Source Water Assessment -
Anchorage Bible Fellowship
Anchorage, Alaska

Hydrogeologic Susceptibility and Vulnerability Analysis

DRINKING WATER PROTECTION PROGRAM REPORT 18

August 2001

Source Water Assessment - Anchorage Bible Fellowship Anchorage, Alaska

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

Source Water Assessment for Anchorage Bible Fellowship's Source of Public Drinking Water, Anchorage, Alaska

Hydrogeologic Susceptibility and Vulnerability Analysis

By Heather A. Hammond

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Anchorage Bible Fellowship's Public Water System is a Class B (transient/non-community) drinking water source consisting of one well. Identified potential and current sources of contaminants for Anchorage Bible Fellowship include: domestic wastewater sewer lines, highways and roads – paved, recreation trails, city parks, an active landing strip, a public utility corridor containing a natural gas pipeline, and approximately 70 acres of residential area. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, Anchorage Bible Fellowship's public water source received a vulnerability rating of **Medium** for nitrates and/or nitrites and a **Low** for bacteria and viruses and volatile organic chemicals.

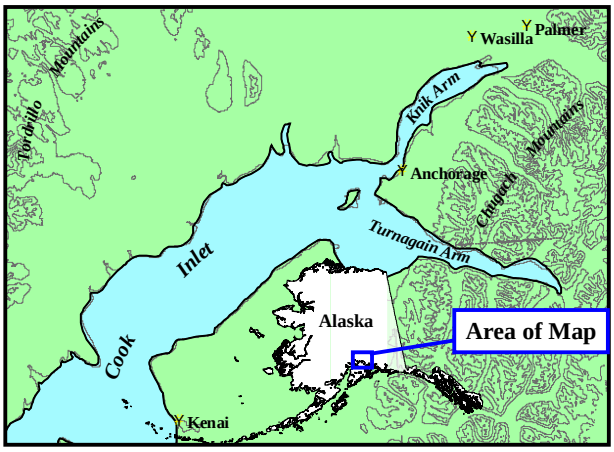

Figure 1. Index map showing the location of Anchorage, Alaska

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 Anchorage Bible Fellowship's source of public drinking water. This source 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.

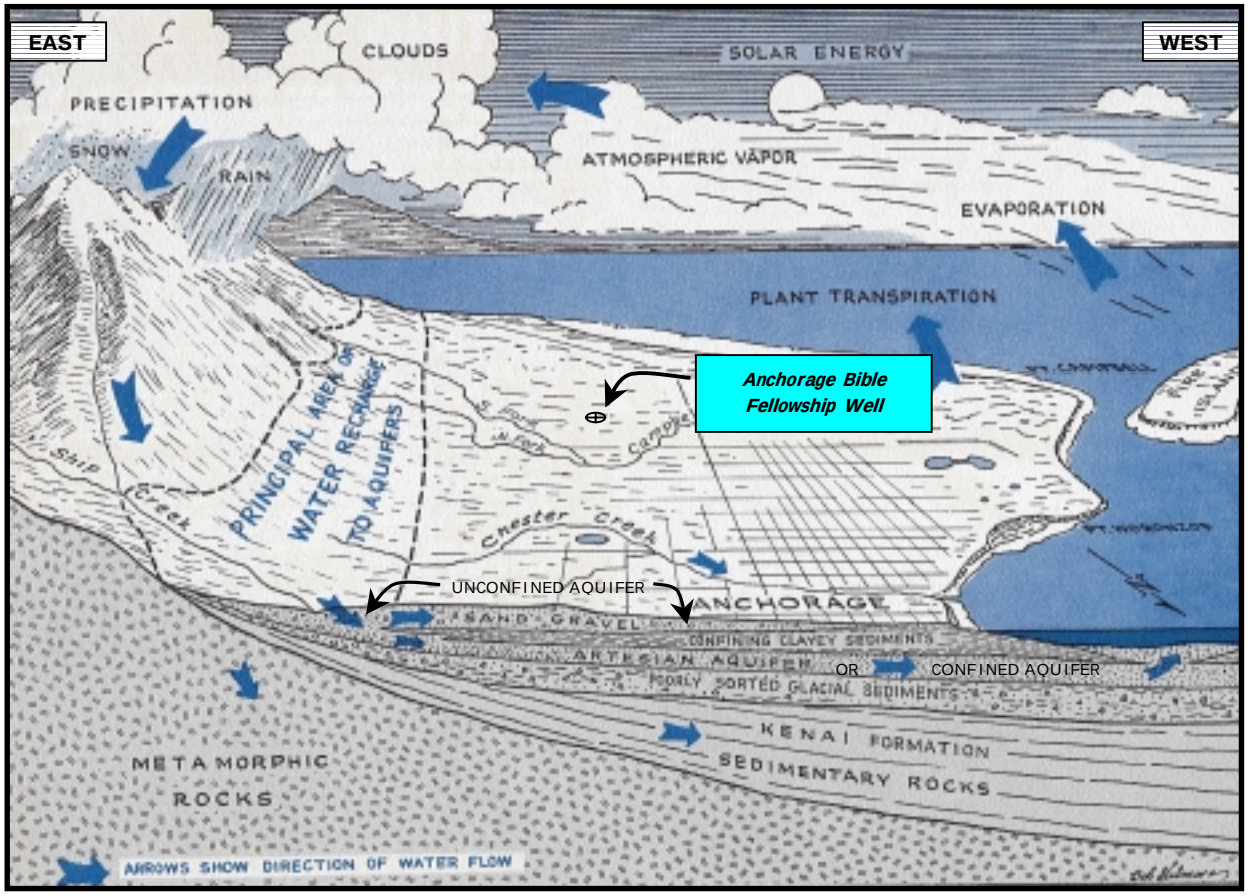

Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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 the 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 the 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 enters 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, 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.

ANCHORAGE BIBLE FELLOWSHIP'S PUBLIC DRINKING WATER SOURCE

Anchorage Bible Fellowship's public water source is a Class B (transient/non-community) water system, which is owned by and operated by the Anchorage Bible Fellowship. The source consists of one well near the base of the Chugach Mountains and is at an elevation of 200 feet above sea level. The well is located near the middle of the north property line at the intersection of Abbott Loop Road and East 72nd Avenue (see Figure 3). According to an engineering report (5/31/96), the well for Anchorage Bible Fellowship penetrates intermittent layers of gravel, sand, silt and clay to a total depth of 74 feet below land surface where it encounters bedrock and does not appear to be properly grouted. Whether the well is screened or has an open hole is unknown. According to the engineering report the static water level was found to be 20.3 feet below land surface.

Anchorage Bible Fellowship's water system operates year round and serves approximately 250 non-residents through one service connection.

ASSESSMENT AND PROTECTION AREA FOR ANCHORAGE BIBLE FELLOWSHIP'S DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Anchorage Bible Fellowship 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. The zone around

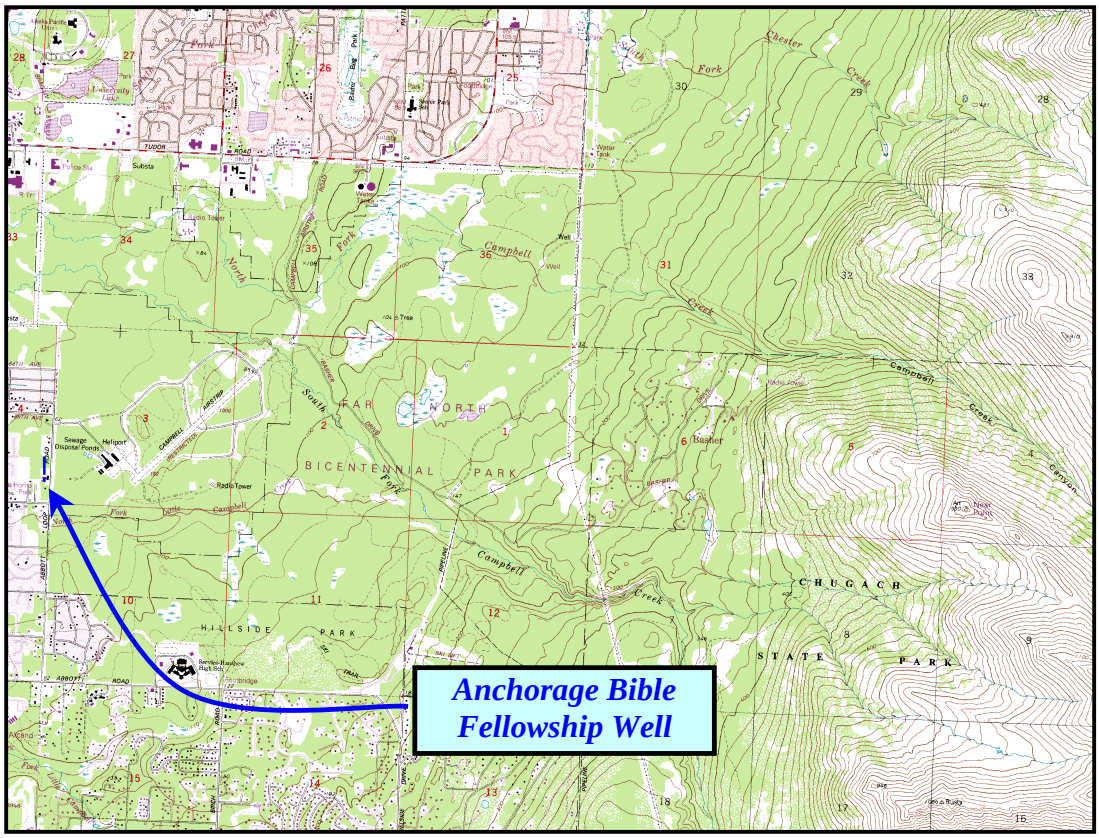

Figure 3. Map showing the location of the drinking water source for Anchorage Bible Fellowship [Base: USGS Anchorage A8 NE].

the drinking water source is the most critical area for the preservation of the quality of the drinking water for this source. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the area of 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 calculate 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 Anchorage Bible Fellowship. 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 area 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 Anchorage Bible Fellowship 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 through 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 Anchorage Bible Fellowship's Drinking Water Protection Area. 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 and
- Volatile organic chemicals.

Map 2 in Appendix C depicts the Contaminant Source Inventory for Anchorage Bible Fellowship. Inventoried potential sources of contamination within Zones A through D were associated with residential, transportation and recreational type activities (see Table 1 in Appendix B). Below is a summary of the contaminant sources inventoried within Anchorage Bible Fellowship's protection area:

- Domestic wastewater sewer lines;
- Recreation trails;
- Residential areas;
- Municipal or city parks;
- Public utility corridor;
- Highways and roads and
- An active landing strip.

These potential contaminant sources present risk for all three categories of drinking water contaminants for Anchorage Bible Fellowship's drinking water source.

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 and density of those types of contaminant sources as well as the proximity of those sources to the well.

VULNERABILITY OF ANCHORAGE BIBLE FELLOWSHIP'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)

Anchorage Bible Fellowship's well penetrates intermittent layers of silt and clay (confining unit), which 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. The well does not appear to be properly grouted as indicated previously from information obtained from Department records. The absence of grouting can promote the transport of contaminants 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 of the well to contamination (See Appendix D). Table 1 shows the overall Susceptibility score and rating for Anchorage Bible Fellowship.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	6	Low
Natural Susceptibility	11	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Approximately 70 acres of residential area, domestic wastewater sewer lines, recreation trails, and highways and roads - paved contribute the highest risk for potential contamination to Anchorage Bible Fellowships source of public drinking water.

A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (Appendix B - Table 1 – Table 4). 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	29	Medium
Volatile Organic Chemicals	12	Low

Appendix D contains eight charts, which together form the 'Vulnerability Analysis' for a source water assessment for a Class B 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 Analysis for nitrates and nitrites, and 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 six categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

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

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	40	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, respectively.

Nitrates and/or nitrites are found in natural background concentrations at the site, as elsewhere in the Alaska. Sampling history of Anchorage Bible Fellowship's source waters indicate low concentrations of nitrate (See Chart 5 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination is approximately 1.5% of the allowable limit (MCL) for this contaminant. The Maximum Contaminant Level or MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. Due to the high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water. Since 1999, nitrate levels detected in the source waters of Anchorage Bible Fellowship have seen a slight decrease.

Overall, contaminant risks for the nitrate/nitrite category is medium with the sewer line (wastewater collection system) along Red Talon Road driving the score. This sewer line is entirely within the Zone A protection area and approximately 180 feet north-northwest of Anchorage Bible Fellowship's well. All contaminant risks associated with the sewer line stems from the potential of the line having a failure, thus releasing the wastewater in the subsurface. Combining this potential nitrates and/or nitrites contamination risk with the susceptibility of the well yields an overall vulnerability to contamination of medium for this source of public drinking water.

Other low potential and existing sources of bacteria and viruses and nitrates and/or nitrites for Anchorage Bible Fellowship's source waters include activities associated with Far North Bicentennial Park, residential areas (lawns and gardens) and recreation trails (horse and foot trails). One natural gas pipeline traverses the Zone B protection area within 600 feet of Anchorage Bible Fellowship's well. Natural gas does not pose a contaminant 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 due to activities along the corridor. Overall, this corridor ranks as a low potential source of contamination due to its proximity to Anchorage Bible Fellowship's well. However, the pipeline owner reserves the right to pump other products such as diesel fuel on an as needed basis. Therefore, depending on the product being transported in the pipeline along this corridor, the contaminant risks may significantly increase within a category (e.g. volatile organic chemicals).

Campbell Airstrip intersects the Zone C protection area along with recreation trails within Far North Bicentennial Park. An accidental release of fuel could enter the aquifer through the land surface and flow toward the well. Due to the potential of an accidental release occurring the airstrip was initially ranked as posing medium potential contaminant risk for volatile organic chemicals. However, this airstrip is only actively used during the summer months (June through September) for emergency purposes only. Therefore, the risk for this potential source of contamination has been reduced and ranks as a low for volatile organic chemicals.

Other low potential and existing sources of volatile organic chemicals for Anchorage Bible Fellowship's source waters include activities associated with highways and roads along the Anchorage Hillside. Because major routes do pose potential for fuel spills to occur, highways and roads within the protection area ranked as a low potential source of contamination.

SUMMARY

A *Source Water Assessment* has been completed for Anchorage Bible Fellowship's source of public drinking water. 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 Bible Fellowship 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 public drinking water source.

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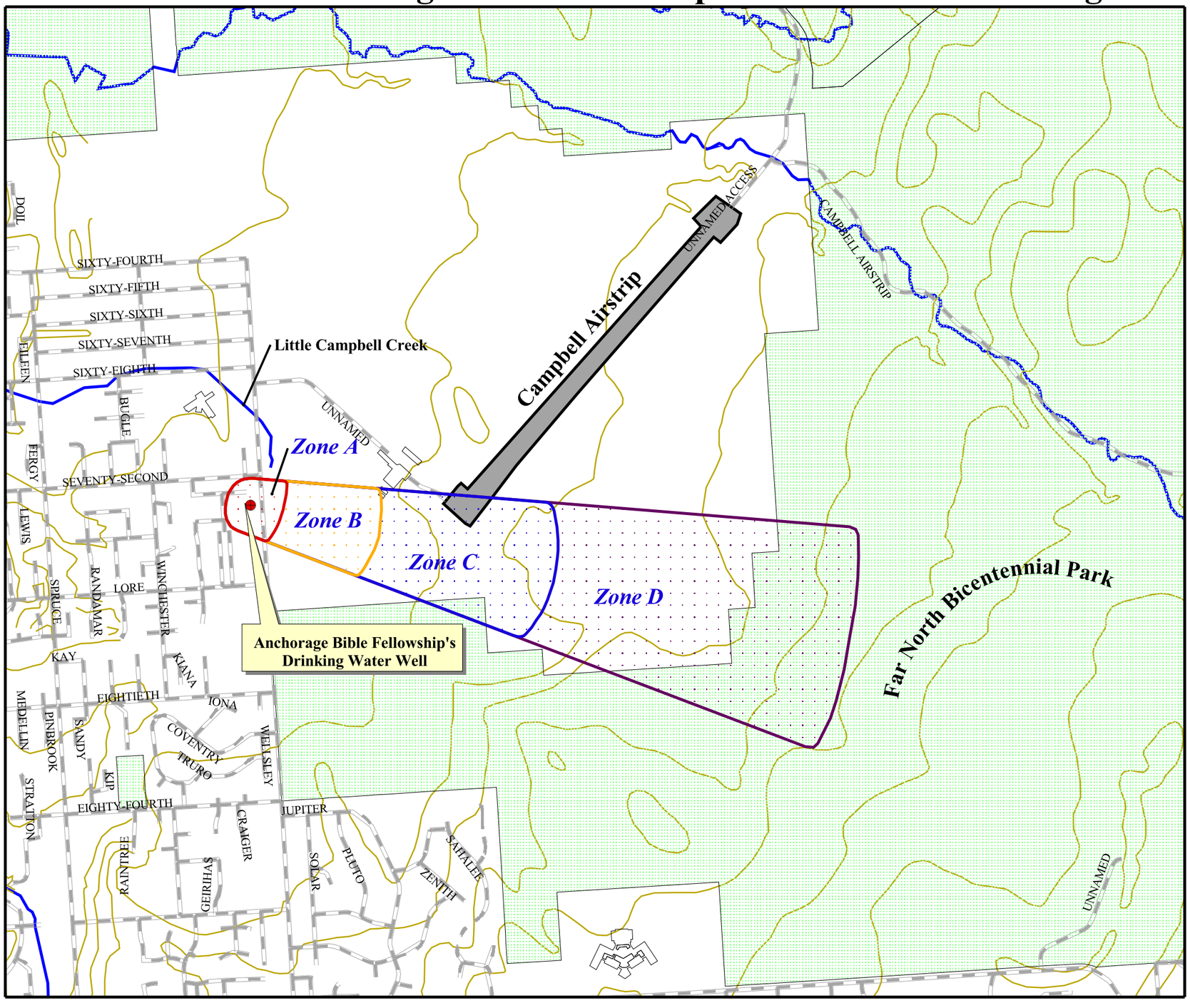
APPENDIX A

Anchorage Bible Fellowship's
Drinking Water Protection Area

Drinking Water Protection Area for
Anchorage Bible Fellowship and Potential & Existing Contaminant Sources



- Anchorage Bible Fellowship Well

Zone A Protection Area
- Several Month 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
- Roads (X20)
- Moa Buildings
- Campbell Landing Strip
- Far North Bicentennial/Hillside Park (X4)
- Elevation contours
- Streams

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3000 0 3000 Feet

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Anchorage Bible Fellowship

Table 1 **Contaminant Source Inventory for Anchorage Bible Fellowship** **PWSID 218516.001**

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	A	Red Talon Road	2	
Residential Areas	R1	R1-1	A	Residential areas located within Zone A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Abbott Loop Road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Red Talon Road	2	
Dog walking areas/foot trails	X46	X46-1	A	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-2	A	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-3	ABC	Trail near 68th and Lore Road	2	
Public utility easements/corridors	X42	X42-1	B	Pipline running through Zone B	2	
Airports	X14	X14-1	C	BLM landing strip - behind BLM	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C	Road to the Airstrip from BLM Building	2	
Dog walking areas/foot trails	X46	X46-5	C	Tour of Anchorage Trail - Zone C	2	
Municipal or city parks (with green areas)	X4	X4-1	CD	Far North Bicentennial Park	2	
Dog walking areas/foot trails	X46	X46-4	CD	8, 12 - 16 Mile Loop Trail - Zone C	2	

Table 2

Potential and Existing Sources of Contaminants for
Anchorage Bible Fellowship
Source of Bacteria and Viruses

PWSID 218516.001

Contaminant Source Category	Contaminant Soruce ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	A	Medium	1	Red Talon Road	2	
Municipal or city parks (with green areas)	X4	X4-1	CD	Medium	2	Far North Bicentennial Park	2	
Residential Areas	R1	R1-1	A	Low	3	Residential areas located within Zone	2	
Dog walking areas/foot trails	X46	X46-1	A	Low	4	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-2	A	Low	5	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-3	ABC	Low	6	Trail near 68th and Lore Road	2	
Dog walking areas/foot trails	X46	X46-4	CD	Low	7	8, 12 - 16 Mile Loop Trail - Zone C	2	
Dog walking areas/foot trails	X46	X46-5	C	Low	8	Tour of Anchorage Trail - Zone C	2	

Table 3

Potential and Existing Sources of Contaminants for
Anchorage Bible Fellowship
Source of Nitrates and/or Nitrites

PWSID 218516.001

Contaminant Source Category	Contaminant Soruce ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	A	Medium	1	Red Talon Road	2	
Residential Areas	R1	R1-1	A	Low	2	Residential areas located within Zone	2	
Dog walking areas/foot trails	X46	X46-1	A	Low	3	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-2	A	Low	4	Trail along Abbott Loop Road	2	
Dog walking areas/foot trails	X46	X46-3	ABC	Low	5	Trail near 68th and Lore Road	2	
Dog walking areas/foot trails	X46	X46-4	CD	Low	6	8, 12 - 16 Mile Loop Trail - Zone C	2	
Dog walking areas/foot trails	X46	X46-5	C	Low	7	Tour of Anchorage Trail - Zone C	2	
Municipal or city parks (with green areas)	X4	X4-1	CD	Low	8	Far North Bicentennial Park	2	

Table 4

Potential and Existing Sources of Contaminants for
Anchorage Bible Fellowship
Source of Volatile Organic Chemicals

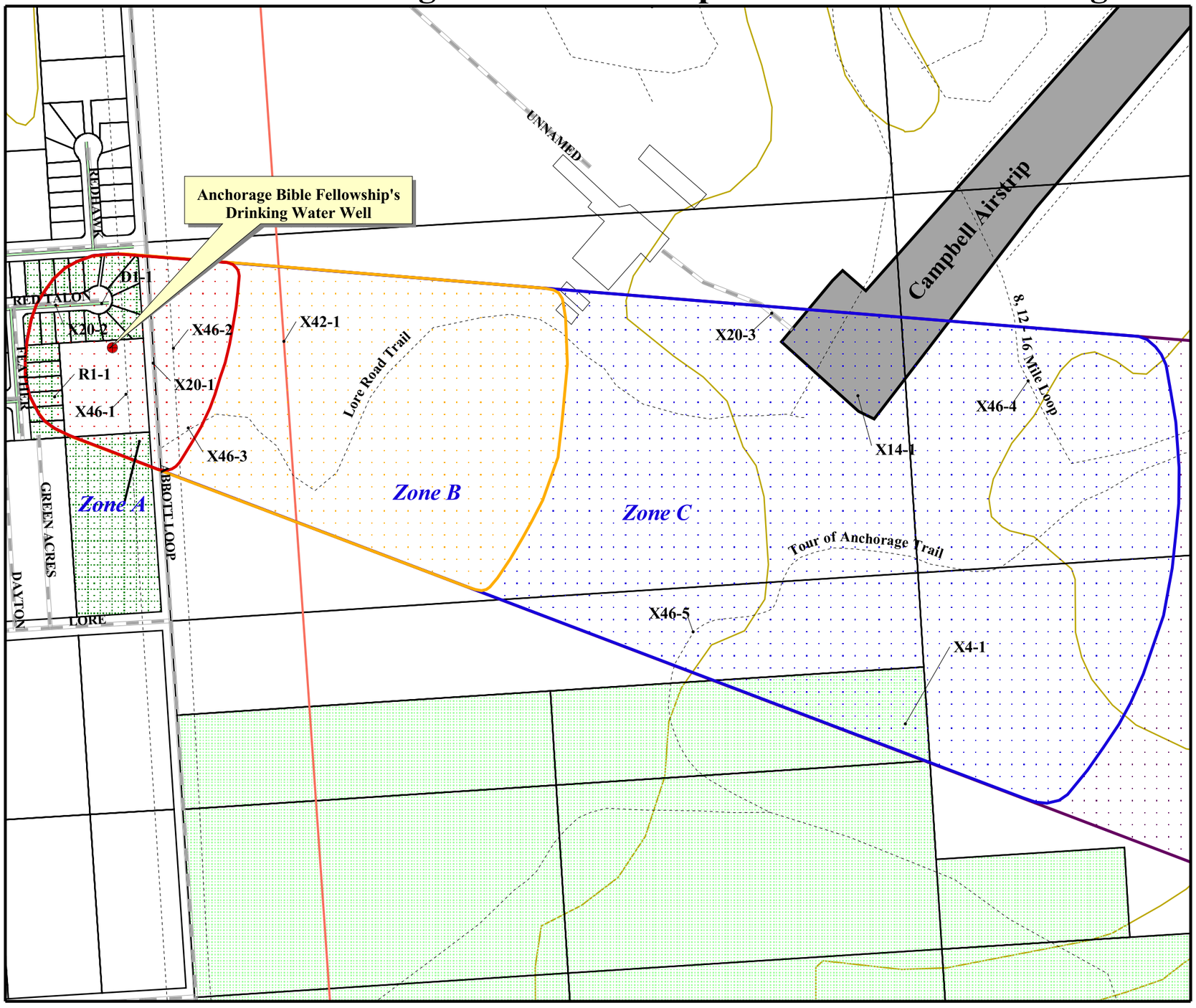
PWSID 218516.001

Contaminant Source Category	Contaminant Soruce ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	1	Red Talon Road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	Abbott Loop Road	2	
Residential Areas	R1	R1-1	A	Low	3	Residential areas located within Zone A	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	A	Low	4	Red Talon Road	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C	Low	5	Road to the Airstrip from BLM Building	2	
Airports	X14	X14-1	C	Low	6	BLM landing strip - behind BLM	2	
Public utility easements/corridors	X42	X42-1	B	Low	7	Pipline running through Zone B	2	

APPENDIX C

Anchorage Bible Fellowship's
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

Drinking Water Protection Area for
Anchorage Bible Fellowship and Potential & Existing Contaminant Sources



- Anchorage Bible Fellowship Well

Zone A Protection Area
- Several Month 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
- Roads (X20)
- Sewers (D1)
- Trails (X46)
- Pipes (X28)
- Moa Land Parcels
- Moa Buildings
- Lawns and Gardens (R1)
- Campbell Landing Strip (X14)
- Far North Bicentennial/Hillside Park (X4)
- Elevation contours

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Map 2

APPENDIX D

Vulnerability Analysis for Anchorage Bible Fellowship's Public Drinking Water Source

Chart 1. Susceptibility of the wellhead – Anchorage Bible Fellowship

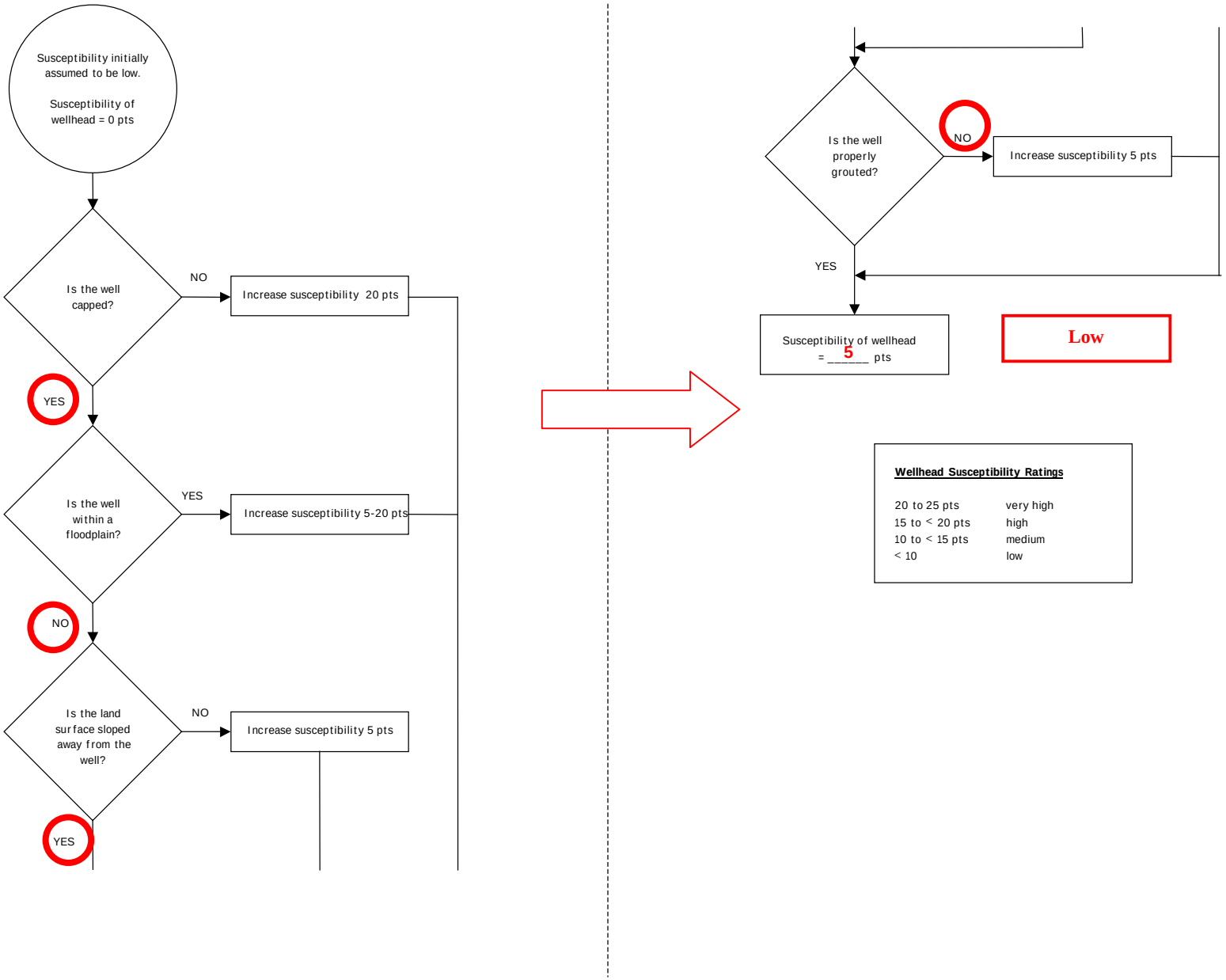
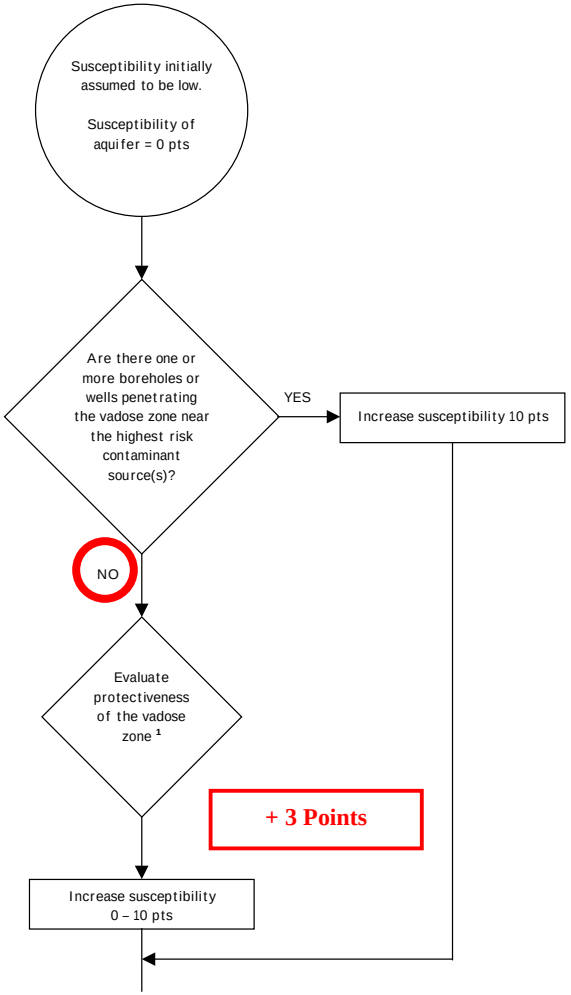
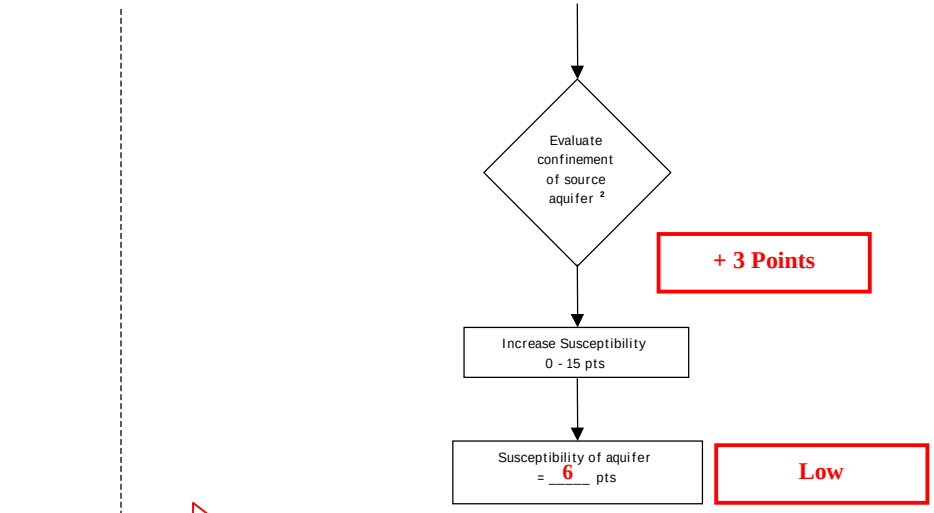


Chart 2. Susceptibility of the aquifer – Anchorage Bible Fellowship





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]

Recharge (20-30 inches per year, base of Chugach Mountains, and silty and clayey gravelly sand)
4/10 = 2 Points
Depth to bottom of confining unit (20.3 feet) 2/10 = 1 Point

Protectiveness of the Vadose Zone Total = **3/10 Points**

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]

Confinement (silt and clay)
4/15 =
3.0 Points

Density of boreholes/wells
0/15 = 0 Point

Degree of Confinement Total = **3/15 Points**

Aquifer Susceptibility Ratings

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

Low

Chart 3. Contaminant risks for Anchorage Bible Fellowship – Bacteria & Viruses

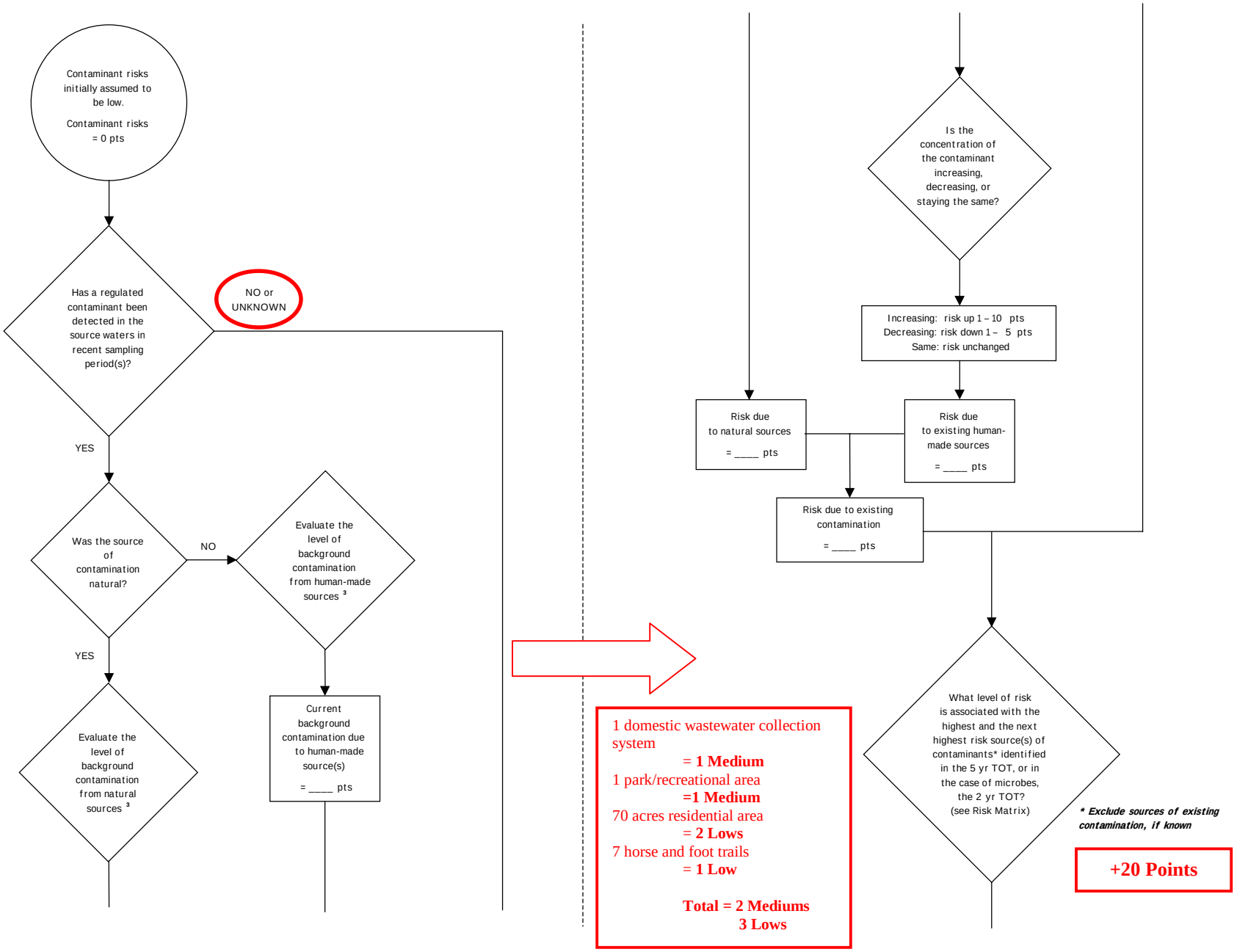


Chart 3. Contaminant risks for Anchorage Bible Fellowship – Bacteria & Viruses (Continued)

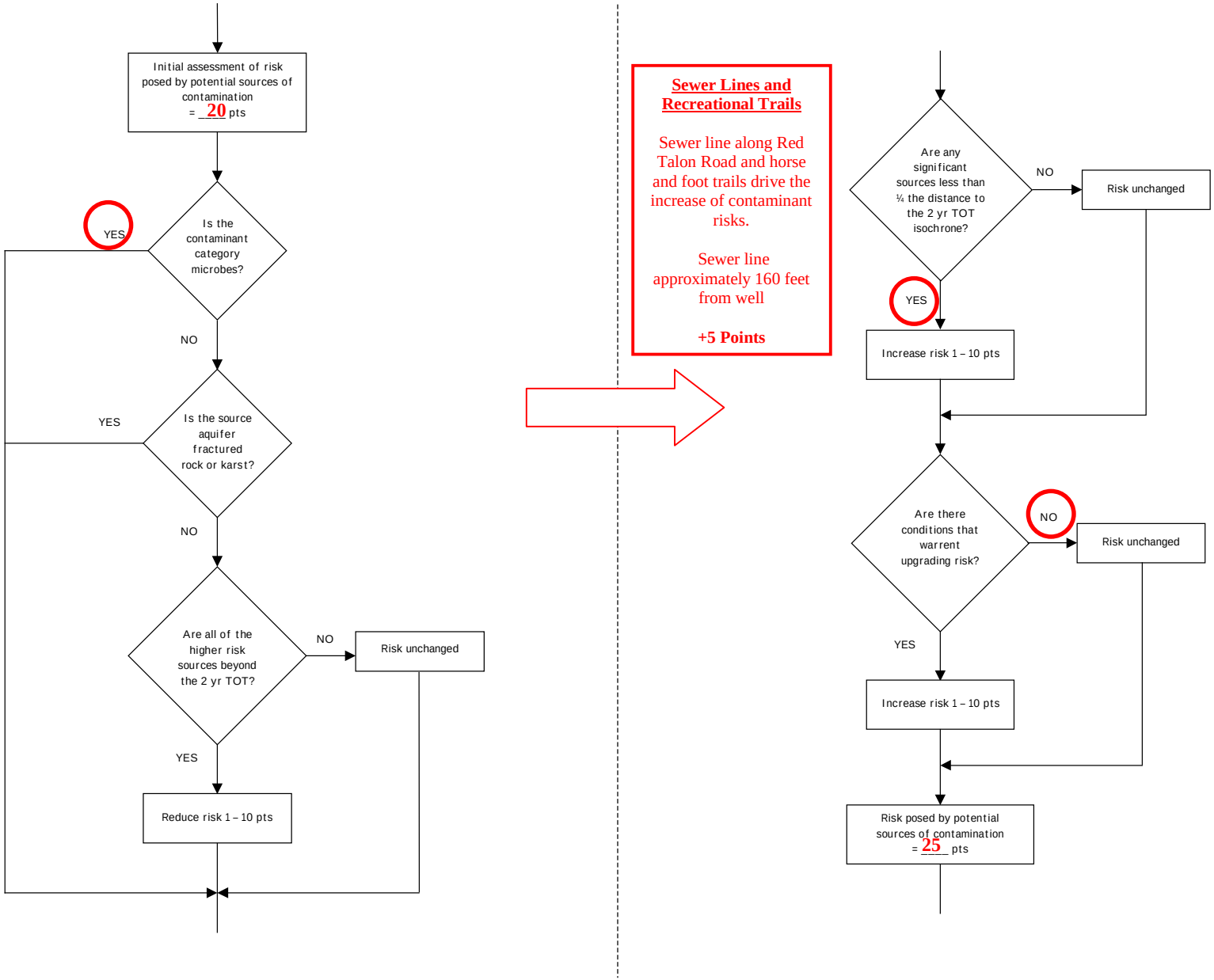
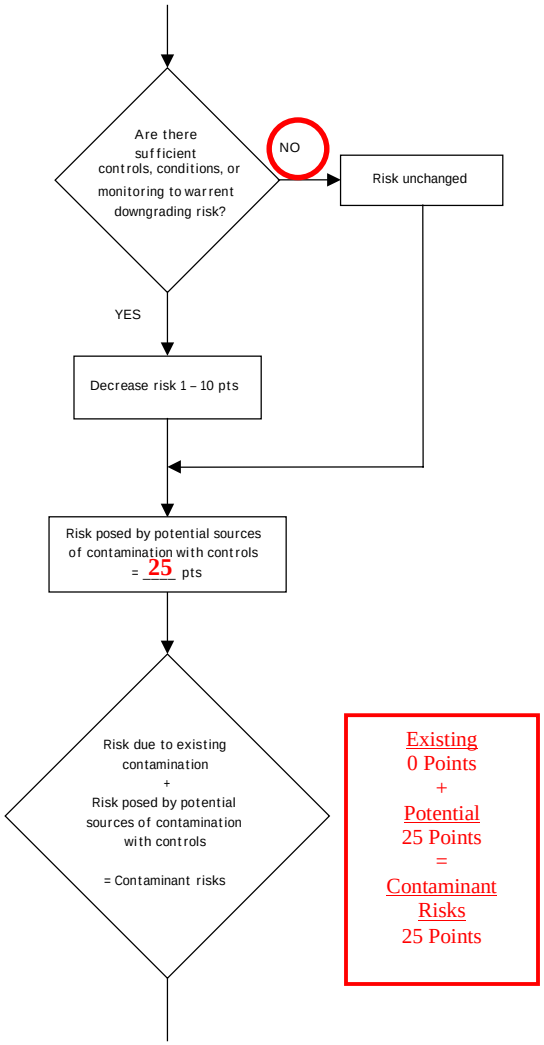
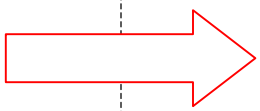
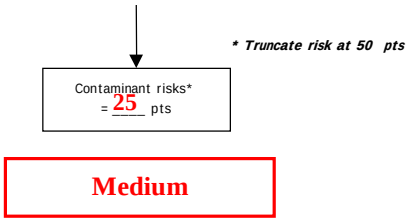


Chart 3. Contaminant risks for Anchorage Bible Fellowship – Bacteria & Viruses (Continued)



Existing
0 Points
+
Potential
25 Points
=
Contaminant Risks
25 Points





3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

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

Table 1. Risk Matrix for Contaminant Sources for Anchorage Bible Fellowship – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

Sewer line along Red Talon Road	**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 4. Vulnerability analysis for Anchorage Bible Fellowship – Bacteria & Viruses

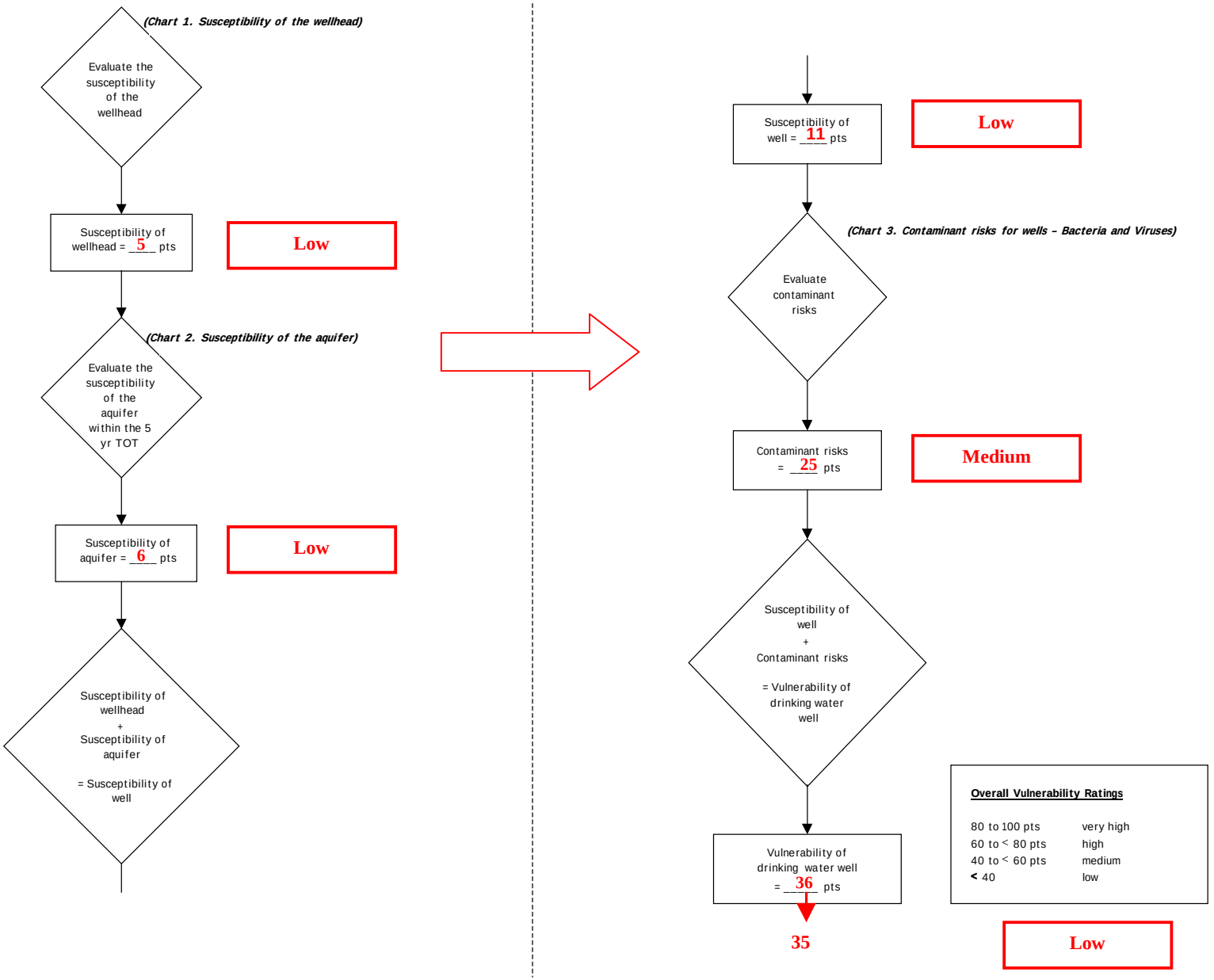


Chart 5. Contaminant risks for Anchorage Bible Fellowship – Nitrates and Nitrites

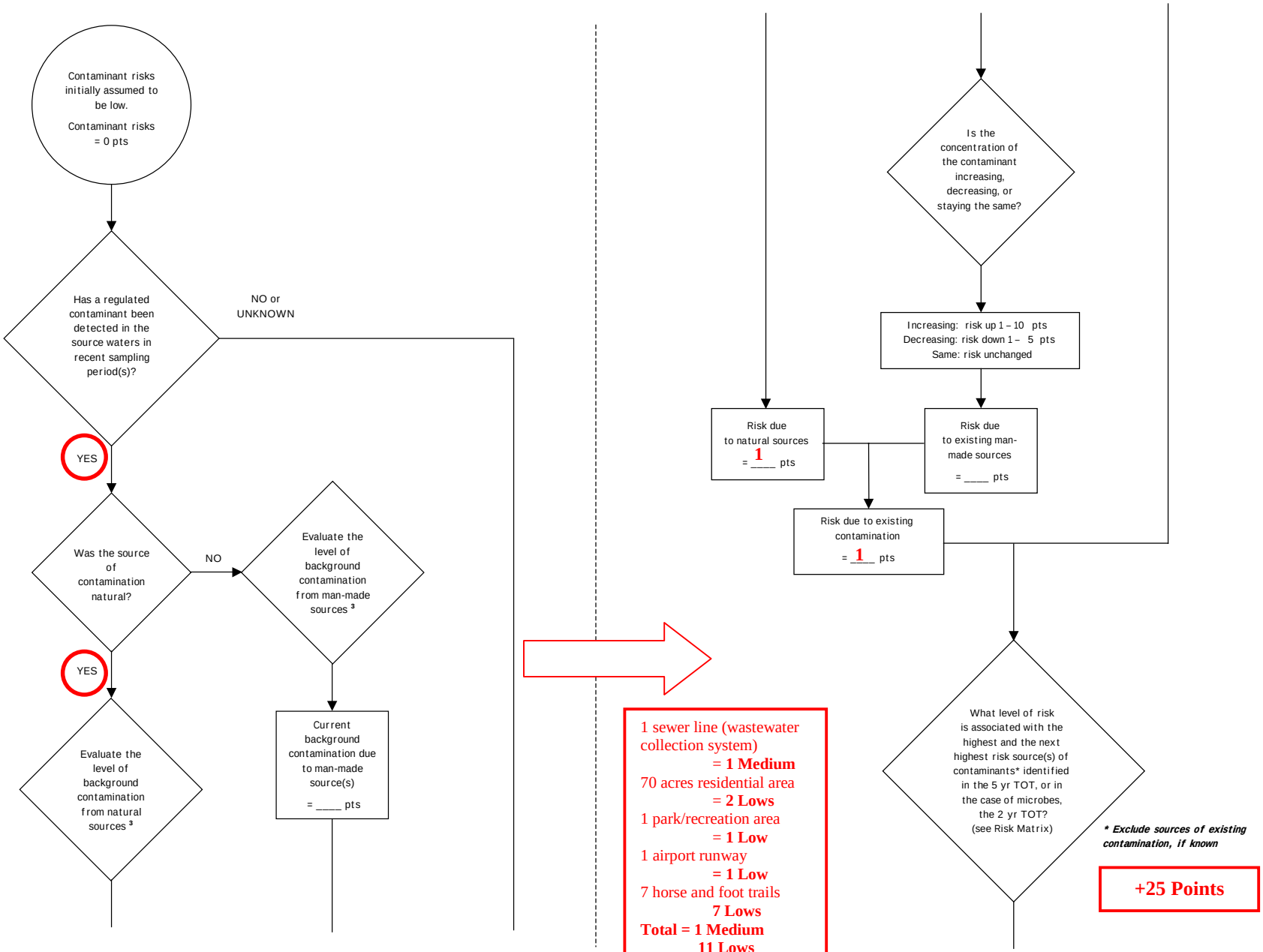


Chart 5. Contaminant risks for Anchorage Bible Fellowship – Nitrates and Nitrites (Continued)

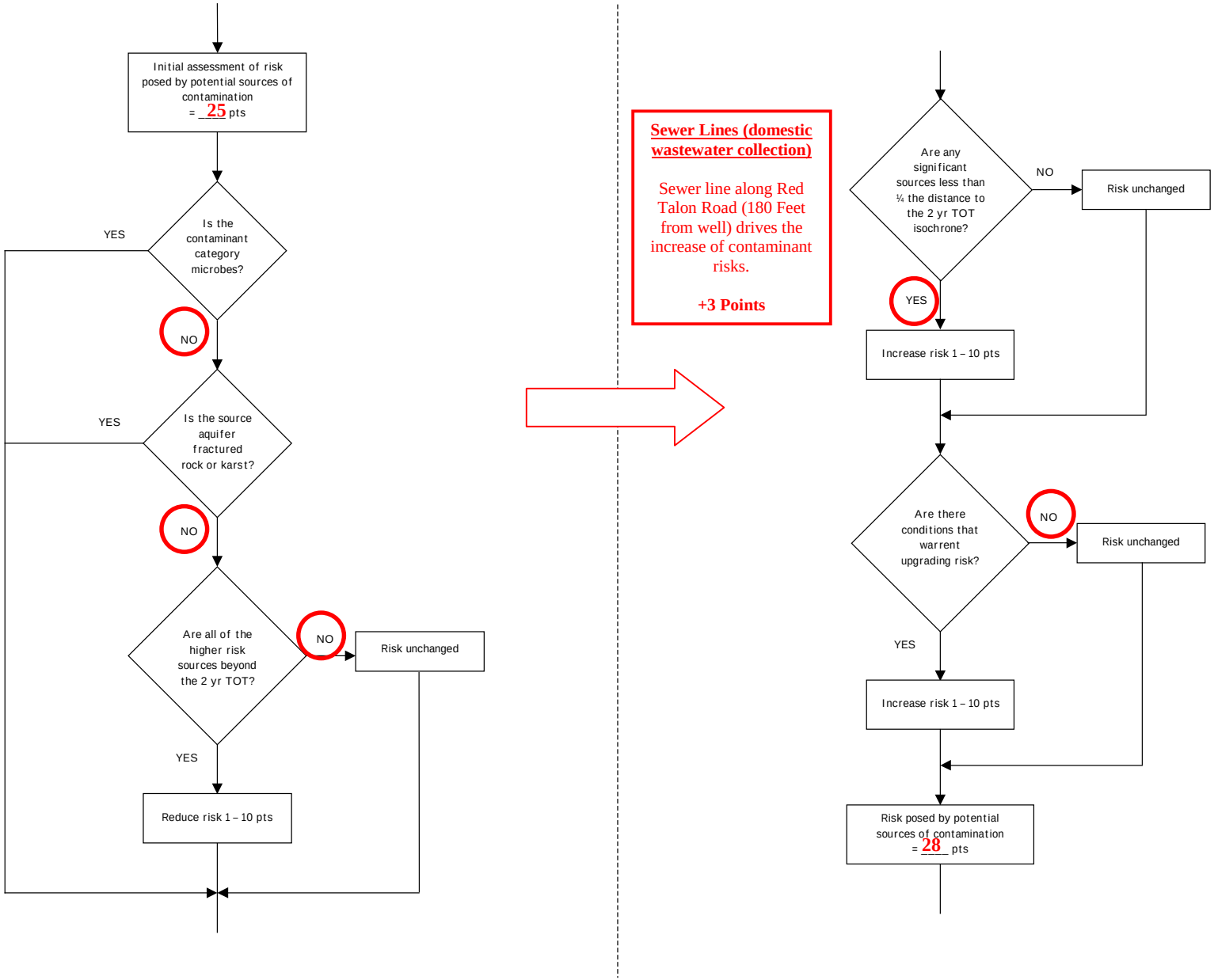
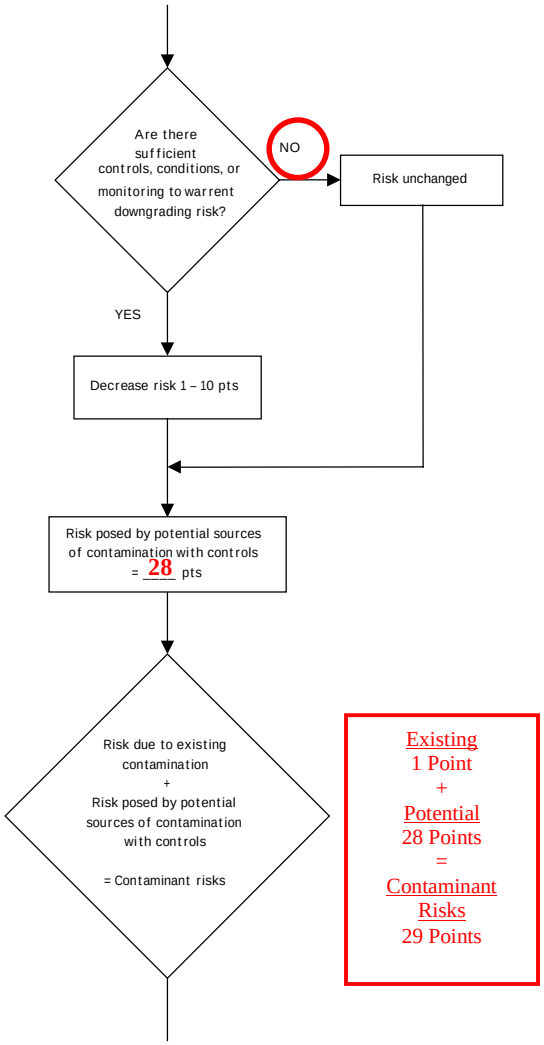


Chart 5. Contaminant risks for Anchorage Bible Fellowship – Nitrates and Nitrites (Continued)



Existing
1 Point
+
Potential
28 Points
=
Contaminant
Risks
29 Points

* *Truncate risk at 50 pts*

Contaminant risks*
= 29 pts

Medium

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

Nitrate
0.16 mg/L on (11/01/00)
0.24 mg/L on (12/13/99)

Maximum Contaminant Level (MCL)
= 10mg/L

0.16/10
= 0.016 or 1.6% of MCL

+1 Point

Table 2. Risk Matrix for Contaminant Sources for Anchorage Bible Fellowship – Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

Horse and foot trails, 2 dirt roads	**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 6. Vulnerability analysis for Anchorage Bible Fellowship – Nitrates and Nitrites

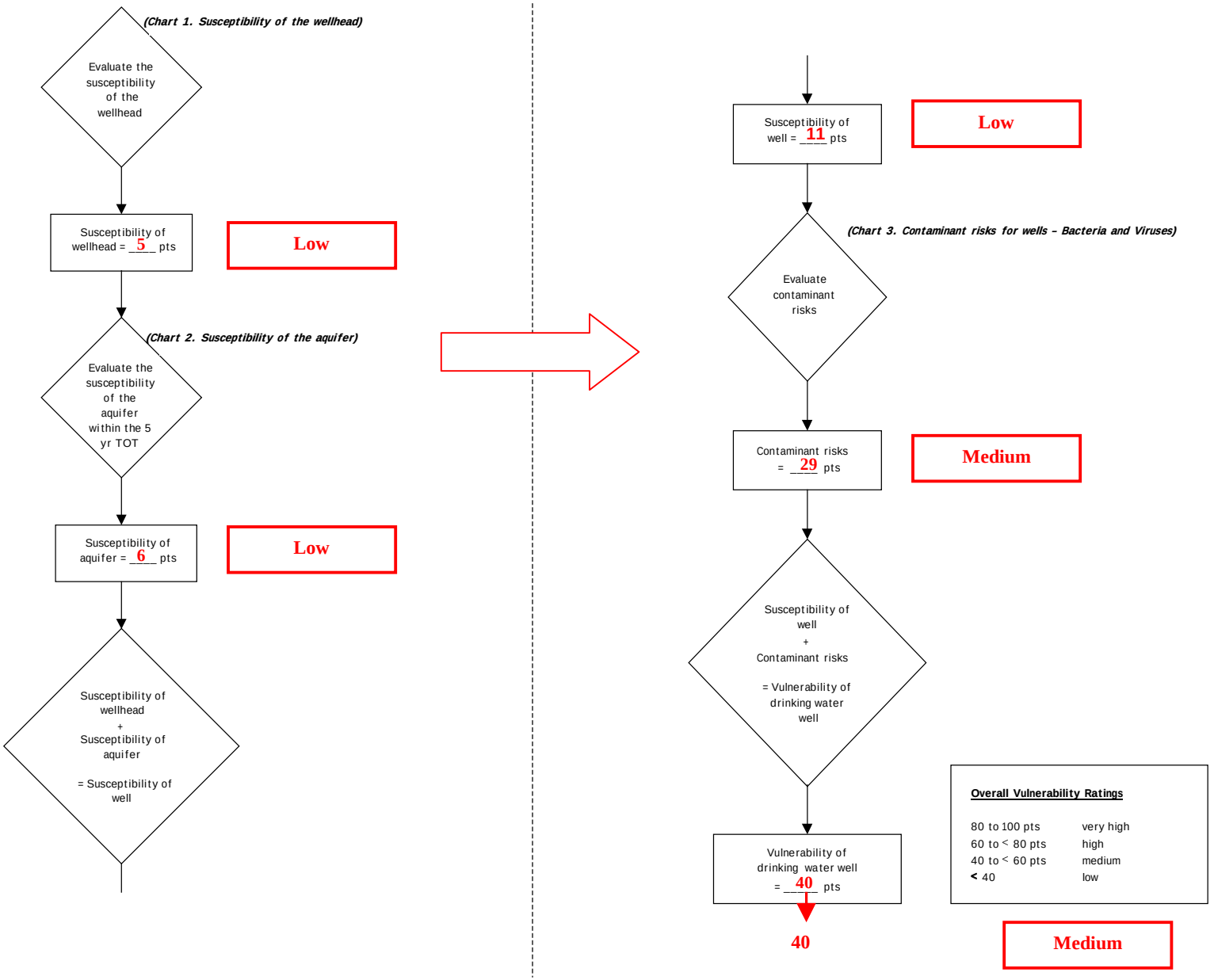


Chart 7. Contaminant risks for Anchorage Bible Fellowship – Volatile Organic Compounds

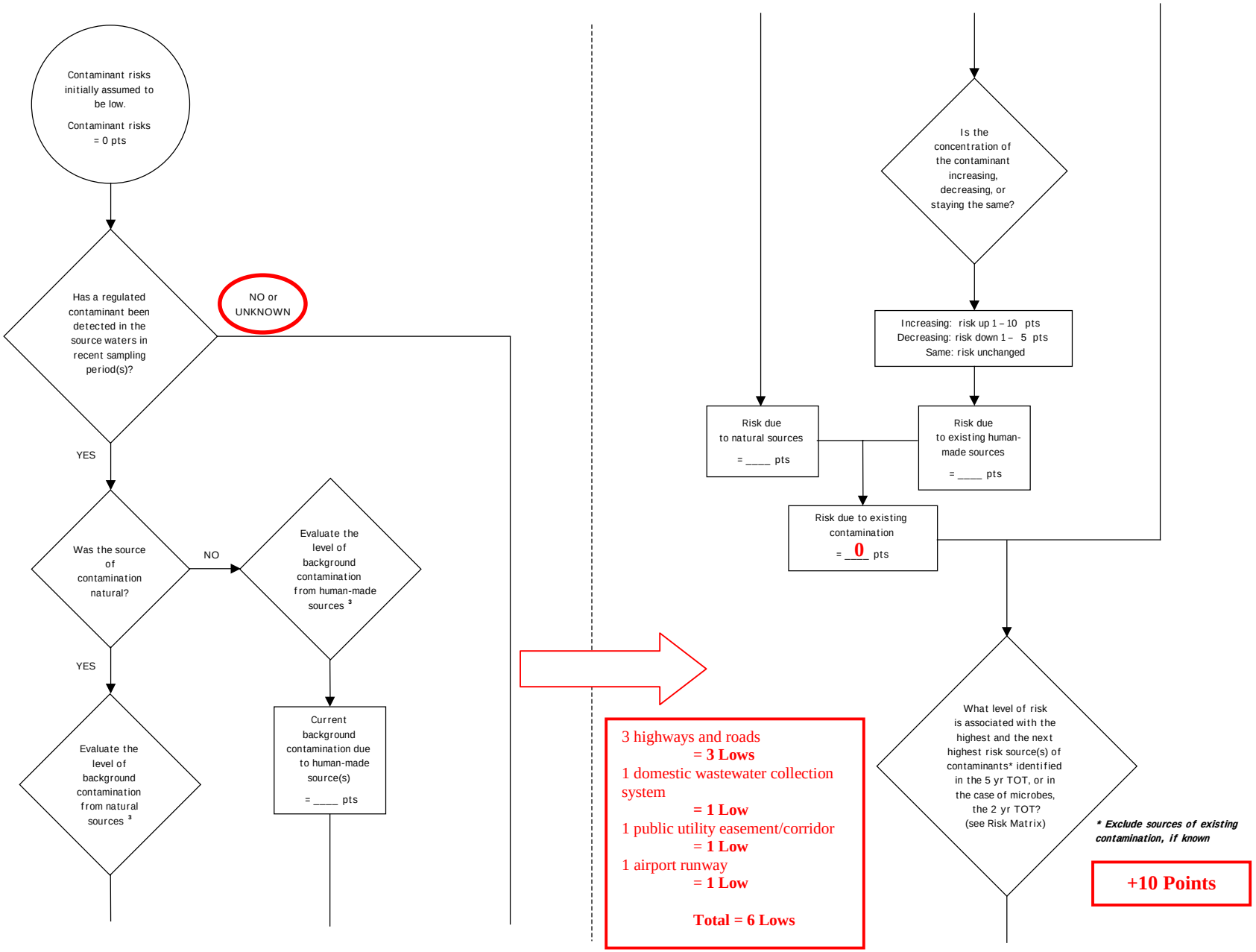


Chart 7. Contaminant risks for Anchorage Bible Fellowship – Volatile Organic Compounds (Continued)

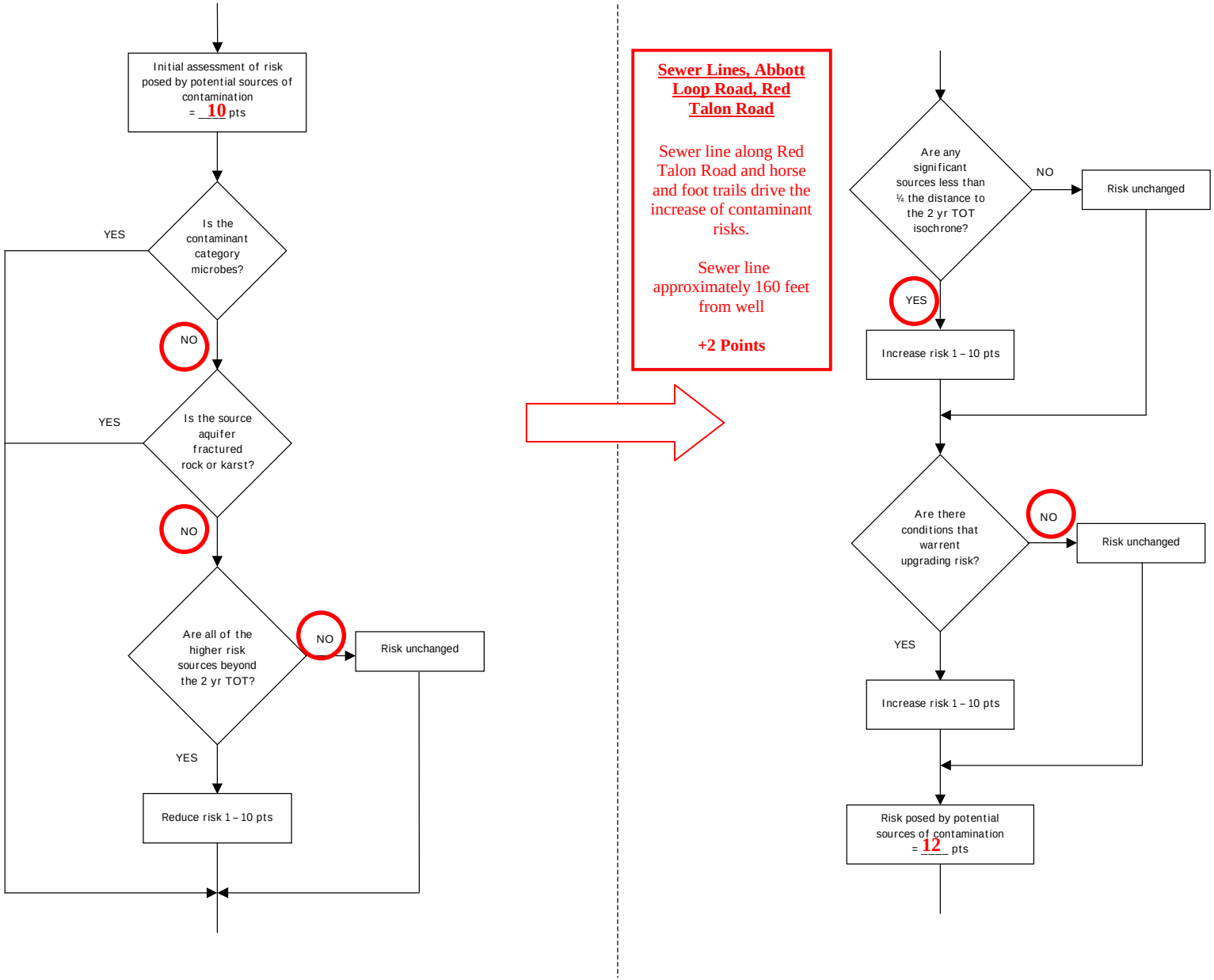
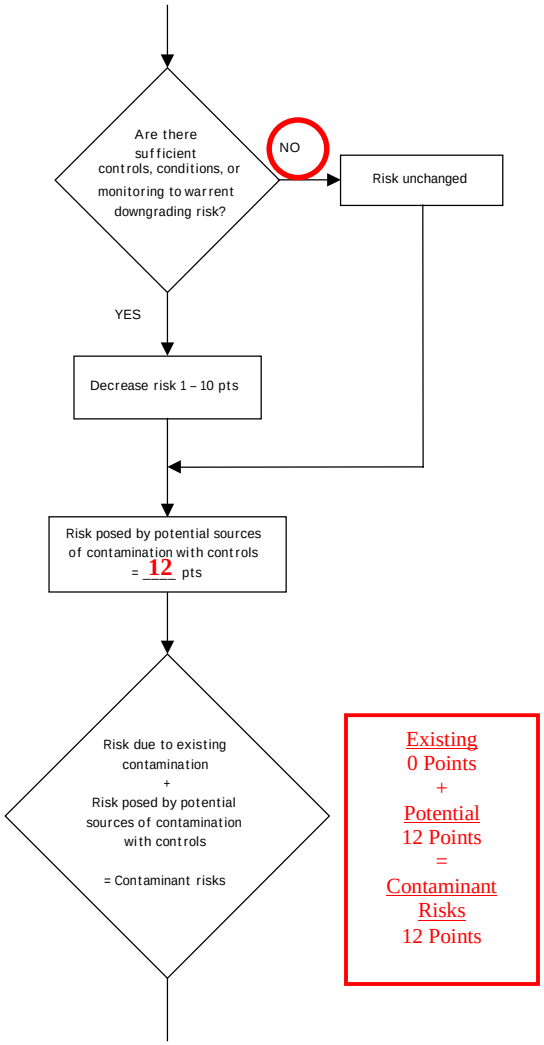


Chart 7. Contaminant risks for Anchorage Bible Fellowship – Volatile Organic Compounds (Continued)



Existing
0 Points
+
Potential
12 Points
=
Contaminant Risks
12 Points

**** Truncate risk at 50 pts***

Contaminant risks*
= 12 pts

Low

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

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

Table 3. Risk Matrix for Contaminant Sources for Anchorage Bible Fellowship – Volatile Organic Compounds

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Sewer line, Abbott Loop Road, Red Talon Road	**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 8. Vulnerability analysis for Anchorage Bible Fellowship – Volatile Organic Chemicals