Source Water Assessment for Anchorage Golf Course Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Analysis

DRINKING WATER PROTECTION PROGRAM REPORT 167
PWSID 215443.001

December 2001

Source Water Assessment for Anchorage Golf Course Anchorage, Alaska

By HEATHER A. HAMMOND

DRINKING WATER PROTECTION PROGRAM REPORT 167
PWSID 215443.001

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

Source Water Assessment for Anchorage Golf Course's Source of Public Drinking Water, Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Analysis

By Heather A. Hammond

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Public Water System for Anchorage Golf Course is a Class B (transient/non-community) water system consisting of one well in the Anchorage area. Identified potential and current sources of contaminants for the Anchorage Golf Course include: residential septic systems, paved roads, recreation trails, a construction trade area, the activities associated with maintaining the Anchorage Golf Course, approximately 80 acres of residential area, and a public utility easement. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water source for the Anchorage Golf Course received a vulnerability rating of **Low** for bacteria and viruses, and volatile organic chemicals; and **Medium** for nitrates and./or nitrites.

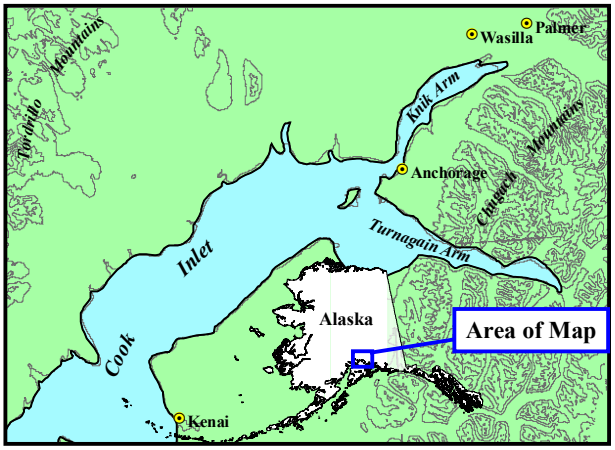


Figure 1. Index map showing the location of Anchorage, Alaska

INTRODUCTION

The purpose of this environmental assessment is to provide public water system owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. This assessment was completed for the source of public drinking water serving the Anchorage Golf Course. This water system consists of one well in the Anchorage area (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 potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

DESCRIPTION OF THE ANCHORAGE AREA, ALASKA

Location

Anchorage, located in southcentral Alaska, encompasses 1,698 square miles of land and 264 square miles of water. The area containing a majority of the urban development, commonly referred to as the Anchorage Bowl, encompasses approximately 180 square miles [*Partick, Brabets, and Glass, 1989*] and envelopes the low lands of the area. This area is bounded on the east by the Chugach Mountains and the north, west, and south by the Knik and Turnagain Arms of Cook Inlet (Figure 1). In recent times, urban development has extended eastward along the flanks of the Chugach Mountains. This area, known locally as the Anchorage Hillside, contains development at elevations exceeding 3,700 feet in elevation above sea level.

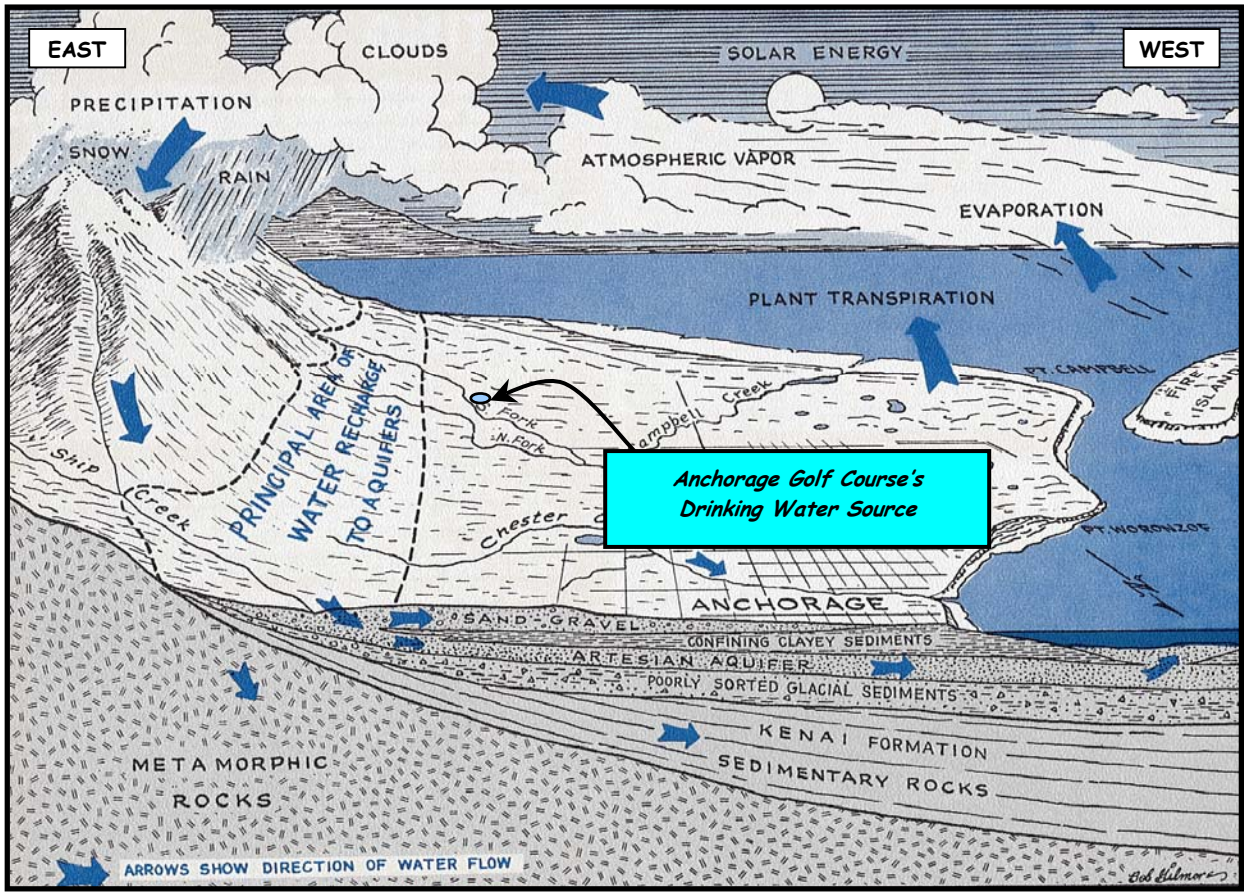


Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

Climate

The Anchorage area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increases inland toward the Chugach Mountains where annual precipitation may exceed 160 inches per year [*Barnwell, George, Dearborn, Weeks, and Zenone*, 1972]. Mean daily temperature ranges from 65^{o} F during July to 8^{o} F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at Knik and Turnagain Arms to well over 5,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Anchorage Bowl.

The backbone of the Chugach Mountains is composed primarily of metamorphic marine and volcanic rocks (bedrock). These high peaks that bound Anchorage's east-side are flanked with colluvium or slope deposits. These slope deposits eventually grade into the glacial and stream deposits at lower elevations in the Anchorage Bowl.

In the Anchorage area, two principal groundwater flow systems or aquifers exist (see Figure 2). The upper unconfined aquifer or water-table aquifer is separated from a lower confined aquifer system by layers of silty, clayey glacially derived sediments (confining layer) [*Ulery and Updike*, 1983]. The lower confined aquifer system consists of a series of hydrologically interconnected layers and lenses of gravel, sand and silt that, collectively, form the confined aquifer. The confining layer ranges from 0 to 270 feet thick throughout the Anchorage area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front [*Patrick, Brabets, and Glass*, 1989].

Water enters or recharges these two aquifer systems in several different ways. Along the front of the Chugach

Mountains, groundwater seeps from fractures in bedrock into the sediments. At these higher elevations, rain and snowmelt also enter the sediments. This area along the mountain front is considered the principal recharge area for wells in the Anchorage area. Precipitation in the low lands may also percolate directly into the ground. Lastly, aquifers may also be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). Groundwater flow in the confined aquifer is generally east to west from the mountain front toward Cook Inlet and Turnagain Arm, except in areas where the direction of flow is influenced by large municipal or industrial production wells. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surfacial topography as well as its close connection with surface water bodies.

THE ANCHORAGE GOLF COURSE PUBLIC DRINKING WATER SYSTEM

The public water system serving the Anchorage Golf Course is a Class B (transient/non-community) water system, which is owned and operated by Seibu Alaska, Inc. The system consists of one well, which is located in the foothills of the Chugach Mountains in the center of the Hillside Area off near the corner of Abbott Loop and O'Malley Road at an elevation of approximately 300 feet above sea level (see Figure 3).

This system operates year round and serves 25 non-residents through one service connection.

ASSESSMENT AND PROTECTION AREA FOR ANCHORAGE GOLF COURSE'S DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for the source of drinking water serving the Anchorage Golf Course 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

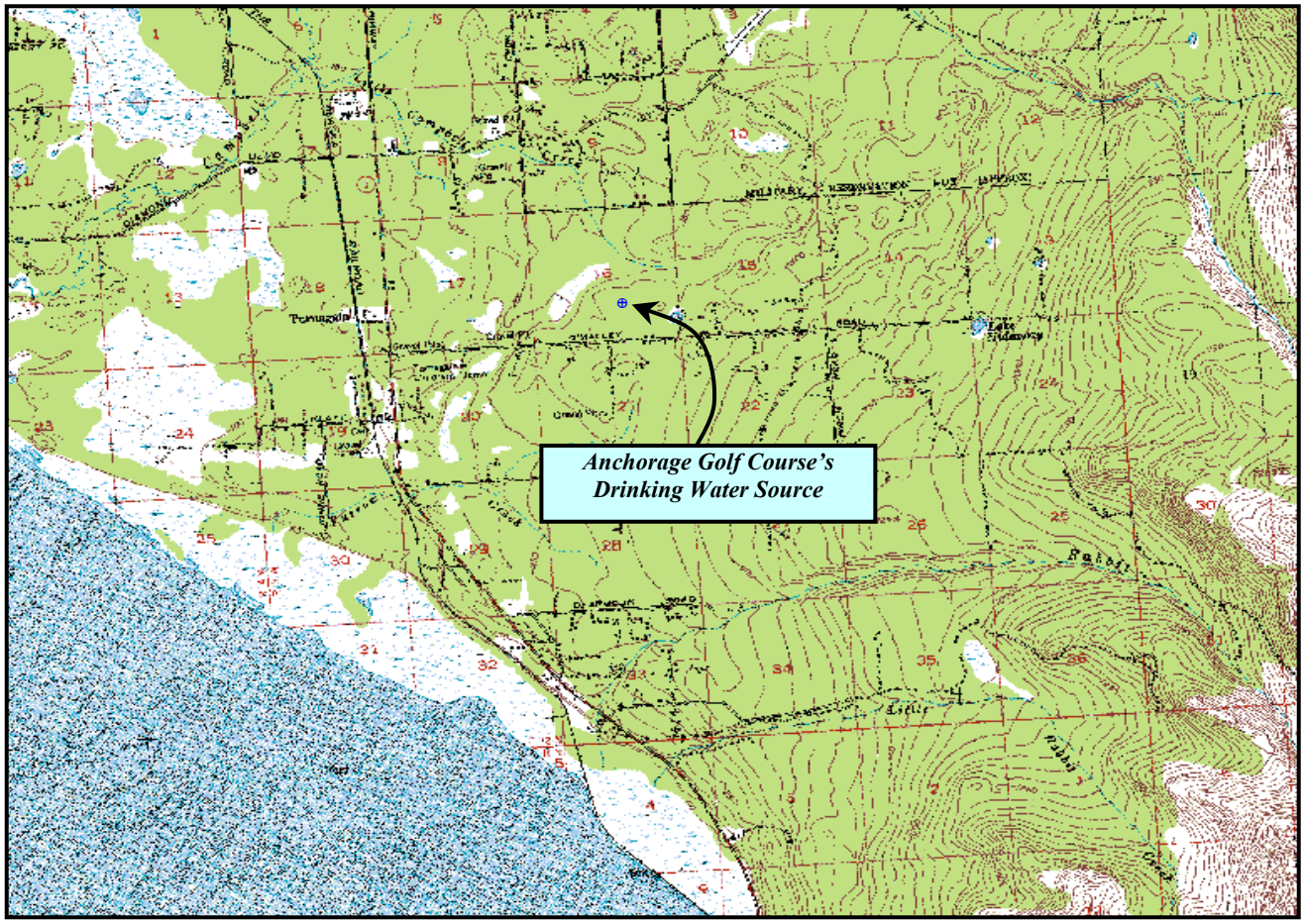


Figure 3. Map showing the location of the drinking water source for Anchorage Golf Course [Base: USGS Anchorage A8].

to contamination. The zones around the drinking water source outline the most critical area for the preservation of the quality of the drinking water for this system. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems along the front range of the Chugach Mountains (Figure 2) and flows toward Cook Inlet. An analytical calculation was used to determine the size and shape of the area that contributes water to the well. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey [*Patrick, Brabets, and Glass, 1989*]. This analytical calculation was used as a guide as the first step in establishing the protection area for each public drinking water source in Anchorage. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at meaningful and conservative protection areas with respect to public health (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

The Drinking Water Protection 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 saturated zone of the ground from a specific point to the well. The Drinking Water Protection Area for the Anchorage Golf Course contains four zones, Zone A through Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the well and the distance equal to ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be on the order of several days to several hours. Zone A also extends downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Zone B corresponds to a time-of-travel of less than two years. Zones C and D correspond to those areas between 5 years and 10 years time-of-travel, respectively.

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 Drinking Water Protection Area for the Anchorage Golf Course. This survey was completed through a search of agency records and other publicly available information. 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 and 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

Maps 2 and 3 in Appendix C depict the Contaminant Source Inventory for the Anchorage Golf Course. Table 1 in Appendix B lists the inventoried potential sources of contamination within Zones A through D. Below is a summary of the contaminant sources inventoried within the Drinking Water Protection Area for Anchorage Golf Course:

- Residential septic systems;
- paved roads;
- recreation trails;
- a construction trade area;
- the Anchorage Golf Course
- approximately 80 acres of residential area;
- a public utility easement.

These potential and existing contaminant sources present risk for all three categories of drinking water contaminants for Anchorage Golf Course's source of public drinking water.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been 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 and density of those types of contaminant sources as well as the proximity of those sources to the public drinking water well.

VULNERABILITY OF ANCHORAGE GOLF COURSE'S DRINKING WATER SOURCE

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

natural susceptibility; and

- contaminant risks.

Each of the three categories of drinking water contaminants have been analyzed and an overall vulnerability score of 0 to 100 ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the
Drinking Water Source to Contamination (0 – 100).

A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)
+
Susceptibility of the Aquifer (0 – 25 Points)

= Natural Susceptibility (Susceptibility of the Well)
(0 – 50 Points)

According to the well log for Anchorage Golf Course's source of public drinking water the well was completed June 20, 1985 in a 6 inch well casing, to a total depth of 242 feet and had a static water level of 179 feet below land surface. The well was completed in a confining aquifer consisting of silty gravel and gravely hardpan. The depth to the top of the confining unit is approximately 105 feet below land surface with a cumulative thickness of approximately 51 feet. This confining layer may provide a protective barrier against the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, these clay layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer.

Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility of the well to contamination (See Appendix D). Table 1 depicts the overall Susceptibility score and rating for the source of public drinking water serving the Anchorage Golf Course.

Table 1. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	9	Low
Natural Susceptibility	14	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (See Appendix B - Table 1 – Table 7). 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 or been detected at the well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	31	High
Volatile Organic Chemicals	10	Low

Appendix D contains eight charts, which together form the 'Vulnerability Analysis' for a Class B public drinking water system. 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 Analysis for nitrates and nitrites, volatile organic chemicals, respectively.

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 (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of Anchorage Golf Course's Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	45	Medium
Volatile Organic Chemicals	25	Low

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.

Overall, contaminant risk for bacteria and viruses is medium with the activities associated with maintaining the Anchorage Golf Course and residential septic systems driving the increase of contaminant risk. Combining this potential bacteria and viruses contamination risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of low.

Other low potential and existing sources of contamination for bacteria and viruses include activities associated with paved roads, and recreation trails.

Overall, contaminant risk for nitrates and/or nitrites is high with the activities associated with maintaining the Anchorage Golf Course driving the increase of contaminant risks. Combining this potential nitrates and/or nitrites contamination risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of medium.

Other low potential and existing sources of nitrates and/or nitrites include residential septic systems, activities associated with recreation trails, residential areas, and paved roads.

The Alaska Zoo and a large horse riding stable are located directly uphill from the Anchorage Golf Course. Both areas fall within the Zone D Protection Area and because of their proximity to the well are considered low potential sources of bacteria and viruses and nitrates and/or nitrites. Historical sampling results indicate that no nitrate and/or nitrite contamination has been detected in the source waters within the past 2 years.

Overall, contaminant risk for volatile organic chemicals is low with paved roads and residential septic systems driving the increase of contaminant risks. Combining this potential volatile organic chemical contamination risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of low.
Other low potential and existing sources of volatile organic chemicals include activities associated with residential areas, septic systems, construction trade areas and a public utility easement.

A natural gas pipeline transverses the Zone C Protection Area. Natural gas does not pose a threat to drinking water supplies. However, this area is an active public utility corridor. This utility corridor, though not heavily used represents a very low contamination risk from volatile organic chemicals. Overall, this corridor ranks as a low potential source of contamination due to its proximity to Anchorage Golf Course's source of public drinking water.

SUMMARY

A *Source Water Assessment* has been completed for the source of public drinking water serving Anchorage Golf Course. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, and volatile organic chemicals; and **Medium** for nitrates and/or nitrites. 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 Anchorage Golf Course 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 Anchorage Golf Course's public drinking water source.

REFERENCES CITED

Barnwell, W.W., George, R.S., Dearborn, L.L., Weeks, J.B., and Zenone, C., 1972, Water for Anchorage: an atlas of the water resources of the Anchorage area, Alaska: U.S. Geological Survey Open-File Report, 76 p.

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

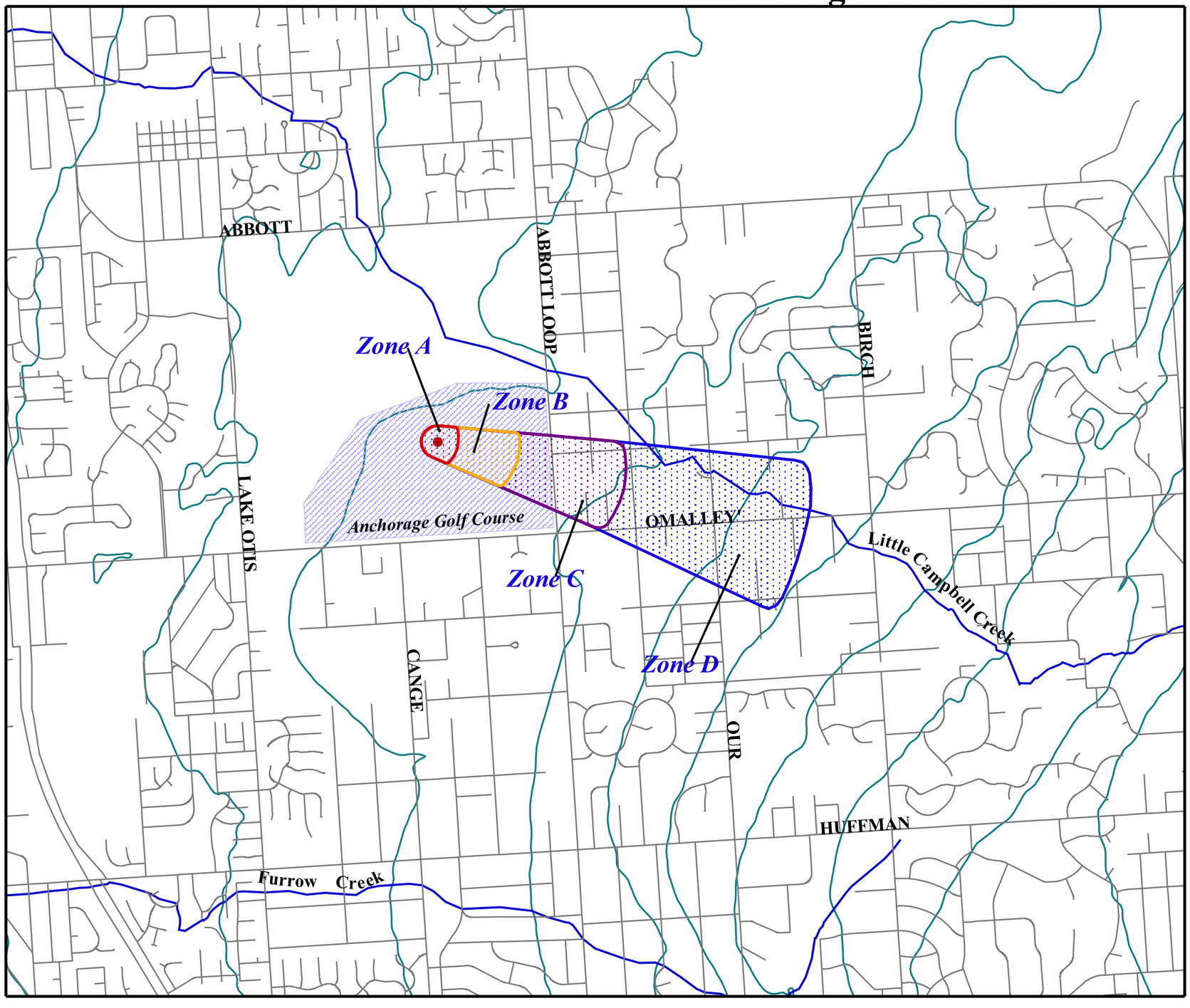
Ulery, C.A. and Updike, R.G, 1983, Subsurface structure of the cohesive facies of the Bootlegger Cove Formation, Southwest Anchorage, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 84, 5 p.

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

Anchorage Golf Course's
Drinking Water Protection Area

Drinking Water Protection Area for Anchorage Golf Course



- Anchorage Golf Course DW Well

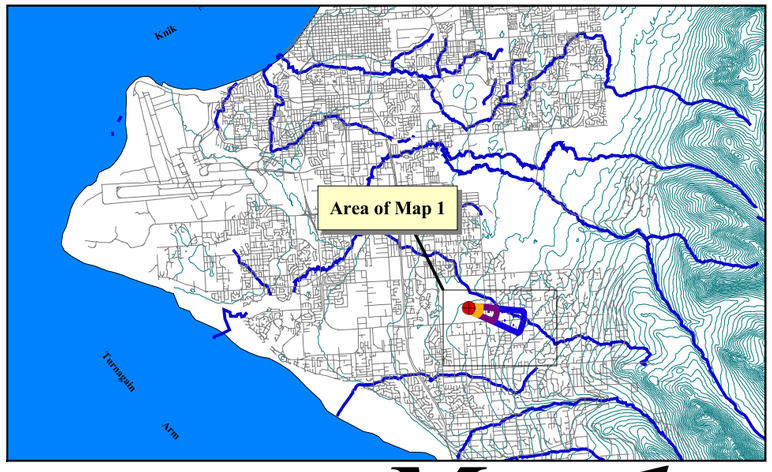
Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time
- Anchorage Golf Course (X2)
- Roads
- Anchorage Streams
- Elevations Contours

N
W E
S



3000 0 3000 6000 Feet

PWSID 215443.001

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Anchorage Golf Course

Table 1

Contaminant Source Inventory for ***Anchorage Golf Course***

PWSID 215443.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Golf courses	X02	X4-1	A	Anchorage Golf Course is located within Zones A, B, C	2	
Construction trade areas and materials	C09	C9-1	C	Off of One-hundred-fourth Ave.	2	
Residential Areas	R01	R1-1	C	Residential areas located within Zone C	2	
Septic systems (serves one or more single-family homes)	R02	R2-1-35	C	All septic systems located within Zone C	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	C	All roads located within Zone C	3	
Public utility easements/corridors	X42	X42-1	C	Public utility easement/corridor running along pipeline intersecting Zone C	2	Pipeline serves dual purpose. Currently carrying natural gas but has been used for oil in the past.
Dog walking areas/foot trails	X46	X46-1-2	C	All trails located within Zone C	3	

Table 2

Contaminant Source Inventory and Risk Ranking for Anchorage Golf Course Sources of Bacteria and Viruses

PWSID 215443.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Golf courses	X02	X4-1	A	Medium	1	Anchorage Golf Course is located within Zones A, B, C	2	
Residential Areas	R01	R1-1	C	Low	2	Residential areas located within Zone C	2	
Septic systems (serves one or more single-family homes)	R02	R2-1-35	C	Low	3	All septic systems located within Zone C	2	
Dog walking areas/foot trails	X46	X46-1-2	C	Low	4	All trails located within Zone C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	C	Low	5	All roads located within Zone C	3	

Table 3

Contaminant Source Inventory and Risk Ranking for Anchorage Golf Course Sources of Nitrates/Nitrites

PWSID 215443.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Overall Rank after Analysis***	***Location***	***Map Number***	***Comments***
Golf courses	X02	X4-1	A	Medium	1	Anchorage Golf Course is located within Zones A, B, C	2	
Residential Areas	R01	R1-1	C	Low	2	Residential areas located within Zone C	2	
Septic systems (serves one or more single-family homes)	R02	R2-1-35	C	Low	3	All septic systems located within Zone C	2	
Dog walking areas/foot trails	X46	X46-1-2	C	Low	4	All trails located within Zone C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	C	Low	5	All roads located within Zone C	3	

Table 4

Contaminant Source Inventory and Risk Ranking for Anchorage Golf Course Sources of Volatile Organic Chemicals

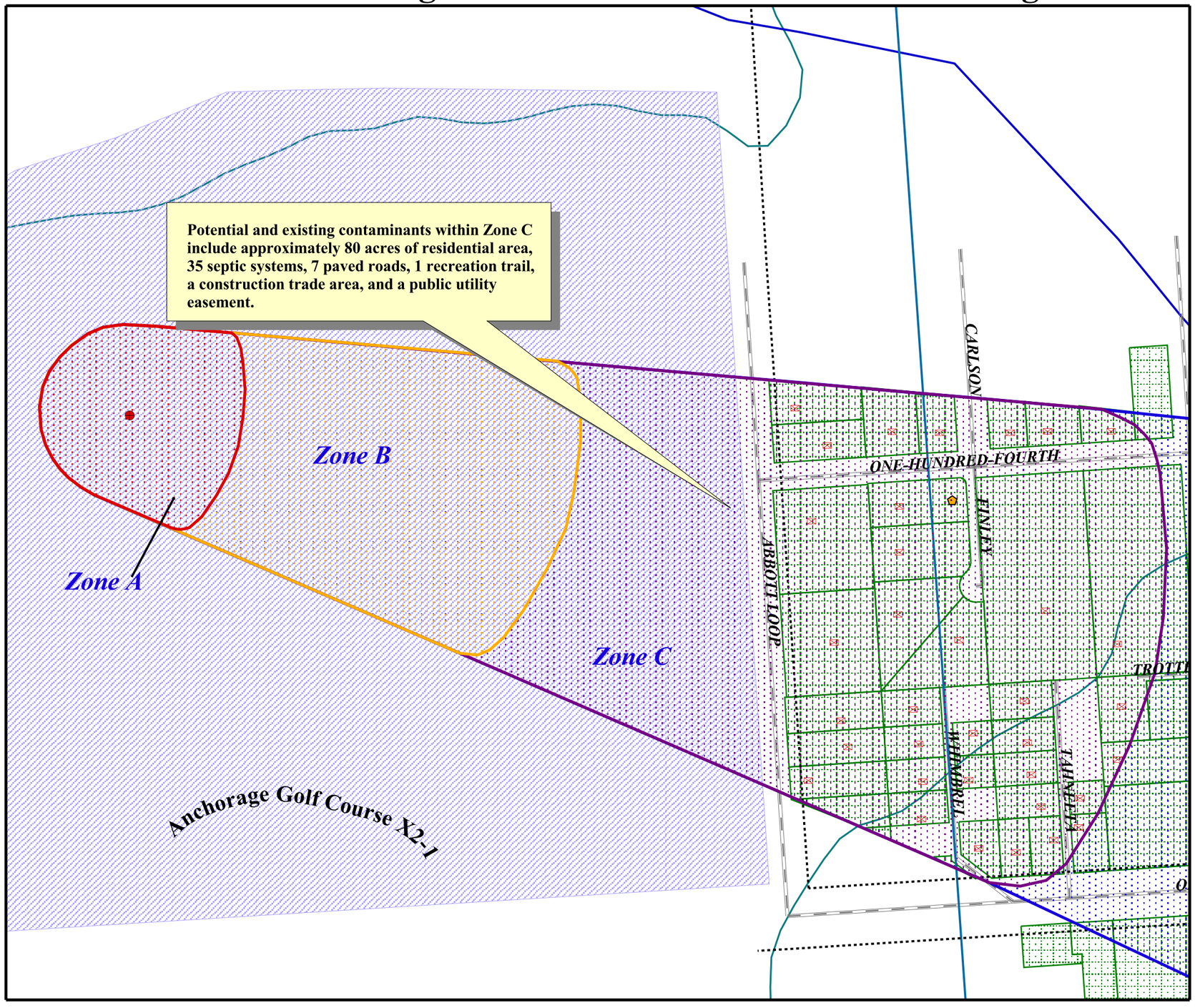
PWSID 215443.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Overall Rank after Analysis***	***Location***	***Map Number***	***Comments***
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	C	Low	1	All roads located within Zone C	3	
Construction trade areas and materials	C09	C9-1	C	Low	2	Off of One-hundred-fourth Ave.	2	
Public utility easements/corridors	X42	X42-1	C	0	3	Public utility easement/corridor running along pipeline intersecting Zone C	2	Pipeline serves dual purpose. Currently carrying natural gas but has been used for oil in the past.
Residential Areas	R01	R1-1	C	Low	4	Residential areas located within Zone C	2	
Septic systems (serves one or more single-family homes)	R02	R2-1-35	C	Low	5	All septic systems located within Zone C	2	

APPENDIX C

Anchorage Golf Course's
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

Drinking Water Protection Area for
Anchorage Golf Course and Potential & Existing Contaminant Sources



- Anchorage Golf Course DW Well

Zone A Protection Area
- Several Months Travel Time

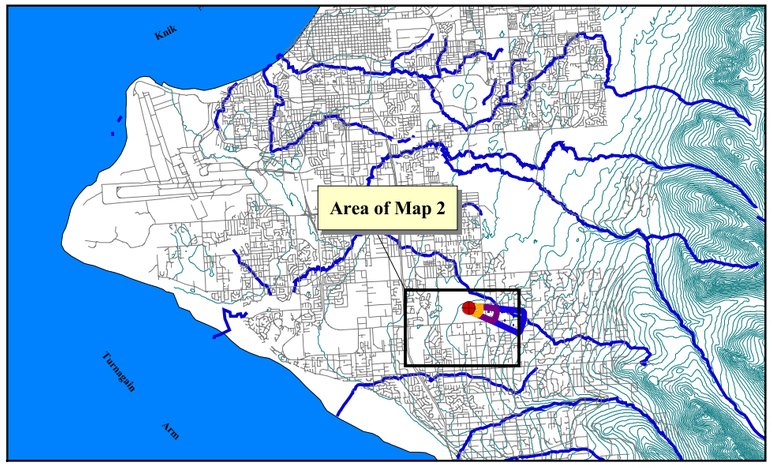
Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time
- Septic Systems (R2)
- Trails (X46)
- Public Utility Easements/Corridors (X42)

Potential and Existing Contaminant Sources
- Construction Trade Areas and Materials (C9)
- Anchorage Golf Course (X2)
- Lawns and Gardens (R1)
- Raods (X20)
- Anchorage Streams
- Elevations Contours

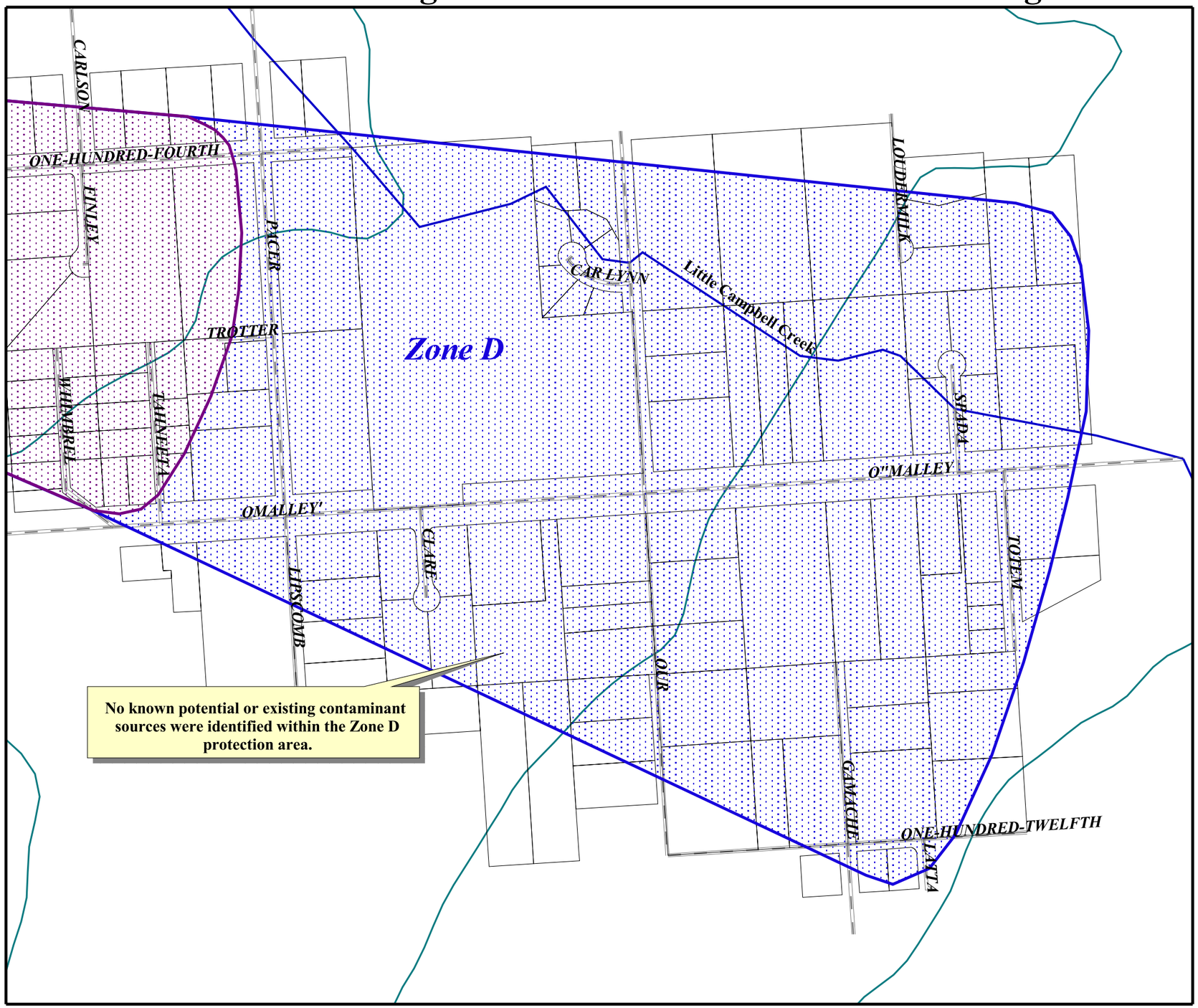
N W E S



PWSID 215443.001

Map 2

Drinking Water Protection Area for
Anchorage Golf Course and Potential & Existing Contaminant Sources



Anchorage Golf Course DW Well

Zone C Protection Area

Less Than 5 Years Travel Time

Zone D Protection Area

Less Than 10 Years Travel Time

MOA Land Parcels

Raods (X20)

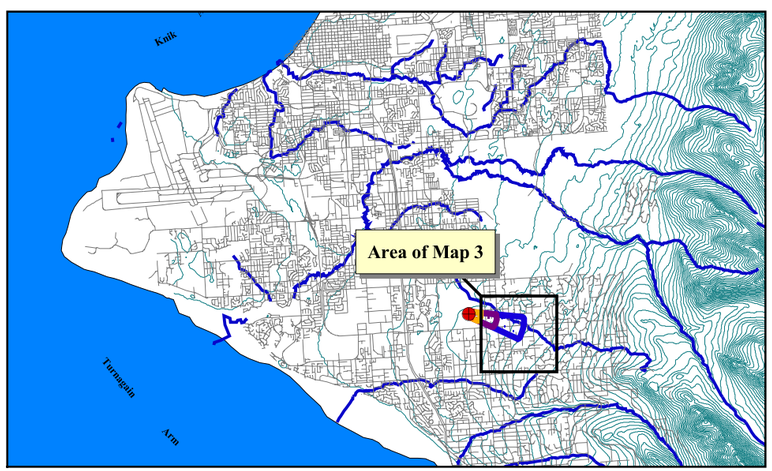
Anchorage Streams

Elevations Contours

N

W E

S



PWSID 215443.001

Map 3

APPENDIX D

Vulnerability Analysis for Anchorage Golf Course's Public Drinking Water Source

Chart 1. Susceptibility of the wellhead - Anchorage Golf Course

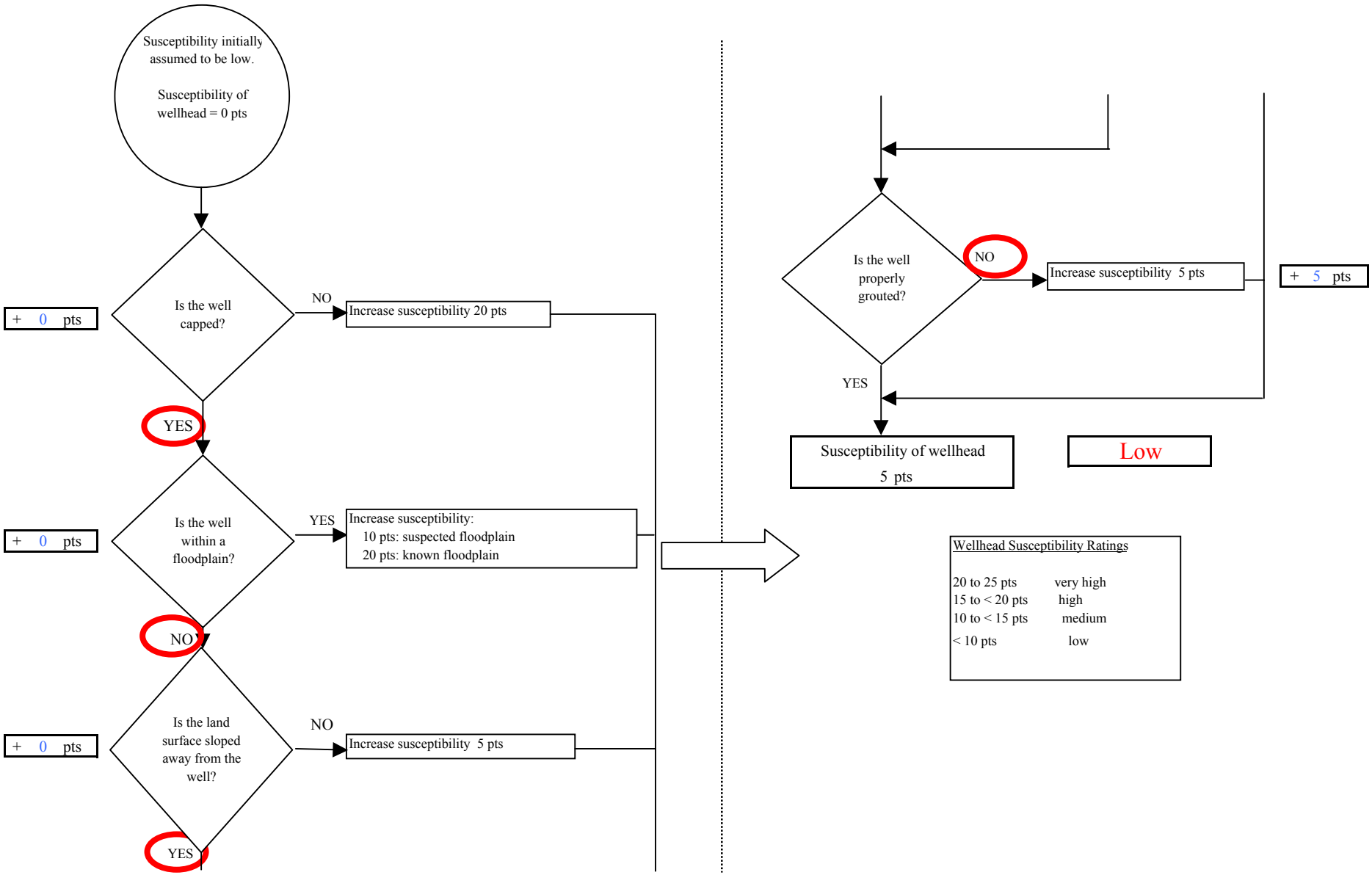


Chart 2. Susceptibility of the aquifer - Anchorage Golf Course

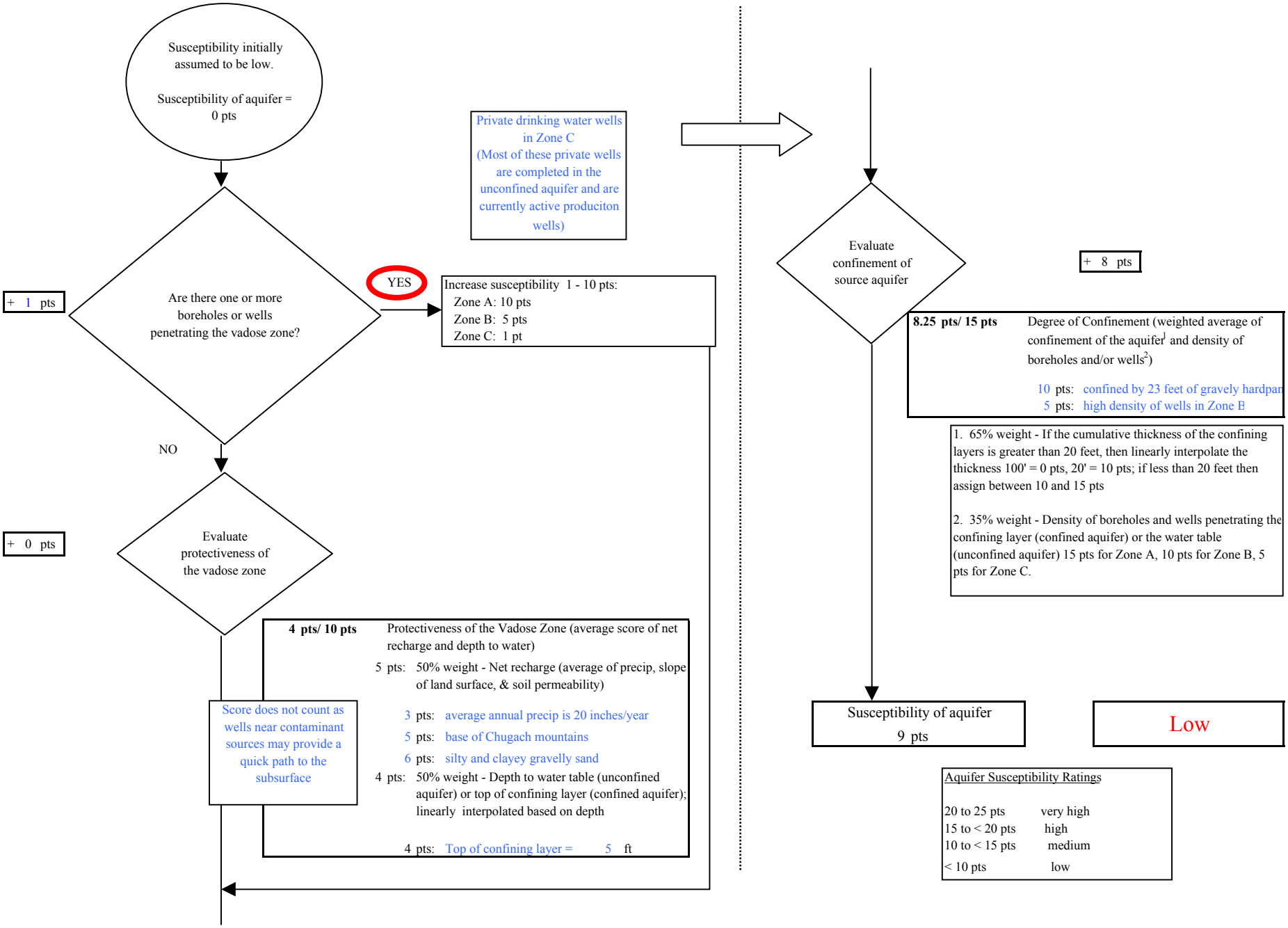
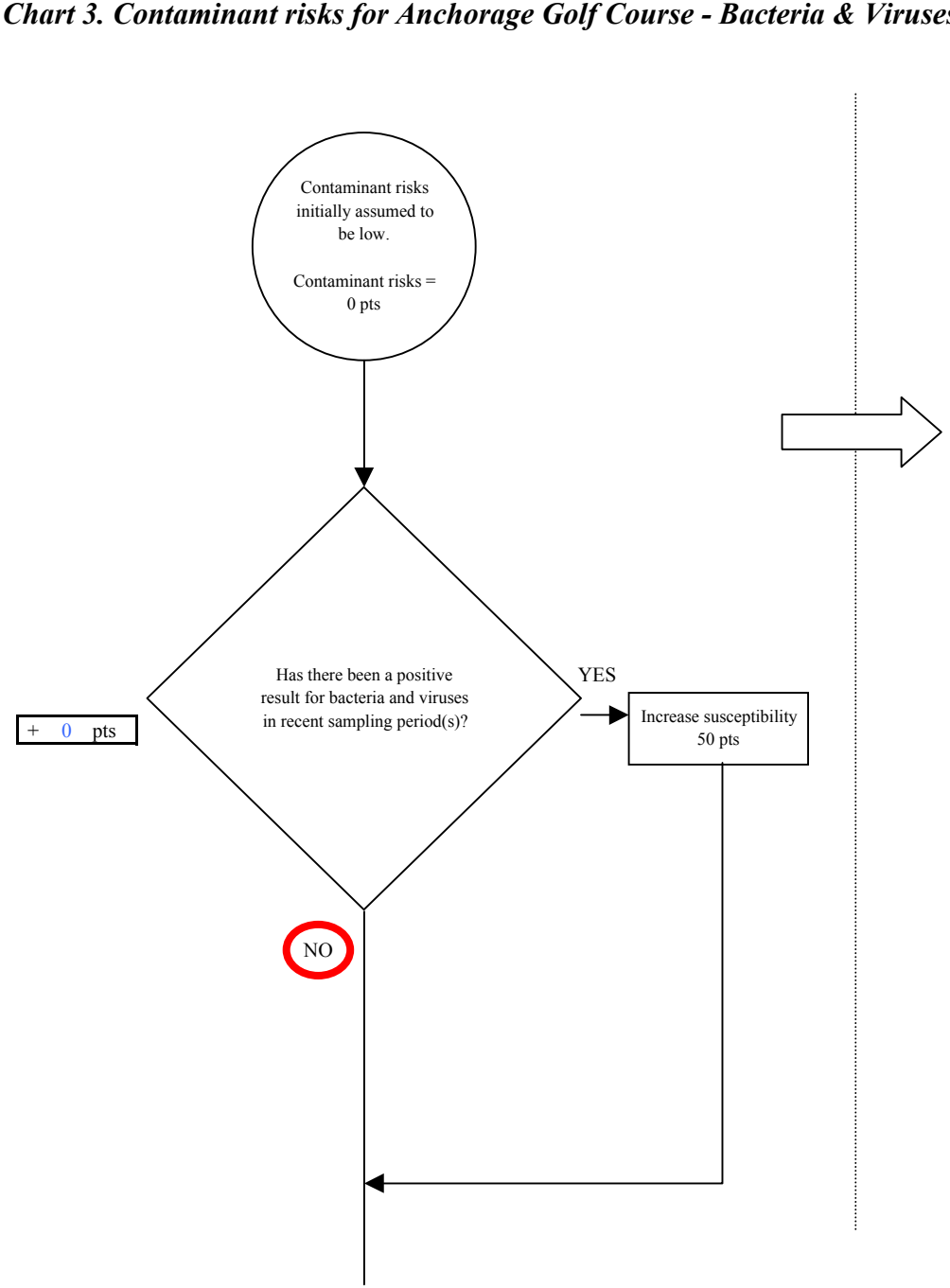
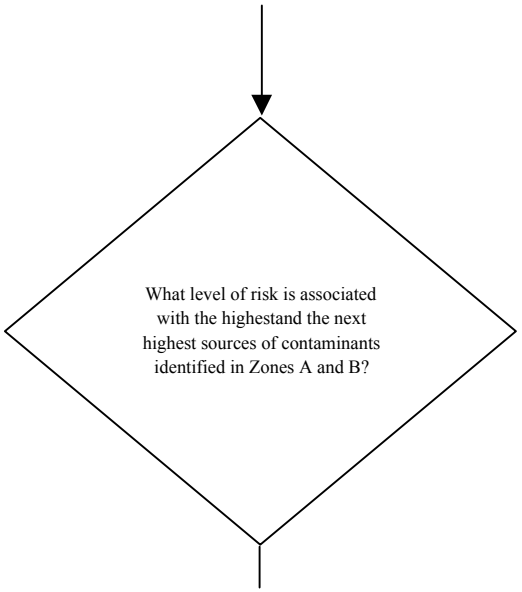


Chart 3. Contaminant risks for Anchorage Golf Course - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	0	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 20

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

Chart 3. Contaminant risks for Anchorage Golf Course - Bacteria & Viruses

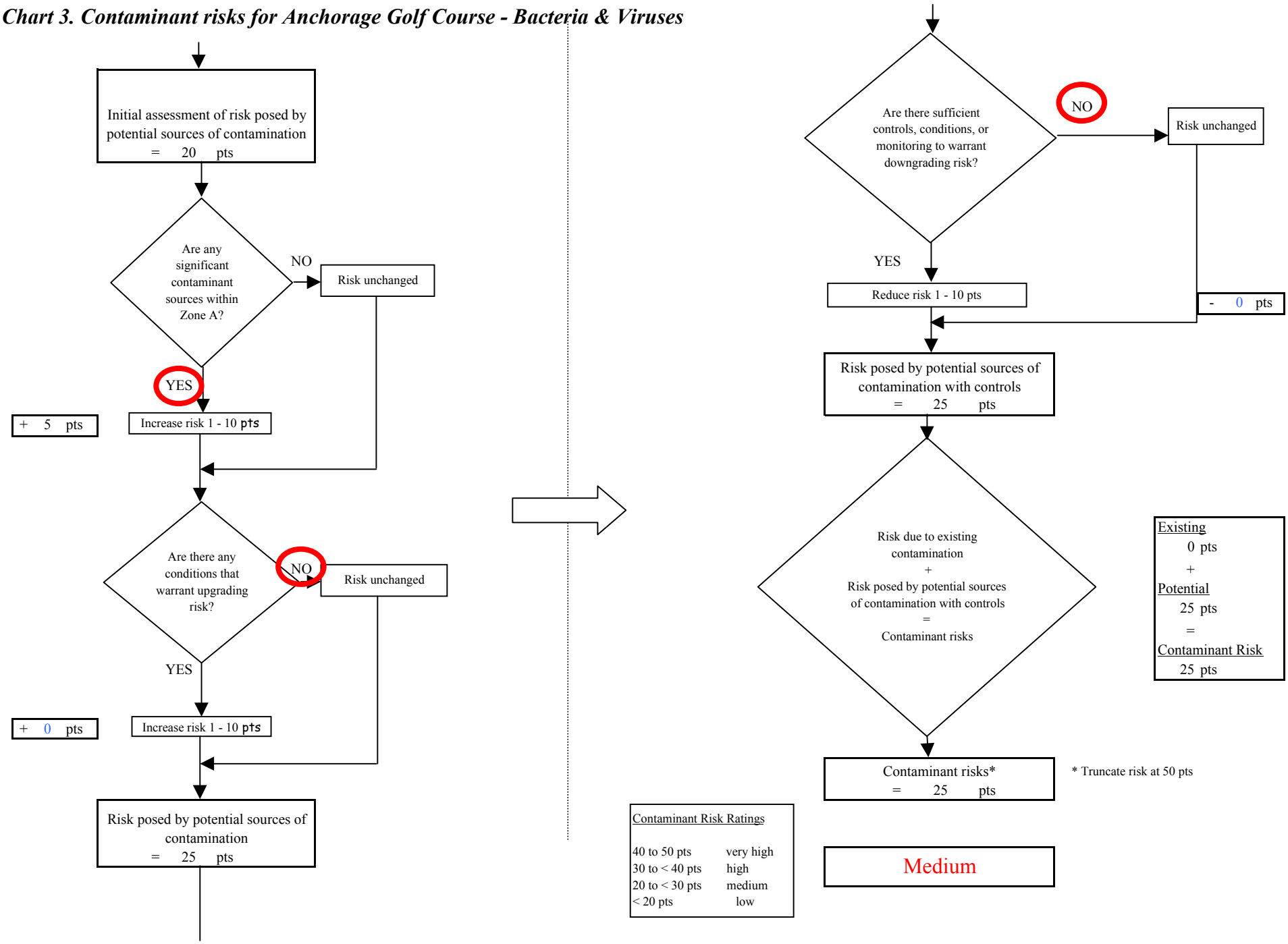


Chart 4. Vulnerability analysis for Anchorage Golf Course - Bacteria & Viruses

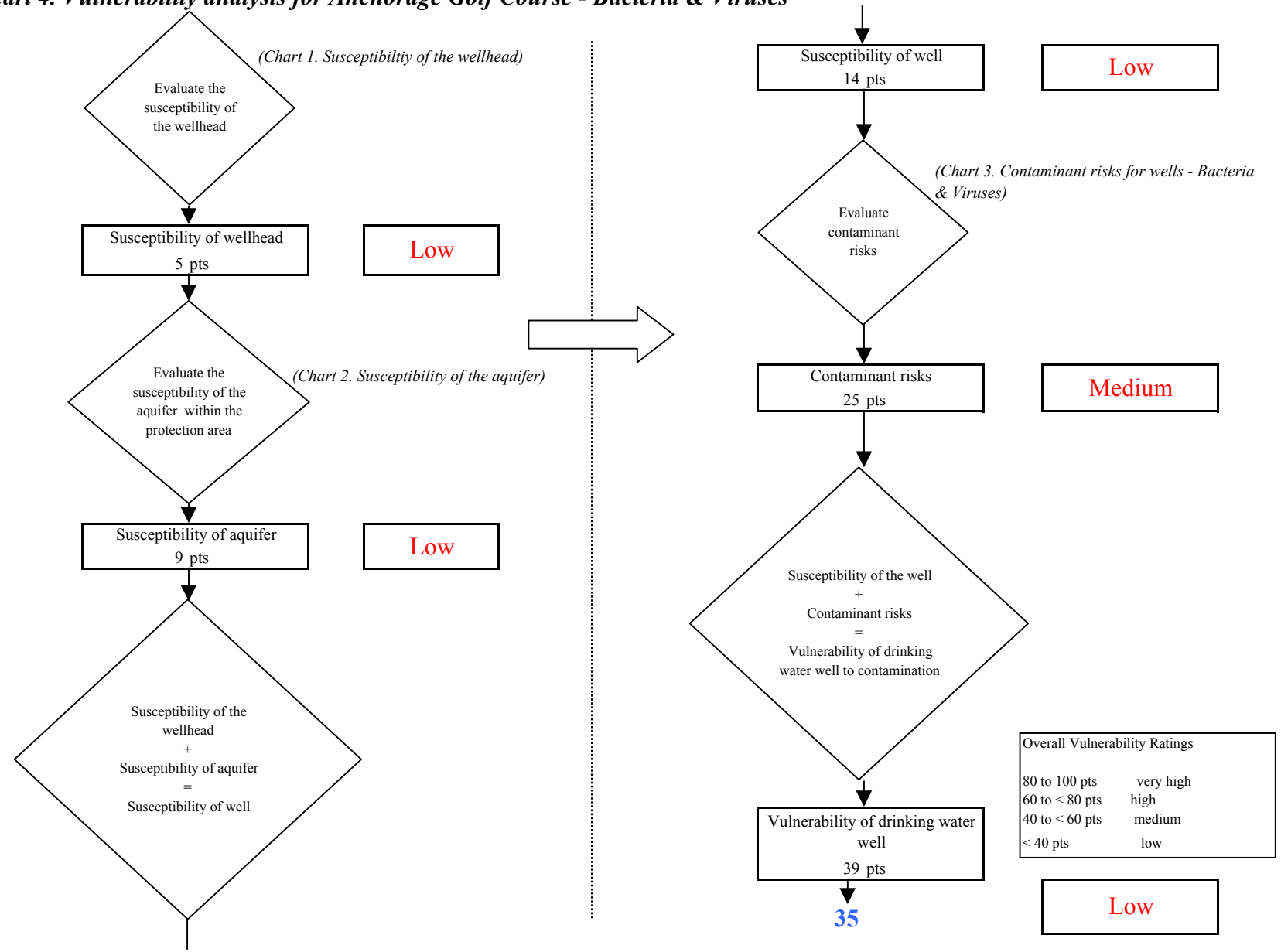


Chart 5. Contaminant risks for Anchorage Golf Course - Nitrates and Nitrites

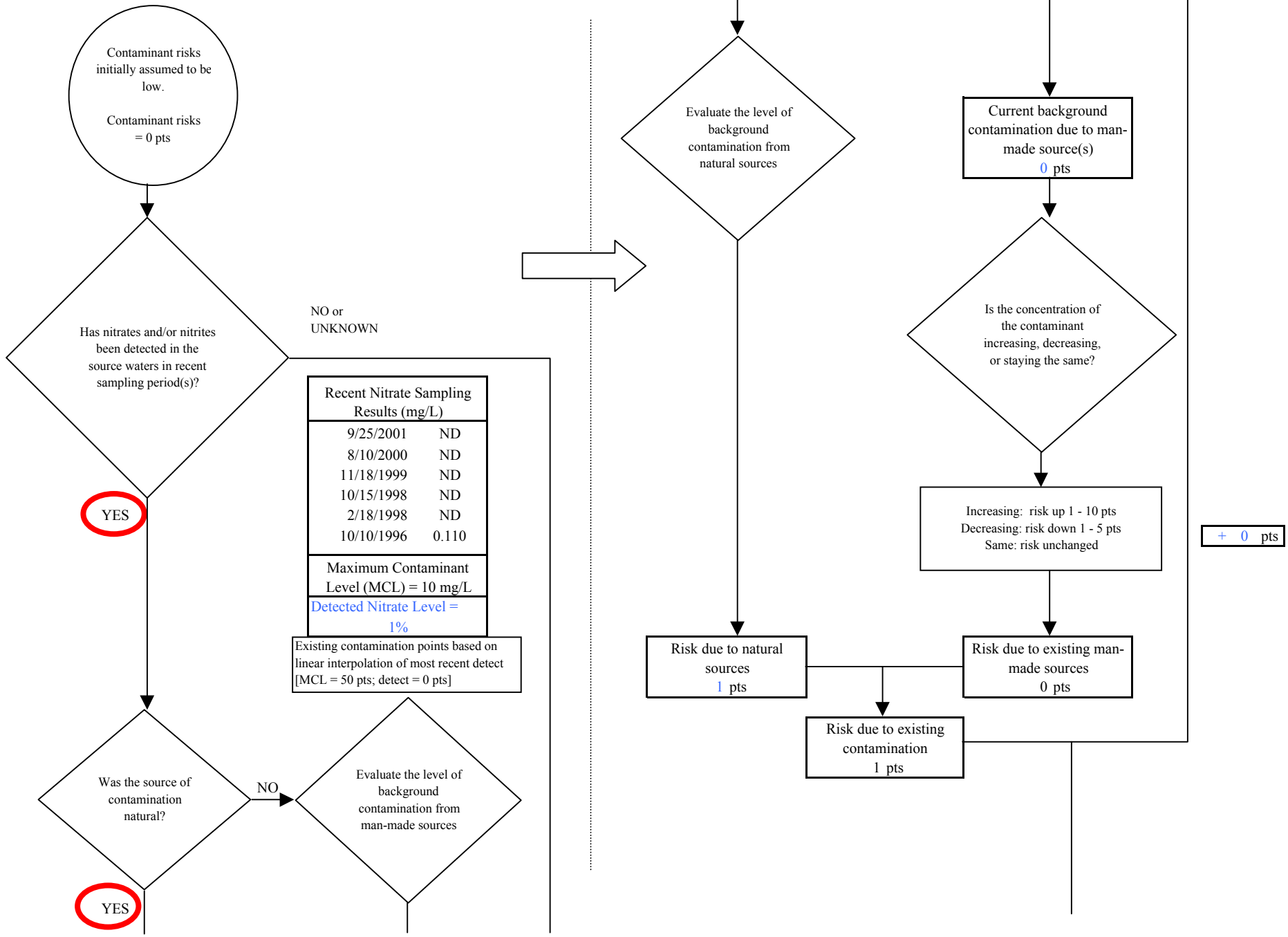


Chart 5. Contaminant risks for Anchorage Golf Course - Nitrates and Nitrites

+ 20 pts

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

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

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

	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 20

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

Initial assessment of risk posed by potential sources of contamination = 20 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

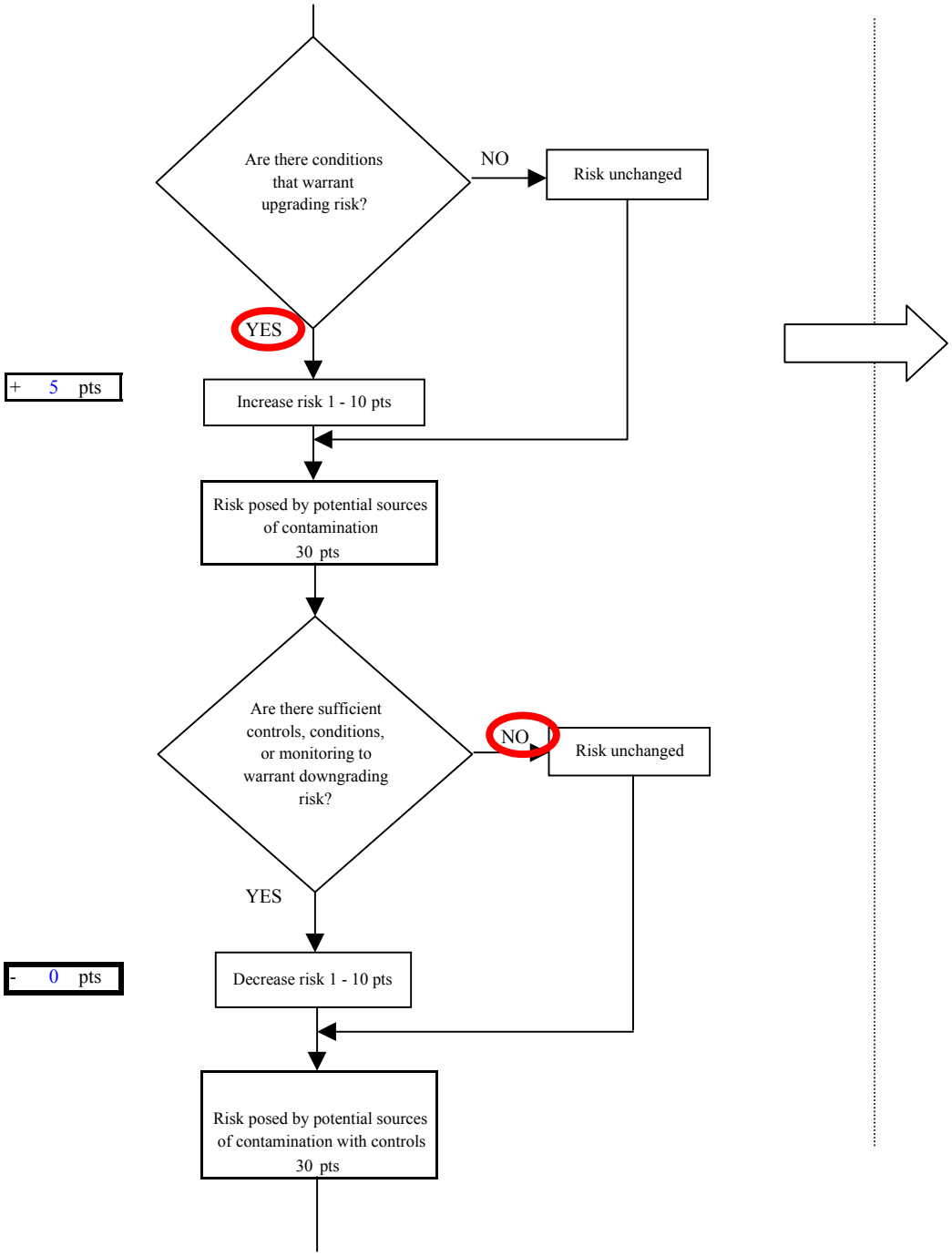
Risk unchanged

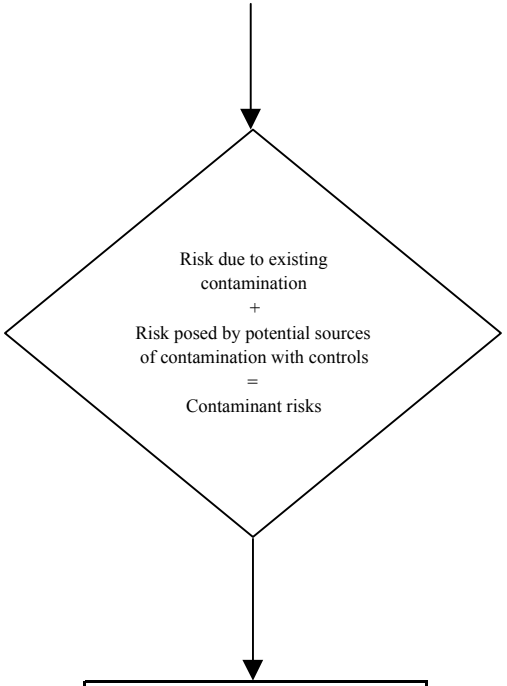
YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 5. Contaminant risks for Anchorage Golf Course - Nitrates and Nitrites





Existing
1 pts
+
Potential
30 pts
=
Contaminant Risk
31 pts

Contaminant risks*
= 31 pts

*Truncate risk at 50 pts

High

Contaminant Risk Ratings

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

Chart 6. Vulnerability analysis for Anchorage Golf Course - Nitrates and Nitrites

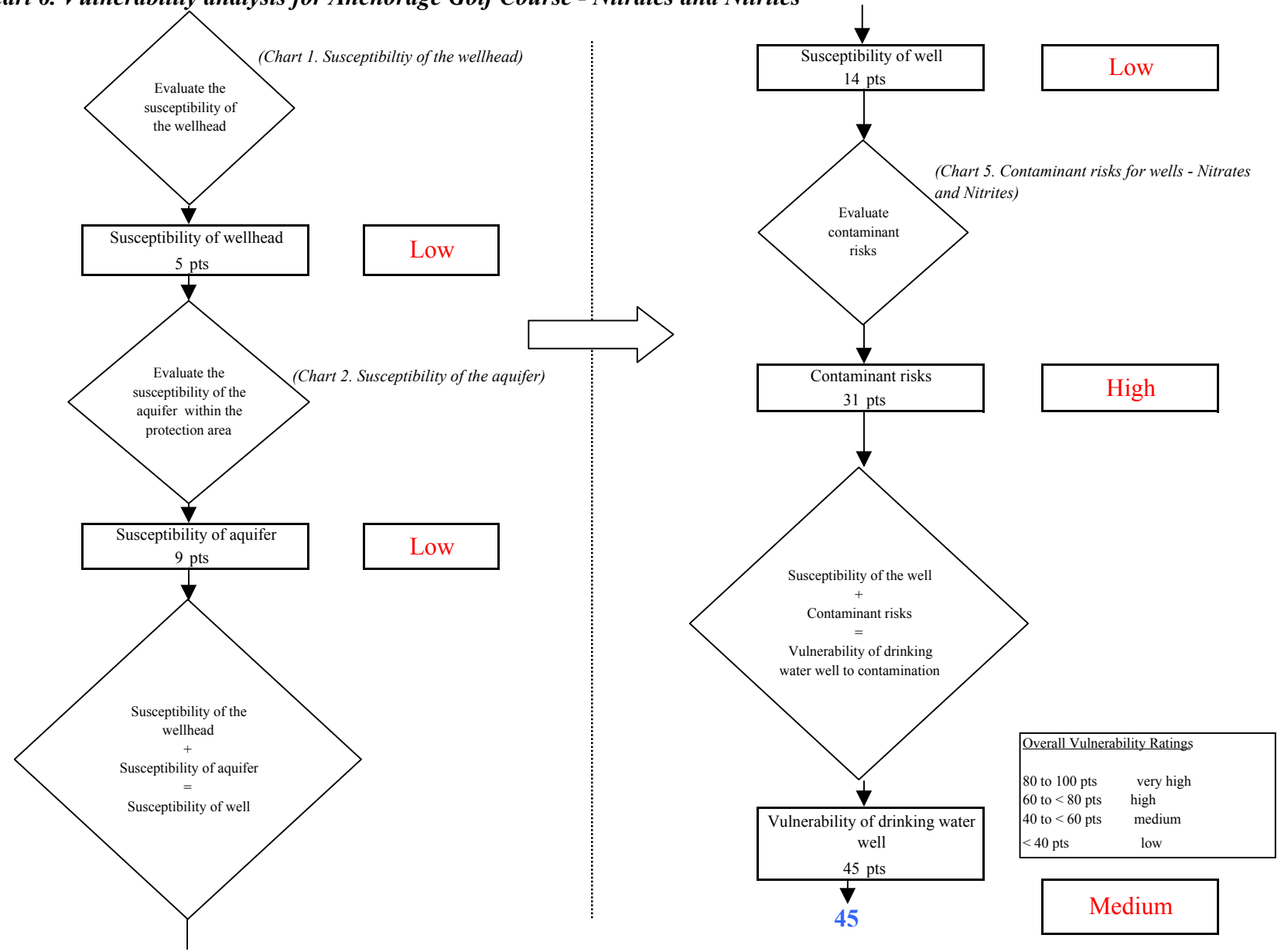


Chart 7. Contaminant risks for Anchorage Golf Course - Volatile Organic Chemicals

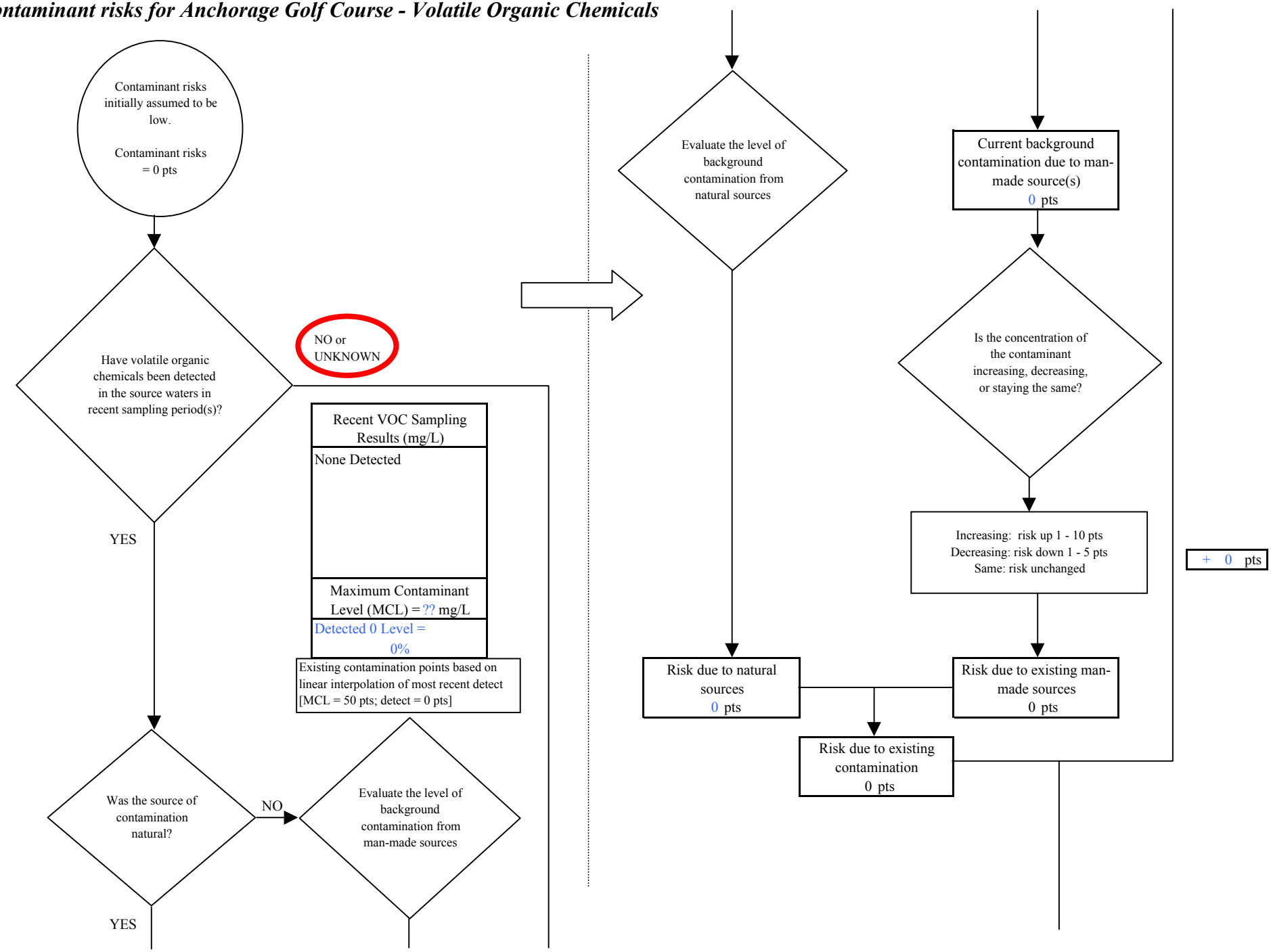


Chart 7. Contaminant risks for Anchorage Golf Course - Volatile Organic Chemicals

+ 10 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	4	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 10

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

Initial assessment of risk posed by potential sources of contamination = 10 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 7. Contaminant risks for Anchorage Golf Course - Volatile Organic Chemicals

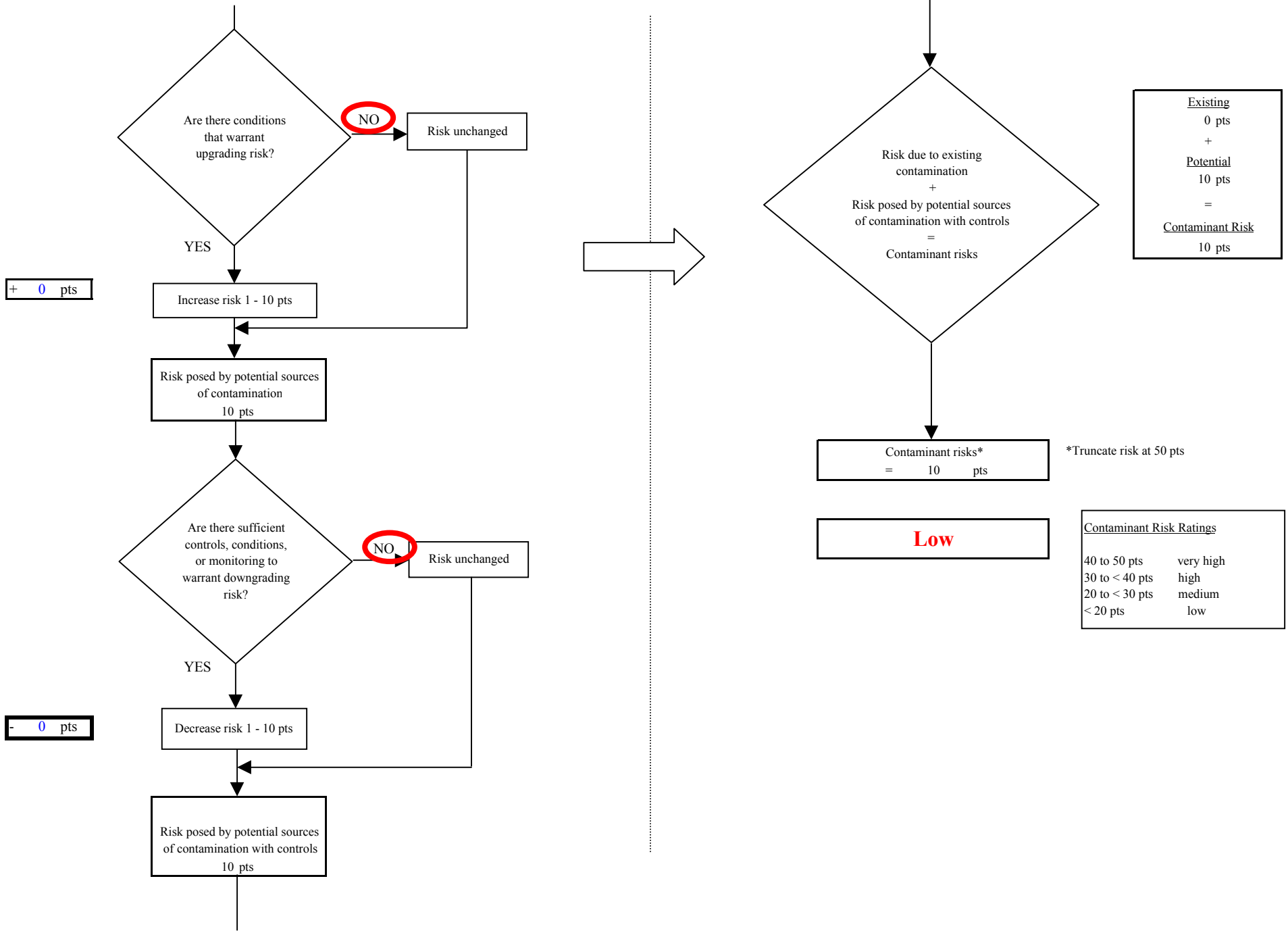


Chart 8. Vulnerability analysis for Anchorage Golf Course - Volatile Organic Chemicals