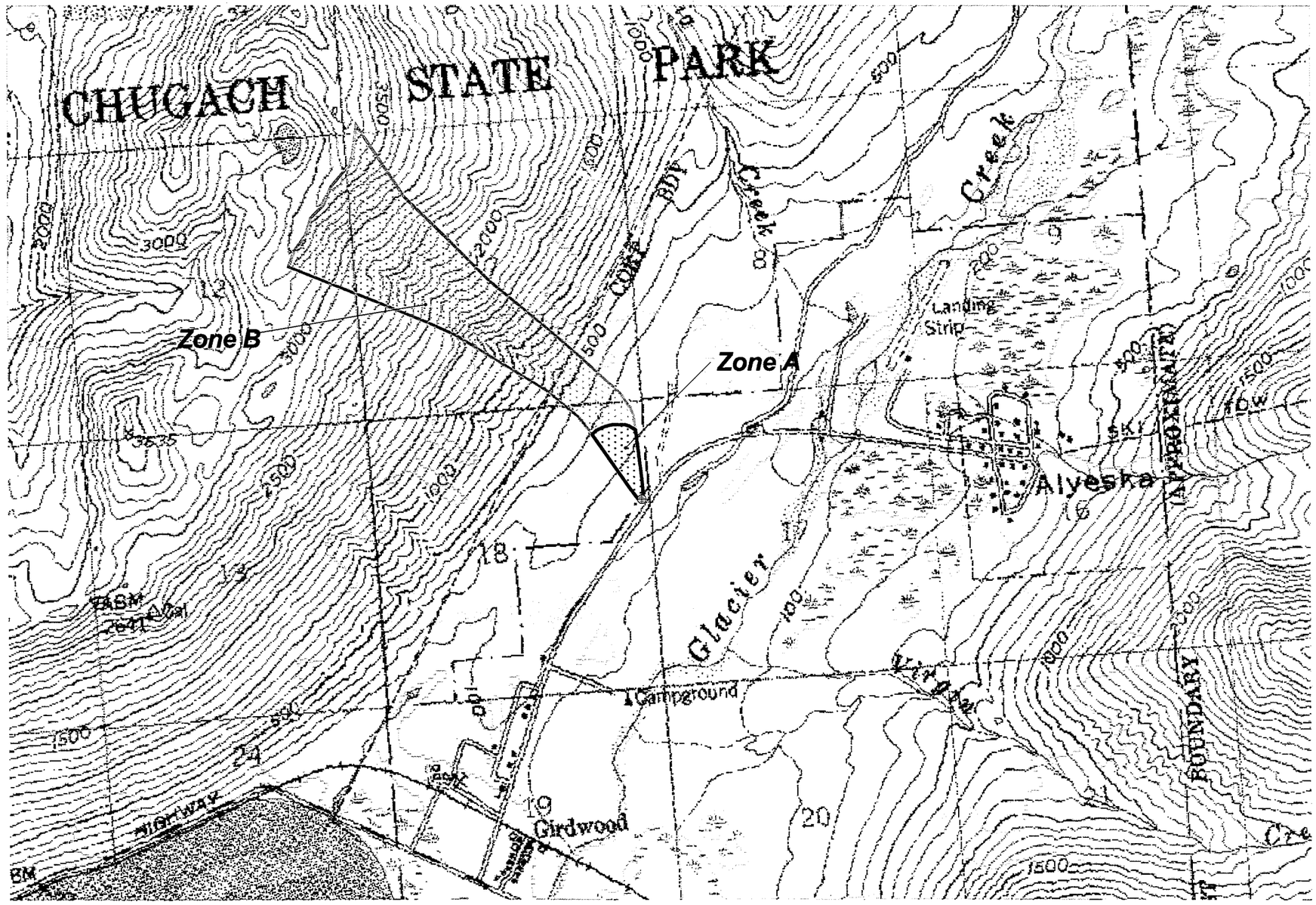
Glass, Roy L. and Brabets, Timothy P., 1988, Summary of water resources data for the Girdwood-Alyeska Area, Alaska: USGS Open-File Report 87-678.

Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wrcc.dri.edu/index.html

APPENDIX A

Alyeska Chalet Condo HOA's
Drinking Water Protection Areas

Alyeska Chalet Condo HOA (PWSID 214007)
Drinking Water Protection Areas



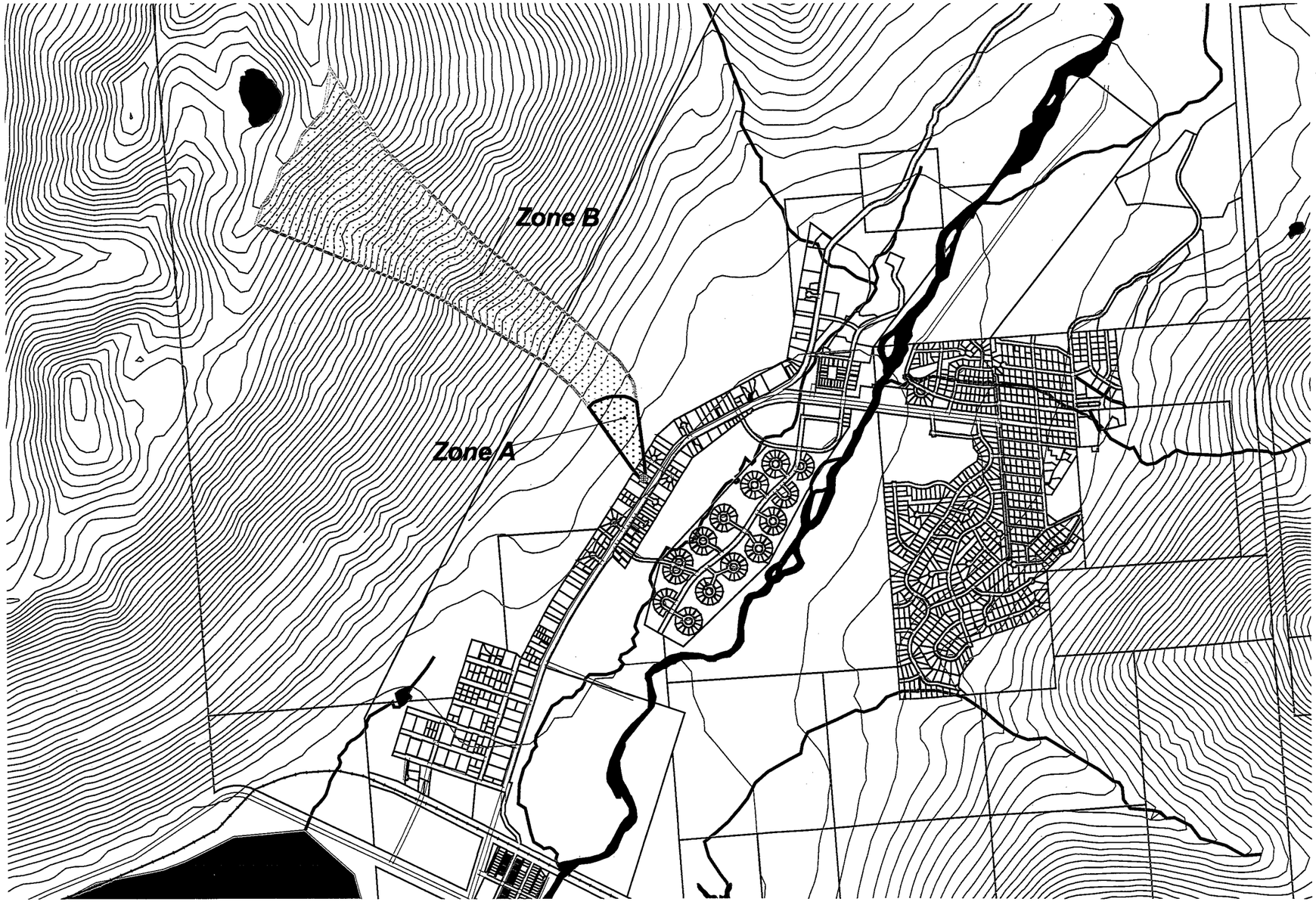
Alyeska Chalet Condos HOA Well
Zone A Protection Area
Alyeska Chalet Condo HOA
Zone B Protection Area
Alyeska Chalet Condo HOA

4000 0 4000 Feet

N
W E
S

Map 1

Alyeska Chalet Condo HOA (PWSID 214007)
Drinking Water Protection Areas



- Alyeska Chalet Condos HOA Well

Zone A Protection Area
- Alyeska Chalet Condo HOA

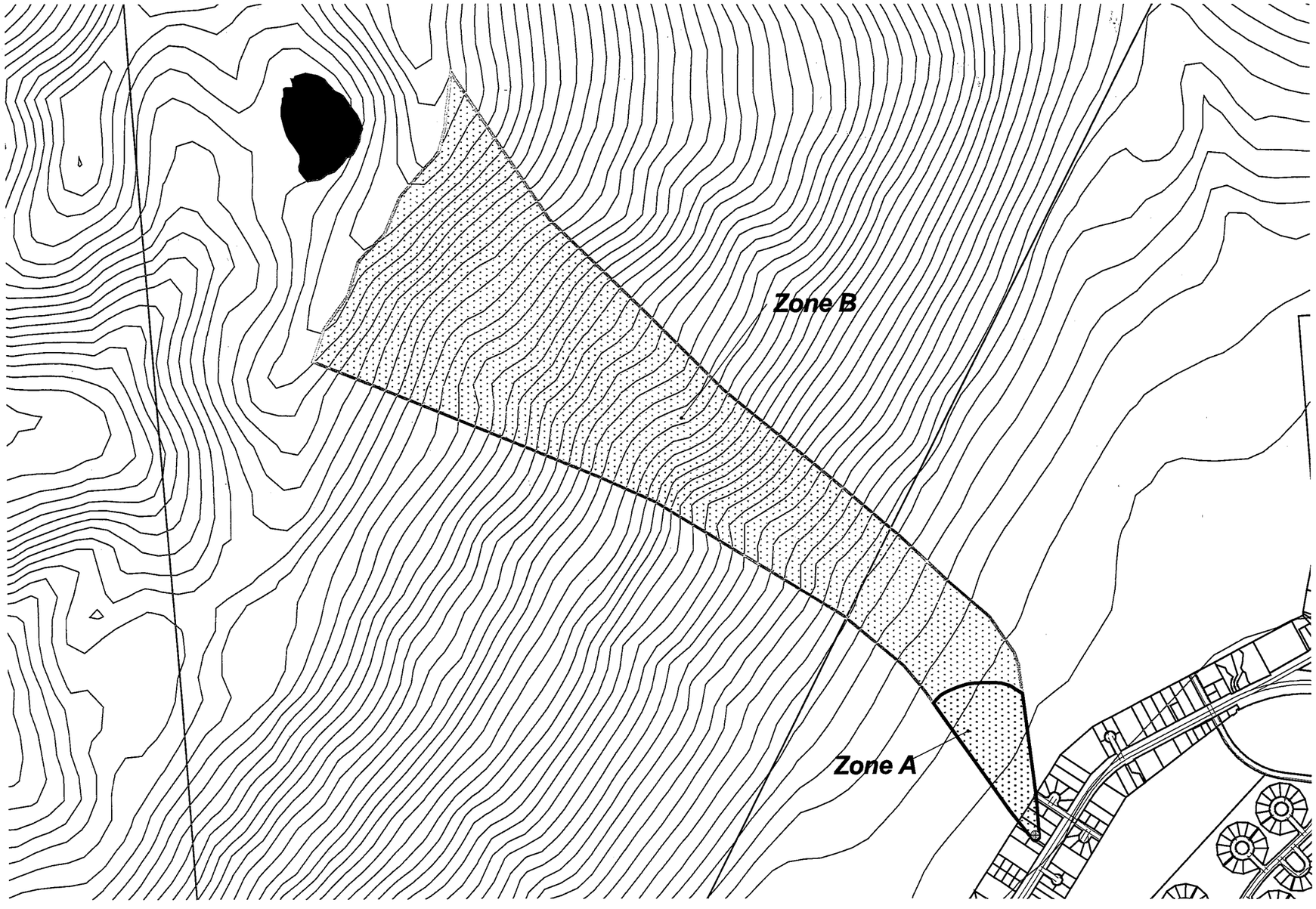
Zone B Protection Area
- Alyeska Chalet Condo HOA
- MOA Roads
- Railroads
- Lakes and Ponds
- Glacier Creek
- Elevation Contours = 20 meters
- MOA Land Parcels
- 2nd order streams
- 3rd order streams
- Turnagain Arm

0.8 0 0.8 Miles

N W E S

Map 2

Alyeska Chalet Condo HOA (PWSID 214007)
Drinking Water Protection Areas



- Alyeska Chalet Condos HOA Well

Zone A Protection Area
- Alyeska Chalet Condo HOA

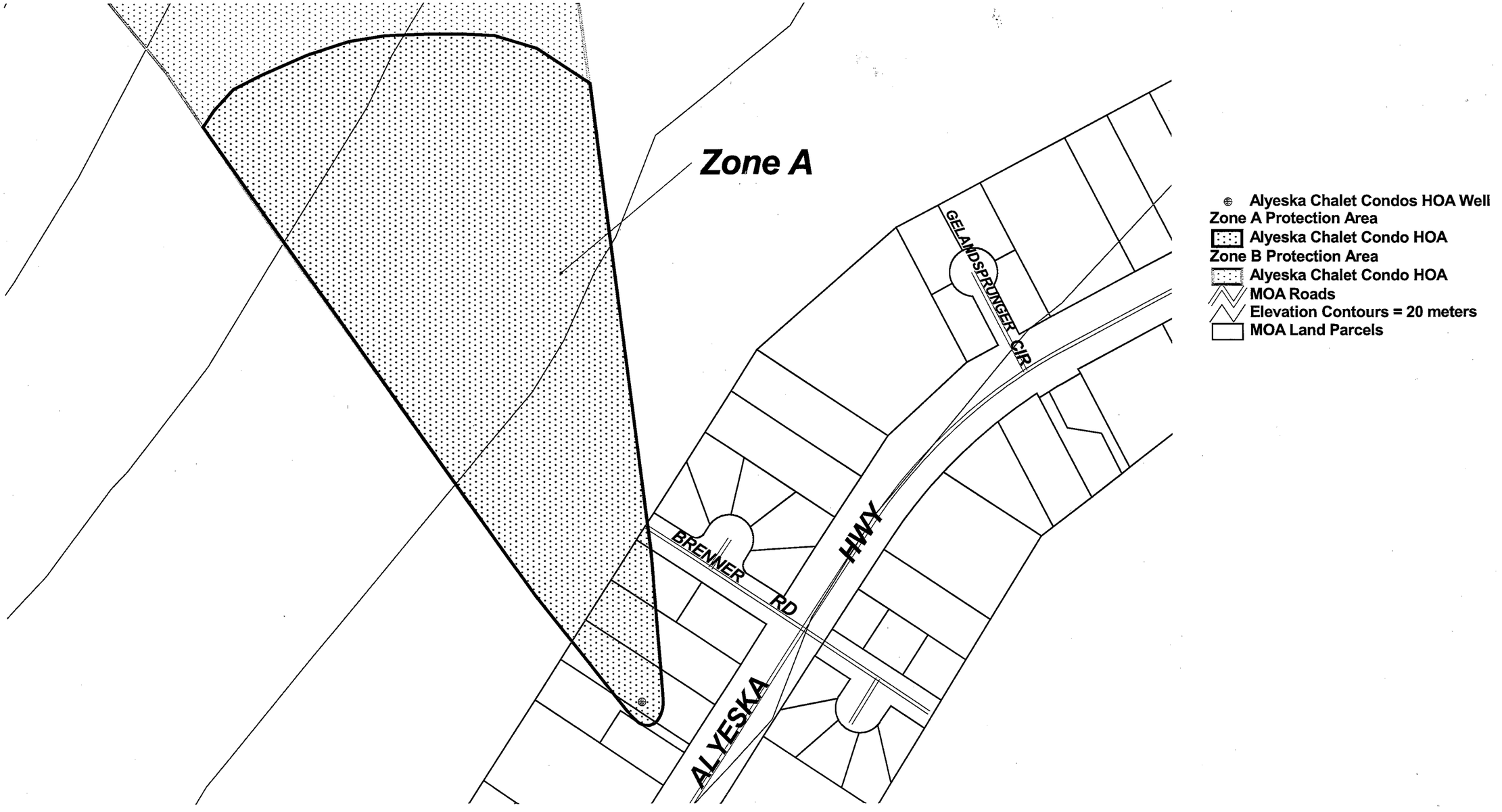
Zone B Protection Area
- Alyeska Chalet Condo HOA
- MOA Roads
- Railroads
- Lakes and Ponds
- Elevation Contours = 20 meters
- MOA Land Parcels

2000 0 2000 Feet

N W E S

Map 3

Alyeska Chalet Condo HOA (PWSID 214007)
Drinking Water Protection Areas



Alyeska Chalet Condos HOA Well
Zone A Protection Area
Alyeska Chalet Condo HOA
Zone B Protection Area
Alyeska Chalet Condo HOA
MOA Roads
Elevation Contours = 20 meters
MOA Land Parcels

500 0 500 Feet

N
W E
S

Map 4

APPENDIX B

Vulnerability Analysis for Alyeska Chalet Condo HOA Public Drinking Water System

Chart 1. Vulnerability analysis for Bacteria & Viruses – Alyeska Chalet Condo HOA

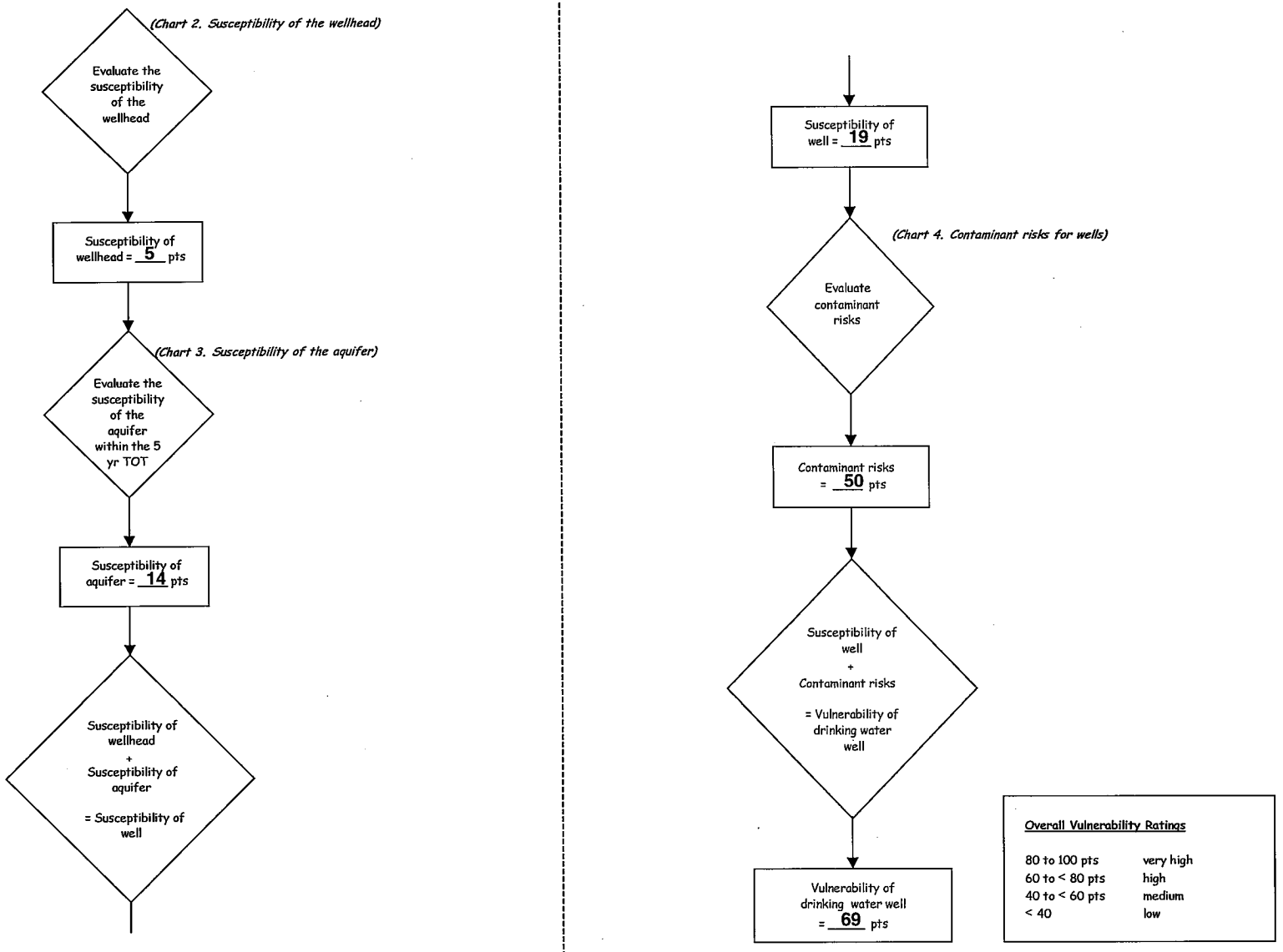
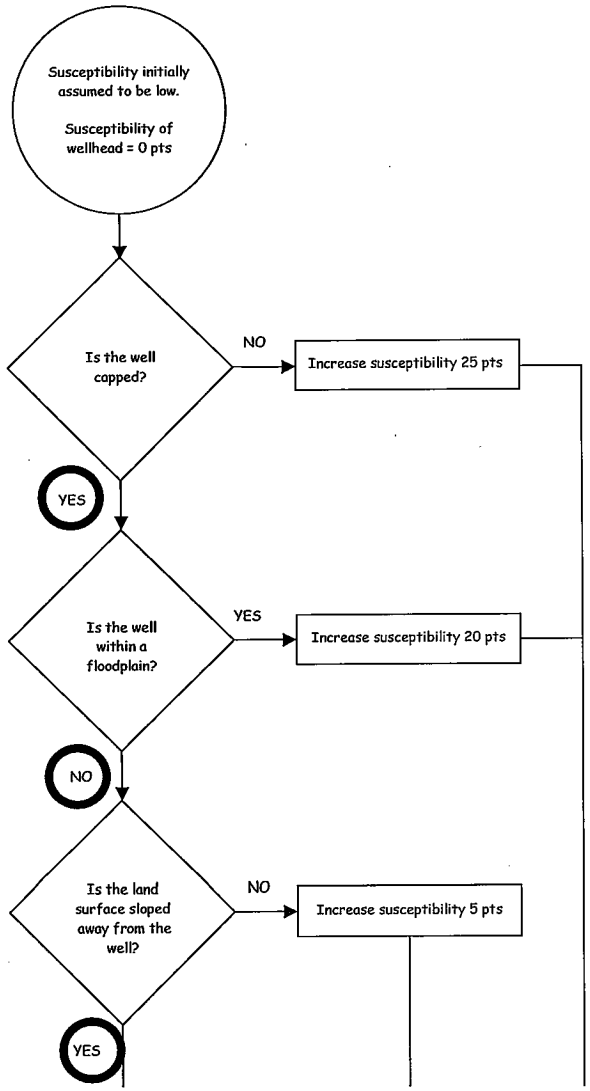
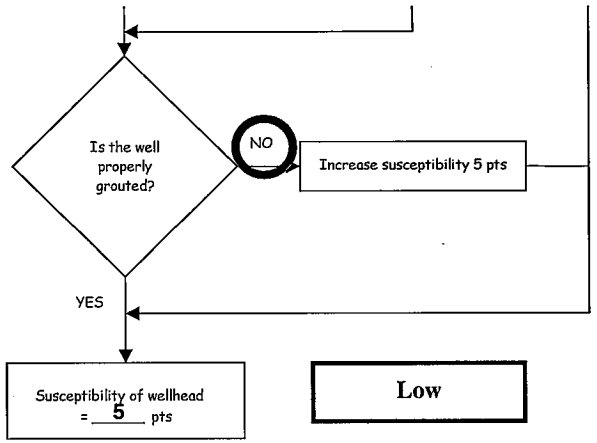


Chart 2. Susceptibility of the wellhead

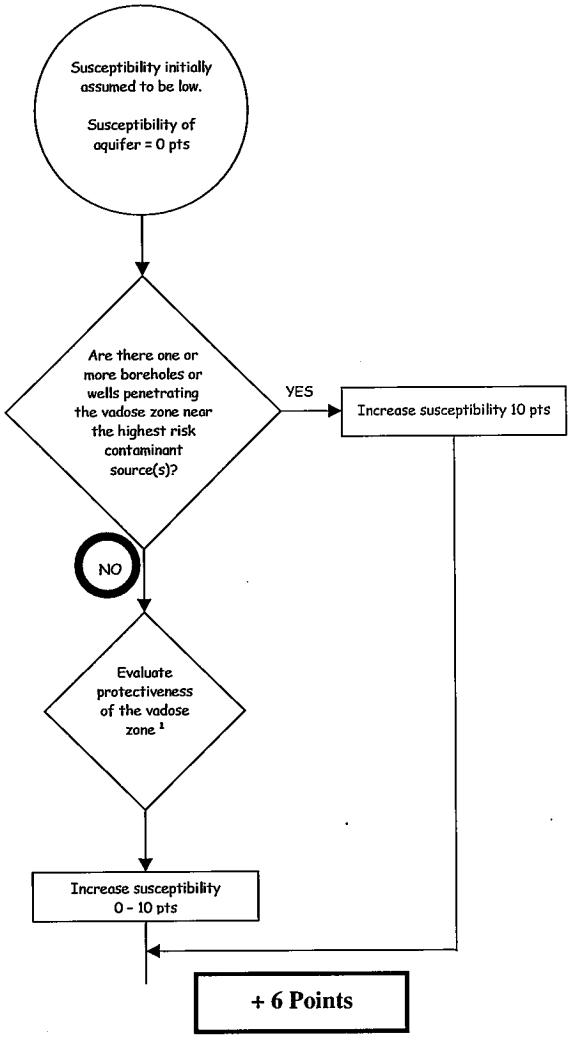


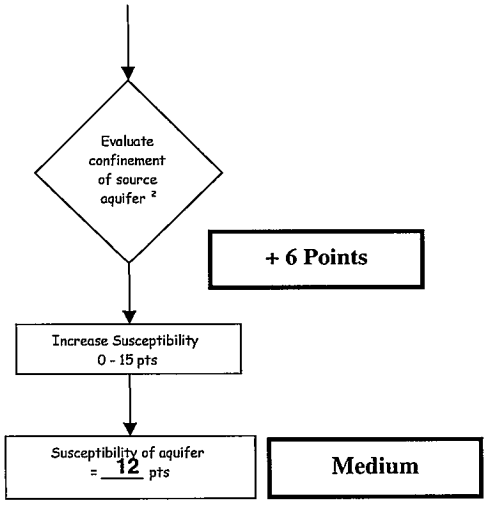


Wellhead Susceptibility Ratings

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

Chart 3. Susceptibility of the aquifer





1. Protectiveness of the Vadose Zone

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

2. Degree of Confinement

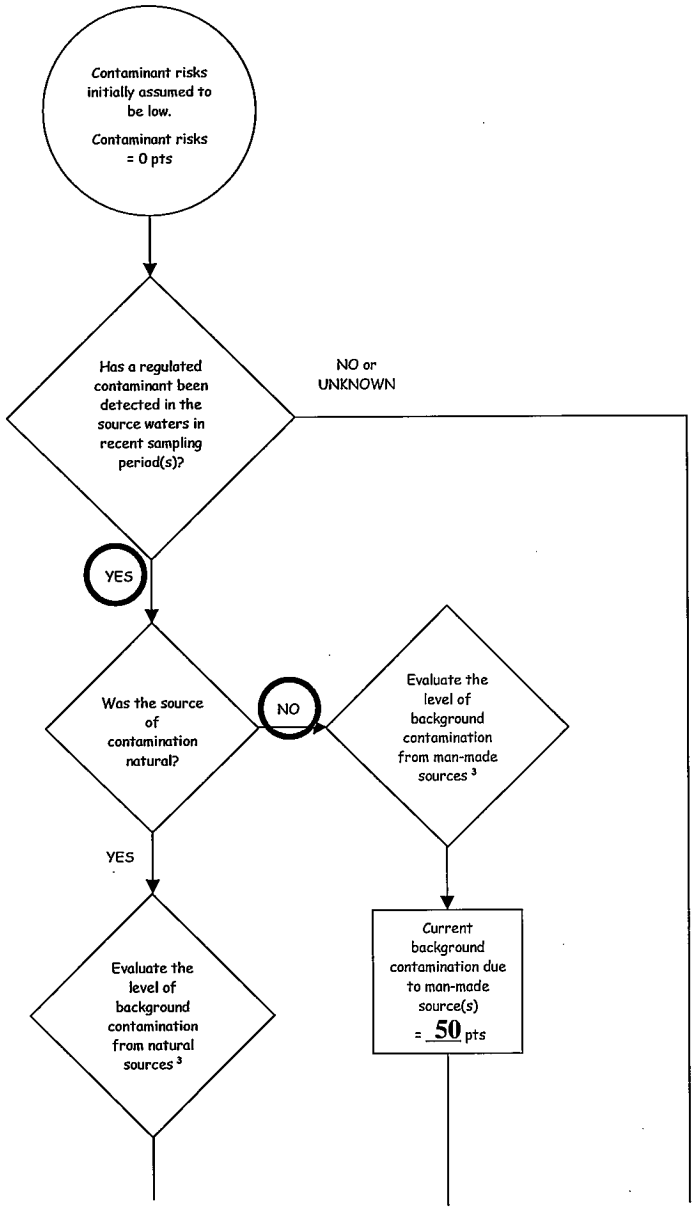
- confined verses unconfined aquifer
  [confined: K ≤ 10^{-6} cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' - 20', 0 - 10 pts; unconfined = 15 pts; 65% weight]
- density of boreholes and wells penetrating the confining layer (confined aquifer) or the water table (unconfined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

Aquifer Susceptibility Ratings

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

Medium

Chart 4. Contaminant risks for Alyeska Chalet Condo HOA – Bacteria & Viruses



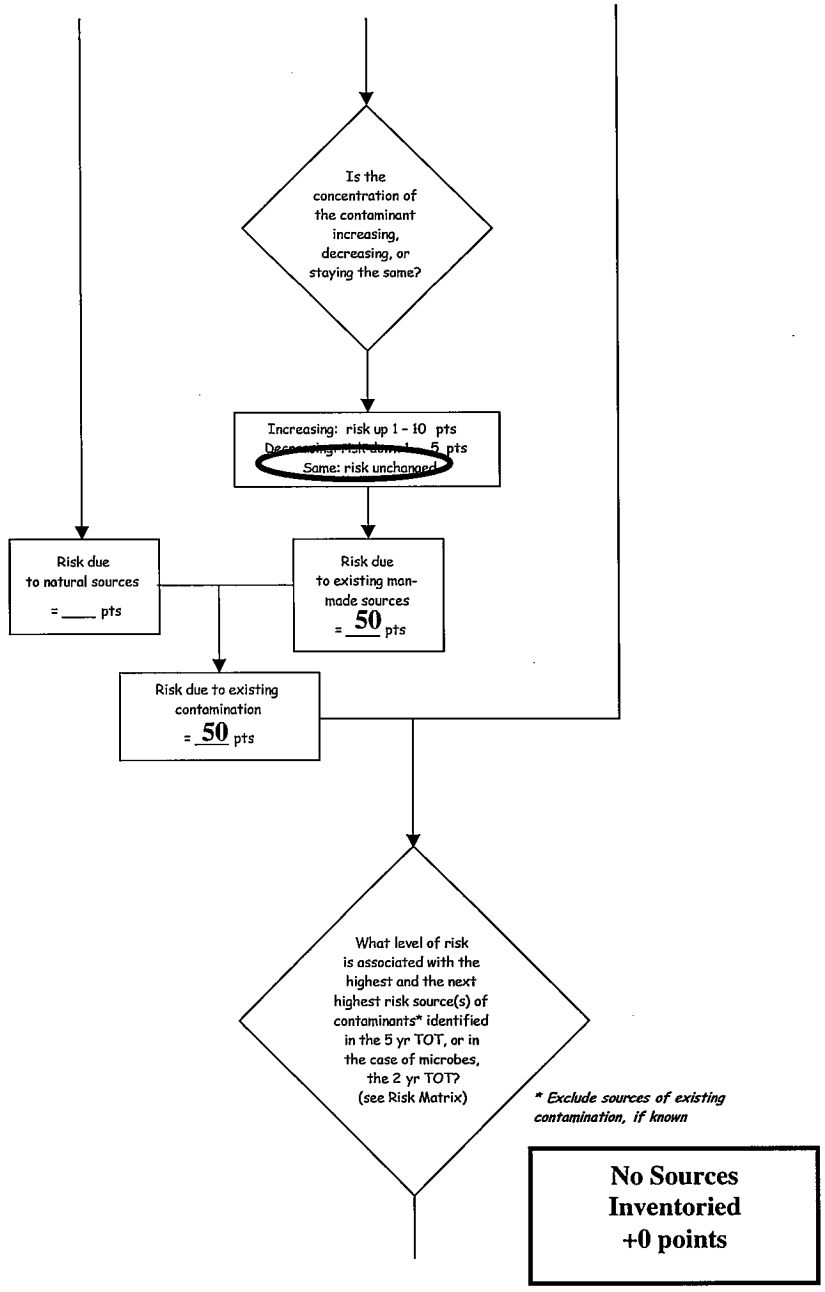
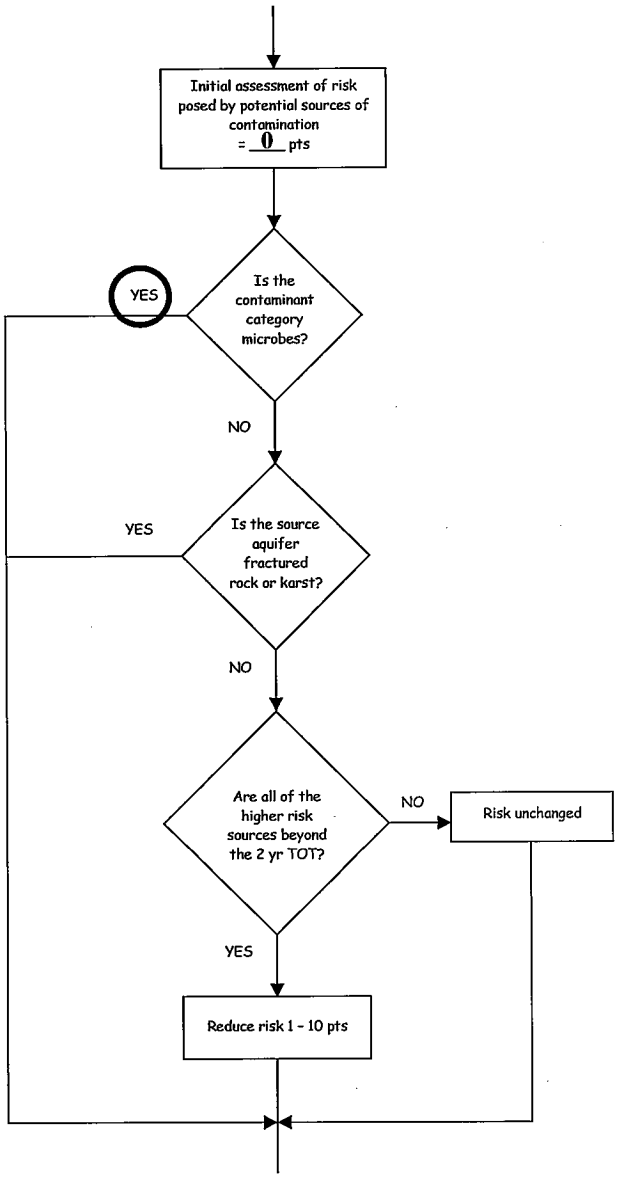


Chart 4. Contaminant risks for Alyeska Chalet Condo HOA – Bacteria & Viruses (Continued)



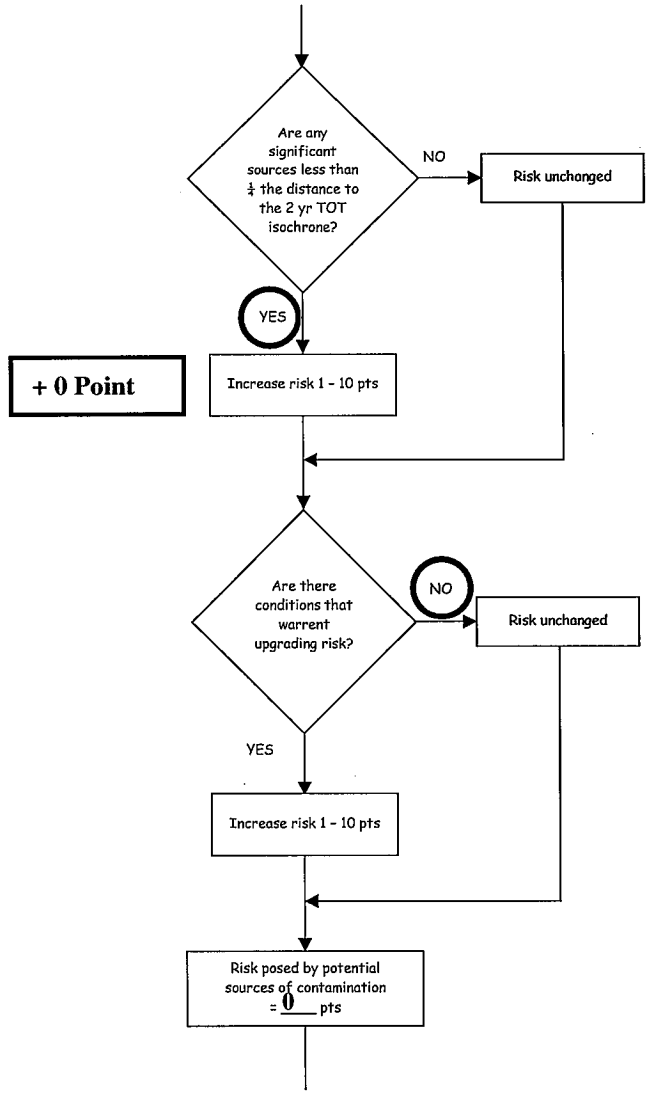
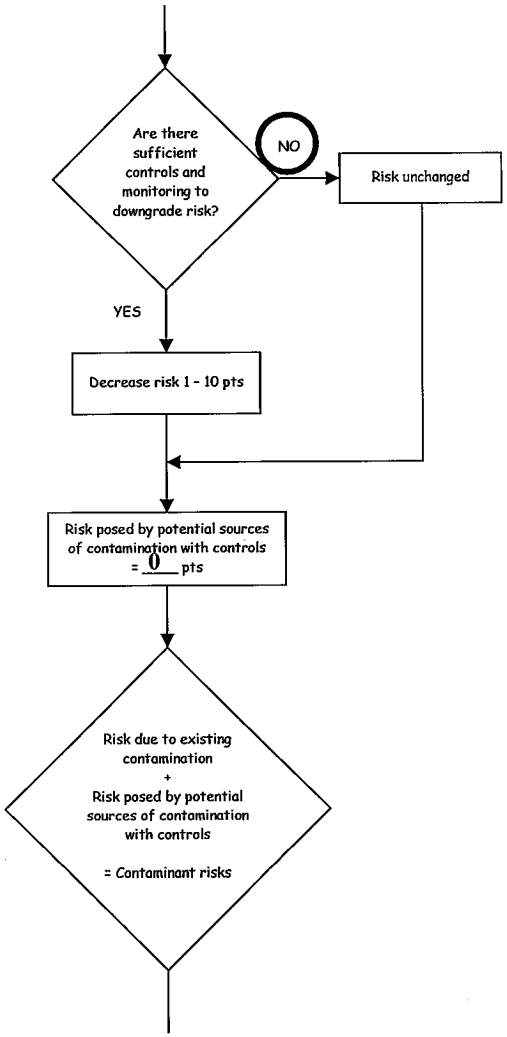
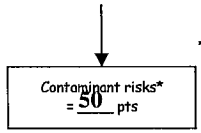


Chart 4. Contaminant risks Alyeska Chalet Condo HOA – Bacteria & Viruses (Continued)





** Truncate risk at 50 pts*

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Very High

Table 1. Risk Matrix for Contaminant Sources for Bacteria & Viruses – Alyeska Chalet Condo HOA

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	No Sources Inventoried	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
Low	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	—	
Medium	—	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts	
High	—	—	1 source + 10 pts	≥ 2 sources + 10 pts	
Very High	—	—	—	1 source + 10 pts	

Chart 5. Vulnerability analysis for Nitrates/Nitrites – Alyeska Chalet Condo HOA

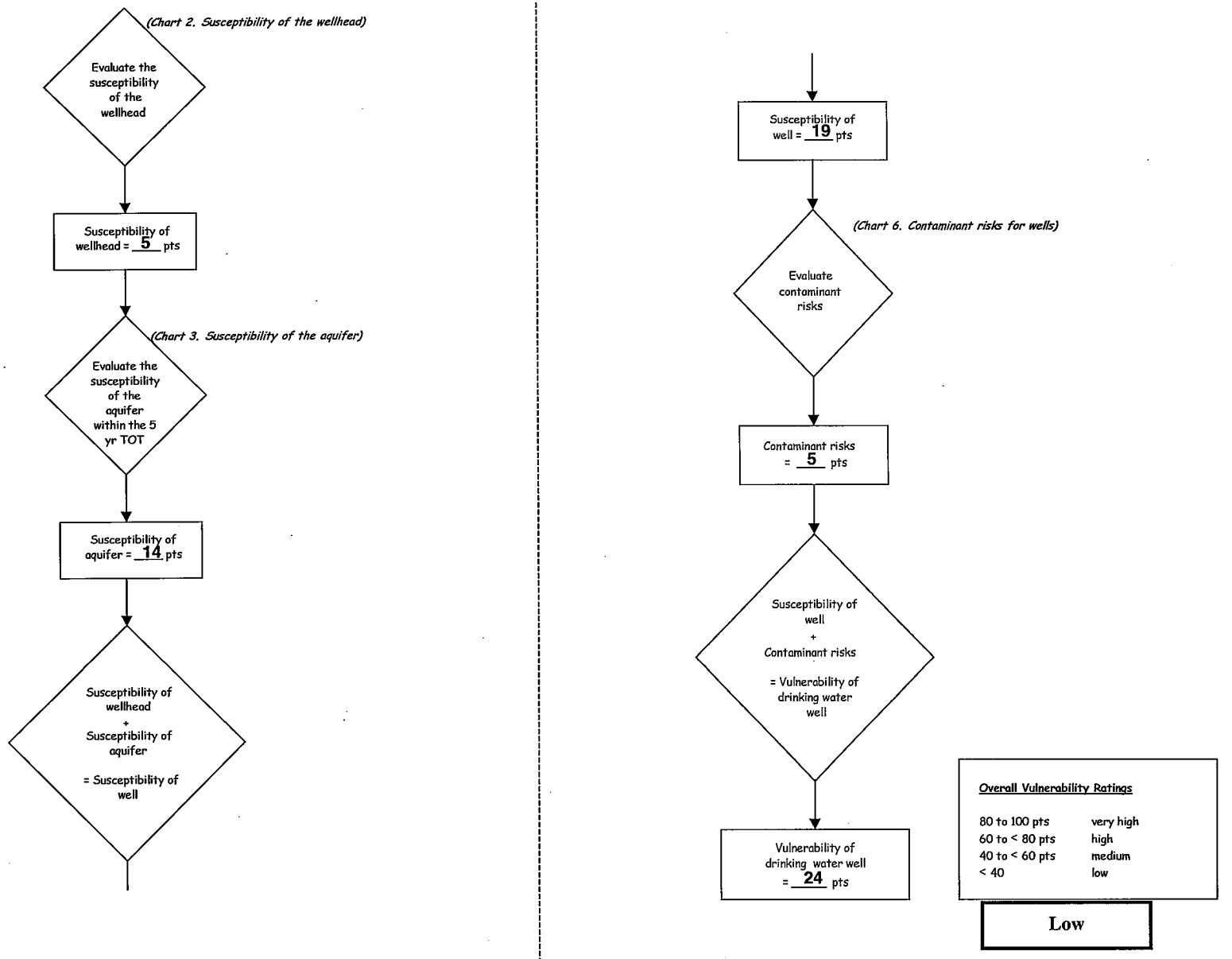
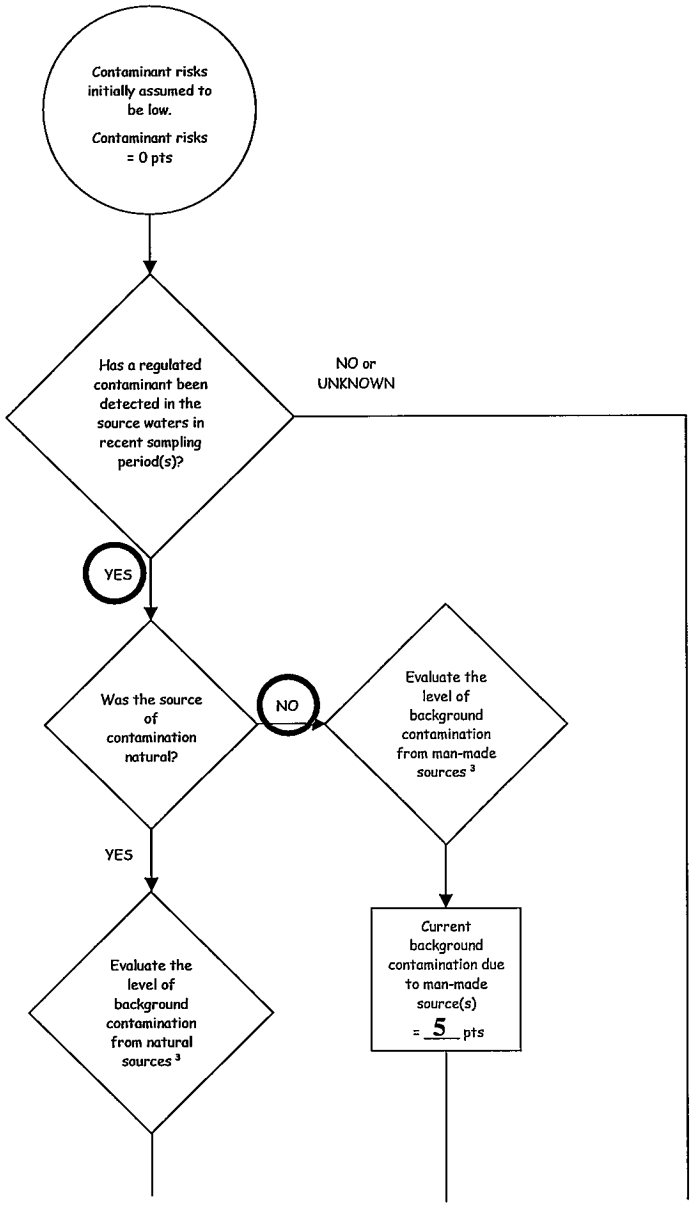


Chart 6. Contaminant risks for Alyeska Chalet Condo HOA – Nitrates/Nitrites



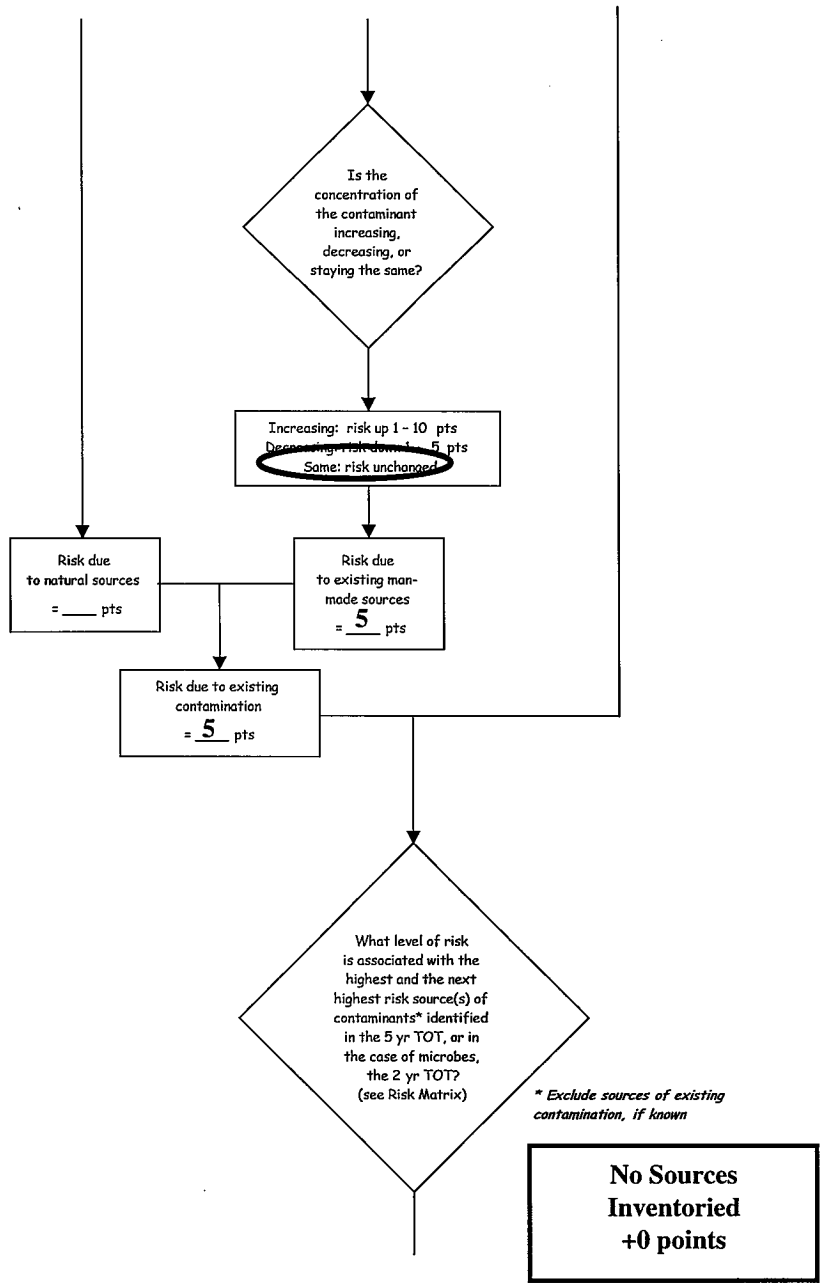
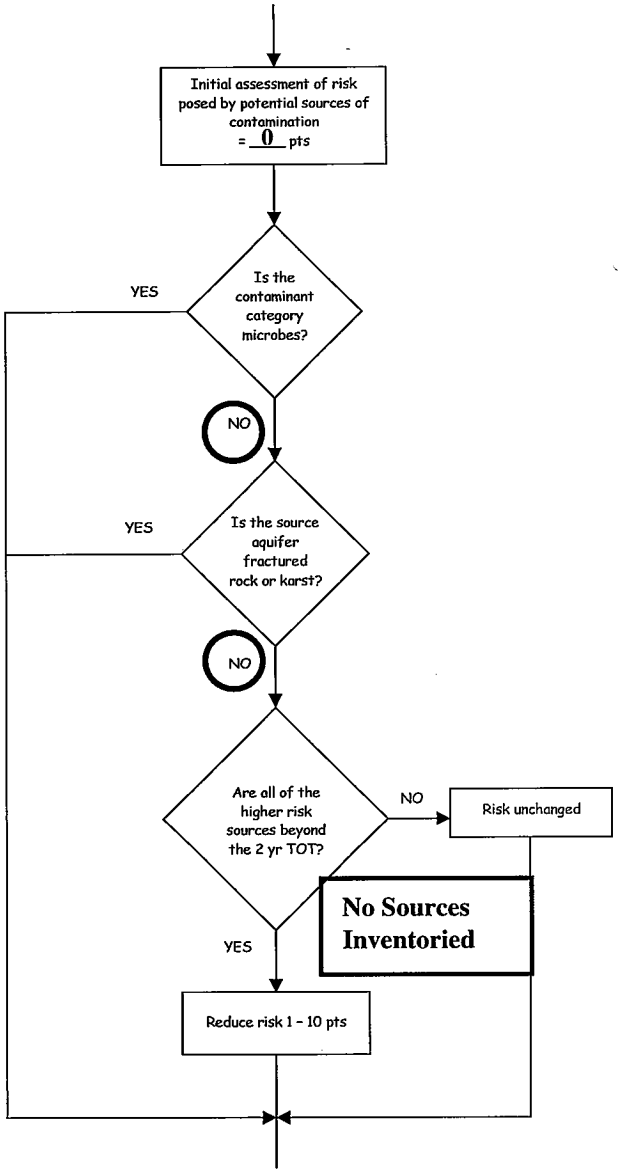


Chart 6. Contaminant risks for Alyeska Chalet Condo HOA – Nitrates/Nitrites (Continued)



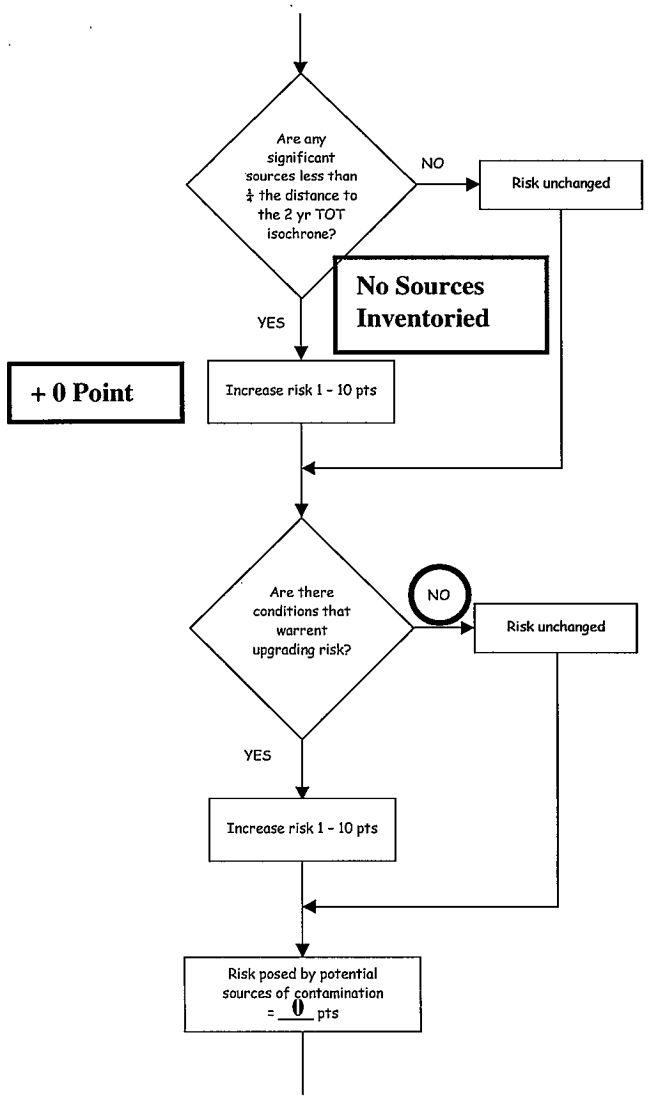
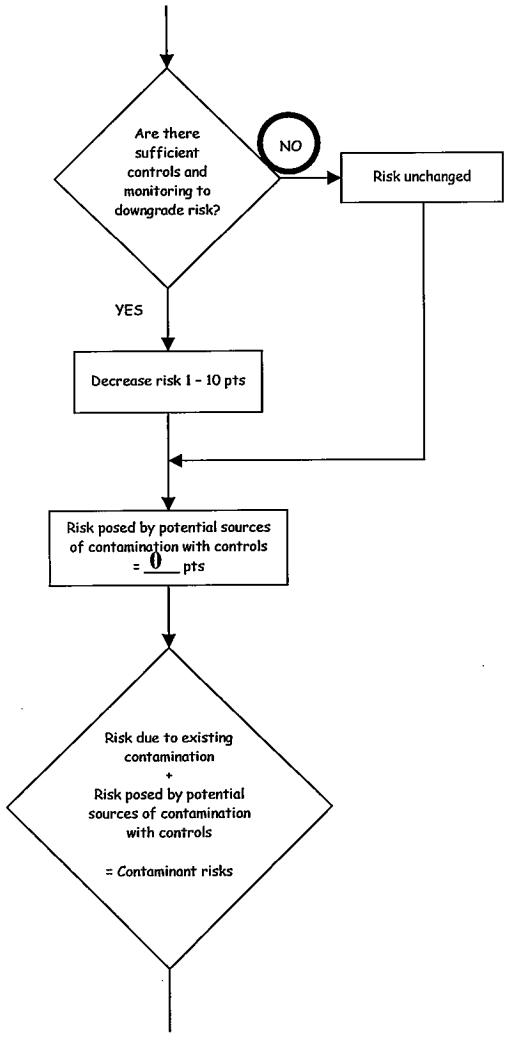
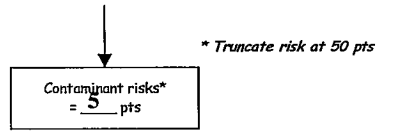


Chart 6. Contaminant risks Alyeska Chalet Condo HOA – Nitrates/Nitrites (Continued)





** Truncate risk at 50 pts*

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

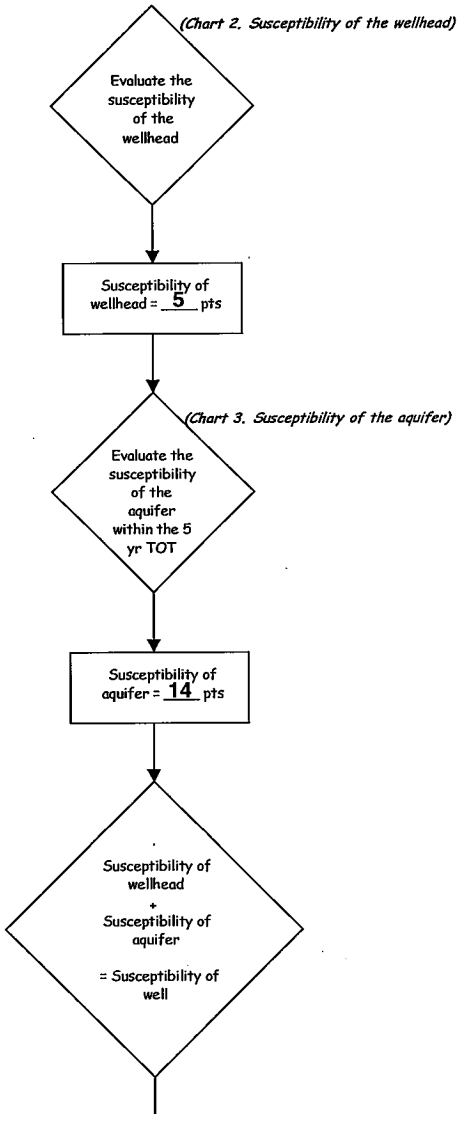
Low

Table 2. Risk Matrix for Contaminant Sources for Nitrates/Nitrites – Alyeska Chalet Condo HOA

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	No Sources Inventoried	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
Low	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	—	
Medium	—	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts	
High	—	—	1 source + 10 pts	≥ 2 sources + 10 pts	
Very High	—	—	—	1 source + 10 pts	

Chart 7. Vulnerability analysis for Volatile Organic Chemicals – Alyeska Chalet Condo HOA



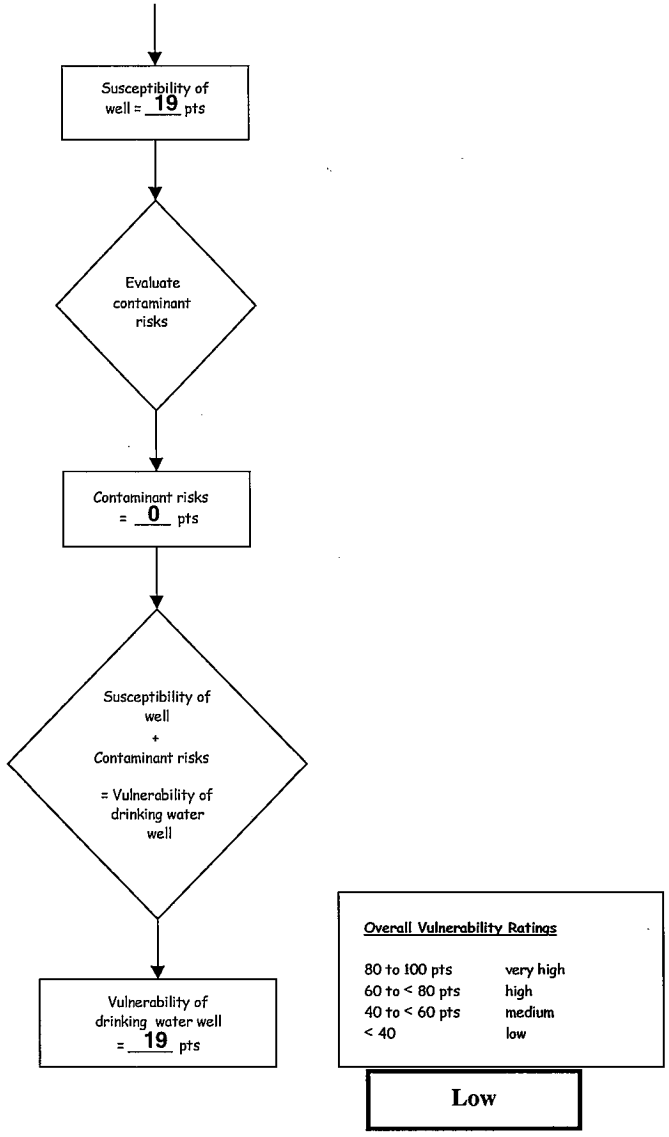
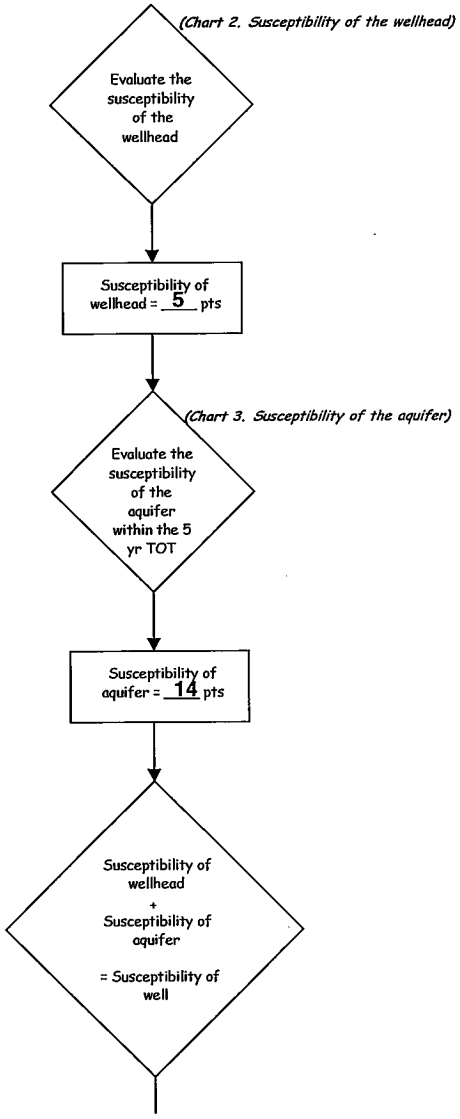


Chart 8. Vulnerability analysis for Heavy Metals and Cyanide – Alyeska Chalet Condo HOA



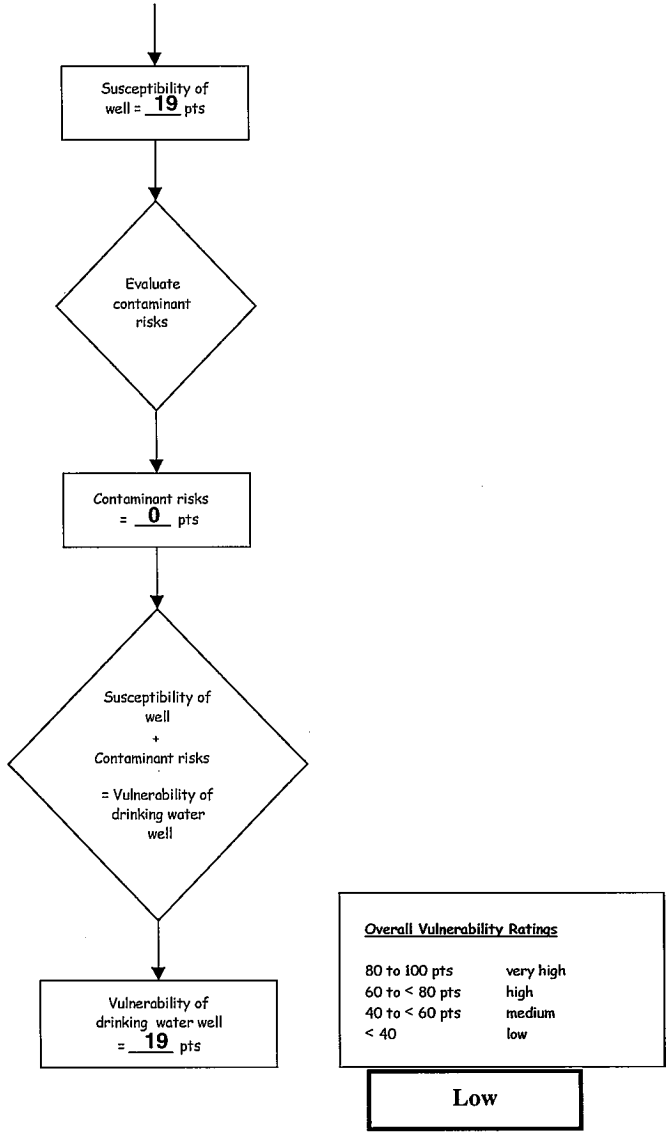


Chart 9. Vulnerability analysis for Synthetic Organic Chemicals – Alyeska Chalet Condo HOA

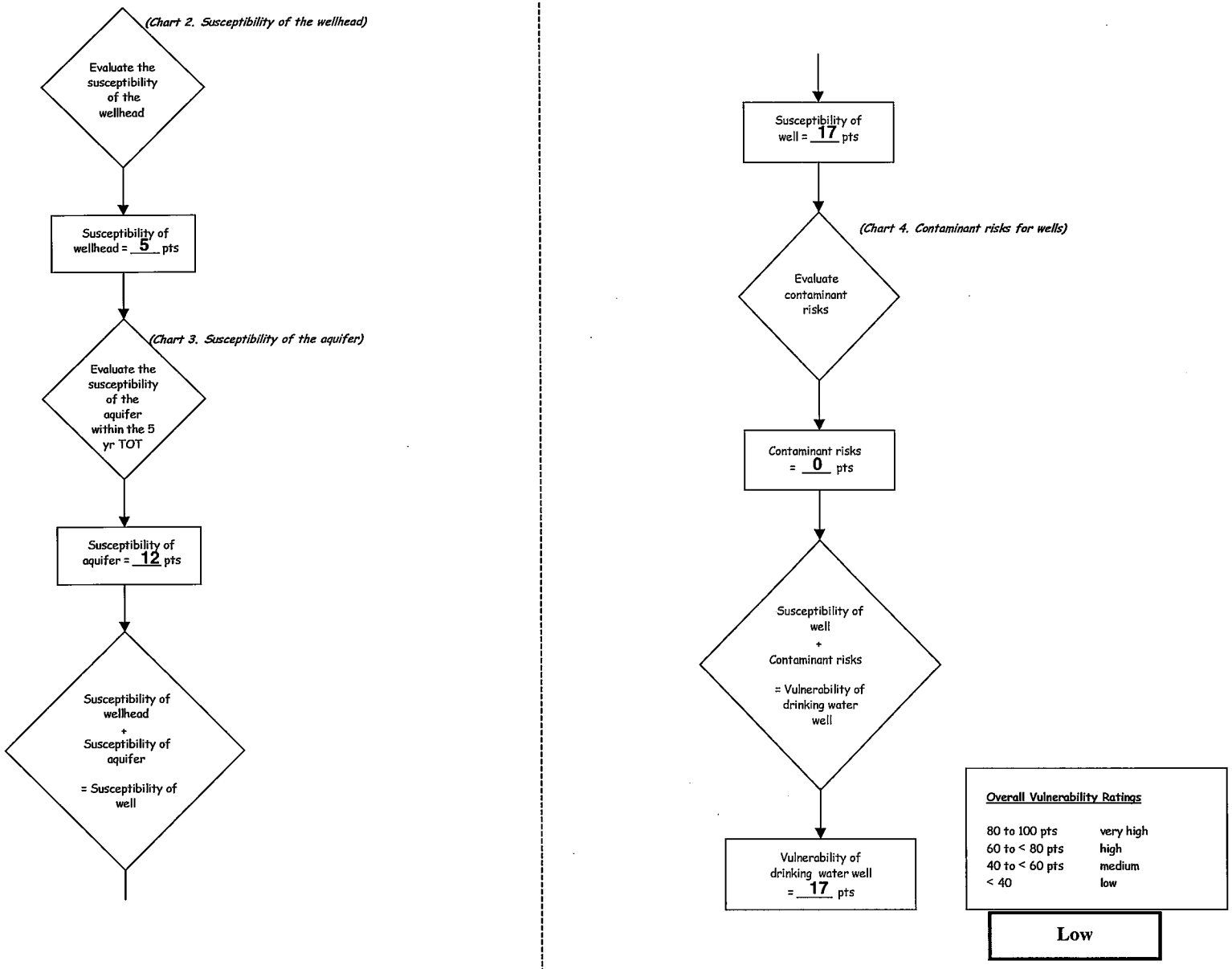


Chart 10. Vulnerability analysis for Other Synthetic Organic Chemicals – Alyeska Chalet Condo HOA