Source Water Assessment

Point Higgins Elementary School
Ketchikan, Alaska

PWSID # 121076.001

August 2004

Drinking Water Protection Program Report #1238

Alaska Department of Environmental Conservation

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

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

CONTENTS

		Page
SECTION	Executive Summary	1
	Area Overview	1
	System Overview	1
	Inventory of Potential and Existing Contaminant Sources	1
	Ranking of Contaminant Risks	2
	Vulnerability of the Drinking Water System	2
	Additional Resources	4
	References	5

TABLES

TABLE	1. Susceptibility of the Roof Catchment	2
	2. Point Higgins Elementary School Contaminant Risks	3
	3. Point Higgins Elementary School Overall Vulnerability	3

APPENDICES

APPENDIX A. Location Map (Map 1)

B. Vulnerability Analysis and Contaminant Risks (Charts 1 – 13)

C. Best Management Practices for Rainwater Catchment Systems in Alaska

Source Water Assessment for the Point Higgins Elementary School Water System

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Point Higgins Elementary School public water system is a Class A (community) water system that obtains water from a roof catchment system. The school is located on North Point Higgins Road, approximately 14.5-miles north of Ketchikan. System operators did not provide the roof collection surface area. The system received a susceptibility rating of "**medium**". *A rating of medium to high is typical for roof catchment systems*. Potential and existing sources of the following contaminants were evaluated for the Source Water Assessment: bacteria and viruses, nitrates and/or nitrites, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, volatile organic chemicals, and other organic chemicals. This evaluation included all available water sampling data submitted to ADEC by the system operator. The samples may have been collected from either raw water or post-treated water. Combining the susceptibility of the surface water source with the contaminant risks, this water system has received a vulnerability rating of **"low"** for all contaminant categories.

AREA OVERVIEW

Ketchikan (Sec. 30, T075S, R091E, Copper River Meridian) is located on the southwestern coast of Revillagigedo Island, opposite Gravina Island, near the southern boundary of Alaska. It is 679 miles north of Seattle and 235 miles south of Juneau. The 2.2 million acre Misty Fiords National Monument lies 22 air miles east of Ketchikan (See Map 1 in Appendix A for location). The current population is approximately 8,000 (ADCED, 2003).

Strong winds and frequent precipitation are normal here. Summer temperatures range from 51 to 65 degrees Fahrenheit; winter temperatures range from 29 to 39 degrees Fahrenheit. Ketchikan averages 162 inches (13.5 feet) of precipitation annually, including 32 inches of snowfall (ADCED, 2003).

SYSTEM OVERVIEW

The Point Higgins Elementary School water system is a Class A (community) water system that operates year round and is designed to provide water for approximately 400 people. The school is located on North Point Higgins Road, approximately 14.5 miles north of Ketchikan (See Map 1 of Appendix A).

The most recent sanitary survey (1999) states that the system has design capacity of 3000 gallons per day. The average daily production is not metered.
The system operator returned a survey to the Drinking Water Protection Program in September 2003 stating:

- the roof is constructed of steel
- the roof is not painted
- the water collection surface area was not provided by the operator
- the collection gutters are constructed of steel
- the collection gutters are screened
- the storage tank is located above ground and is constructed of wood
- the storage tank does not have a liner
- there is no vegetation directly overhanging the roof

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination for the Point Higgins Elementary School drinking water system. This inventory was completed through a search of agency records and other publicly available information. Even though roof catchment systems have small collection areas when compared with surface water or groundwater systems, there are still potential risks to the quality of water that is collected. These risks may come from either plant, animal, or bacterial matter deposited onto the roof or from material used in the construction of the water collection and treatment system.

For 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 evaluation of these contaminants was performed by reviewing all available water sampling data submitted to ADEC by the system operator during the past 5-years. The samples may have been collected from either raw water or post-treated water.

RANKING OF CONTAMINANT RISKS

Once sources of contamination have been identified, they are assigned a ranking according to what category and level of risk they represent. Ranking of contaminant risks for sources of contamination is a function of the toxicity and the volume of specific contaminants associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

VULNERABILITY OF THE DRINKING WATER SYSTEM

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

- Susceptibility of the Roof Catchment; and
- Contaminant risks.

Appendix B contains 13 charts, which together form the 'Vulnerability Analysis' for the Source Water Assessment. Chart 1 analyzes the 'Susceptibility of the Roof Catchment' to contamination by looking at some design and construction characteristics of the system. Chart 2 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis is the result of reviewing historical water quality samples for the system. Chart 3 contains the 'Vulnerability Analysis for Bacteria and Viruses', which is a composite score of the Vulnerability Analysis and the overall Susceptibility. Charts 4 through 13 repeat the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

A score for the Susceptibility of the Roof Catchment is determined by considering the properties of the water intake and the surrounding area. The derivation of this information is presented below and the data for this source is shown in Chart 1 of Appendix B.

Susceptibility of the Roof Catchment – always considered to be at least "moderate" (20 points)

\+

Roof construction material (0 – 5 Points)

\+

Is the roof painted? (0 – 5 Points)

\+

Are collection gutters covered or screened ?

(0 – 10 Points)

\+

Does any vegetation overhang the roof?

(0 – 5 points)

\+

Is the first flush of water collected into storage?

(0 – 5 points)

=

Natural Susceptibility
(0 – 45 Points)

A ranking is assigned for the Surface Water Susceptibility according to the point score:

Surface Water Source Susceptibility Ratings	
40 to 45 pts	Very High
30 to 39 pts	High
20 to 29 pts	Medium

Table 1 summarizes the susceptibility scoring for the Point Higgins Elementary School.

Table 1. Susceptibility of the Roof Catchment

	Score	Rating
Minimum Allowable Susceptibility	20	
Roof construction	0	
Roof painted	0	
Collection gutters screened	0	
Overhanging vegetation	0	
First flush collected	5	
Overall Susceptibility	25	Medium

As previously mentioned, the Contaminant Risk score is derived from the review of historical water quality samples from the past 5-years for the system. Flow charts are used to assign a point score, and ratings are assigned in the same manner as susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Point Higgins Elementary School Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	0	Low
Nitrates and/or Nitrites	0	Low
Volatile Organic Chemicals	0	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	0	Low
Synthetic Organic Chemicals	0	Low
Other Organic Chemicals	0	Low

Finally, an overall vulnerability score is assigned for each contaminant type by combining each of the contaminant risk scores with the susceptibility score:

Susceptibility of Roof Catchment

(0 – 45 points)

\+

Contaminant Risks (0 – 50 points)

=

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

Again, rankings are assigned according to a point score:

Overall Vulnerability Ratings	
80 to 100 pts	Very High
60 to < 80 pts	High
40 to < 60 pts	Medium
< 40 pts	Low

Table 3 contains the overall vulnerability scores and ratings for each of the six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 3. Point Higgins Elementary School Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and Nitrites	25	Low
Volatile Organic Chemicals	25	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	25	Low
Synthetic Organic Chemicals	25	Low
Other Organic Chemicals	25	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is “low”.

Coliforms (a bacteria) are found naturally in the environment and although they aren’t necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2003). Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination. Typically, coliform detection in raw water samples collected from surface water sources is normal. (See Chart 2 – Contaminant Risks for Bacteria and Viruses in Appendix B).

A possible source of bacteria could be animal excrement (birds, squirrels, etc.) on the roof.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the source, the overall vulnerability of the source to bacteria and virus contamination becomes “low”.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is “low” (See Chart 4 - Contaminant Risks for Nitrates and/or Nitrites in Appendix B). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history for the water source indicates that nitrates have not been detected in sampling reviewed from 1998 - 2003. The Maximum Contaminant Level (MCL) for nitrates is 10 milligrams per liter (mg/L).

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 (EPA, 2003). A possible source of nitrate/nitrites is the presence of animal (birds, squirrels, etc.) excrement on the roof.

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

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is "low" (See Chart 6 – Contaminant Risks for Volatile Organic Chemicals in Appendix B).

Chloroform and trihalomethanes were detected at levels below the MCL during sampling in 2001 – 2003. These chemicals typically originate during the process of water treatment and not from the source waters. The MCL for chloroform is 0.2 milligrams per liter (mg/L) and the MCL for total trihalomethanes is 0.1 mg/L.

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

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is "low". Copper and lead were detected in samples collected during 1998 - 2003 (See Chart 8 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix B). The MCL for copper is 1.3 mg/l. and the MCL for lead is 0.015 mg/l.

The most common source of these chemicals is the infrastructure of the distribution system following the treatment process.

After combining the contaminant risk for heavy metals with the natural susceptibility of the source, the overall vulnerability of the source to contamination is "low".

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is "low". After combining the contaminant risk with the natural susceptibility of the source, the overall vulnerability to synthetic organic chemicals of the source is "low" (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix B).

Review of the historical sampling data indicates that sampling for dibromochloropropane and ethylene dibromide was negative in 2002 and 2003.

Other Organic Chemicals

The contaminant risk for other organic chemicals is "low". After combining the contaminant risk with the natural susceptibility of the source, the overall vulnerability to other organic chemicals of the source is "low" (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

Review of the historical sampling data indicates that no other organic chemicals have been sampled recently.

ADDITIONAL RESOURCES

Appendix C contains the results of a comprehensive evaluation of Best Management Practices for rainwater catchment systems in Alaska. It is recommended that the system operator review this document when considering ways to protect the quality of their drinking water system.

REFERENCES

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

United States Environmental Protection Agency (EPA), 2003 [WWW document]. URL http://www.epa.gov/safewater/mcl.html.

APPENDIX A

Location Map
(Map 1)

Map 1: Location of Point Higgins Elementary School

PWSID: 121076.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 625 1,250 2,500 3,750 5,000 Feet

1:15,010

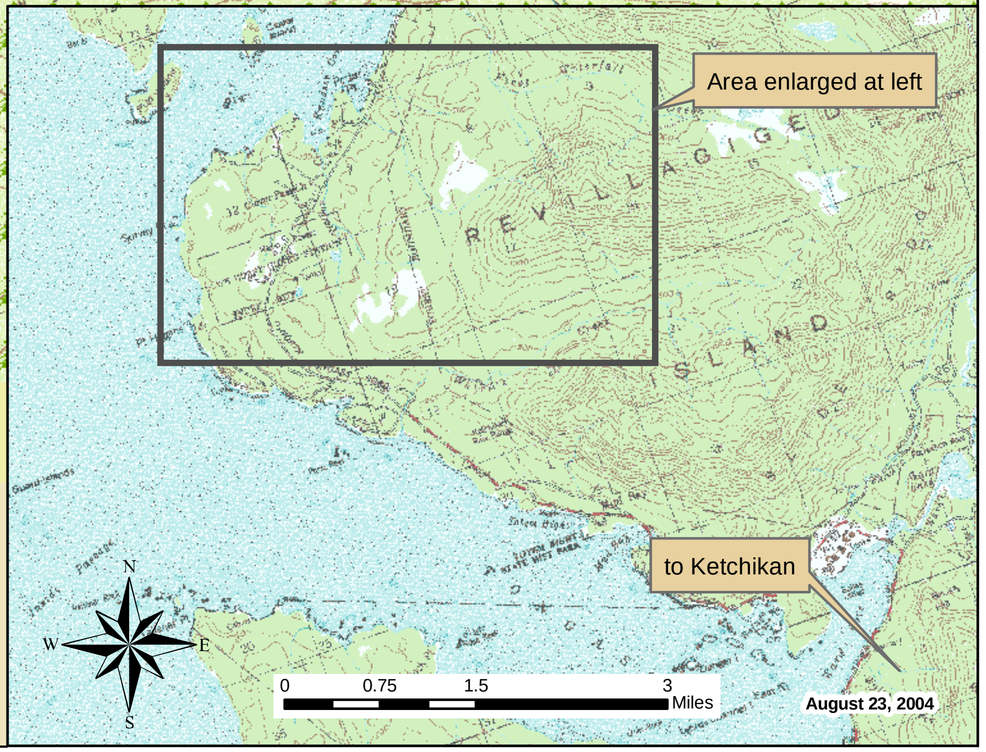
Data Sources:

Background image - USGS 1:24,000 mapping
Lakes & streams - U.S. Forest Service, Tongass
Roads, property lines - Ketchikan Gateway Borough

Protection areas are delineated based upon streams noted on USGS 1:63,000 mapping.

Legend

- Point Higgins Elem. School
- Potential Tree Harvest Areas
- Streams
- Roads
- Elevation contours



APPENDIX B

Vulnerability Analysis and Contaminant Risks

(Charts 1-13)

Chart 1. Susceptibility of the Roof Catchment - Point Higgins Elementary School

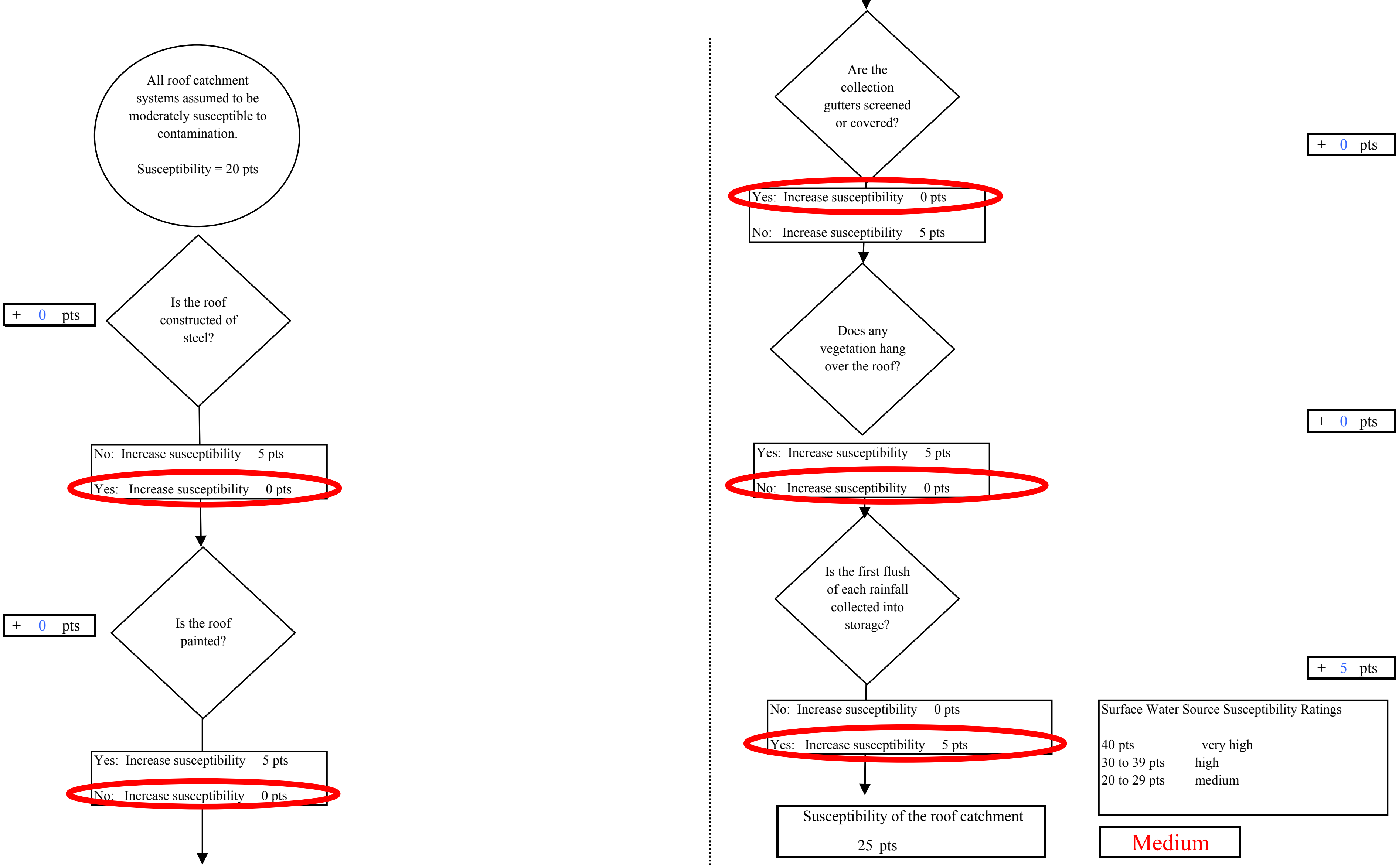
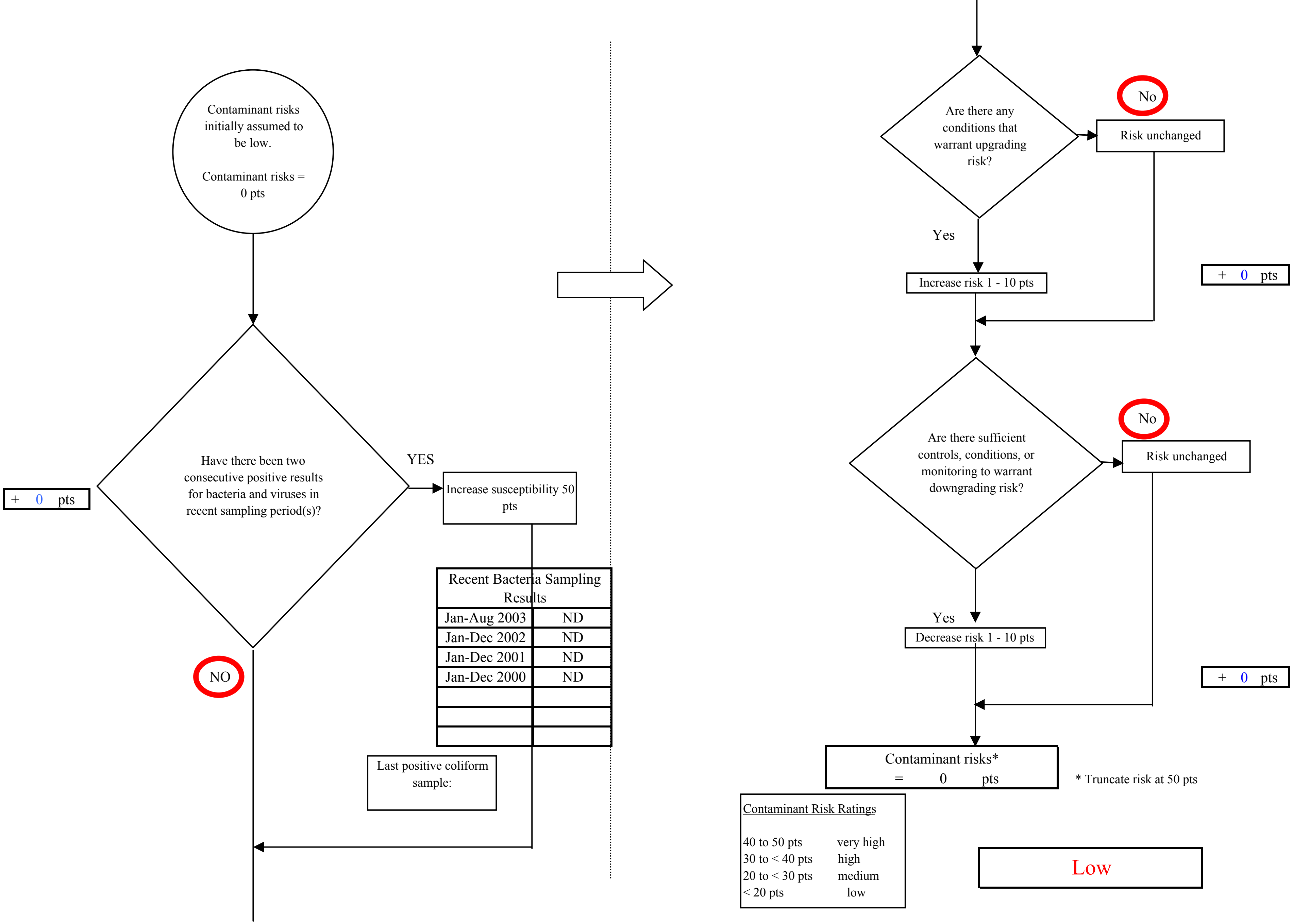


Chart 2. Contaminant risks for Point Higgins Elementary School - Bacteria & Viruses



Recent Bacteria Sampling Results	
Jan-Aug 2003	ND
Jan-Dec 2002	ND
Jan-Dec 2001	ND
Jan-Dec 2000	ND

Chart 3. Vulnerability analysis for Point Higgins Elementary School - Bacteria & Viruses

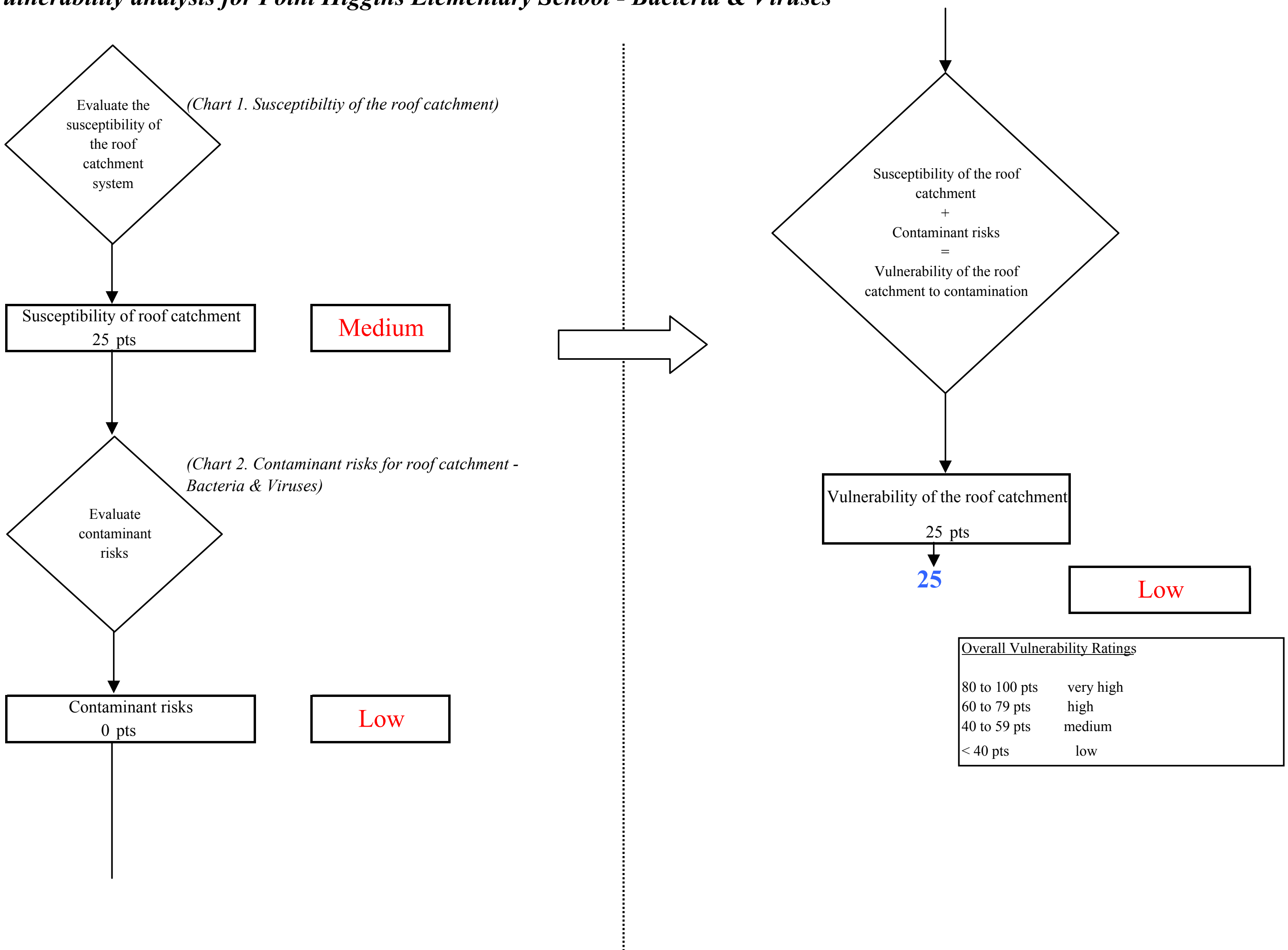


Chart 4. Contaminant risks for Point Higgins Elementary School - Nitrates and Nitrites

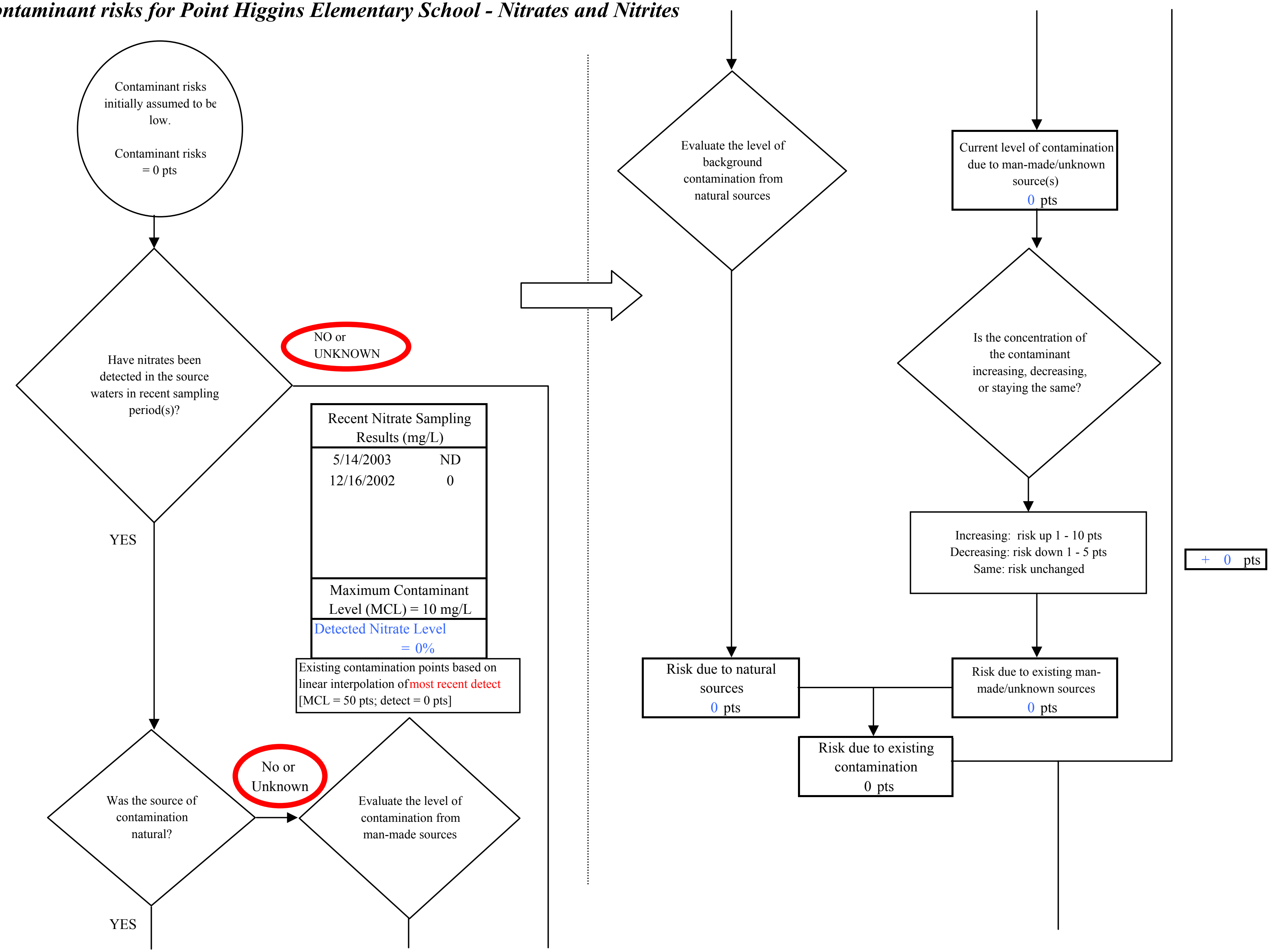


Chart 4. Contaminant risks for Point Higgins Elementary School - Nitrates and Nitrites

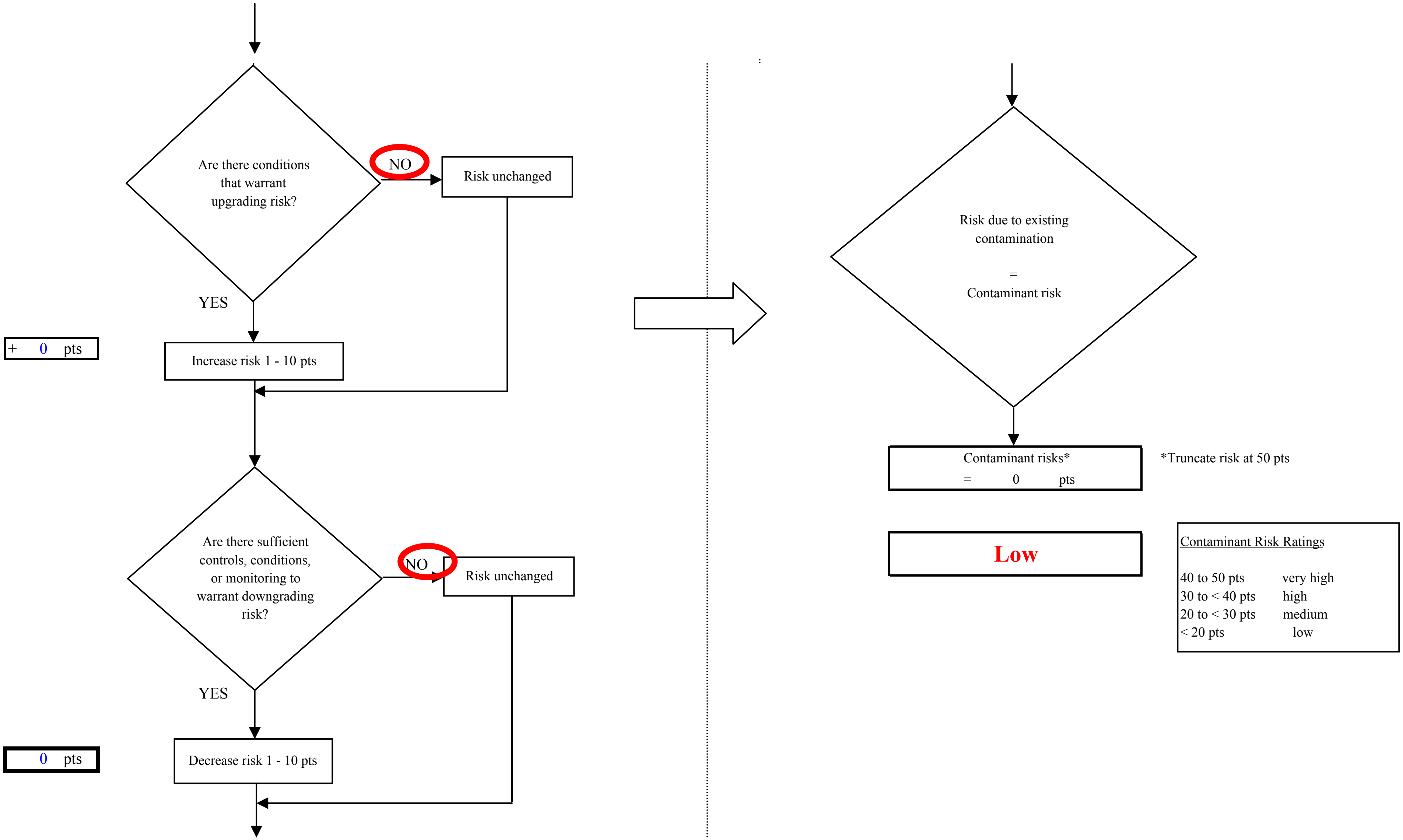


Chart 5. Vulnerability analysis for Point Higgins Elementary School - Nitrates and Nitrites

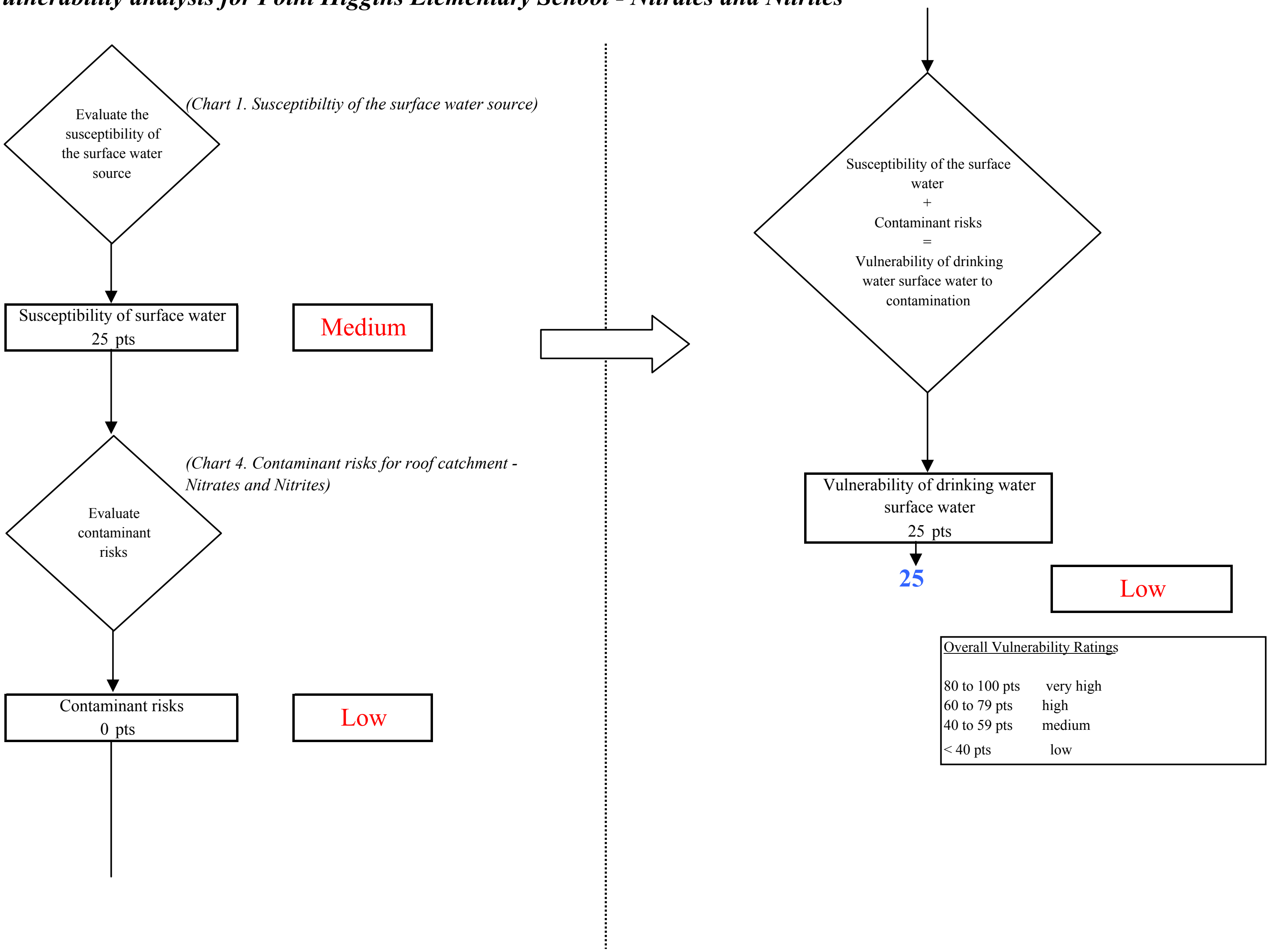
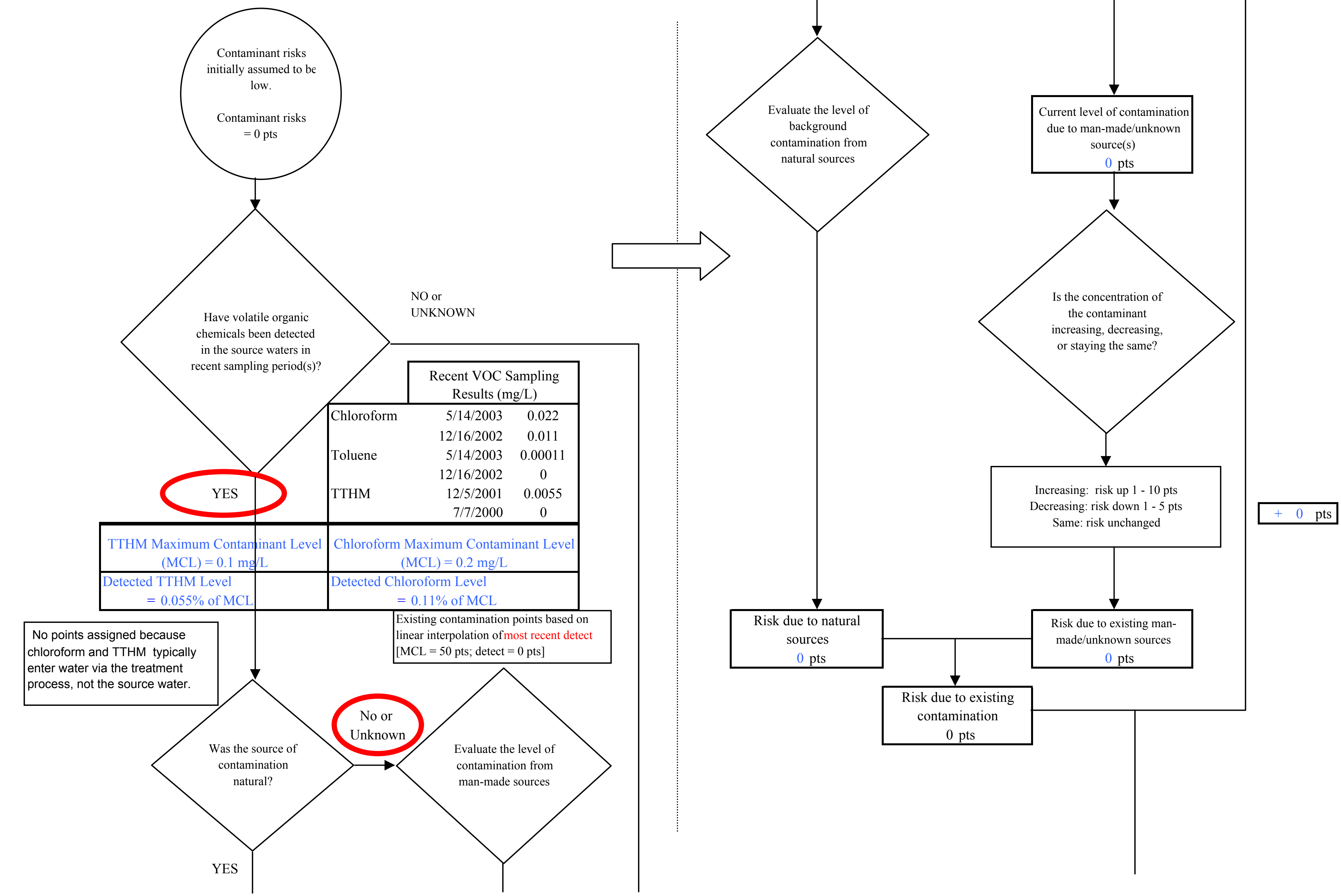


Chart 6. Contaminant risks for Point Higgins Elementary School - Volatile Organic Chemicals



Recent VOC Sampling Results (mg/L)		
Chloroform	5/14/2003	0.022
	12/16/2002	0.011
Toluene	5/14/2003	0.00011
	12/16/2002	0
TTHM	12/5/2001	0.0055
	7/7/2000	0

Chart 6. Contaminant risks for Point Higgins Elementary School - Volatile Organic Chemicals

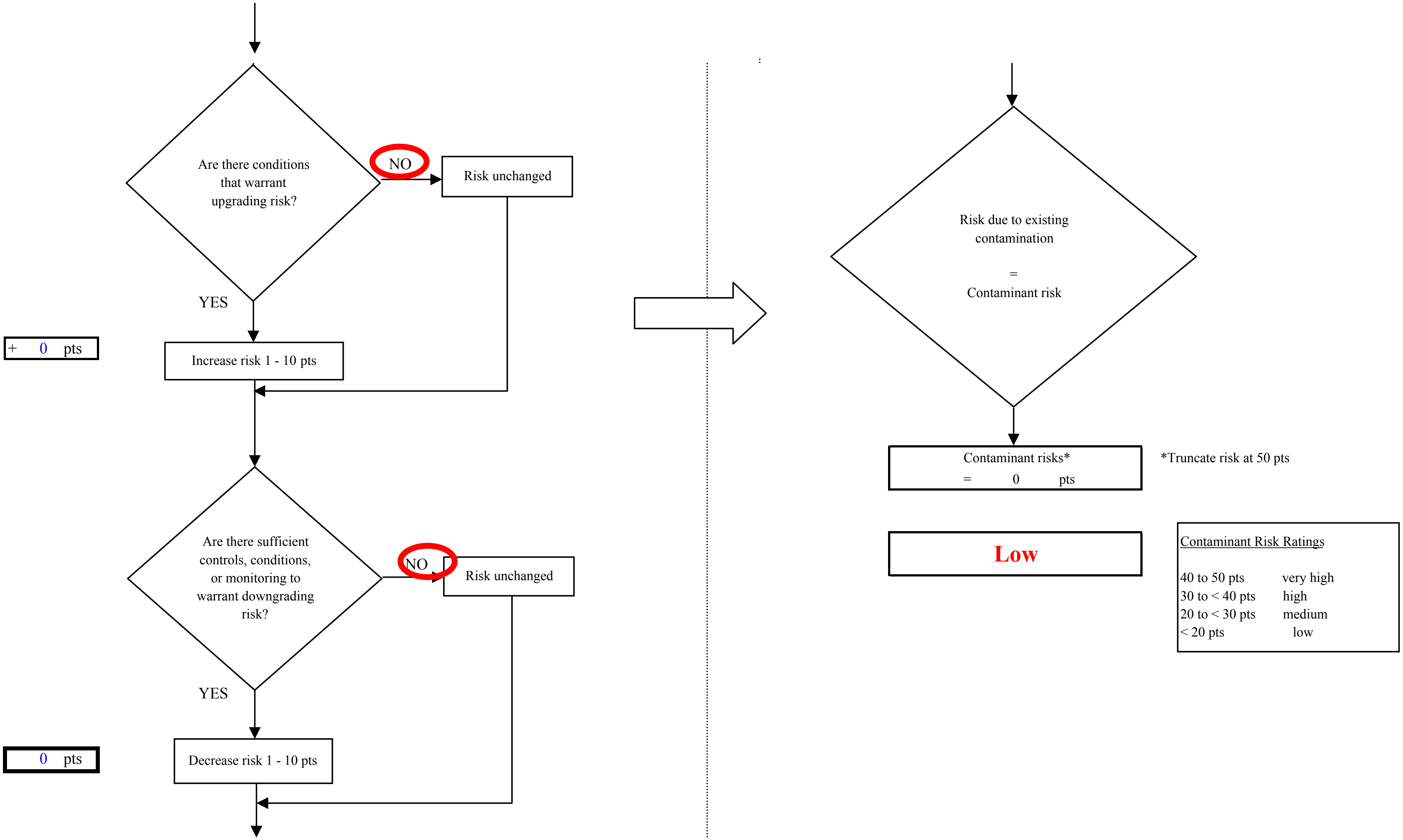


Chart 7. Vulnerability analysis for Point Higgins Elementary School - Volatile Organic Chemicals

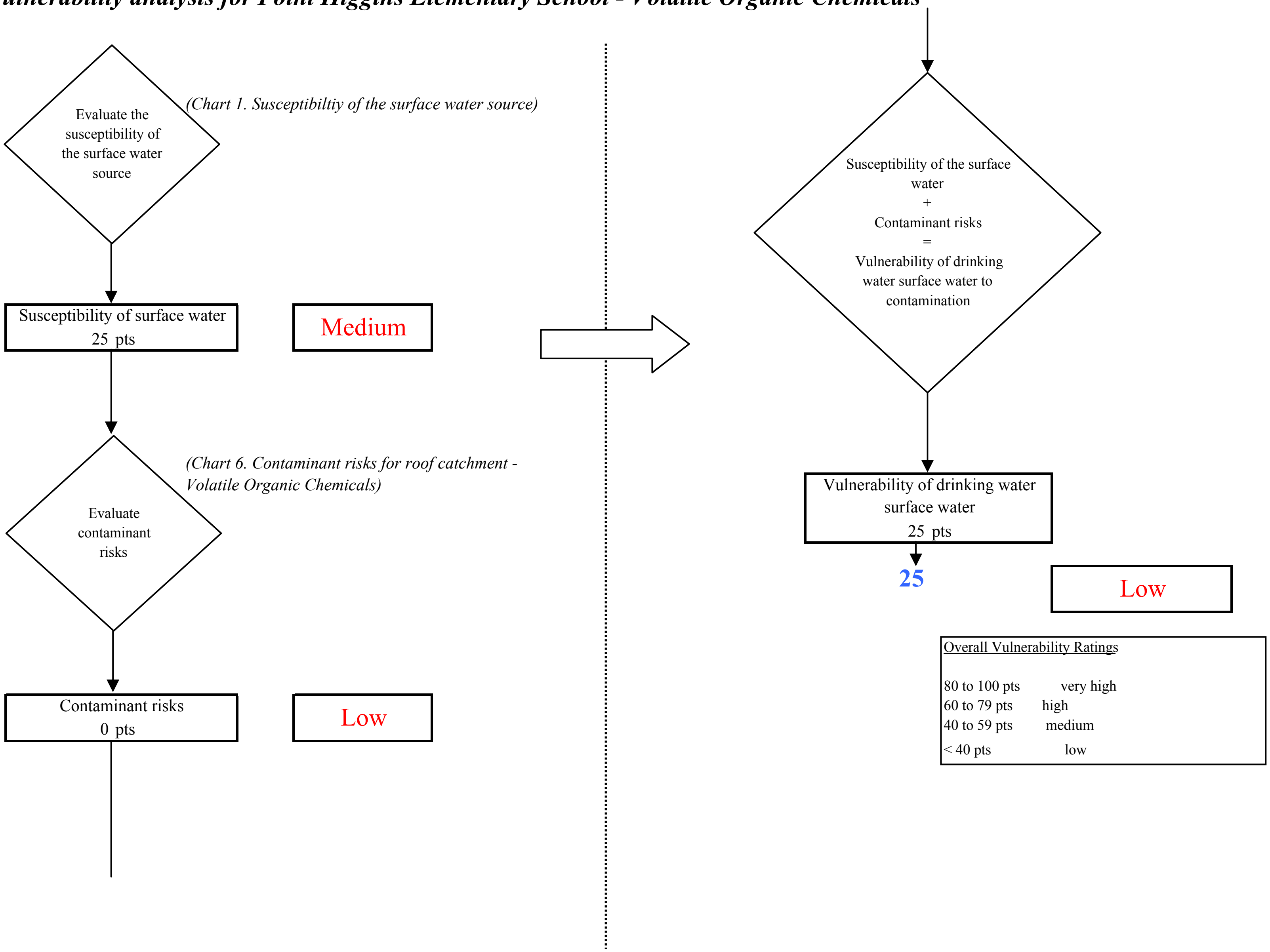
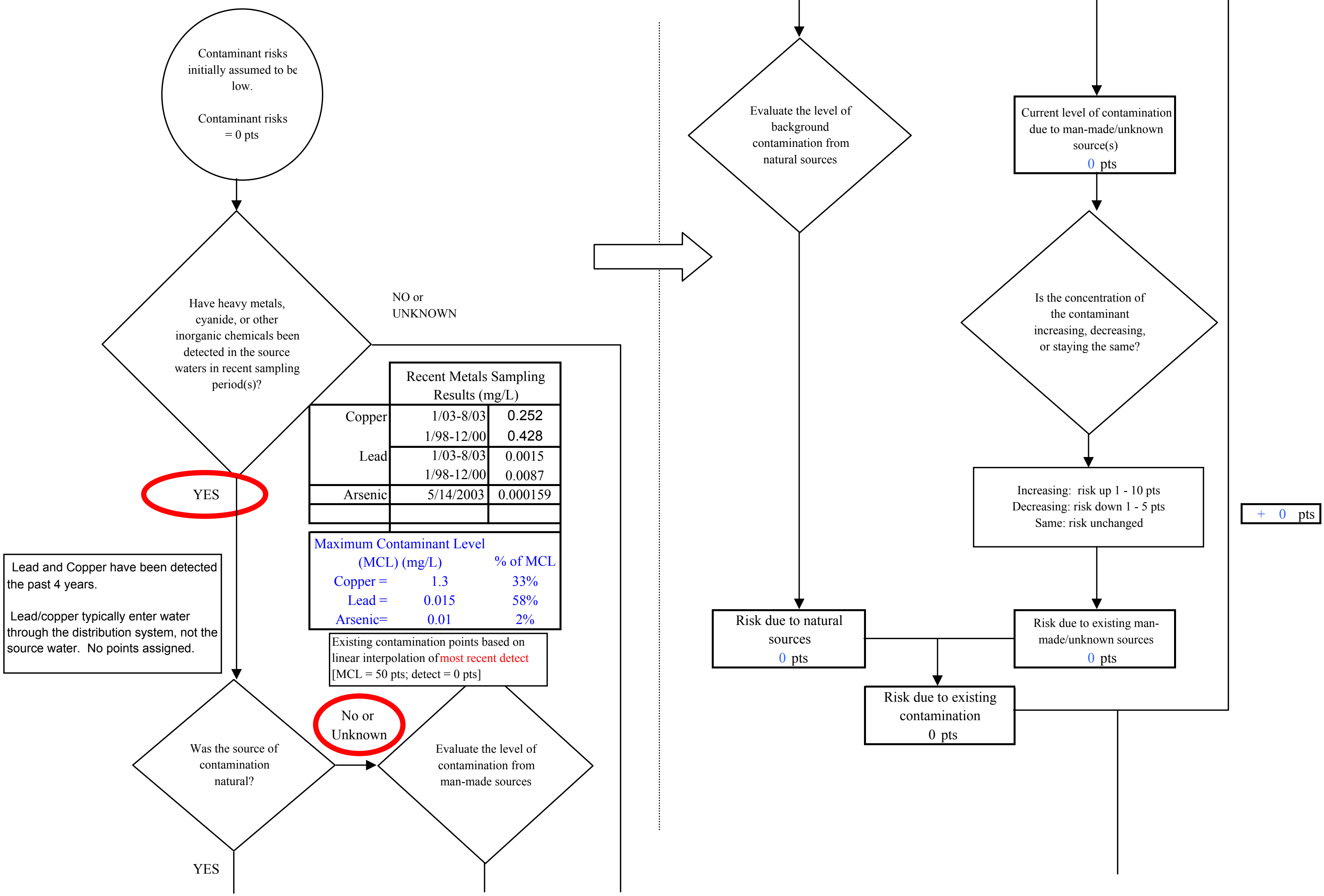


Chart 8. Contaminant risks for Point Higgins Elementary School - Heavy Metals, Cyanide and Other Inorganic Chemicals



	Recent Metals Sampling Results (mg/L)	
Copper	1/03-8/03	0.252
	1/98-12/00	0.428
Lead	1/03-8/03	0.0015
	1/98-12/00	0.0087
Arsenic	5/14/2003	0.000159

Maximum Contaminant Level (MCL) (mg/L)		% of MCL
Copper =	1.3	33%
Lead =	0.015	58%
Arsenic=	0.01	2%

Chart 8. Contaminant risks for Point Higgins Elementary School - Heavy Metals, Cyanide and Other Inorganic Chemicals

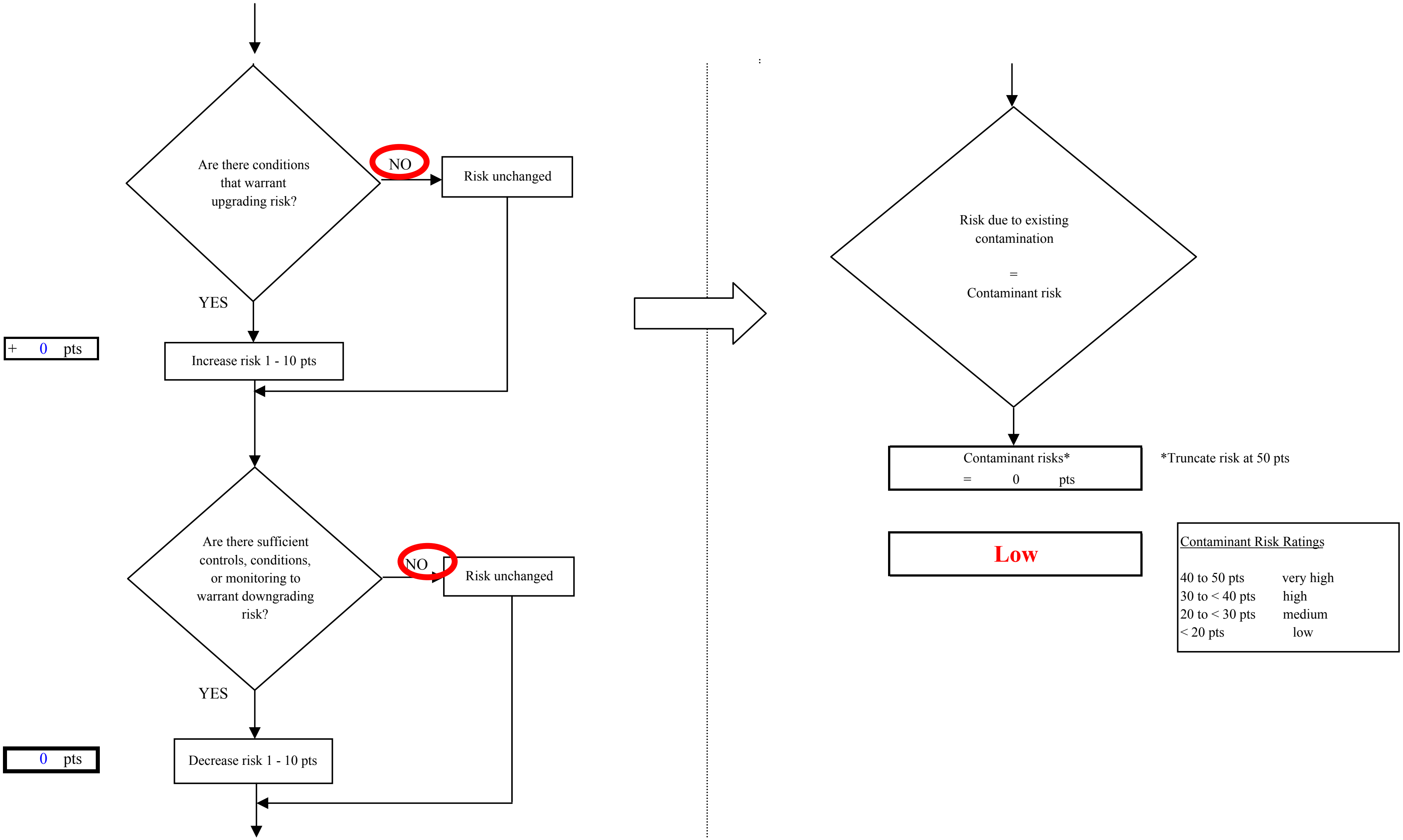


Chart 9. Vulnerability analysis for Point Higgins Elementary School - Heavy Metals, Cyanide and Other Inorganic Chemicals

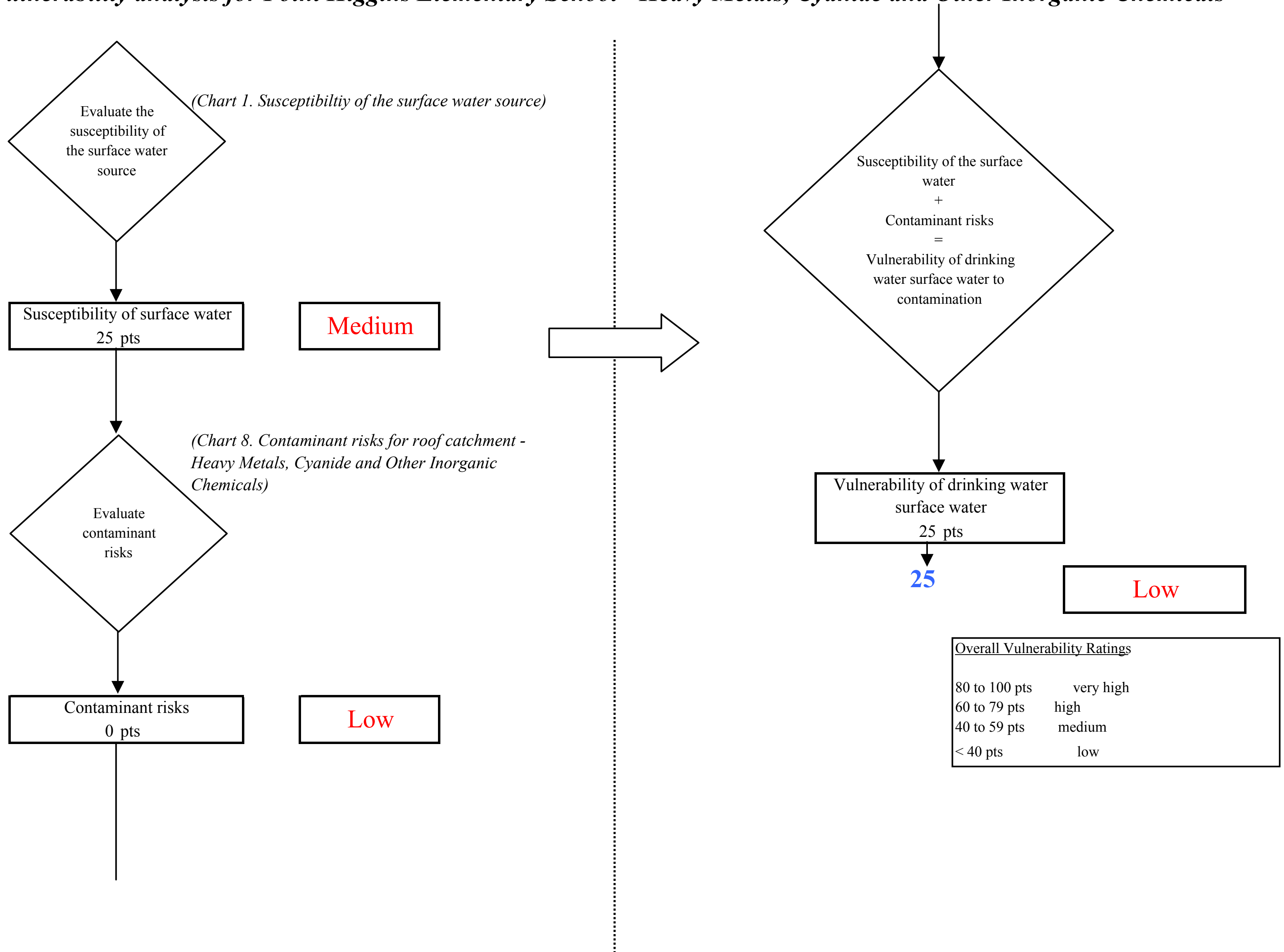


Chart 10. Contaminant risks for Point Higgins Elementary School - Synthetic Organic Chemicals

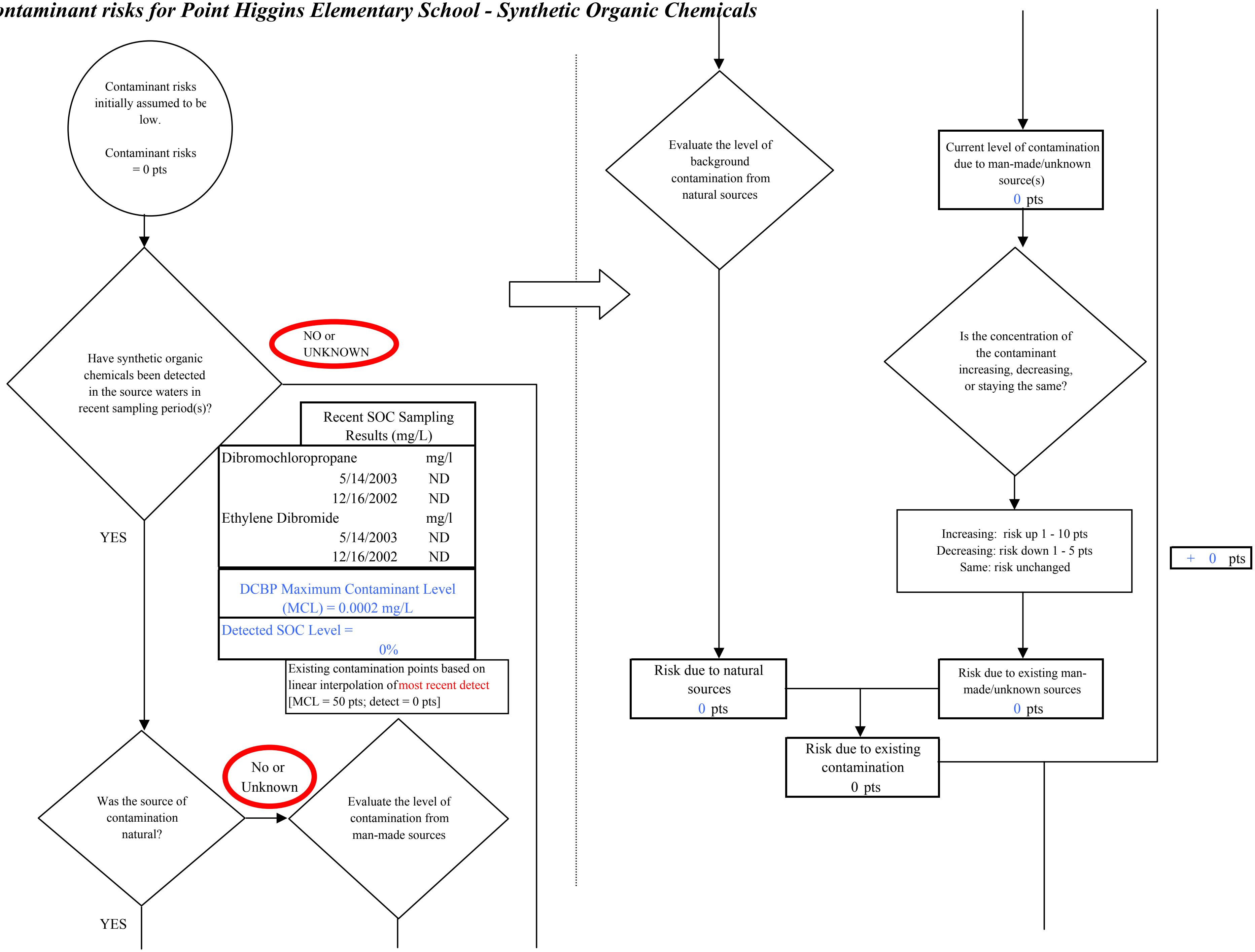


Chart 10. Contaminant risks for Point Higgins Elementary School - Synthetic Organic Chemicals

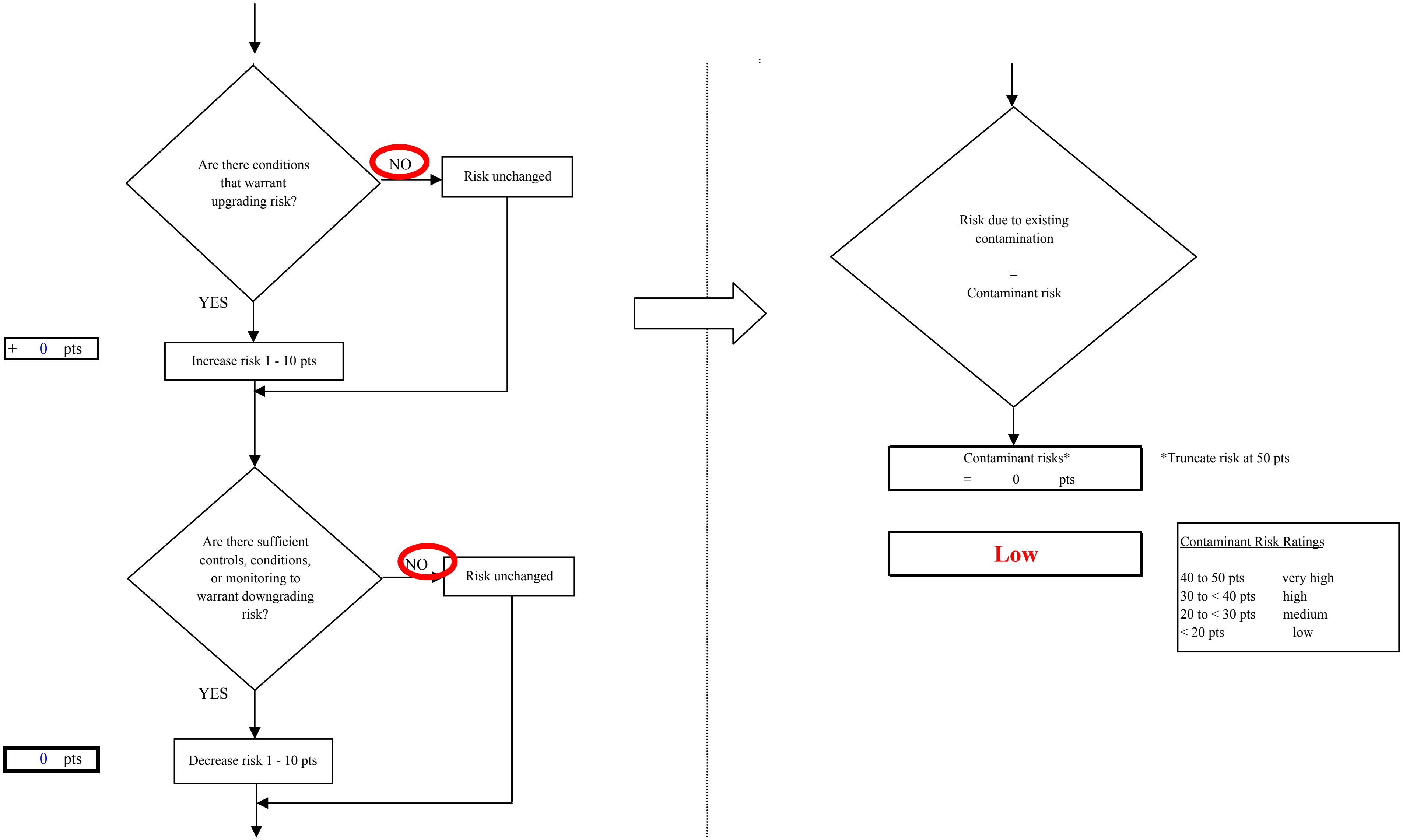


Chart 11. Vulnerability analysis for Point Higgins Elementary School - Synthetic Organic Chemicals

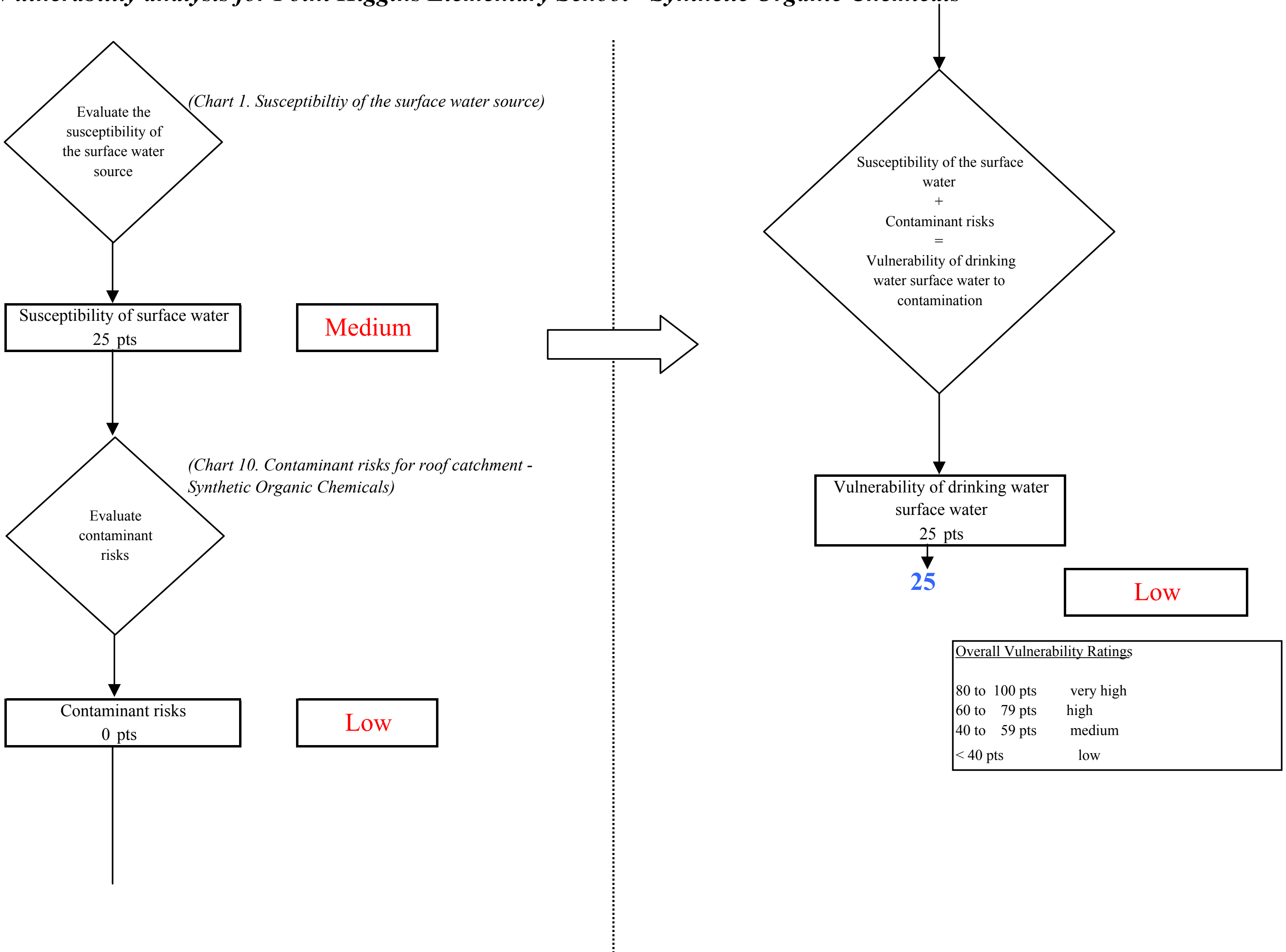


Chart 12. Contaminant risks for Point Higgins Elementary School - Other Organic Chemicals

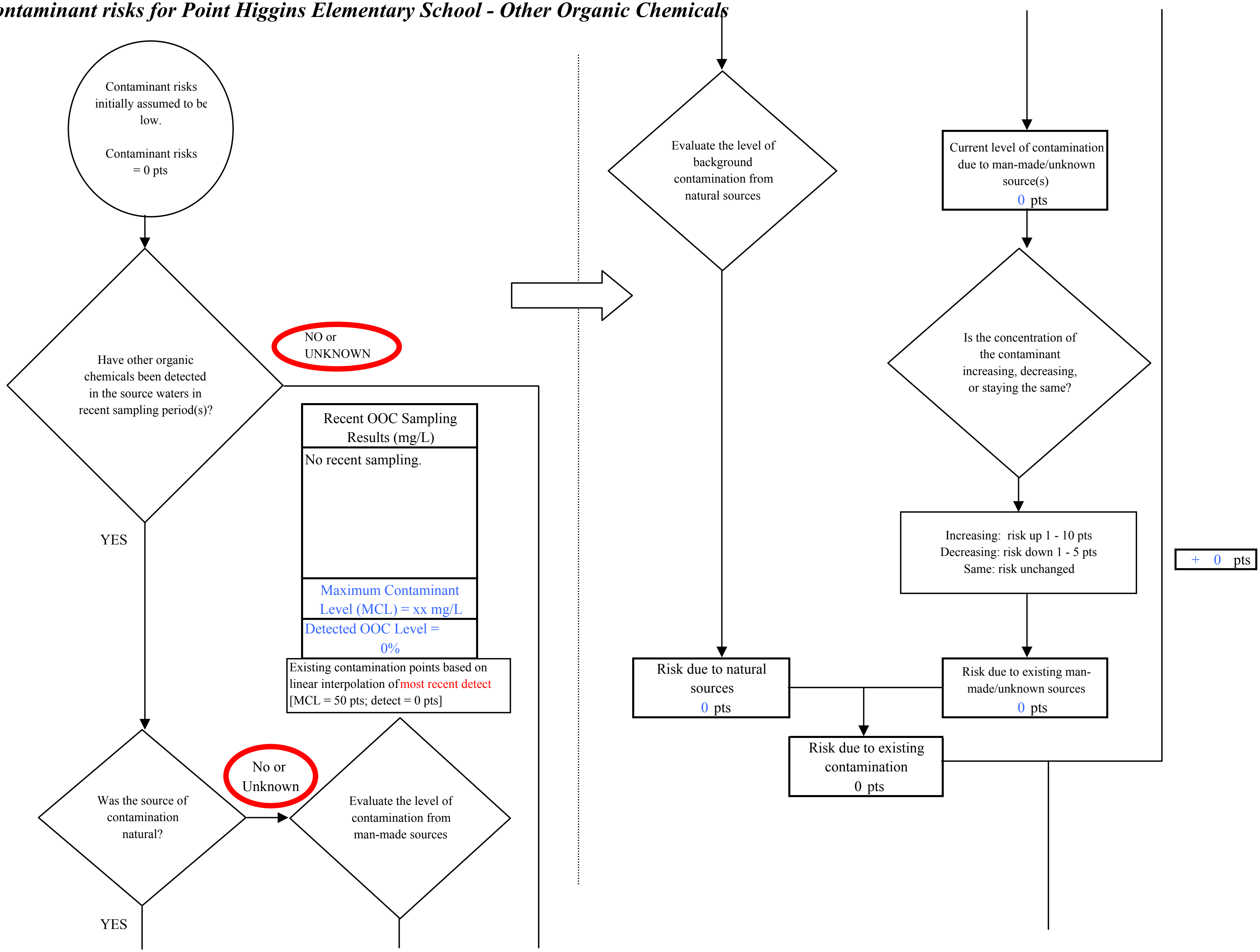


Chart 12. Contaminant risks for Point Higgins Elementary School - Other Organic Chemicals

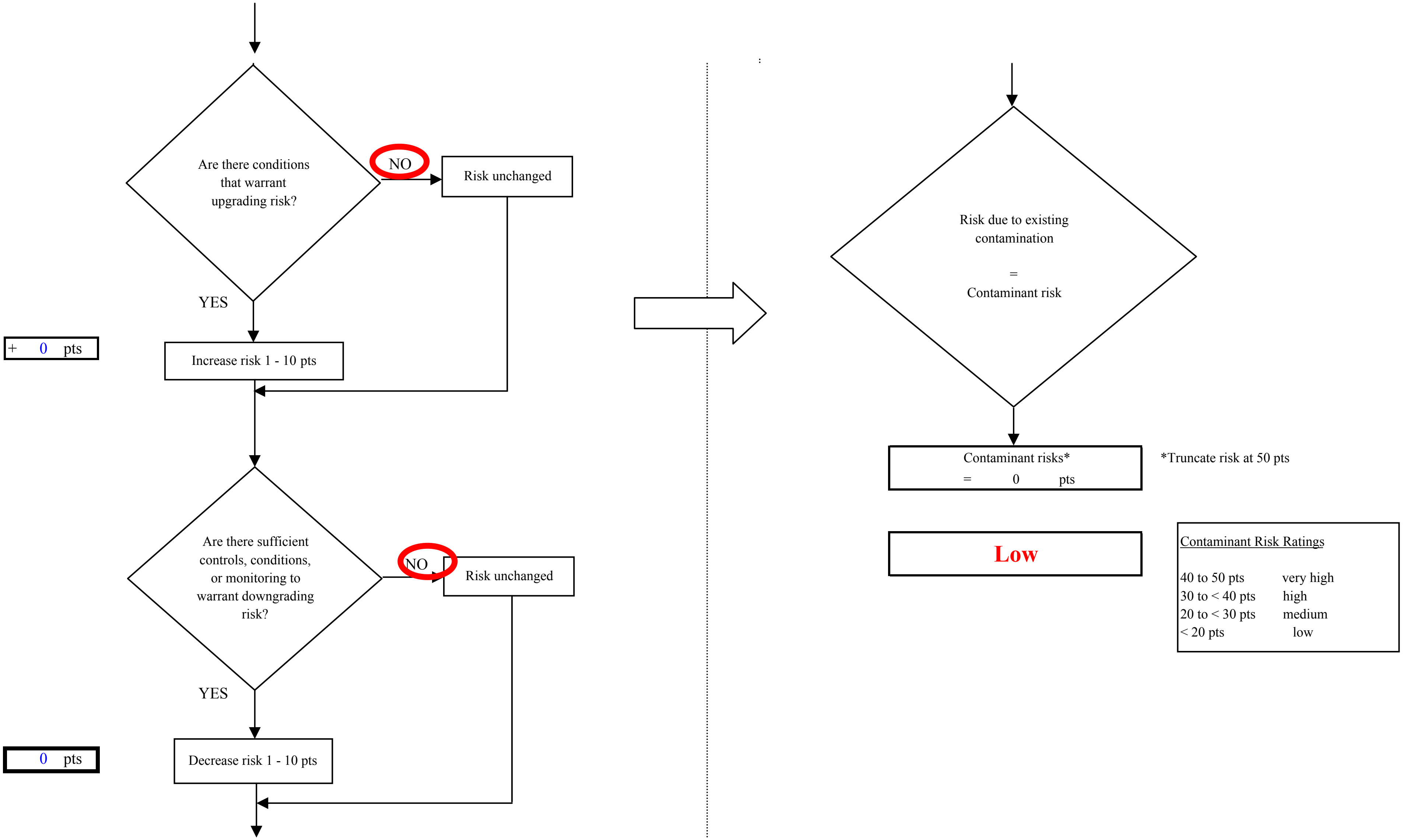
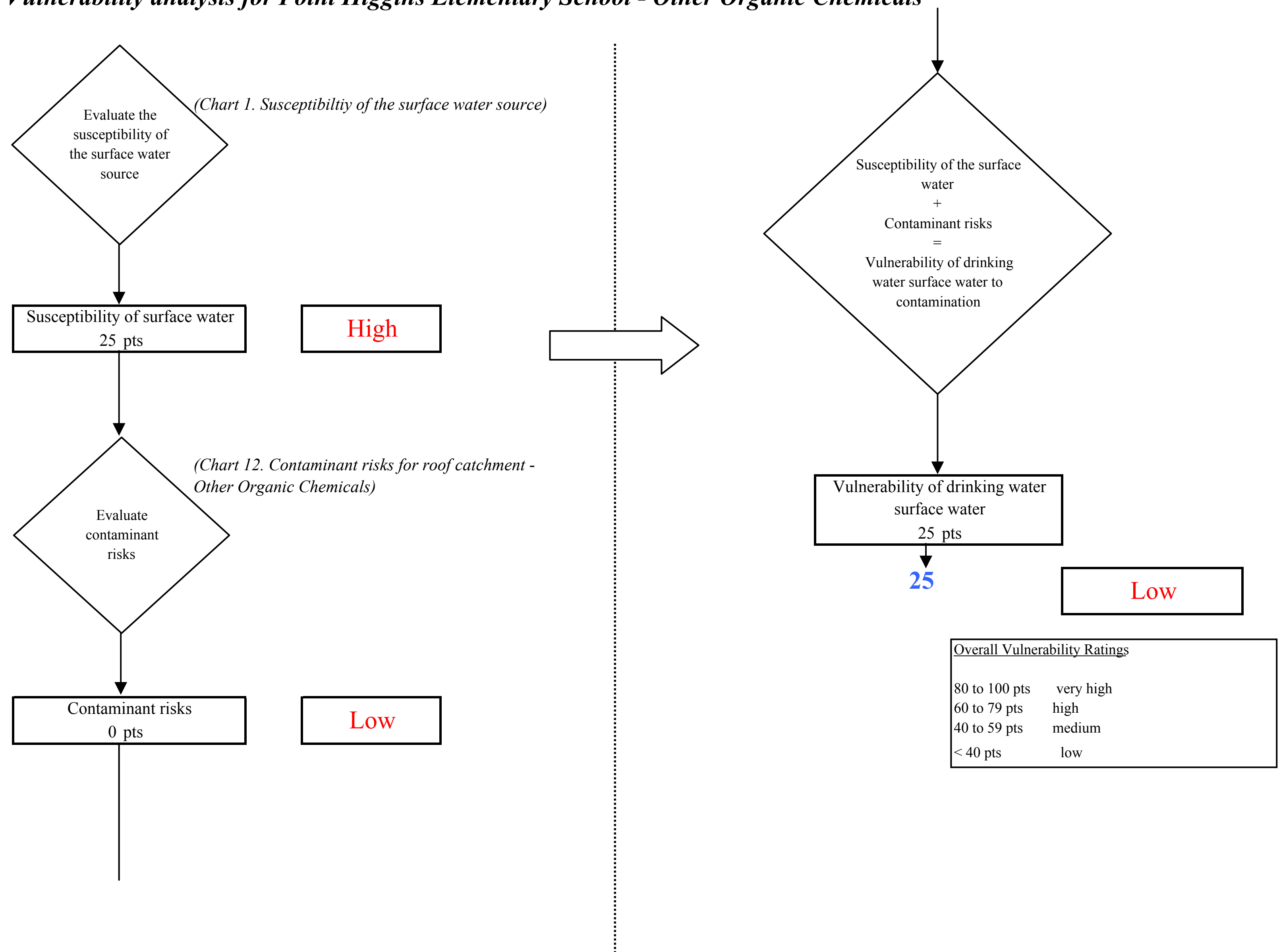


Chart 13. Vulnerability analysis for Point Higgins Elementary School - Other Organic Chemicals



APPENDIX C

Best Management Practices for
Rainwater Catchment Systems in Alaska

COLD CLIMATE HOUSING RESEARCH CENTER

CCHRC

Promoting the development and advancement of healthy, durable and economically sound shelter for Alaskans and circumpolar people.

Best Management Practices for Rainwater Catchment Systems in Alaska

A publication of the Cold Climate Housing Research Center Feb. 2003

Applications for Domestic Water Use

Corianne Hart, Dr. Dan White
Water and Environmental Research Center
University of Alaska, Fairbanks

Many families throughout Alaska depend on water catchment systems to provide water for washing, cleaning, cooking and drinking purposes. The high quality of rainwater is one reason to use rain as a primary drinking water source. However, once rainwater comes in contact with materials in the catchment system, contaminants can be introduced that adversely affect human health.

UAF was funded by CCHRC through a grant from AHFC to evaluate best management practices (BMPs) for rainwater catchment systems in Alaska. The study included the impact of roof, gutter, reservoir, pump, pipe, and filter materials on the suitability of water for human consumption. This was accomplished through literature research with particular attention to building materials in common use in Alaska. This study is not limited to a specific region of Alaska and makes suggestions as to which material(s) would best reduce the risk of drinking water contamination by water catchment systems.

DISCUSSION ABOUT CURRENT DRINKING WATER STANDARDS:

Products that come into contact with drinking water can be tested and certified to ensure that they do not leach chemicals into the drinking water. Several non-profit organizations specialize in testing and certifying such products. The leader in this field is the National Sanitation Foundation which is now called NSF International (http://www.nsf.org/). Together with the American National Standard Institute (ANSI), NSF International has created testing/material standards widely used and accepted for drinking water.

NSF/ANSI Standard 61, 'Drinking Water System Components-Health Effects,' is the most important drinking water standard. It covers many materials from the tank to the faucet. The standard addresses crucial aspects of drinking water system components: such as contaminants that leach or migrate from the product/material into the drinking water. (http://www.nsf.org/)

NSF/ANSI Standard 53, 'Drinking Water Treatment Units-Health Effects,' applies to filters. This standard has similar requirements as Standard 61, plus the added requirement that it may be effective in reducing substances, such as microbiological, chemical or contaminants, under the appropriate flow rate. (http://www.nsf.org/)

NSF Protocol P151, 'Health Effects from Rainwater Catchment System Components,' deals only with products used in rainwater catchment systems. This Protocol evaluates Environmental Protection Agency regulated contaminants which could leach from materials used in rainwater catchment systems, such as roofing materials, coatings, paints, liners and gutters. Products meeting the requirements of this protocol are required to maintain contaminate levels below those specified in the latest version of the EPA's Drinking Water Regulations and Health Advisories. (http://www.nsf.org/)

ROOF:

Potable Water Use: There are a wide variety of roof materials found on Alaska homes. The most common are asphalt based shingles, painted calume steel, wood shingles, and painted and unpainted aluminum. In general, metal roofs are the recommended roofing material in rainwater catchment systems[1, 2]. They are smoother, cleaner, more impervious and more durable than other types of roofing materials[1, 3].

Currently, there is no roofing material certified for potable water. Therefore, a coating, or membrane applied to the top of the roofing material is the best practice. Of the several coatings certified under NSF 61 or NSF P151, only one is rated for freezing temperatures (SEALPRO, http://users.rcn.com/sealproinc/protective_coatings.htm).

Non-Potable Water Use: If a rainwater catchment is going to be used for purposes other than drinking or cooking use, many roofing

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materials can be considered suitable for catchment surfaces. When considering non-potable uses for rainwater, the roofing material and use compatibility should be considered. For example, wood and asphalt roofs tend to collect bacteria. In addition, organic and inorganic chemicals, such as asbestos can be leached from asphalt roofing [3, 5, 6]. Aluminum roofs could react with acidic rainwater and lead to increased levels of aluminum in the water. Any contact with lead paint or copper and lead flashings could lead to an unacceptable concentration of heavy metals in the water[1-3, 5, 7-9]. Galvanized metal roofs are a controversial material because zinc and other metals could be leached into the water, however, in most cases the zinc concentration is below the maximum concentration limit set by the World Health Organization (WHO)[1, 8, 10]. Some sheet metal materials may contain lead and caution is needed when considering this roofing material in catchment systems[6, 10].

ROOF WASHER/LEAF SCREENS:

Roof washer systems are used to discard the first flush of rain at the beginning of a rain event. The purpose of a roof washer is to reduce the concentration of containments, including bacteria and other debris by discarding the first flush of rainwater collected from the roof [1-3, 5, 9, 11]. A roof washer minimizes the amount of leaves, twigs, insects and other matter in the reservoir. This, in turn, improves the taste, color and odor of the reservoir water.

Currently there are no leaf screens made from material certified for potable water. However, screens could potentially improve the quality of the water by keeping leaves and other debris out of the reservoir[1, 2]. They are installed along the entire length of the gutter, or they could consist of wire baskets at the heads of the downspouts. A course leaf filter can also be installed anywhere from the gutter to the entrance to the tank. The most popular positions are in the gutter, at the beginning of the down pipe or in the down pipe. These leaf filters must be cleaned and maintained on a regular basis to prevent blockage to the reservoir[1, 2]. Trees surrounding the roof can be strategically removed to decrease the amount of pine needles, leaves and small twigs that might fall on the catchment surface[1, 4].

GUTTER:

There are no approved or certified potable water gutters currently available. For catchment systems intended for potable water, a membrane approved for potable water could be applied over the gutter material to prevent leaching of chemicals. Certified membranes can be used to cover aluminum, galvanized steel and plastic gutters. Aluminum is sunlight-resistant and naturally resistant to corrosion [1, 3]. Galvanized steel is widely used because of its pliability [3]. Copper and iron gutters could leach metals into the drinking water when exposed to acidic rain water. All gutter materials should be free of lead[1, 3, 5, 7-9].

Careful attention to the shape and angle at which the gutters are placed on the house can improve the flow rate into the reservoir. Water should not be allowed to remain stagnant in the gutter where it provides an excellent breeding ground for mosquitoes[1].

RESERVOIRS:

Types of Reservoirs:

Underground: Underground tanks are best for year round use[1-4, 12]. Appropriate measures should be taken to protect the tanks from freezing[3, 4, 12]. Underground tanks have less chance for contamination and evaporation[13]. However, care and maintenance are needed to ensure the structural integrity of the tank.

Concrete: Although concrete tanks have the reputation of being strong and long-lasting, they are subject to cracking, especially underground and should be checked for leaks yearly[3]. They are more permanent than other types of tanks because they are heavy and cannot be easily moved[3, 12]. Concrete tanks can be poured into different shapes and sizes giving them an advantage over other tanks[4, 12].

Fiberglass: Fiberglass tanks are popular because they are lightweight, reasonably priced, long lasting, prefabricated and certified in many different sizes and shapes[3, 4, 12]. They are easy to transport[3]. Fiberglass tanks should include a coating to prevent sunlight from penetrating the tank[3].

Poly-plastic: Poly-plastic tanks have similar benefits to Fiberglass tanks and they are readily available from several manufacturers in Alaska.

Galvanized Steel: Galvanized steel tanks are noted for their strength and for being lightweight and moveable[3]. Like roofs and gutters made from the same material, they are known to leach zinc when exposed to acidic rainwater[1, 3]. For use in potable water systems, a certified inner membrane or liner is required.

Redwood: Redwood tanks have a reputation as a durable water storage tank with an average life expectancy of approximately 50 years[3]. Redwood has a natural preservative which makes it resistant to insects and decay[3]. Redwood does not tarnish or decay and requires no paint or protective outside coating[3]. However, redwood tanks will eventually leak due to fluctuations in water levels throughout the years. Therefore, for potable water, it is suggested that a certified inside liner be installed.

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Liners, Bags and Membranes: Liners, bags and membranes can be installed or applied inside reservoirs to prevent leakage or provide a low-cost, temporary collection tank or surface[3]. They also prevent leaching of chemicals from tanks such as zinc from newly galvanized tanks or lime from concrete tanks[1]. All liner materials should be certified for potable water by an appropriate source, such as NSF International.

A Must if Potable: All materials used in the reservoir system (membranes, liners, sealant, paints and the actual reservoir) should be certified for potable water by an accredited source[2, 3, 12]. All reservoirs should have a tight fitting cover which will prevent evaporation, mosquito breeding and will keep insects, birds, and animals from entering the tank[2, 3]. All tanks should have an overflow [1, 2, 12]. The tank should not only have adequate structural strength to withstand wear and tear but should have easy access for cleaning[1-3, 12]. Finally all potable water tanks should be located at least 10 feet away[14] from sources of pollution, such as septic tank fields,[3, 12] and should be located in a location accessible to a water truck in case of severe drought[3, 12].

Disinfection: There are many methods in which reservoirs can be disinfected. The suggested method is ultraviolet (UV) light[3]. Ultraviolet light is an effective way to kill most bacteria and viruses. A UV system does not require that chemicals be added to the water, however the ultraviolet bulbs should be changed on a regular basis because they naturally loose their ability to transmit the proper wavelength. Ultraviolet disinfection systems can be installed with an audible and visual alarm indicating lamp failure. Ultraviolet systems should be installed with a properly sized pre-filter to remove any sediment that could potentially shadow the bacteria as the water passes the UV light[3].

Chlorine is often added as part of the final drinking water treatment process[1, 3, 6]. However, chlorine also reacts with the organic matter naturally present in water, such as decaying leaves that could pass filters. This chemical reaction forms a group of chemicals known as disinfection by-products (DBPs). DBPs are known carcinogens in animals.

Access and Cleaning: The inside of the reservoir should be thoroughly scrubbed and rinsed before the system is put into use[5, 12]. This can be done with a soft brush, water, and baking soda[4] or a diluted bleach solution (both rinsed with ample amounts of water)[5, 12]. This can be followed with annual cleanings of the reservoir when the tank can be drained and emptied of accumulated sediment[5]; cracks can be patched at this time with non-toxic sealant[4, 5]. It is important to have good ventilation when working inside of the tank[5, 12]. In general, a manhole and a vent for cleaning purposes are suggested as standards for reservoirs, and regular cleaning helps to improve the quality of potable water[5]. Multi-tank systems are suggested if rainwater is the only source of water for the family[4]. Other tanks can be used while one of the tanks is being cleaned or maintained, without a stop in water use. Incoming and outgoing pipes can also be regularly maintained and cleaned for optimal water flow[5].

After the system is completely operational, but before any water is consumed, have the water tested by a laboratory certified by the Environmental Protection Agency to ensure that the water is safe to drink.

PUMPS:

Water pumps should be approved for potable water by the Food and Drug Administration (FDA), NSF, or Underwriters Laboratories Inc. (UL). (http://www.ul.com/).

FILTERS*:*

The recommended filter size for drinking water is 1 micron. A cartridge this size will remove any particle which is 1 micron or larger. Filters should be certified under NSF Standard 53. The Alaska Department of Environmental Conservation (ADEC) has issued a list of approved filters, which can be found at http://www.state.ak.us/dec/deh/water/filtration.htm.

Activated carbon filters can be used to remove any unpleasant appearance, odor, and taste. Carbon is best at removing organic chemicals and chlorine.

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