Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for C & S Rentals, Anchorage, Alaska PWSID # 215558

DRINKING WATER PROTECTION PROGRAM REPORT 584

Alaska Department of Environmental Conservation

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C & S Rentals
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The Drinking Water Protection Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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Source Water Assessment for C & S Rentals' Source of Public Drinking Water, Anchorage, Alaska

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Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for C & S Rentals is a Class A (community) water system consisting of one well in the Anchorage area. Identified potential and current sources of contaminants for C & S Rentals' public drinking water source include: residential area, sewer lines, roads, a medical facility, a photography supply/photo processing facility, and parks and recreation trails. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. Overall, the public drinking water source for C & S Rentals received a vulnerability rating of **Medium** for bacteria and viruses, nitrates and/or nitrites, and heavy metals, and **Low** for synthetic organic chemicals, and other organic chemicals.

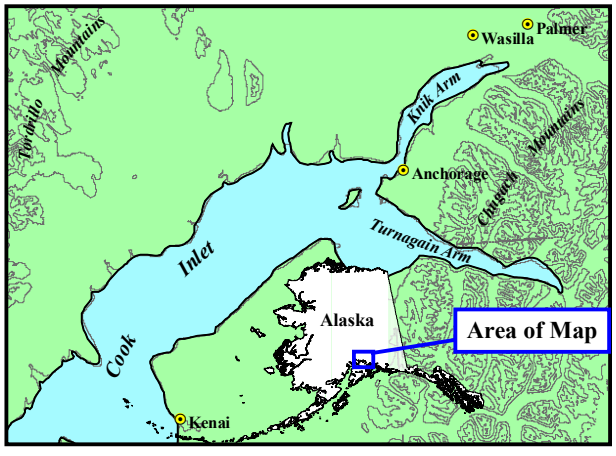

Figure 1. Index map showing the location of Anchorage, Alaska

INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this 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. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE ANCHORAGE AREA, ALASKA

Location

Anchorage, located in south-central 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 Arm 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.

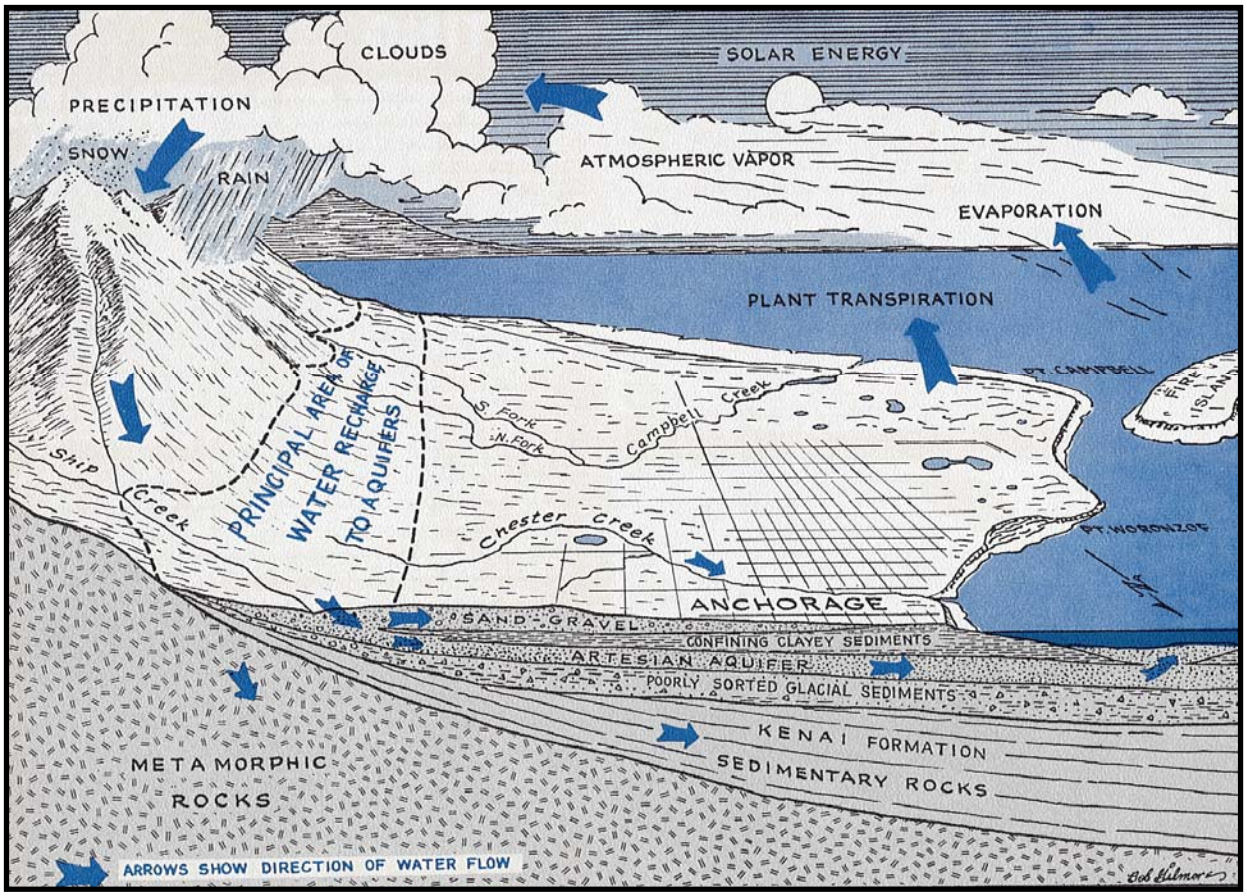

Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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 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 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.

C & S RENTALS' PUBLIC DRINKING WATER SYSTEM

C & S Rentals is a Class A (community) water system. The system consists of one well located off of Tudor Road (See Map 1 of Appendix A). This area is at an elevation of approximately 300 feet above sea level.

According to the most recent Sanitary Survey (09/30/01) the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The Sanitary Survey also notes that the land surface is appropriately sloped to provide adequate surface water drainage. It is suspected that the well was not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

There is no well log available for the well serving C & S Rentals. Well logs from wells within a ¼-mile radius of C & S Rentals indicate that there is a confining layer consisting of clay from 32 to 52 feet below land surface. Near the base of the Chugach Mountains, these clay layers tend to thin out 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.

This system operates year-round and serves 78 non-residents through 1 service connection.

C & S RENTALS' PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. Some areas are more likely to allow contamination to reach the well than others. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate watershed was used to determine the size and shape of the DWPA for C & S Rentals. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The DWPAs established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the DWPA. 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*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four DWPA zones and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. TOT
B	Less than the 2 year TOT
C	Less Than the 5 year TOT
D	Less than the 10 year TOT

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within C & S Rentals' DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals
- Heavy metals, cyanide, and other inorganic chemicals,
- Synthetic organic chemicals, and
- Other organic chemicals.

The sources are displayed on Maps 2 & 3 in Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

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

Tables 2 through 7 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF C & S RENTALS' 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 six categories of drinking water 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 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)

Table 2 shows the Susceptibility scores and ratings for the wells serving C & S Rentals.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	11	Medium
Natural Susceptibility	16	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	22	Medium
Nitrates and/or Nitrites	26	Medium
Volatile Organic Chemicals	22	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	22	Medium
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	12	Low

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	40	Medium
Nitrates and Nitrites	40	Medium
Volatile Organic Chemicals	40	Medium
Heavy Metals, Cyanide and Other Inorganic Chemicals	40	Medium
Synthetic Organic Chemicals	30	Low
Other Organic Chemicals	30	Low

Bacteria and Viruses
The contaminant risk for bacteria and viruses is medium with sewer lines, roads, and residential area presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability is medium.

Nitrates and Nitrites
The contaminant risk for nitrates and nitrites is medium with sewer lines, roads, and residential area presenting the most significant risk to the drinking water well.

Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000]. Sampling history for C & S Rentals indicates low concentrations of nitrates have been detected in source waters. The most recent nitrate detection occurred August 6, 1999, at approximately 8% of the Maximum contaminant Level or MCL. (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

The MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. Due to the high solubility and weak retnetnion by soil, nitrates are very mobile, moving at approximately the same rate as water. Though nitrates were detected at the site, concentrations remain at safe levels with respect to human health.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Volatile Organic Chemicals
The contaminant risk for volatile organic chemicals is medium with sewer lines, and roads presenting the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). Other potential contaminant sources for volatile organic chemicals include the public utility easement, a medical facility and the photography supply/photo processing facility.

Recent sampling history of C & S Rentals' well indicates that no volatile organic chemicals have been detected in the source waters.

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Heavy Metals, Cyanide, and Other Inorganic Chemicals
The contaminant risk for heavy metals, cyanide and other inorganic chemicals is medium with the sewer lines, roads, and the photography supply/photo processing facility presenting the most significant risk to the drinking water source (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Review if recent sampling history revealed that low concentrations of inorganic chemicals have been detected in C & S Rentals' source waters. Sampling done on June 10, 1998 contained barium at 0.0.019mg/L or 1% of the MCL for barium. The most recent water sample was taken on December 27, 2002 and lab analysis revealed that barium was not detected (See Chart 9 – Contaminant Risks for Heavy Metals and Other Inorganic Chemicals in Appendix D).

According to the U.S. Environmental Proteciton Agency's Consumer Fact Sheet barium is a lustrous, machinable metal which exists in nature only in ores containing mixtures of elements. It is used in making a wide variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In particular, it is used in well drilling operations where it is directly released into the ground. EPA has found that short term exposure to barium can potentially cause the following health effects when people are exposed to it at levels above the MCL for relatively short periods of time: gastrointestinal disturbances and muscular weakness. Long-term exposure has the potential to cause the following effects from a lifetime exposure at levels above the MCL: high blood pressure.

Combining the contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to heavy metals and other inorganic chemical contamination of medium.

Synthetic Organic Chemicals
The contaminant risk for synthetic organic chemicals is low with sewer lines and residential area representing the most significant risk. Other potential sources of contamination for synthetic organic chemicals include medical facilities, and the photography supply/photo processing facility. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to synthetic organic chemicals is low (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D, respectively).

Other Organic Chemicals
The contaminant risk for other organic chemicals is low with the sewer lines, roads, and the photography supply/photo processing facility presenting the most significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals is low (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D, respectively).

SUMMARY

A *Source Water Assessment* has been completed for the source of public drinking water serving C & S Rentals. The overall vulnerability of well to contamination is **Medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, and heavy metals and **Low** for synthetic organic chemicals, and other 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 C & S Rentals 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 C & S Rentals' public drinking water source.

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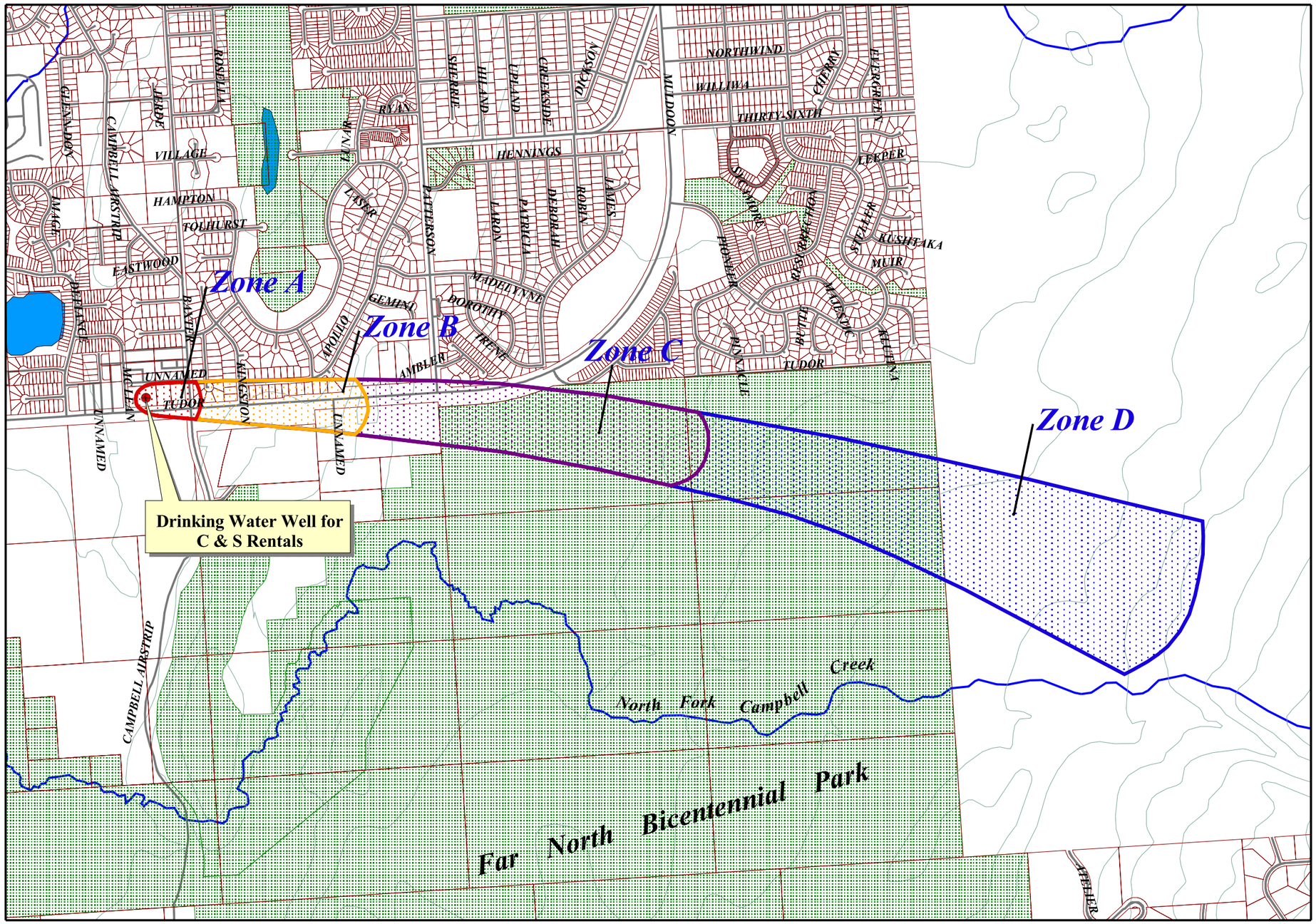
APPENDIX A

C & S Rentals'
Drinking Water Protection Area Location Map
(Map 1)

Drinking Water Protection Area and Potential & Existing Contaminant Sources for C & S Rentals



C & S Rental
- Drinking Water 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

MOA Land Parcels

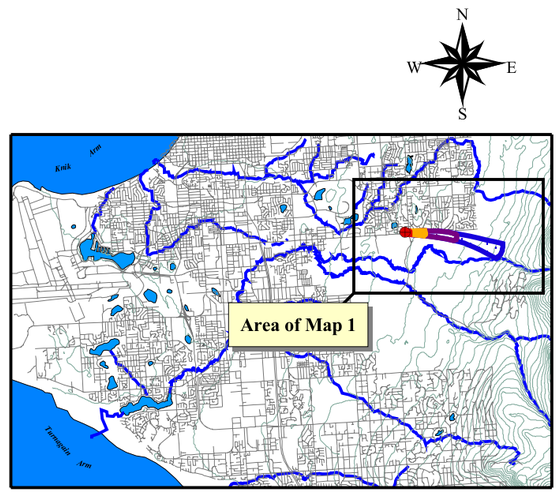
Parks (X4)

Roads

Elevation Contours

Streams

Lakes



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for C & S Rentals (Tables 1-7)

Table 1

Contaminant Source Inventory for ***C & S Rentals***

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Tudor	2	
Dog walking areas/foot trails	X46	X46-1	A, B		2	
Dog walking areas/foot trails	X46	X46-2	A, B		2	
Dog walking areas/foot trails	X46	X46-3	A, B		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B		2	
Residential Areas	R01	R1-2	B	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B		2	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-1	B	4316 Kingston	2	
Public utility easements/corridors	X42	X42-1	B		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	1 sewer line in Zone C	3	
Highways and roads, paved (cement or asphalt)	X20		C	1 road in Zone C	3	
Photography supplies/photo processing laboratories	C36	C36-1	C	6901 Tudor	3	

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Municipal or city parks (with green areas)	X04	X4-1	C	Far North Bicentennial Park	3	

Table 2

Contaminant Source Inventory and Risk Ranking for C & S Rentals

Sources of Bacteria and Viruses

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Low	Tudor	2	
Dog walking areas/foot trails	X46	X46-1	A, B	Low		2	
Dog walking areas/foot trails	X46	X46-2	A, B	Low		2	
Dog walking areas/foot trails	X46	X46-3	A, B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Medium		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Medium	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Medium	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Medium		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Medium		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low		2	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-1	B	Medium	4316 Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Medium	1 sewer line in Zone C	3	
Highways and roads, paved (cement or asphalt)	X20		C	Low	1 road in Zone C	3	
Municipal or city parks (with green areas)	X04	X4-1	C	Medium	Far North Bicentennial Park	3	

Table 2 (continued)

Contaminant Source Inventory and Risk Ranking for C & S Rentals Sources of Bacteria and Viruses

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*

Table 3

Contaminant Source Inventory and Risk Ranking for C & S Rentals
Sources of Nitrates/Nitrites

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Low	Tudor	2	
Dog walking areas/foot trails	X46	X46-1	A, B	Low		2	
Dog walking areas/foot trails	X46	X46-2	A, B	Low		2	
Dog walking areas/foot trails	X46	X46-3	A, B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Medium		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Medium	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Medium	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Medium		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Medium		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20		C	Low	1 road in Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Medium	1 sewer line in Zone C	3	
Municipal or city parks (with green areas)	X04	X4-1	C	Medium	Far North Bicentennial Park	3	

Table 4

Contaminant Source Inventory and Risk Ranking for C & S Rentals

Sources of Volatile Organic Chemicals

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Low	Tudor	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Low	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Low	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Low		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low		2	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-1	B	Low	4316 Kingston	2	
Public utility easements/corridors	X42	X42-1	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20		C	Low	1 road in Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Low	1 sewer line in Zone C	3	
Photography supplies/photo processing laboratories	C36	C36-1	C	Medium	6901 Tudor	3	

Table 5

Contaminant Source Inventory and Risk Ranking for C & S Rentals

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Low	Tudor	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Low	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Low	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Low		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low		2	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-1	B	Low	4316 Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Low	1 sewer line in Zone C	3	
Highways and roads, paved (cement or asphalt)	X20		C	Low	1 road in Zone C	3	
Photography supplies/photo processing laboratories	C36	C36-1	C	Medium	6901 Tudor	3	

Table 6

Contaminant Source Inventory and Risk Ranking for C & S Rentals

Sources of Synthetic Organic Chemicals

PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Low	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Low	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Low		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-1	B	Low	4316 Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Low	1 sewer line in Zone C	3	
Photography supplies/photo processing laboratories	C36	C36-1	C	Low	6901 Tudor	3	
Municipal or city parks (with green areas)	X04	X4-1	C	Low	Far North Bicentennial Park	3	

Table 7

Contaminant Source Inventory and Risk Ranking for C & S Rentals

Sources of Other Organic Chemicals

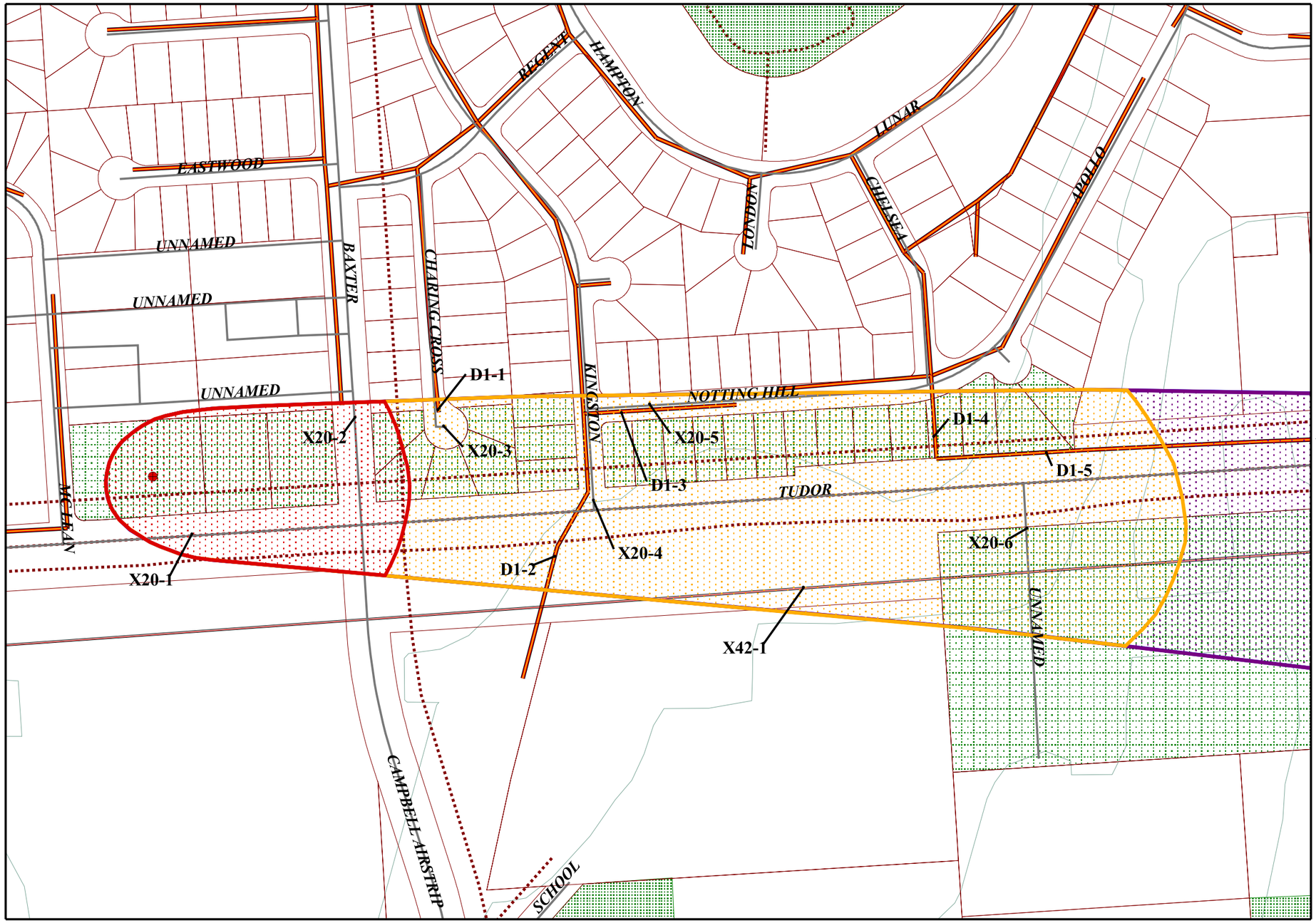
PWSID 215558.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Low	Baxter	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A, B	Low	Tudor	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Low	along Kingston	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Low	along Notting Hill	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Low		2	
Residential Areas	R01	R1-2	B	Low	entire subidivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	B	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Kingston	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	Notting Hill	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Low	1 sewer line in Zone C	3	
Highways and roads, paved (cement or asphalt)	X20		C	Low	1 road in Zone C	3	
Photography supplies/photo processing laboratories	C36	C36-1	C	Low	6901 Tudor	3	

APPENDIX C

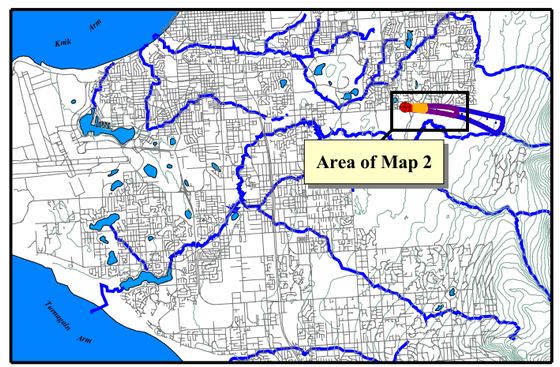
C & S Rentals'
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps 2 & 3)

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for C & S Rentals



C & S Rental
Drinking Water 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
MOA Land Parcels
Roads
Parks (X4)
Public utility eastements/corridors (X42)
Trails (X46)
Sewers (R2)
Residential lawns (R1)
Elevation Contours
Streams
Lakes

N
W E
S

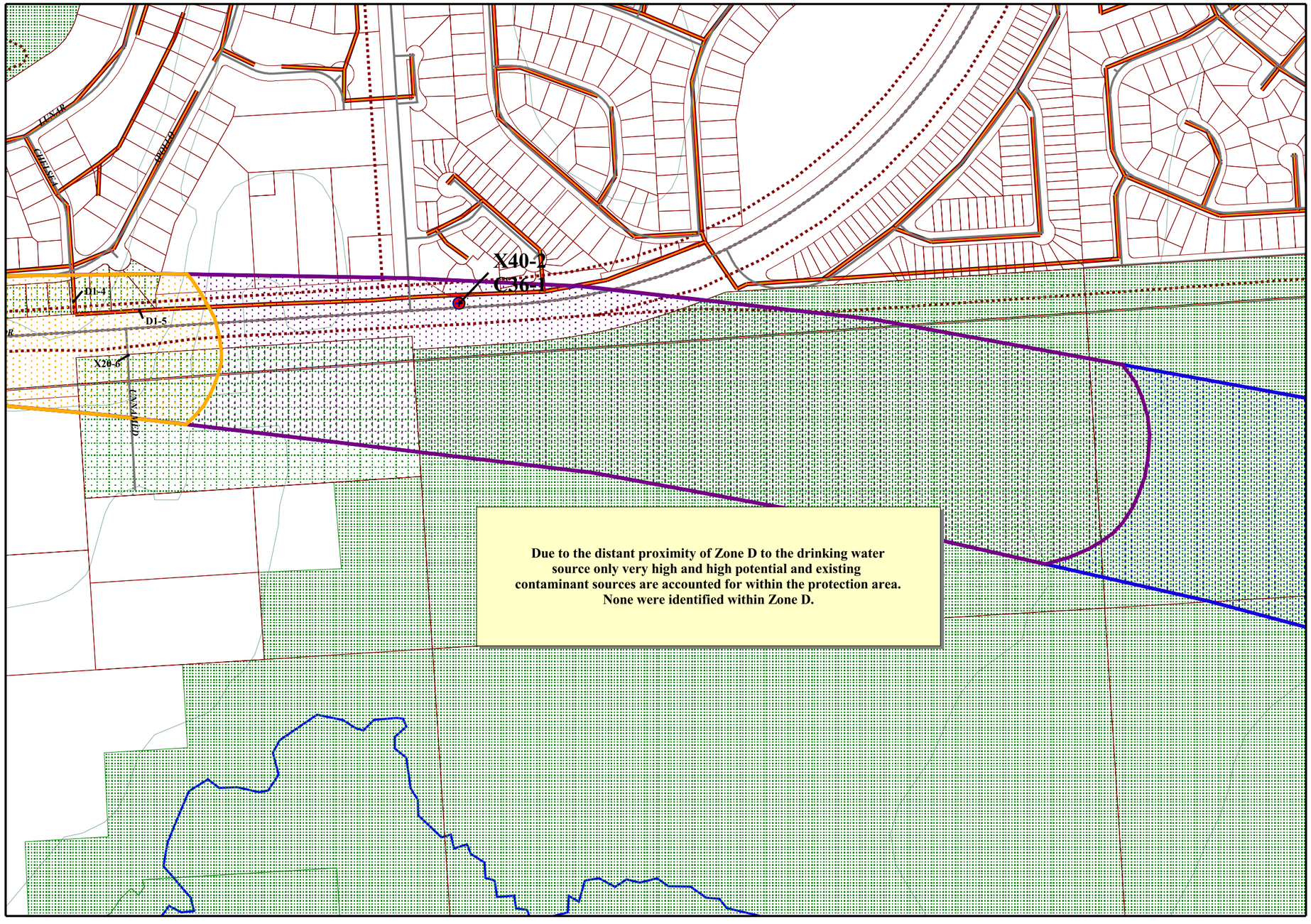


500 0 500 1000 1500 Feet

PWSID 215558.001

Map 2

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for C & S Rentals



C & S Rental
- Drinking Water Well

Zone A Protection Area
- Several Months Travel Time

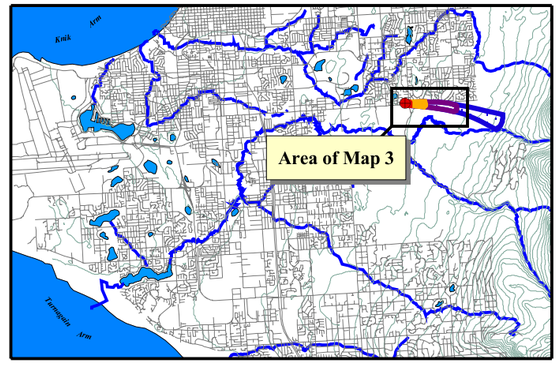
Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time

Potential & Existing Contaminant Sources
- Photography supplies/photo processing (C36)
- Medical/veterinary facilities (X40)
- MOA Land Parcels
- Roads
- Parks (X4)
- Public utility eastements/corridors (X42)
- Trails (X46)
- Sewers (R2)
- Residential lawns (R1)
- Elevation Contours
- Streams
- Lakes

N
W E
S



700 0 700 1400 2100 Feet

PWSID 215558.001

Map 3

APPENDIX D

Vulnerability Analysis for
C & S Rentals
(Charts 1-14)

Chart 1. Susceptibility of the wellhead - C & S Rentals

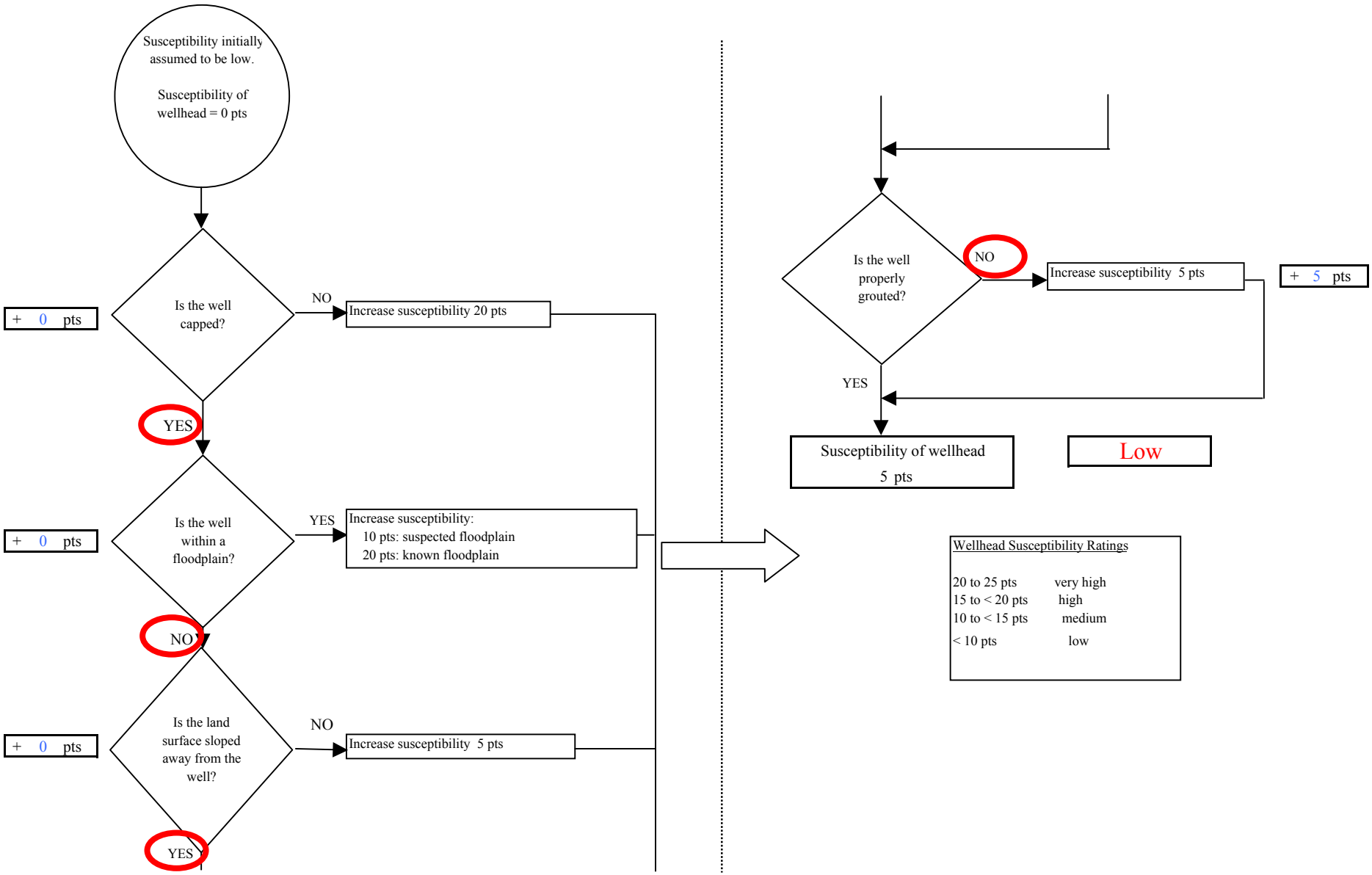


Chart 2. Susceptibility of the aquifer - C & S Rentals

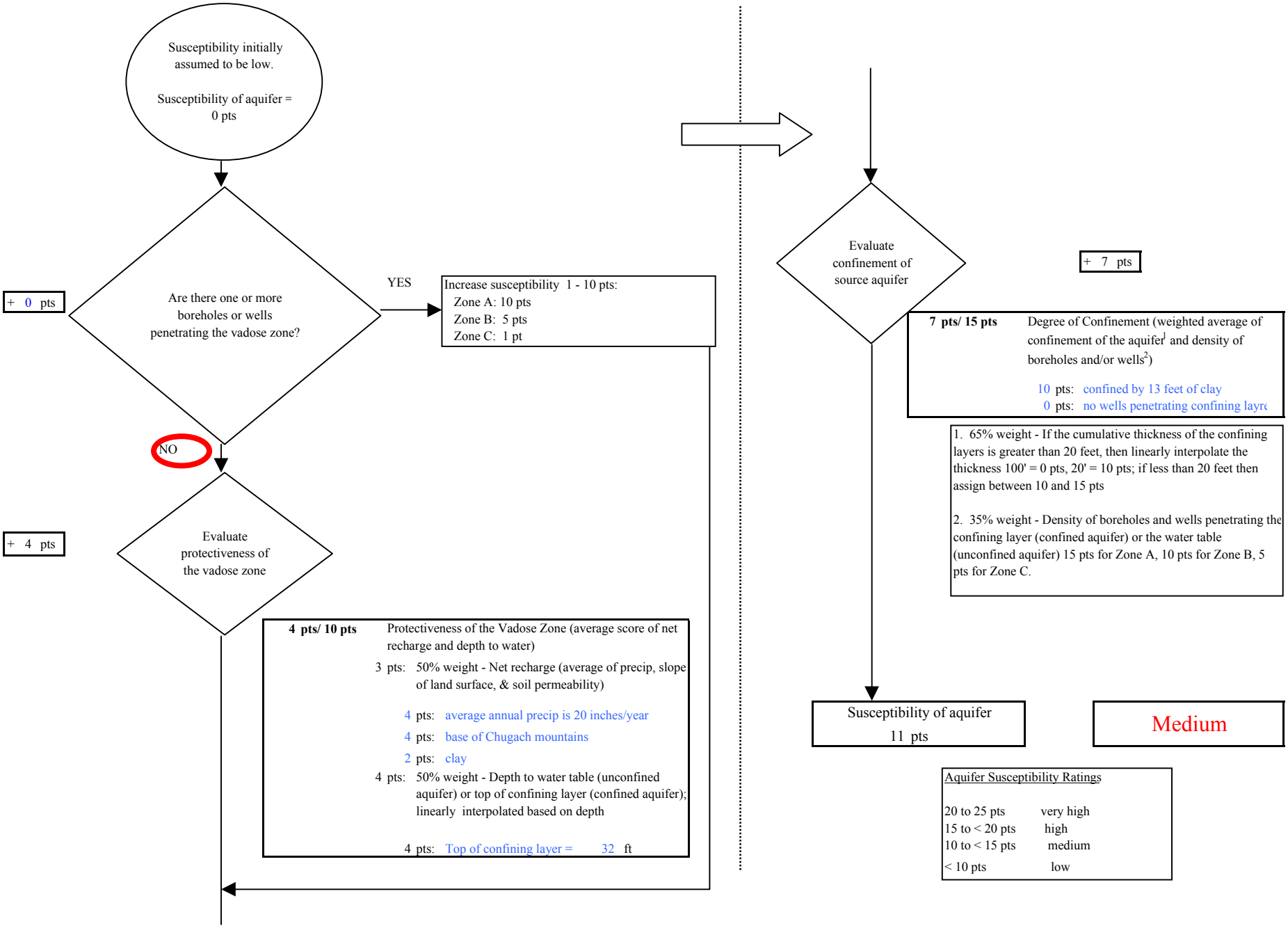
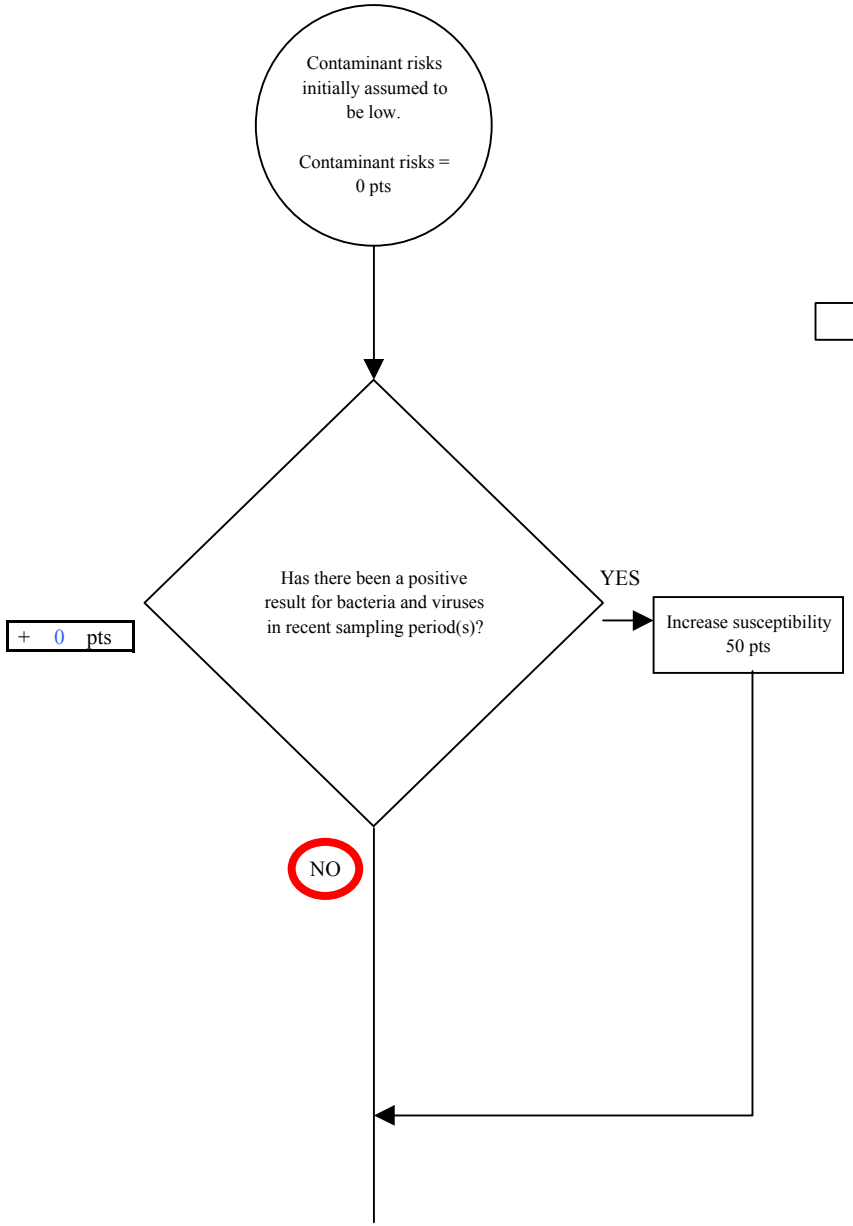
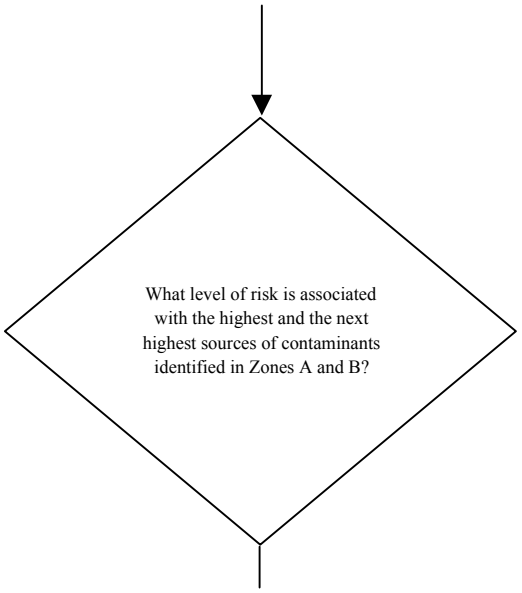


Chart 3. Contaminant risks for C & S Rentals - Bacteria & Viruses





+ 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)	0	1	1
Low(s)	2	3	5

	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 C & S Rentals - Bacteria & Viruses

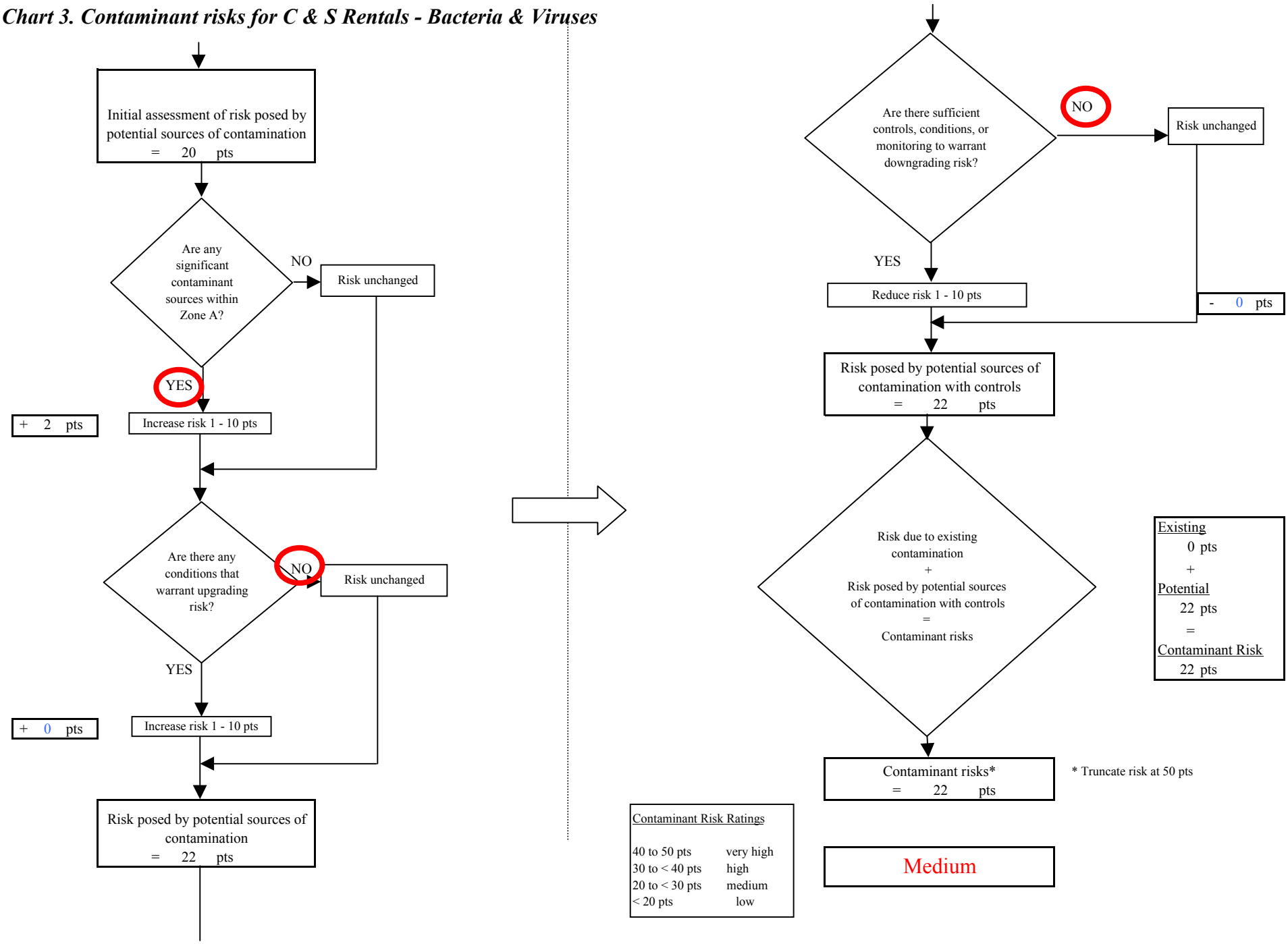


Chart 4. Vulnerability analysis for C & S Rentals - Bacteria & Viruses

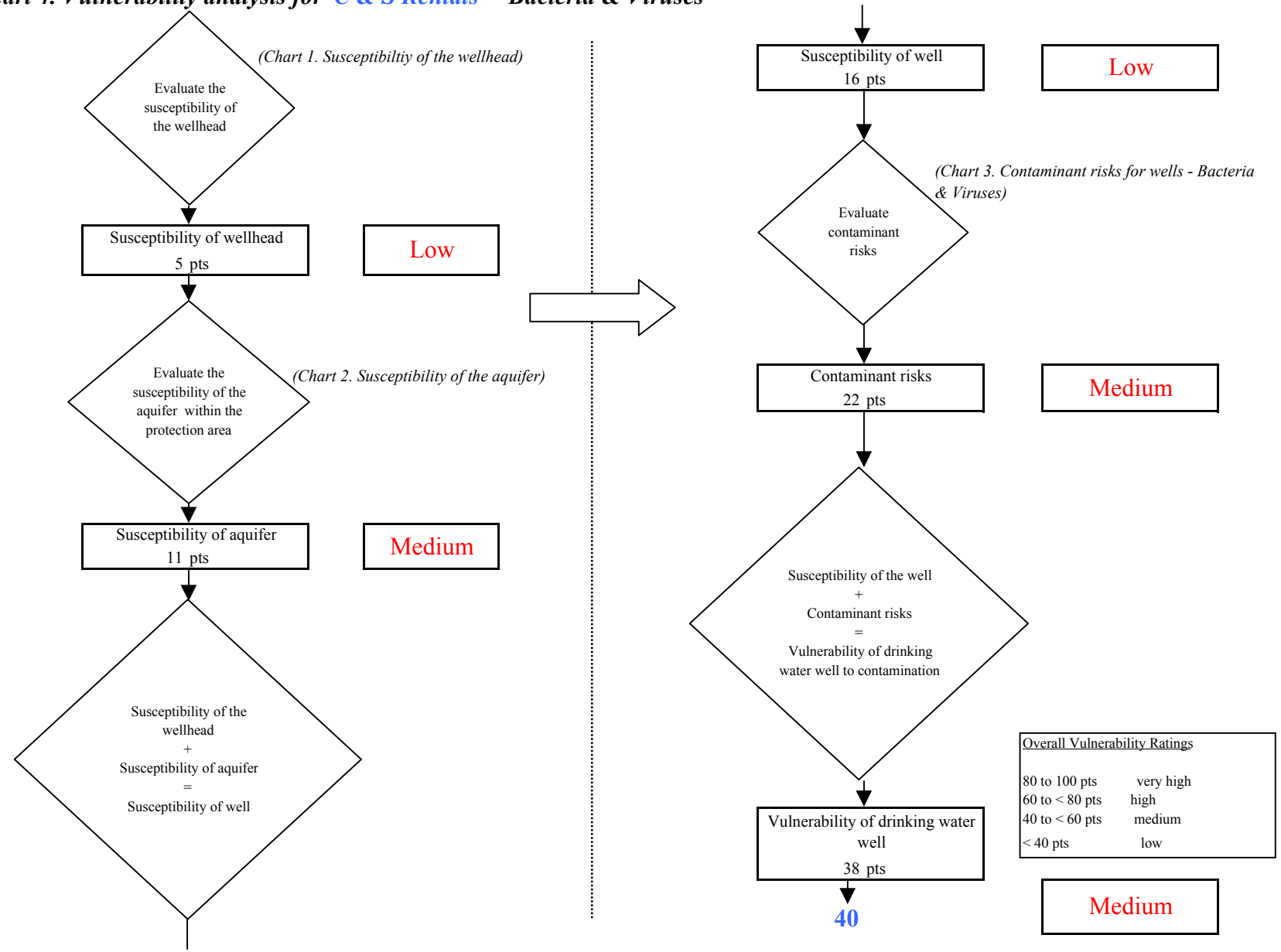


Chart 5. Contaminant risks for C & S Rentals - Nitrates and Nitrites

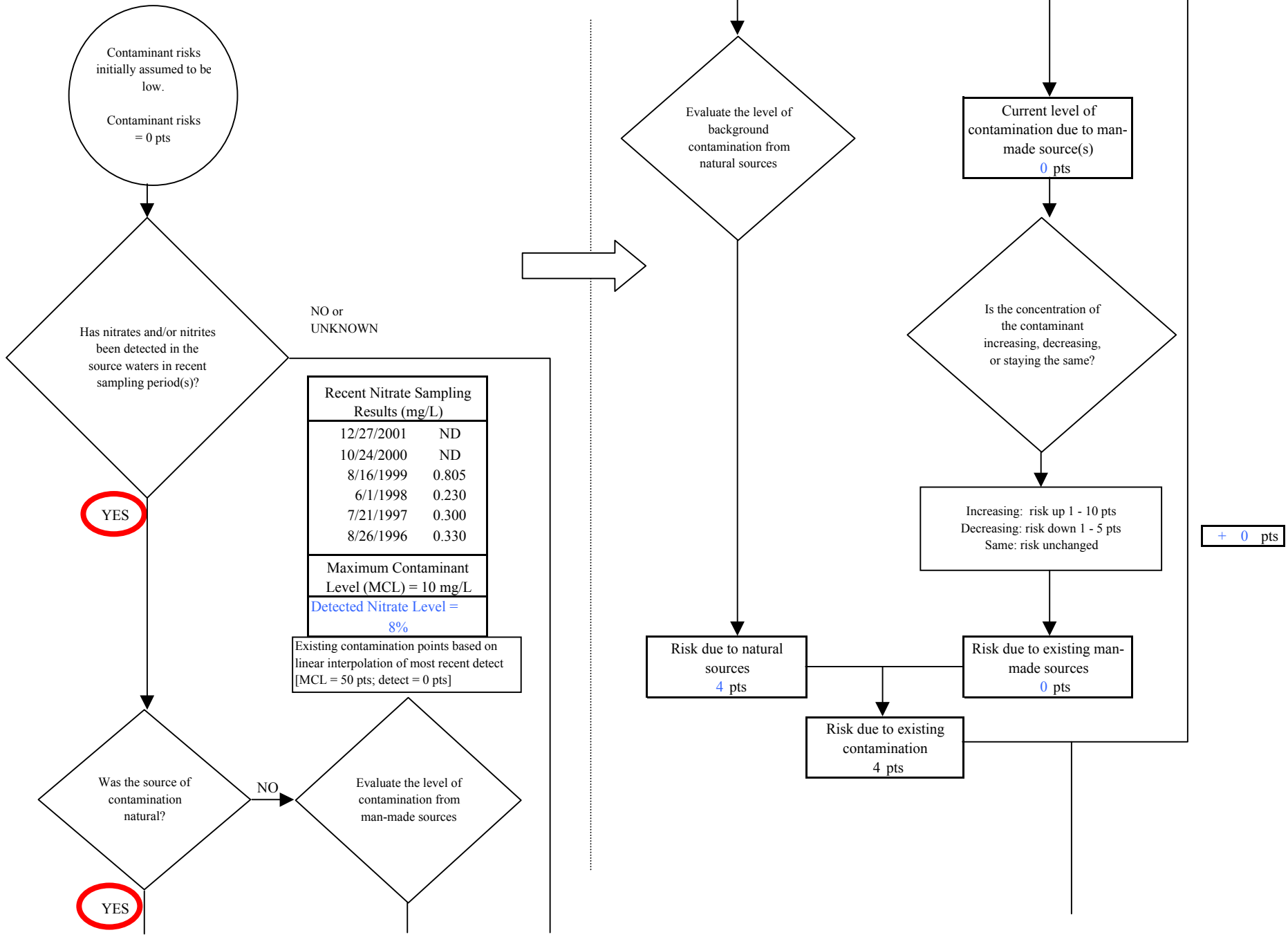


Chart 5. Contaminant risks for C & S Rentals - Nitrates and Nitrites

+ 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)	0	1	1
Low(s)	5	3	8

	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

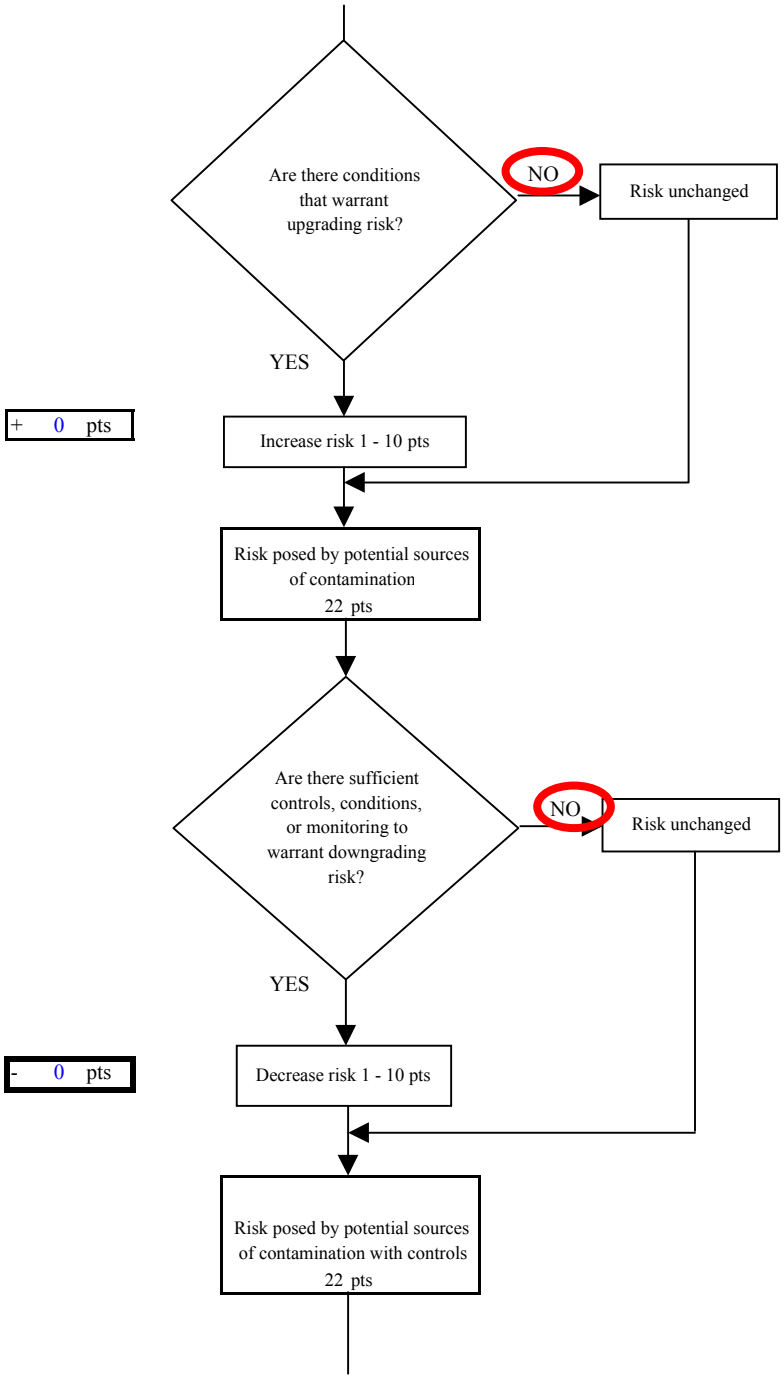
Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 5. Contaminant risks for C & S Rentals - Nitrates and Nitrites



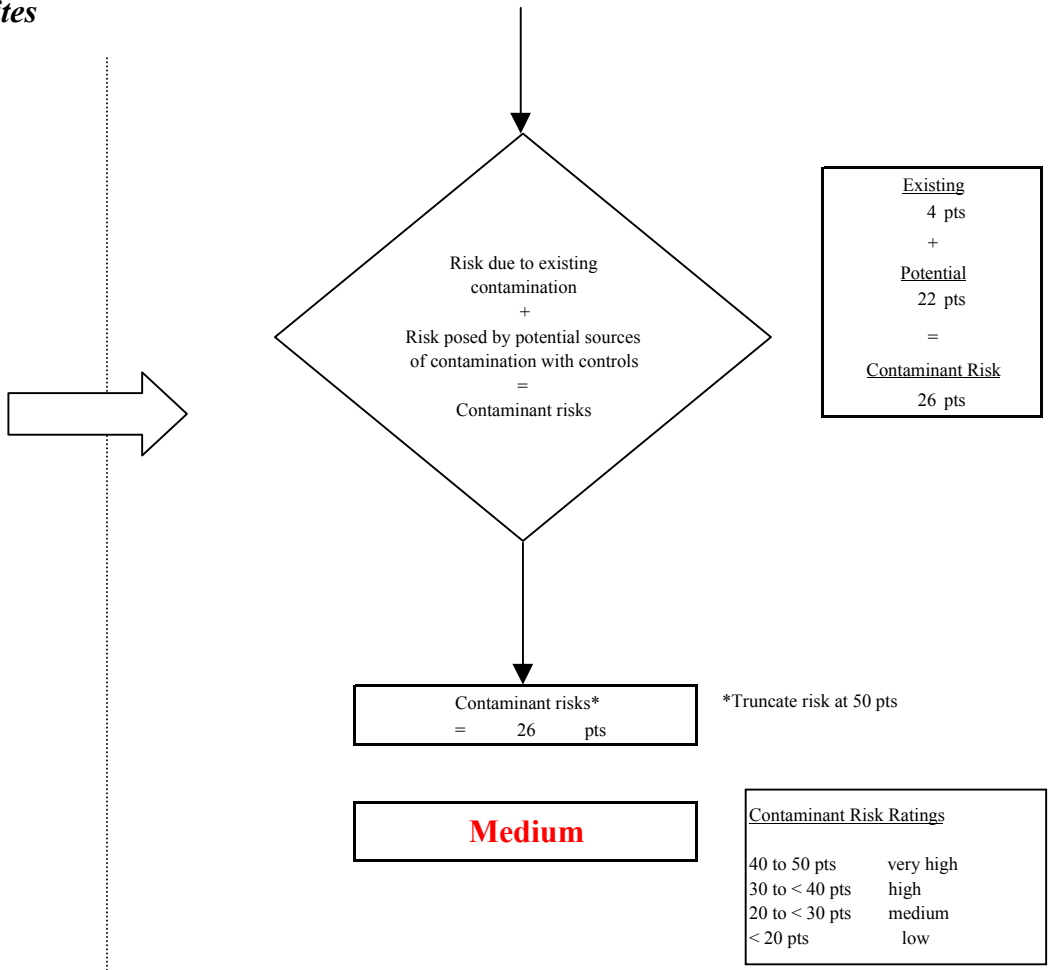


Chart 6. Vulnerability analysis for C & S Rentals - Nitrates and Nitrites

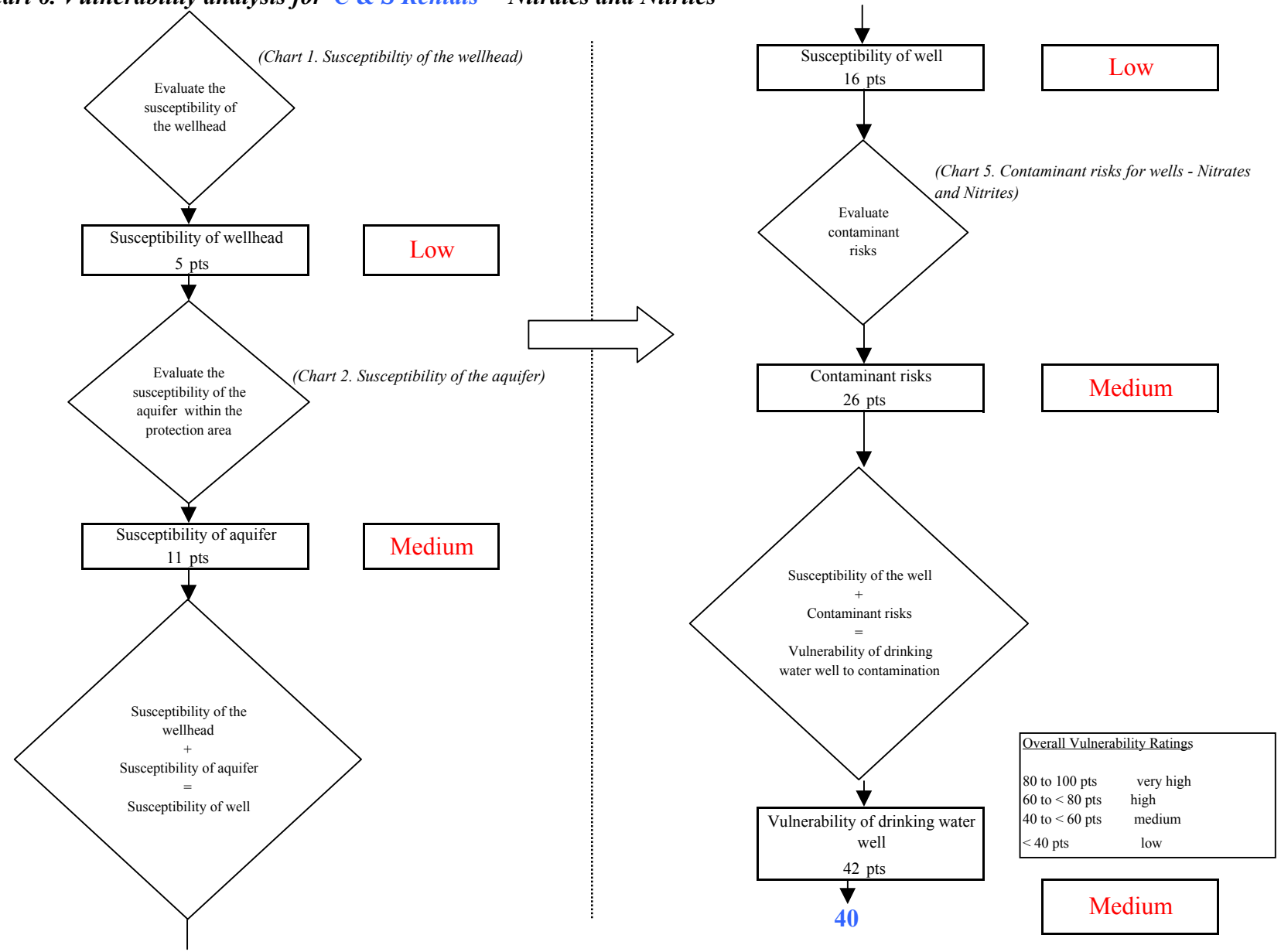


Chart 7. Contaminant risks for C & S Rentals - Volatile Organic Chemicals

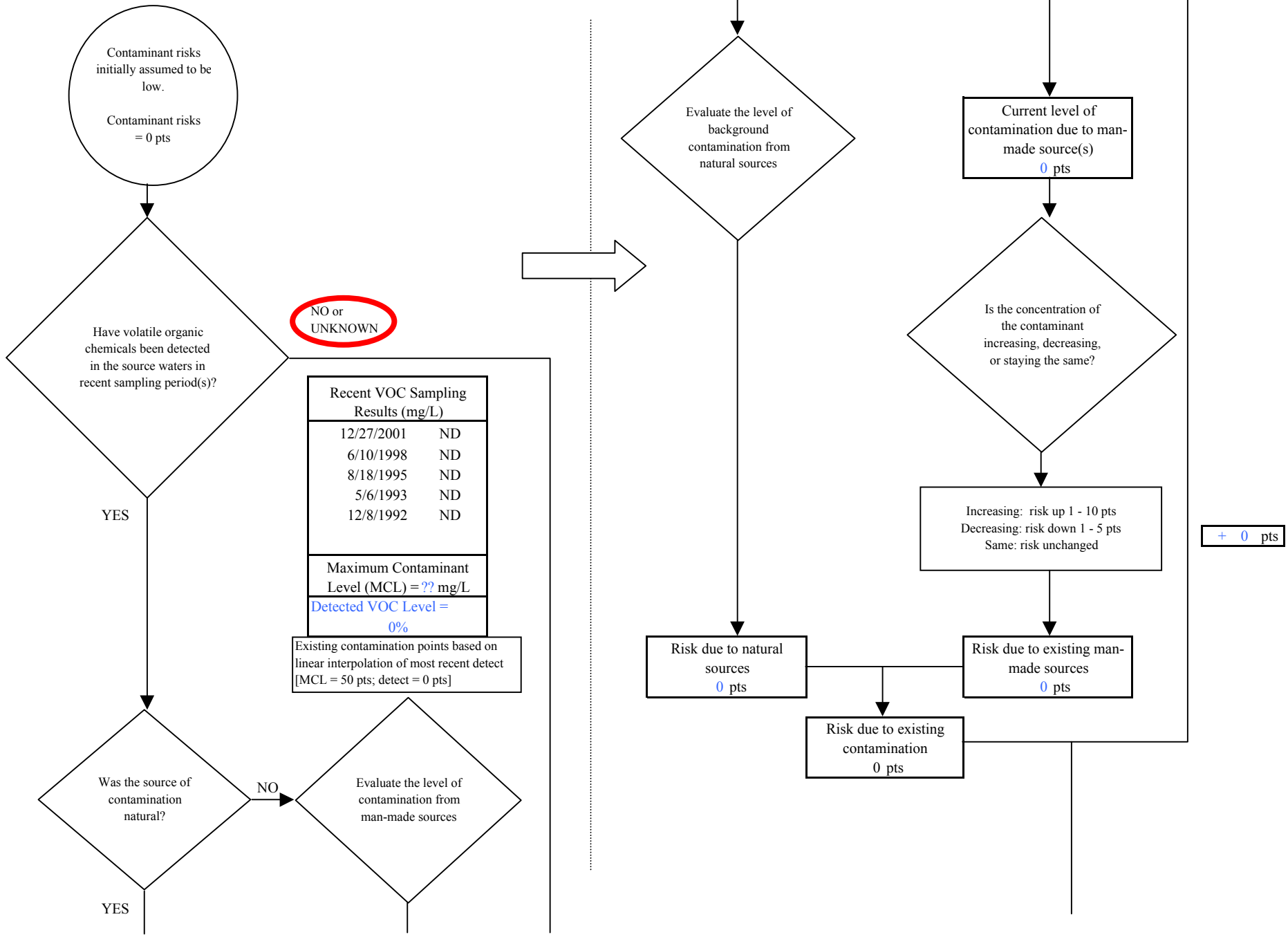


Chart 7. Contaminant risks for C & S Rentals - Volatile Organic Chemicals

+ 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)	0	1	1
Low(s)	2	5	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

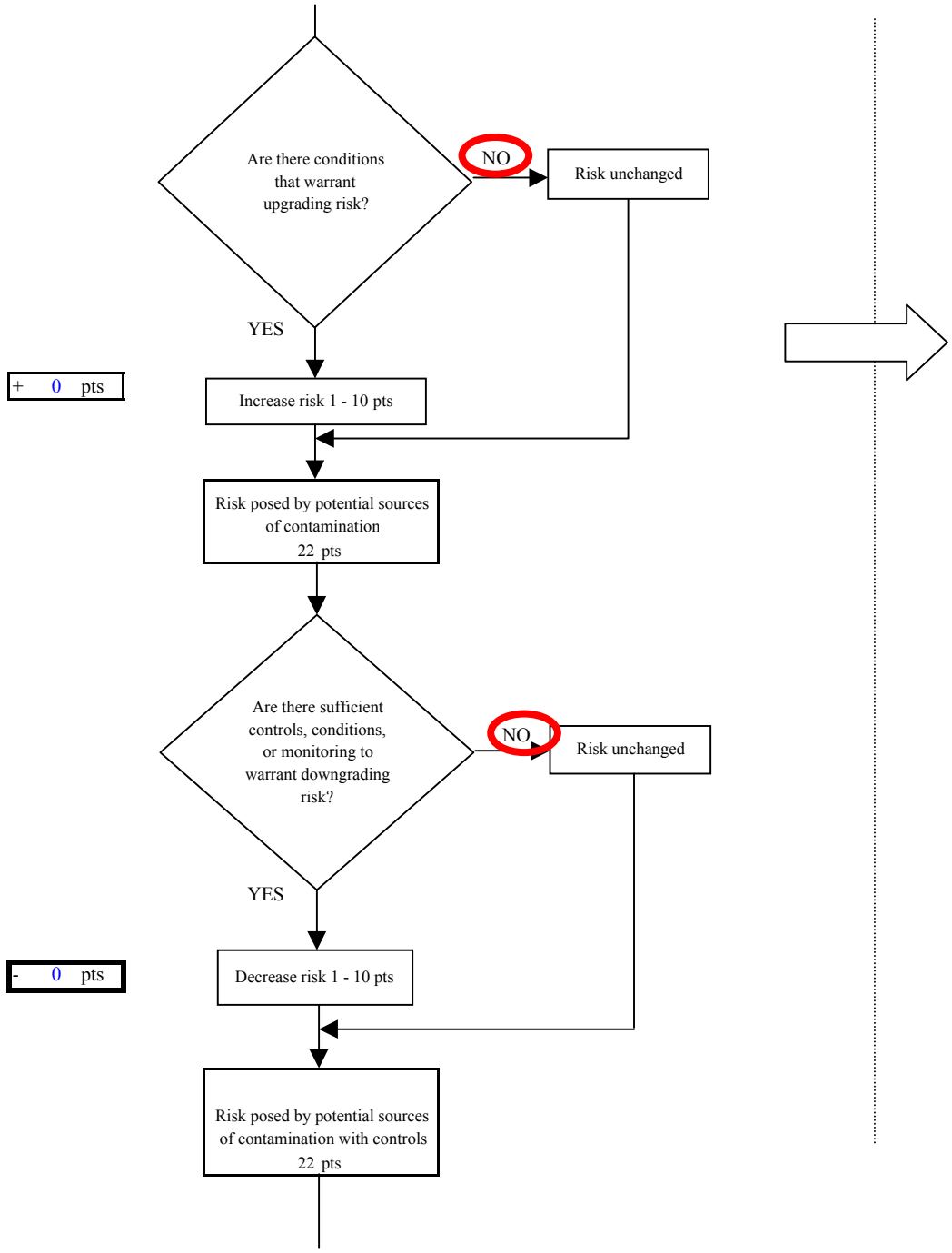
Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 7. Contaminant risks for C & S Rentals - Volatile Organic Chemicals



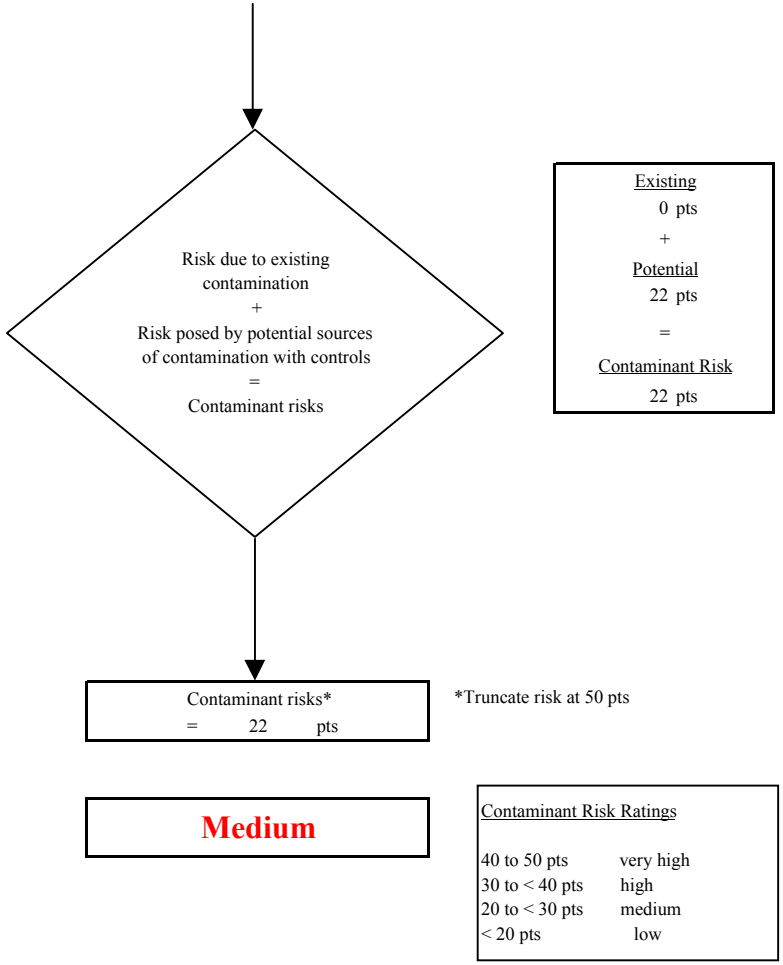


Chart 8. Vulnerability analysis for C & S Rentals - Volatile Organic Chemicals

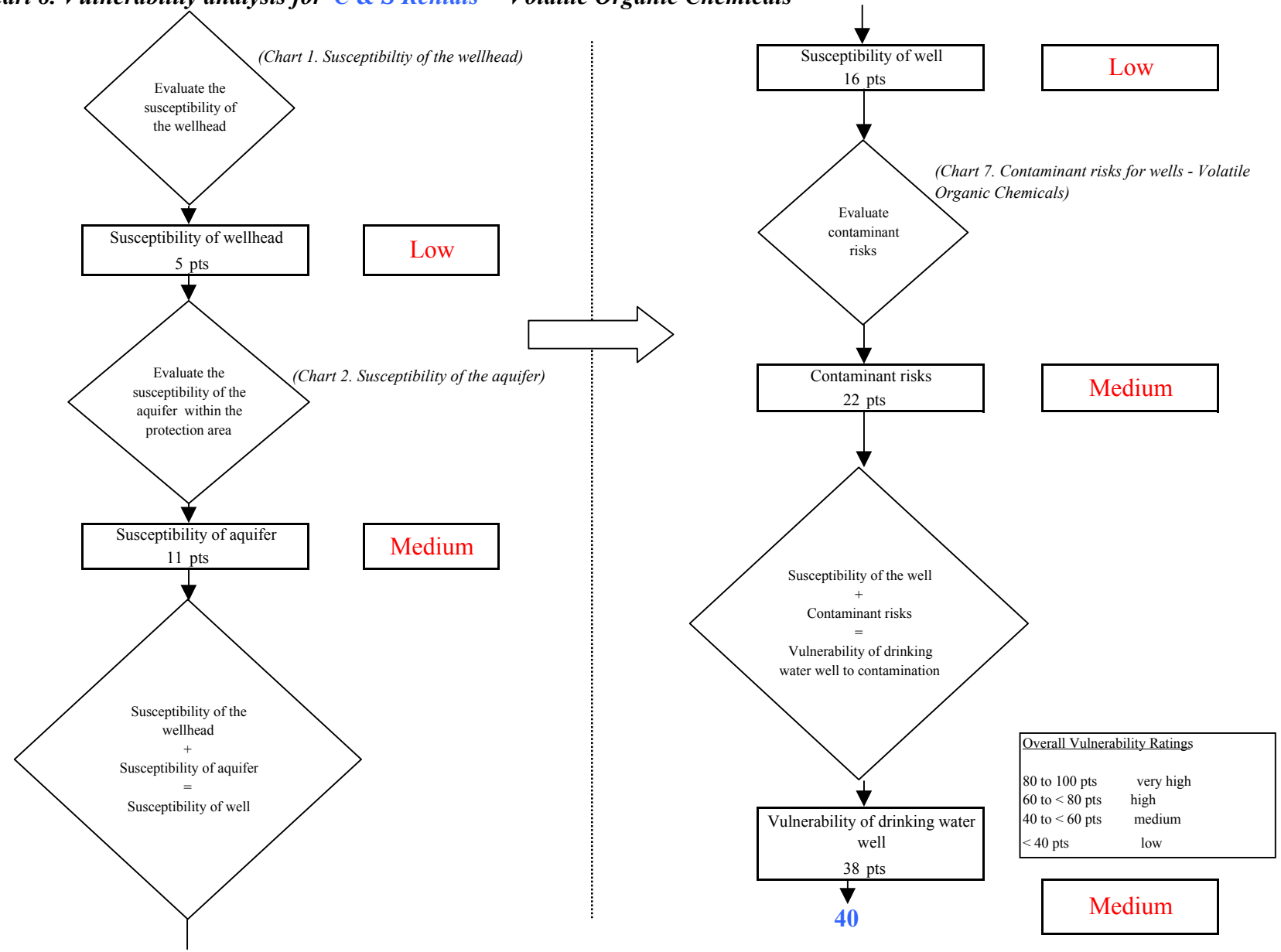


Chart 9. Contaminant risks for C & S Rentals - Heavy Metals, Cyanide and Other Inorganic Chemicals

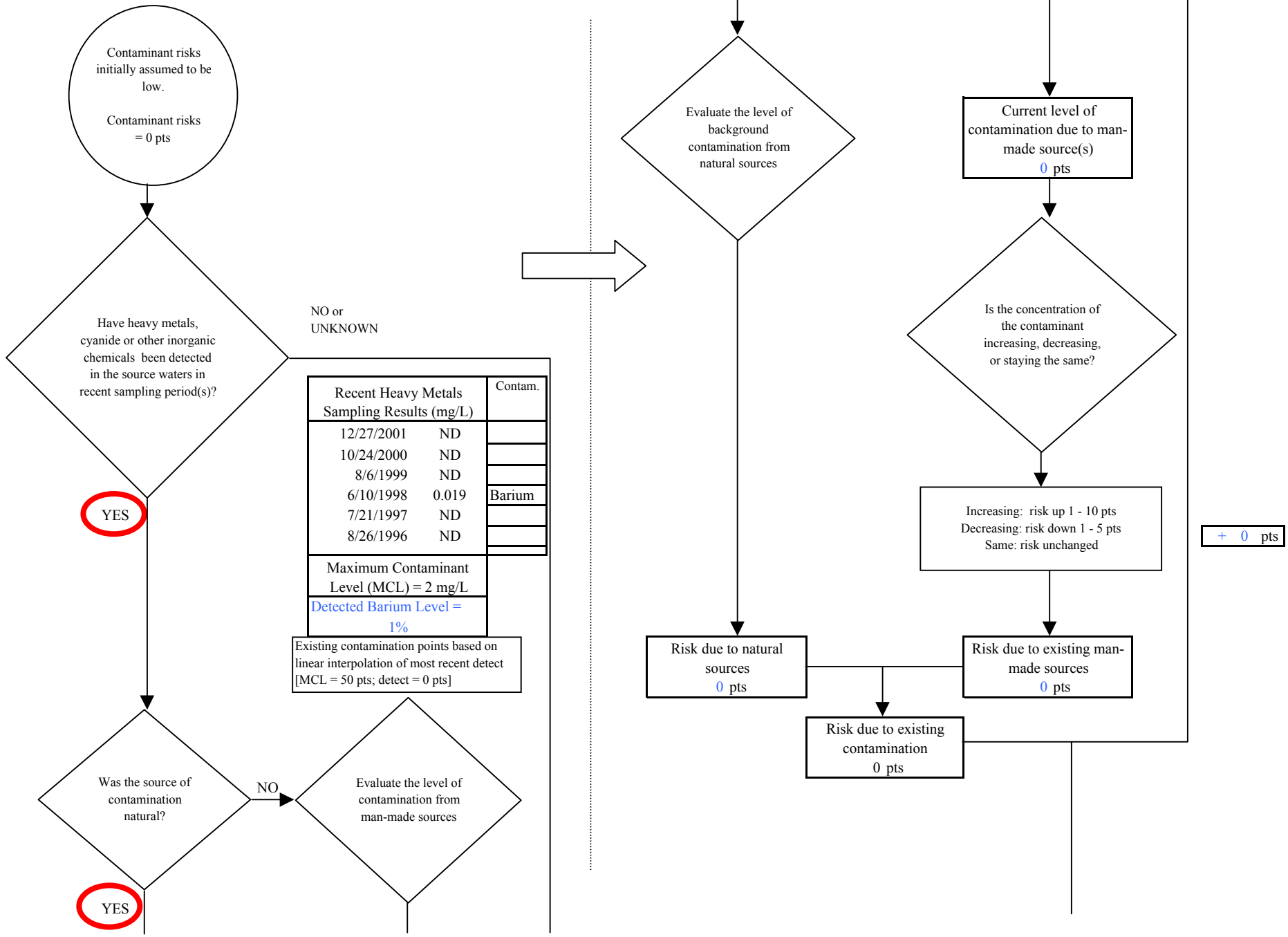
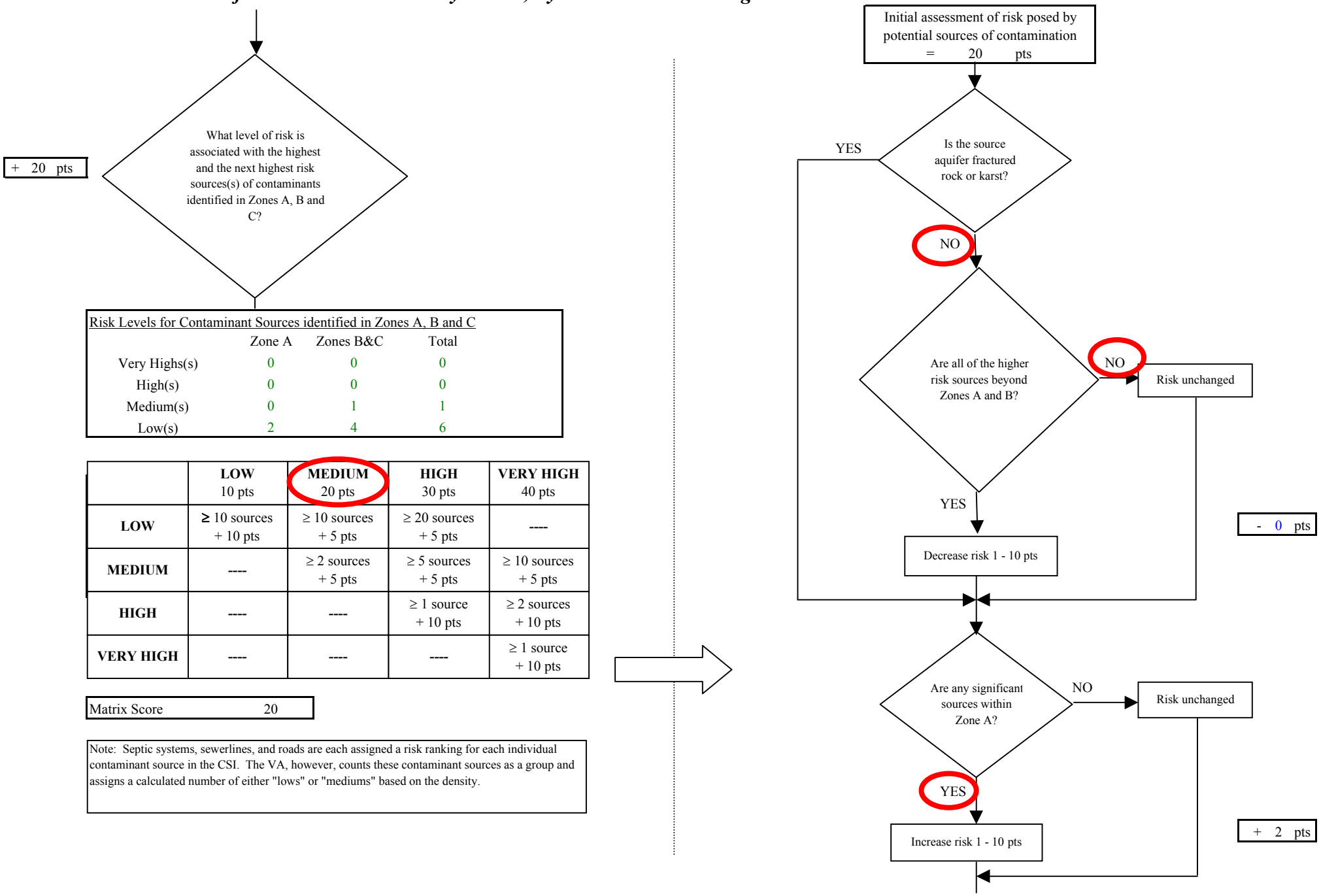


Chart 9. Contaminant risks for C & S Rentals - Heavy Metals, Cyanide and Other Inorganic Chemicals



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

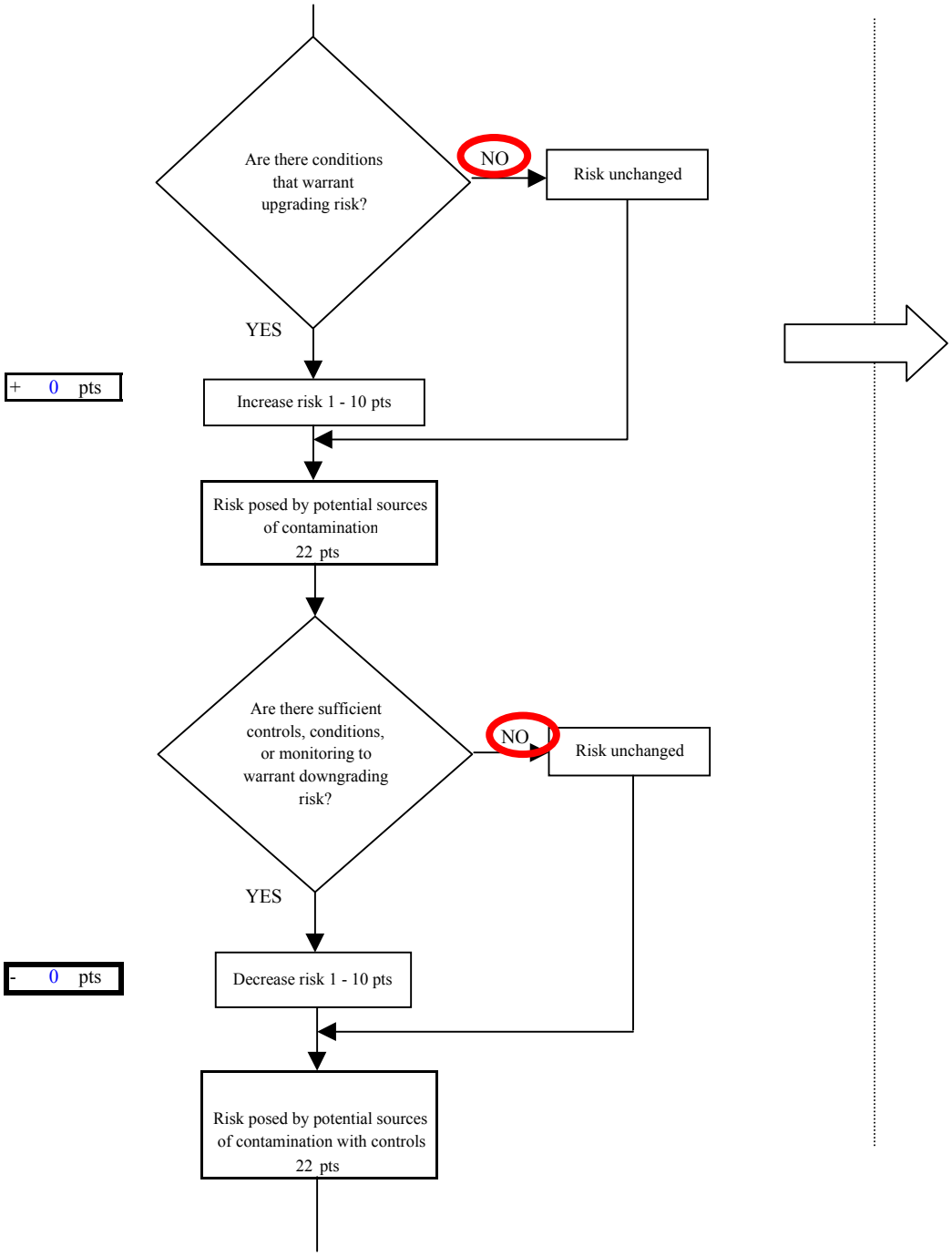
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	2	4	6

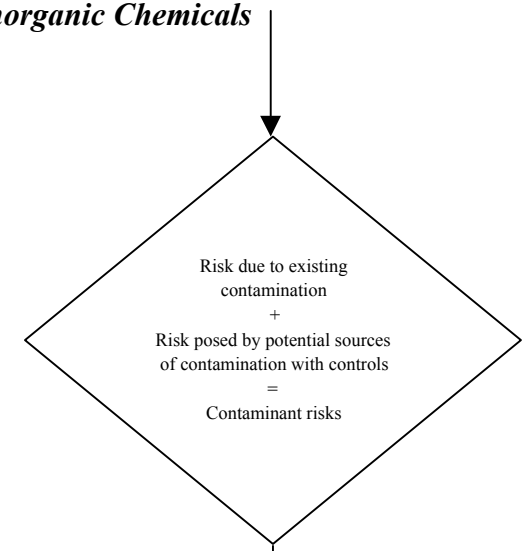
	LOW 10 pts	**MEDIUM** 20 pts	**HIGH** 30 pts	**VERY HIGH** 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source + 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 9. Contaminant risks for C & S Rentals - Heavy Metals, Cyanide and Other Inorganic Chemicals





Existing
0 pts
+
Potential
22 pts
=
Contaminant Risk
22 pts

Contaminant risks*
= 22 pts

*Truncate risk at 50 pts

Medium

Contaminant Risk Ratings

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

Chart 10. Vulnerability analysis for C & S Rentals - Heavy Metals, Cyanide and Other Inorganic Chemicals

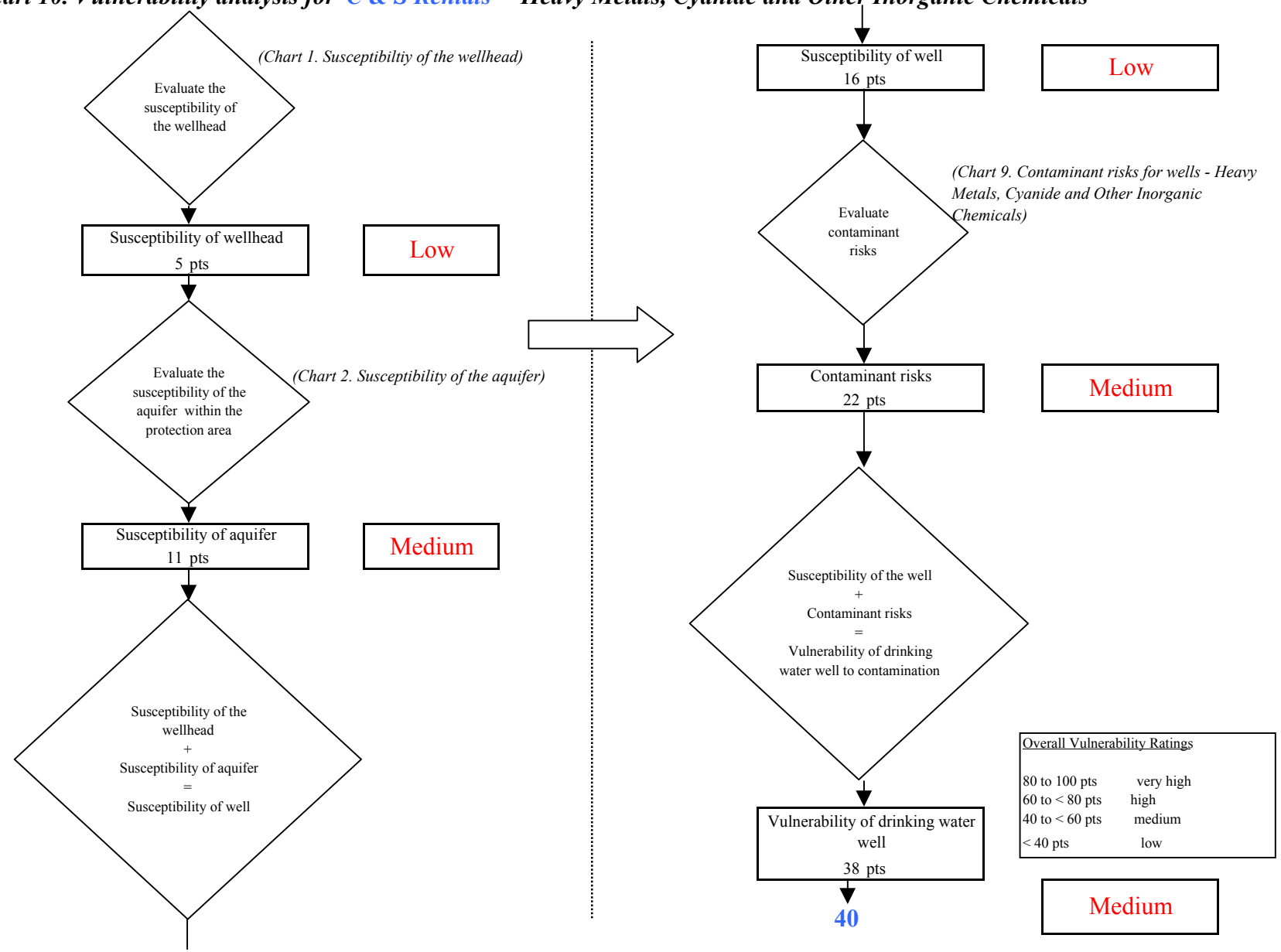


Chart 11. Contaminant risks for C & S Rentals - Synthetic Organic Chemicals

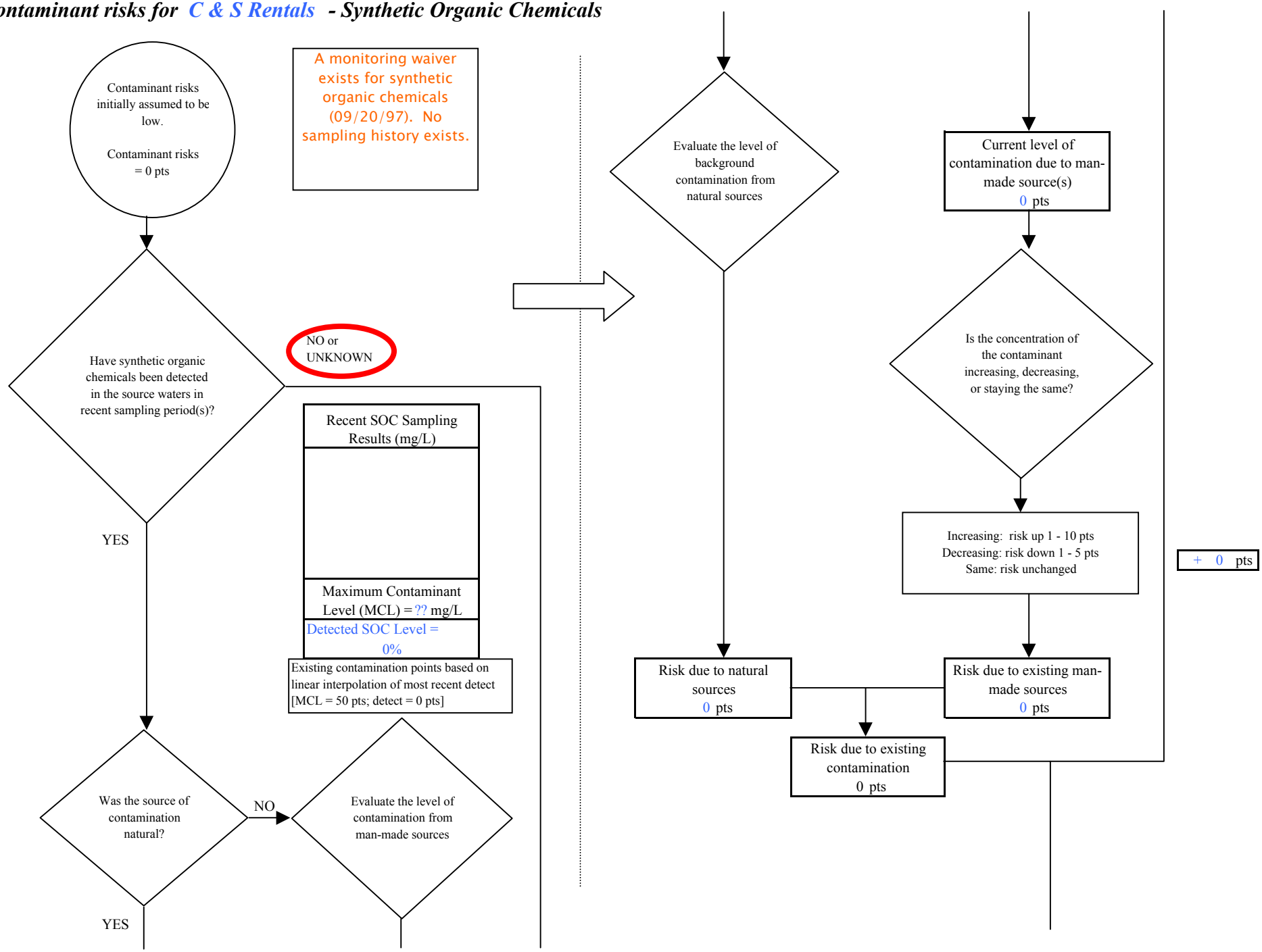
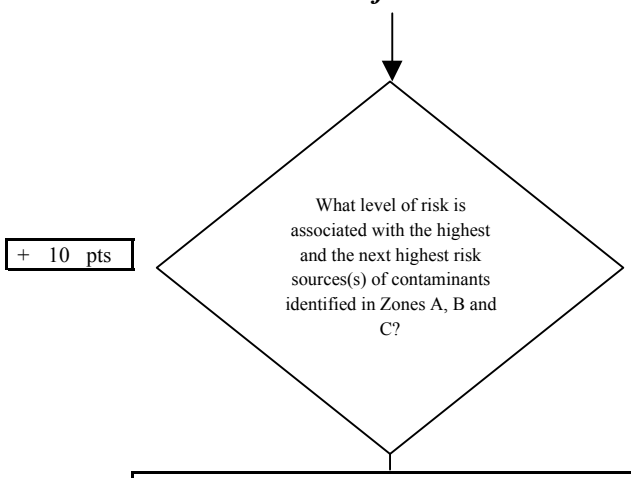


Chart 11. Contaminant risks for C & S Rentals - Synthetic Organic Chemicals

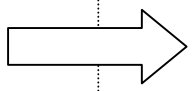


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	1	5	6

	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.



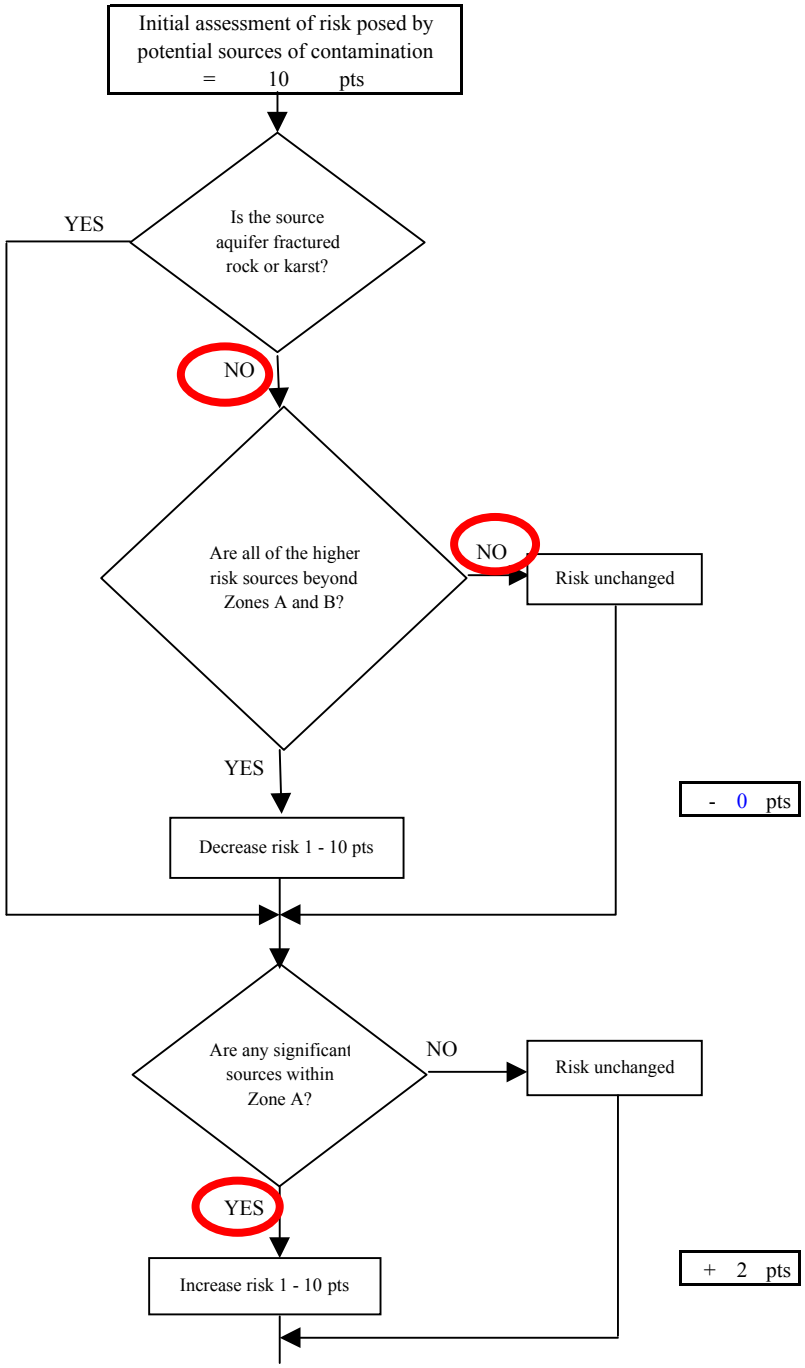
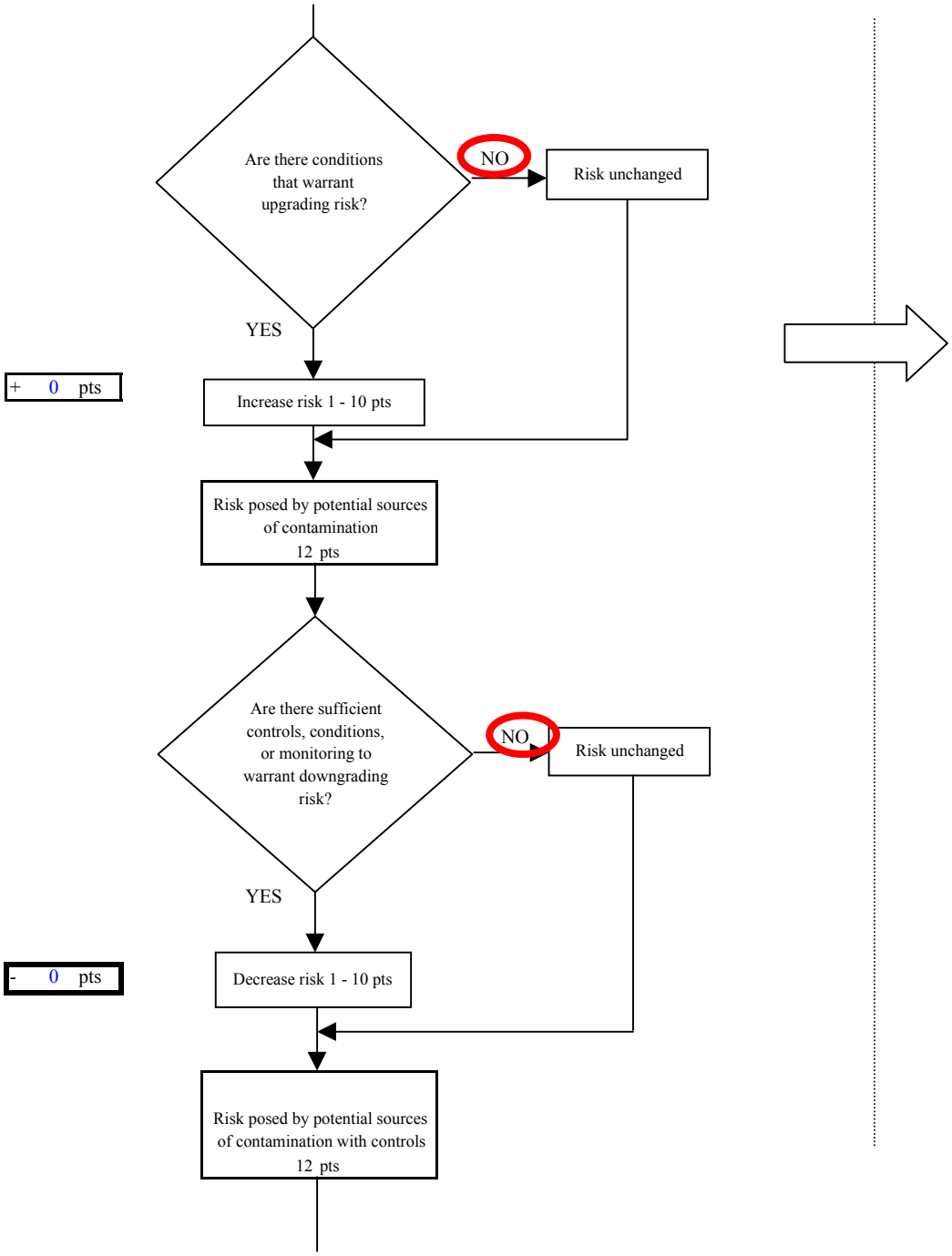
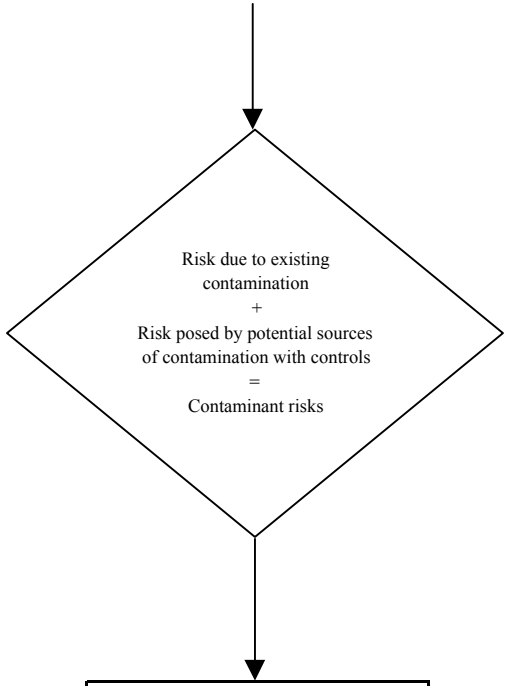


Chart 11. Contaminant risks for C & S Rentals - Synthetic Organic Chemicals





Existing
0 pts
+
Potential
12 pts
=
Contaminant Risk
12 pts

Contaminant risks*
= 12 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 12. Vulnerability analysis for C & S Rentals - Synthetic Organic Chemicals

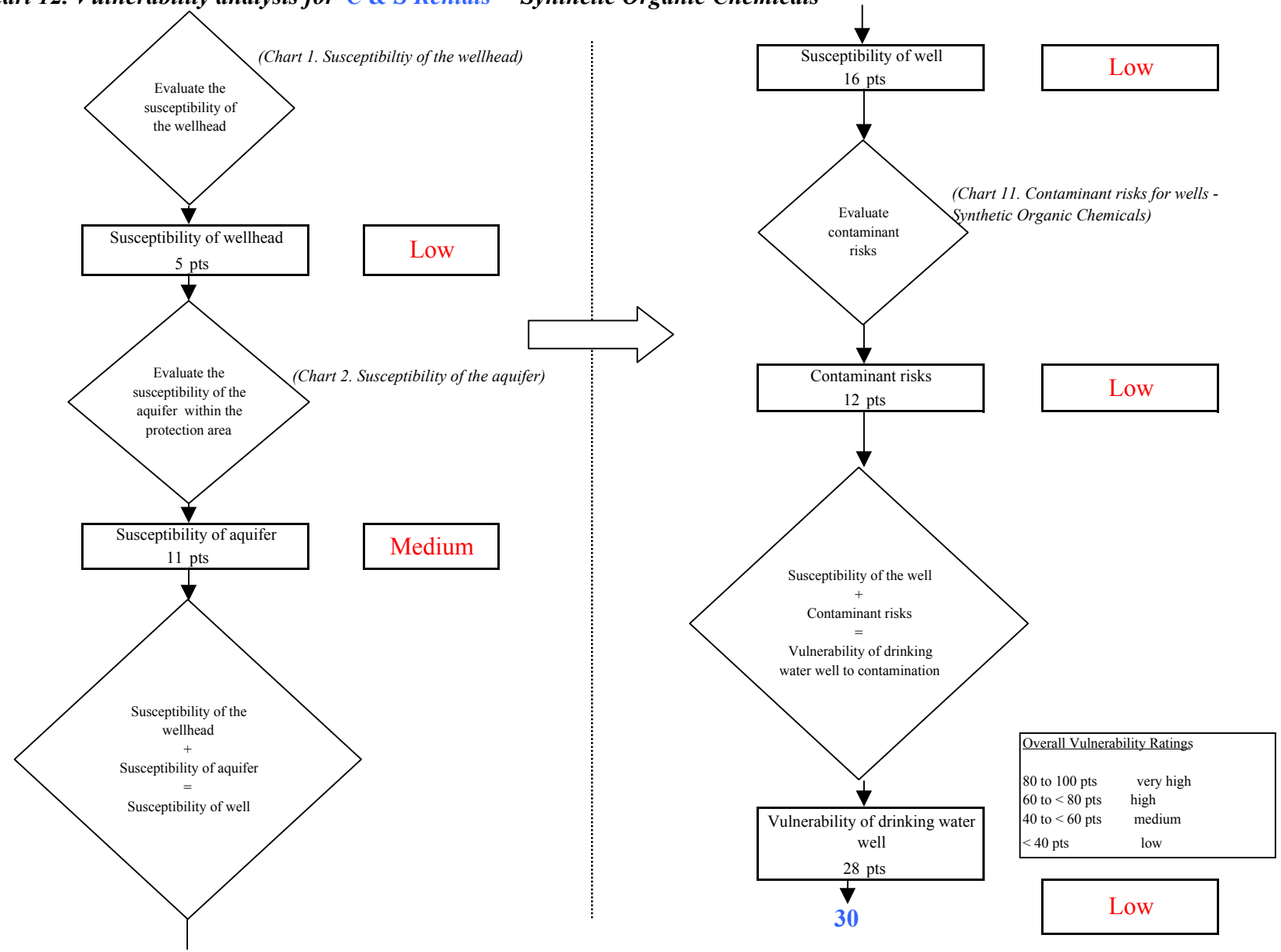


Chart 13. Contaminant risks for C & S Rentals - Other Organic Chemicals

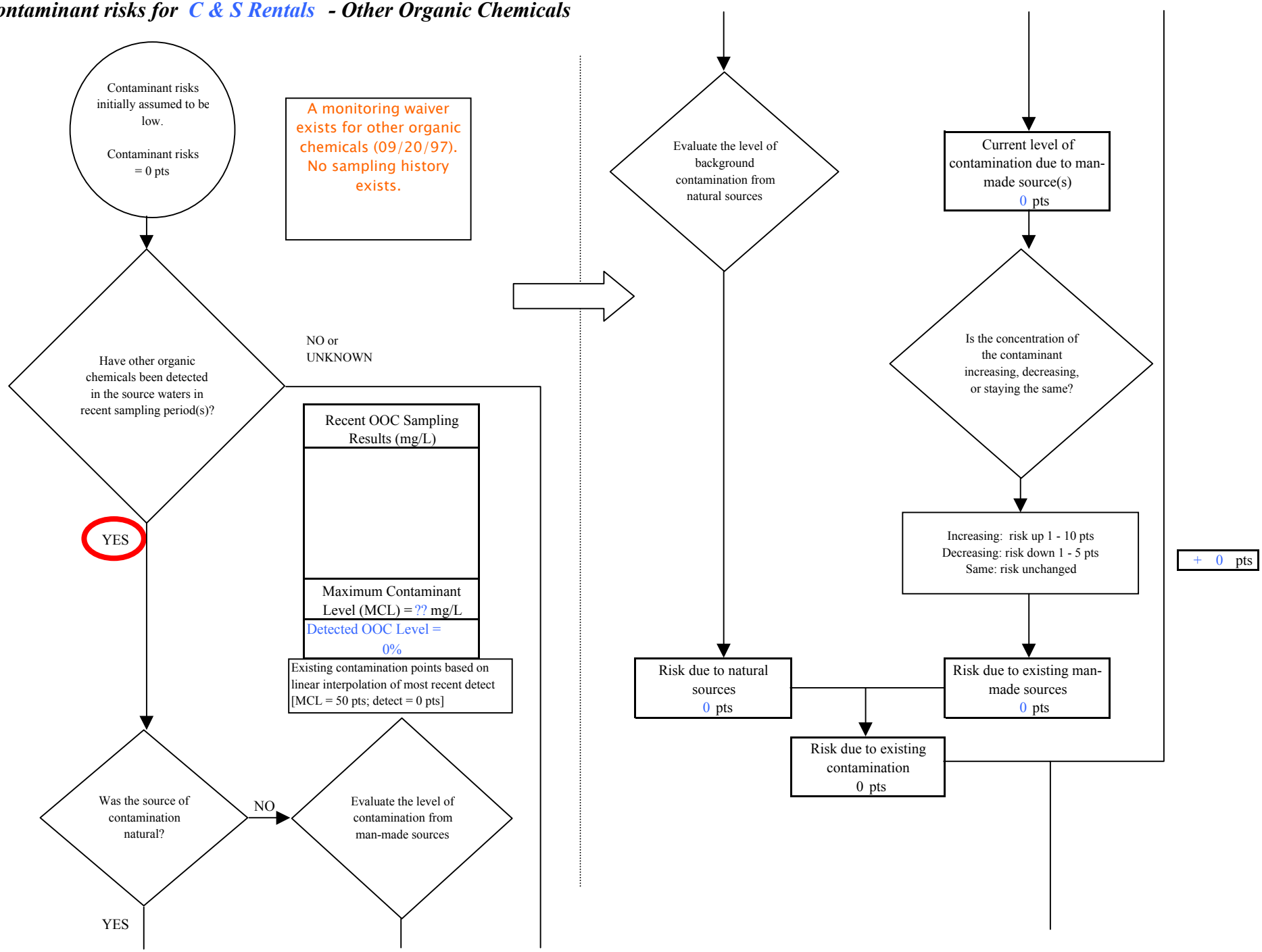
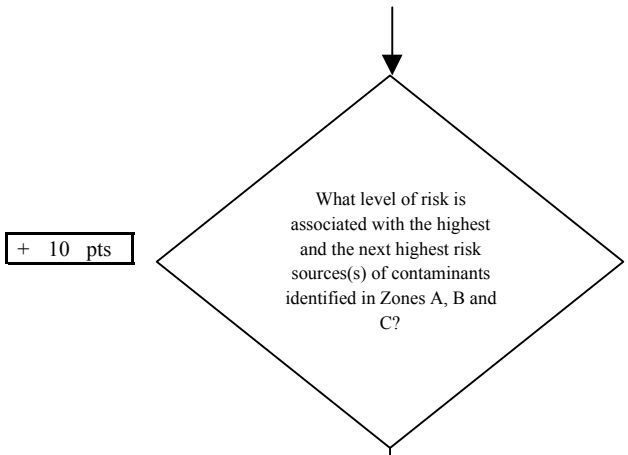


Chart 13. Contaminant risks for C & S Rentals - Other Organic Chemicals



+ 10 pts

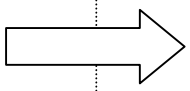
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	3	5

	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.



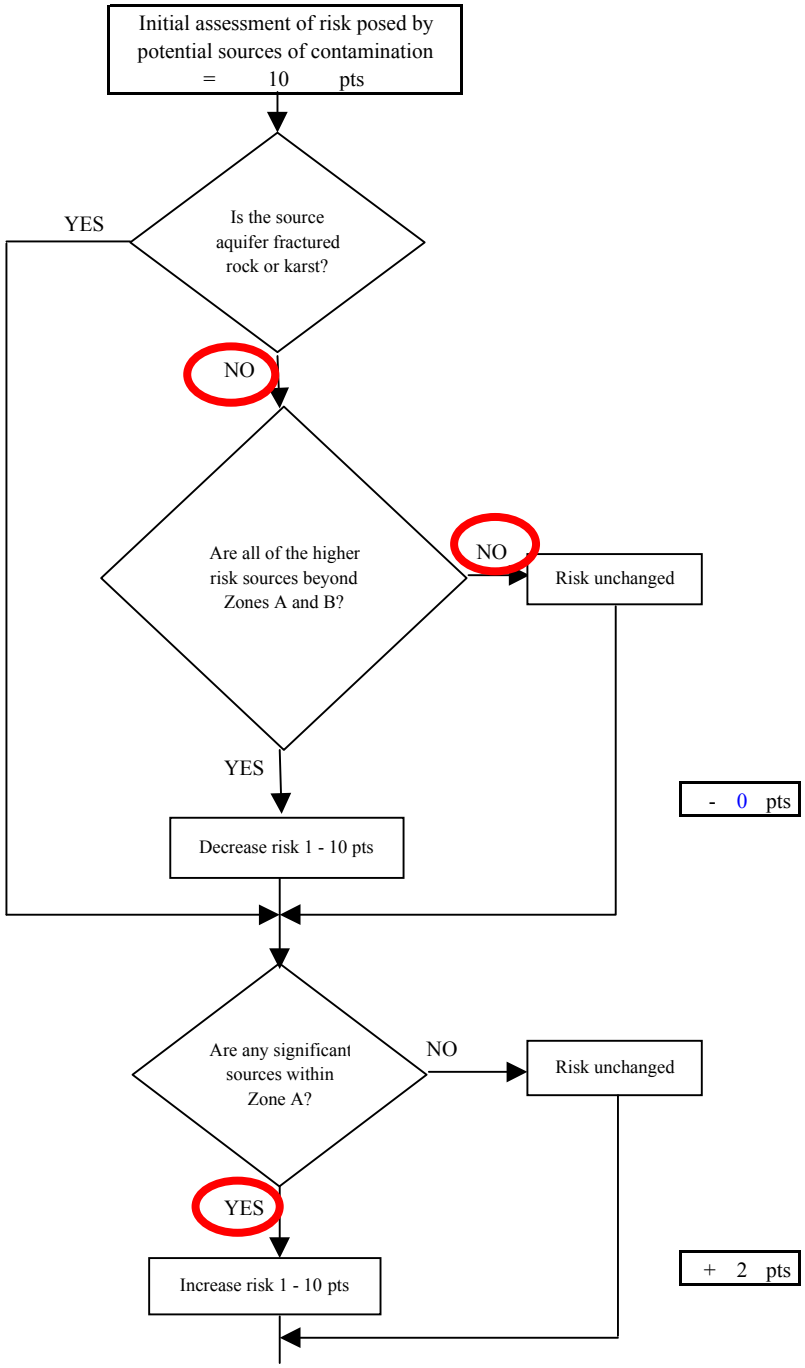
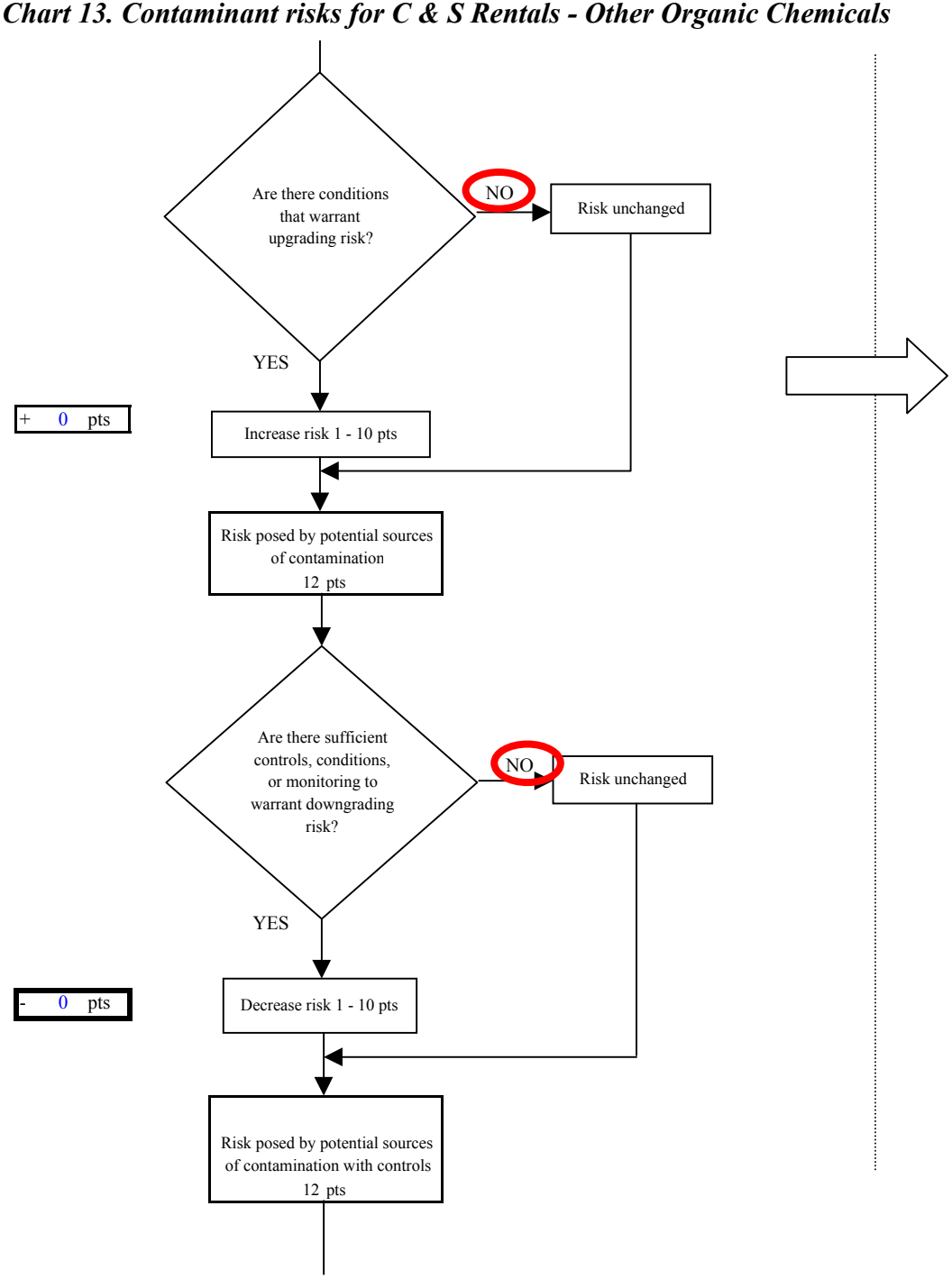
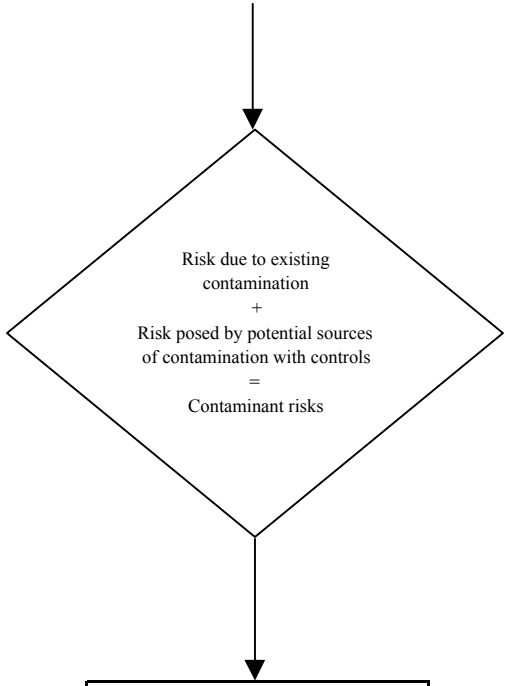


Chart 13. Contaminant risks for C & S Rentals - Other Organic Chemicals





Existing
0 pts
+
Potential
12 pts
=
Contaminant Risk
12 pts

Contaminant risks*
= 12 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 14. Vulnerability analysis for C & S Rentals - Other Organic Chemicals