# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Zapadni Bay Harbour Drinking Water System, St. George Island, Alaska

PWSID # 263029.002

May 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1465
Alaska Department of Environmental Conservation

# Source Water Assessment for
# Zapadni Bay Harbour
# Drinking Water System
# St. George Island, Alaska

## PWSID # 263029.002

DRINKING WATER PROTECTION PROGRAM REPORT 1465

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.

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# APPENDICES

# Source Water Assessment for Zapadni Bay Harbour Source of Public Drinking Water, St. George Island, Alaska

**Drinking Water Protection Program**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

Zapadni Bay Harbour has seven Public Water System (PWS) wells. It is assumed that the well (PWSID# 263029.002) has been used as a drinking water source since it was drilled in 1988. This source water assessment report is exclusively limited to PWSID# 263029.002.

The well is a Class B (transient/non-community) water system located on the east side of Zapadni Rookery Road on St. George Island, Alaska. It is unknown if the drinking water source is treated. Available records indicate that there is a 500,000-gallon storage tank for drinking water. This system operates year round and serves approximately 450 non-residents and 20 residents. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Very High**. Combining these two ratings produce a **High** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for the primary public drinking water source include: water supply wells, roads, and a landfill. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the water well received a vulnerability rating of **Medium** for the bacteria and viruses, nitrates and nitrites, and volatile organic chemicals contaminant categories.

## ZAPADNI BAY HARBOUR PUBLIC DRINKING WATER SYSTEM

The Zapadni Bay Harbour well is a Class B (transient/non-community) public water system. The well is located on the east side of Zapadni Rookery Road on St. George Island, Alaska (Sec. 3, T42S, R130W, Seward Meridian; see Map A of Appendix A). Zapadni Bay Harbour is located on the western coast of St. George Island, approximately 47 miles south of St. Paul Island, 750 air miles west of Anchorage, and 250 miles northwest of Unalaska. The community of St. George has a population of 149 (ADCED, 2003). Average annual precipitation on St. George Island is 23 inches of rain, with 57 inches of snowfall. Temperatures range from 24 to 52°F.

The community of St. George is served by a piped water and sewer system. St. George Island receives electrical power from the St. George Municipal Electric Utility. Power generating facilities are fueled by diesel. Refuse is collected by the City of St. George and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the Zapadni Bay Harbour PWS, the depth of the primary water well is 91 feet below the ground surface. The well is not screened and, based on well construction details, is in an unconfined aquifer. Unconfined aquifers are more susceptible to groundwater impacts resulting from the downward migration of surface contaminants. The well is not located within a floodplain.

Information acquired from ADEC for the public water system indicated that the land surface was sloped away from the well. Generally, land surfaces that slope away from the wellhead promote surface water drainage, which reduces potential of contaminant migration down the well casing annulus. It is assumed that the well is not grouted according to ADEC regulations based on the well construction date (1988). Proper grouting provides added protection against contaminants traveling along the well casing annulus and into source waters.

St. George Island is the second largest of five islands in the Pribilof Islands group. The island is about eleven miles long and two miles wide. The central portion of the island bulges to the south widening to five miles and forming the Zapadni Bay embayment. High bluffs at the northwestern end of the island and Ulakaia Hill at the east central part of the island reach approximately 1,000 feet above mean sea level. St. George village lies just northeast of Ulakaia Hill, along the northeastern shore.

St. George Island is comprised of basalt flows resting on a locally exposed peridotite basement. The flows

are often partly vesicular and frequently separated by scoriaceous material. Tuffs and pyroclastic deposits form a small but significant percentage of St. George Island. Unconsolidated sediments, including beach deposits, colluvium, retransported and windblown silt, and highly fractured rubble obscure underlying rocks over much of the island surface.

The hydrogeoglogy of St. George Island has been described simply as an island system of highly permeable lava flows with a low rate of groundwater recharge due to low total precipitation (Wheaton, 1984).

## ZAPADNI BAY HARBOUR DRINKING WATER 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. 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 protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. An analytical calculation was used to determine the size and shape of the DWPA for the Zapadni Bay Harbour PWS. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (Freeze and Cherry, 1979). Available geology and groundwater contours were also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

The protection areas 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 (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

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 protection area zones for wells and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

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

The DWPA for the Zapadni Bay Harbour PWS was determined using an analytical calculation and includes Zones A, B, and D (See Map A of Appendix A).

## INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Zapadni Bay Harbour 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 B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses,
- Nitrates and/or nitrites,
- Volatile organic chemicals.

The sources are displayed on Map C of 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. Rankings include:

- Low,
- Medium,
- High, and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well. 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.

**VULNERABILITY OF THE ZAPADNI BAY HARBOUR DRINKING WATER SYSTEM**

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

- Natural susceptibility, and
- Contaminant risks.

Appendix D contains eight 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 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

A score for the Natural Susceptibility is reached by considering the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)
(Chart 1 of Appendix D)

+

Susceptibility of the Aquifer (0 – 25 Points)
(Chart 2 of Appendix D)

=

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

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

| Natural Susceptibility Ratings | |
|---|---|
| 40 to 50 pts | Very High |
| 30 to < 40 pts | High |
| 20 to < 30 pts | Medium |
| < 20 pts | Low |

The Zapadni Bay Harbour's water well is in an unconfined aquifer. Unconfined aquifers are more susceptible to potential groundwater quality impacts posed by the migration of surface water contaminants downward from the surface. Table 2 shows the susceptibility scores and ratings for this PWS.

**Table 2. Susceptibility**

| | **Score** | **Rating** |
|---|---|---|
| Susceptibility of the Wellhead | 5 | Low |
| Susceptibility of the Aquifer | 25 | Very High |
| Natural Susceptibility | 30 | High |

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score 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. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

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

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

**Table 3. Contaminant Risks**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 12 | Low |
| Nitrates and/or Nitrites | 21 | Medium |
| Volatile Organic Chemicals | 14 | Low |

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

Natural Susceptibility (0 – 50 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 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

**Table 4. Overall Vulnerability**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 40 | Medium |
| Nitrates and Nitrites | 50 | Medium |
| Volatile Organic Chemicals | 45 | Medium |

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is **Low**. The risk is primarily attributed to the presence of a landfill located in Zone D (see Table 2 – Appendix B).

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.

No positive bacteria counts have been reported in recent (within five years) sampling events (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D). Only a small amount of bacteria and viruses are required to endanger public health.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Medium**.

**Nitrates and Nitrites**

The contaminant risk for nitrates and nitrites is **Medium**. The risk to this source of public drinking water is primarily attributed to the presence a landfill in Zone D (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately the same rate as water. The sampling history for this well indicates that low levels of nitrates have been detected in recent sampling events. However, the reported concentrations of nitrates do not exceed the maximum contaminant level (MCL) of 10 mg/L. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L; therefore, nitrate concentrations above 2 mg/L may be indicative of man-made sources (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Nitrate levels are often derived from the decomposition of organic matter in soils. Although the nitrate source is unknown, such occurrences may be attributed to septic systems or other sources. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to nitrate and nitrite contamination is **Medium**.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is **Low**. The risk is primarily attributed to the presence of a landfill located in Zone D. Several other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

No recent sampling data was available in ADEC records for Zapadni Bay Harbour (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

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**.

**Using the Source Water Assessment**

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 Zapadni Bay Harbour and the community of St. George Island 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 drinking water source.

# REFERENCES

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

Freeze, R. A., and Cherry, J.A. 1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey

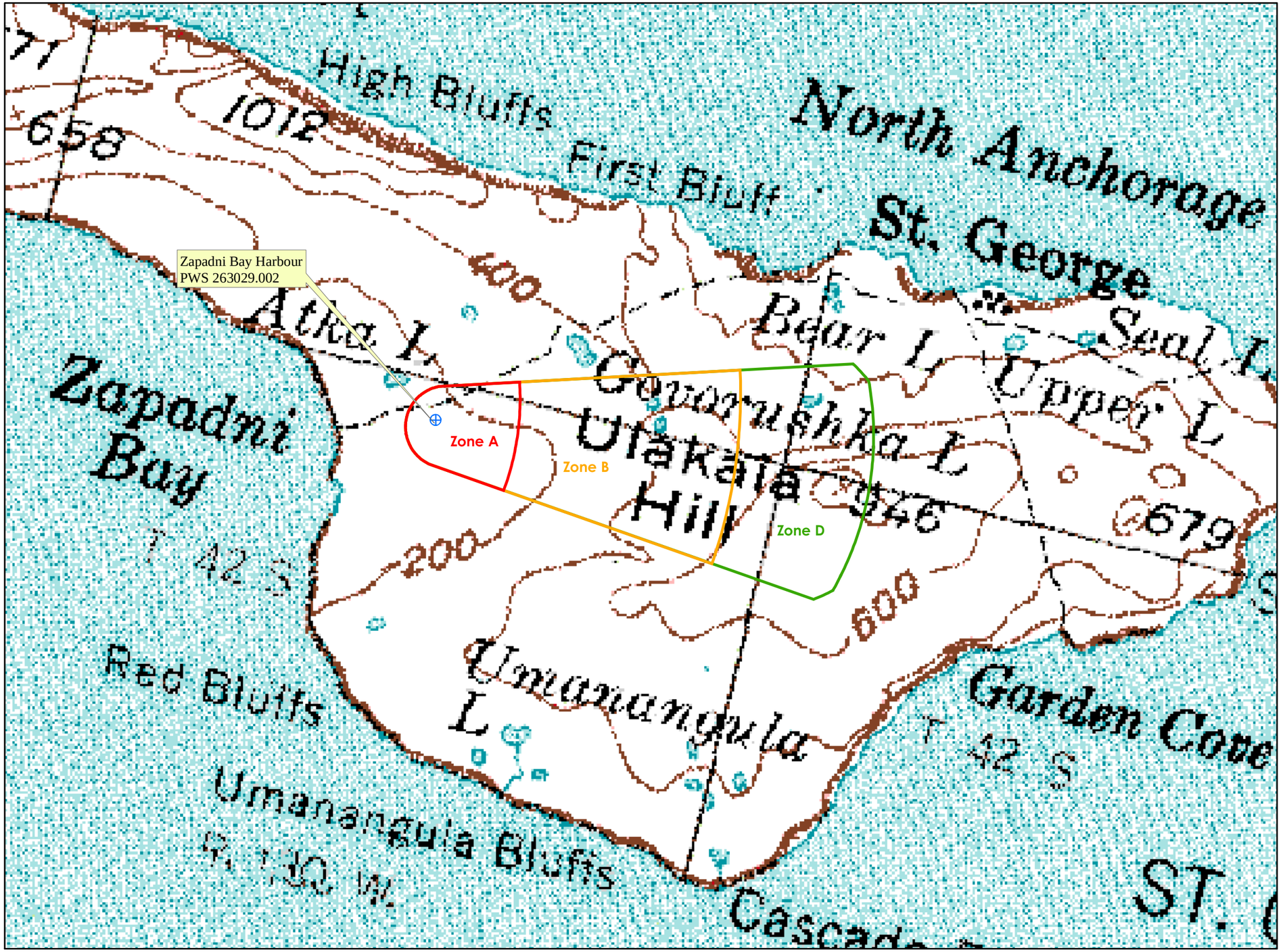
United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL http://www.epa.gov/safewater/mcl.html.

Wheaton, Scott R. 1984, Hydrogeologic Analysis and Well Site Recommendations at St. George Island and City of St. George, Alaska, U.S. Public Health Service, Alaska Area Native Health Service.

# APPENDIX A

## Drinking Water Protection Area Location Map
## (Map A)

# Public Water Well System for PWSID 263029.002 Zapadni Bay Harbour




## LEGEND

- Public Water System Well

***Groundwater Protection Zones***

- Zone A – 2 Months Travel Time
- Zone B – 2 Years Travel Time
- Zone D – 10 Years Travel Time or Watershed Boundary

***Hydrography/Physical***

- Parcels
- Stream
- Lake or Pond
- Contours

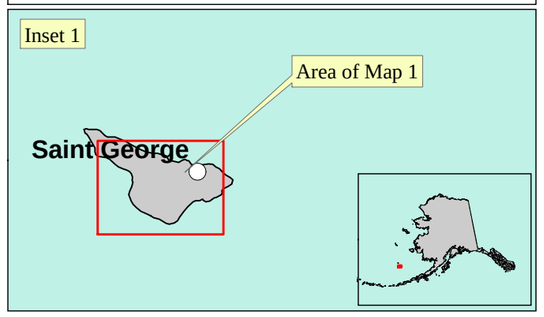
***Transportation***

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

Data Sources:
- Contaminant Sources, Public Water System Wells, Contours
  Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:
- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.




0 0.375 0.75 1.5 2.25 3 Miles

Zapadni Bay Harbour
PWS 263029.002
**Appendix A Map A**

# APPENDIX B

## Contaminant Source Inventory and Risk Rankings (Tables 1-4)

***Table 1***

# *Contaminant Source Inventory for*
# ***Zapadni Bay Harbour***

***PWSID 263029.002***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Map Number* | *Comments* |
|---|---|---|---|---|---|
| Water supply wells | W09 | W09-01 | A | C | 6 water supply wells in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | C | Assume 1-20 roads in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-02 | B | C | Assume 1-20 roads in Zone B |
| Landfills (municipal; Class III) | D51 | D51-01 | D | C | |

***Table 2***

# *Contaminant Source Inventory and Risk Ranking for Zapadni Bay Harbour*
## *Sources of Bacteria and Viruses*

***PWSID 263029.002***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-02 | B | Low | C | Assume 1-20 roads in Zone B |
| Landfills (municipal; Class III) | D51 | D51-01 | D | High | C | |

***Table 3***

# *Contaminant Source Inventory and Risk Ranking for Zapadni Bay Harbour*
## *Sources of Nitrates/Nitrites*

***PWSID 263029.002***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-02 | B | Low | C | Assume 1-20 roads in Zone B |
| Landfills (municipal; Class III) | D51 | D51-01 | D | Very High | C | |

***Table 4***

# *Contaminant Source Inventory and Risk Ranking for Zapadni Bay Harbour*
## *Sources of Volatile Organic Chemicals*

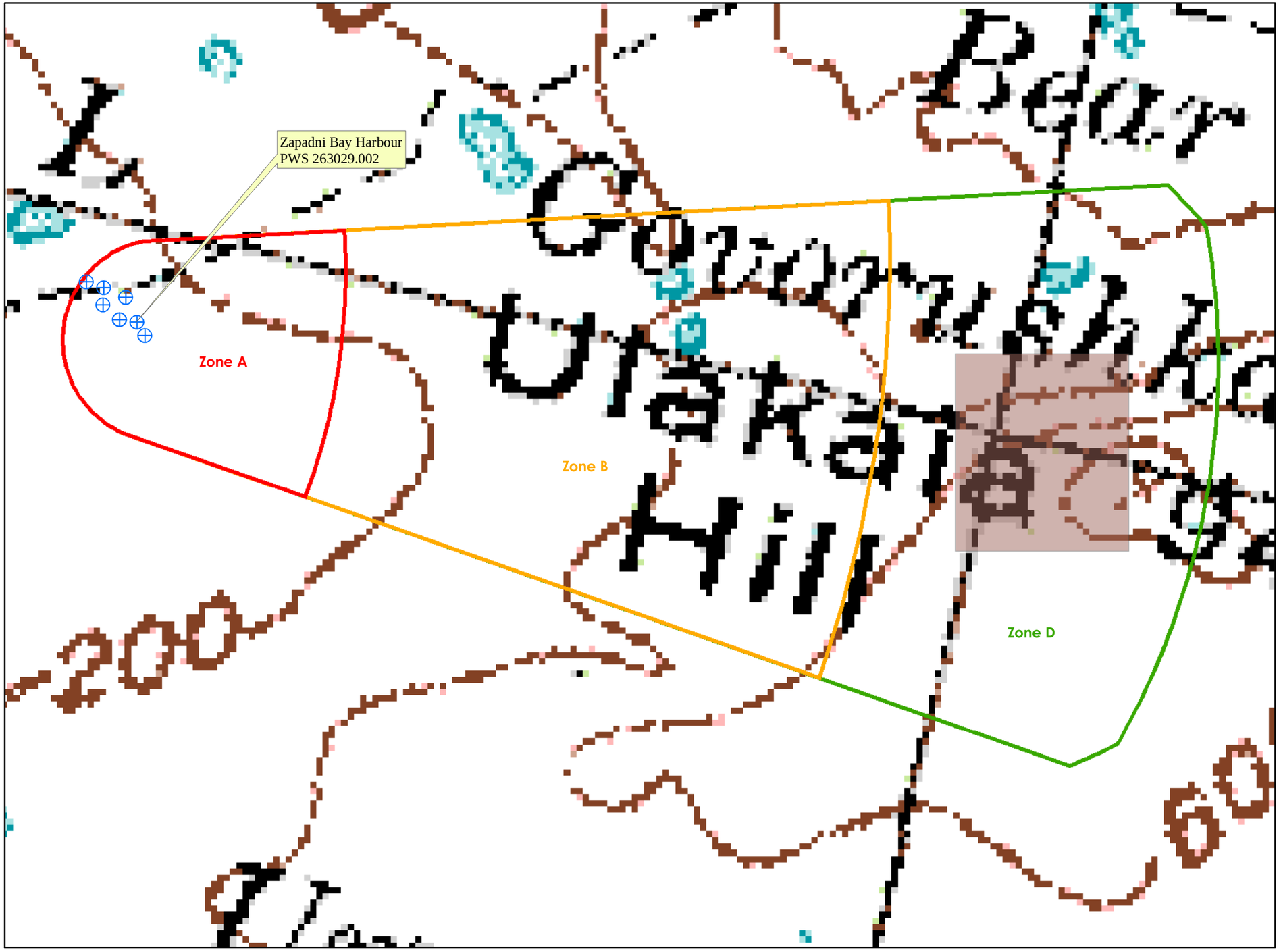
***PWSID 263029.002***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | C | Assume 1-20 roads in Zone A |
| Highways and roads, dirt/gravel | X24 | X24-02 | B | Low | C | Assume 1-20 roads in Zone B |
| Landfills (municipal; Class III) | D51 | D51-01 | D | High | C | |

# APPENDIX C

## Drinking Water Protection Area
## and Potential and Existing Contaminant Sources
## (Map C)

# Public Water Well System for PWSID 263029.002 Zapadni Bay Harbour
## Showing Potential and Existing Sources of Contamination




## LEGEND

Public Water System Well

***Groundwater Protection Zones***

- Zone A – 2 Months Travel Time
- Zone B – 2 Years Travel Time
- Zone D – 10 Years Travel Time or Watershed Boundary

***Hydrography/Physical***

- Parcels
- Stream
- Lake or Pond
- Contours

***Transportation***

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

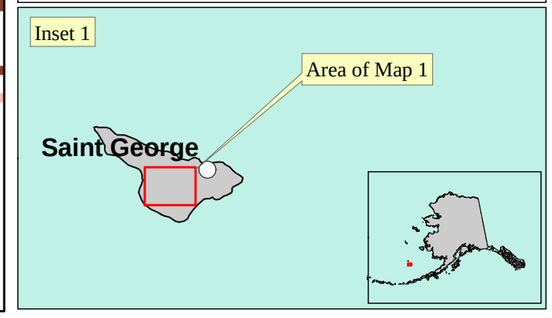
***Existing or Potential Contaminant Sources***

- Landfills (Municipal, Class III) (D51)

Data Sources:
- Contaminant Sources, Public Water System Wells, Contours Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:
- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.




Zapadni Bay Harbour
PWS 263029.002
**Appendix C Map C**

# APPENDIX D

## Vulnerability Analysis for Public Drinking Water Source (Charts 1-8)

***Chart 1. Susceptibility of the wellhead - Zapadni Bay Harbour (PWS No. 263029.002)***

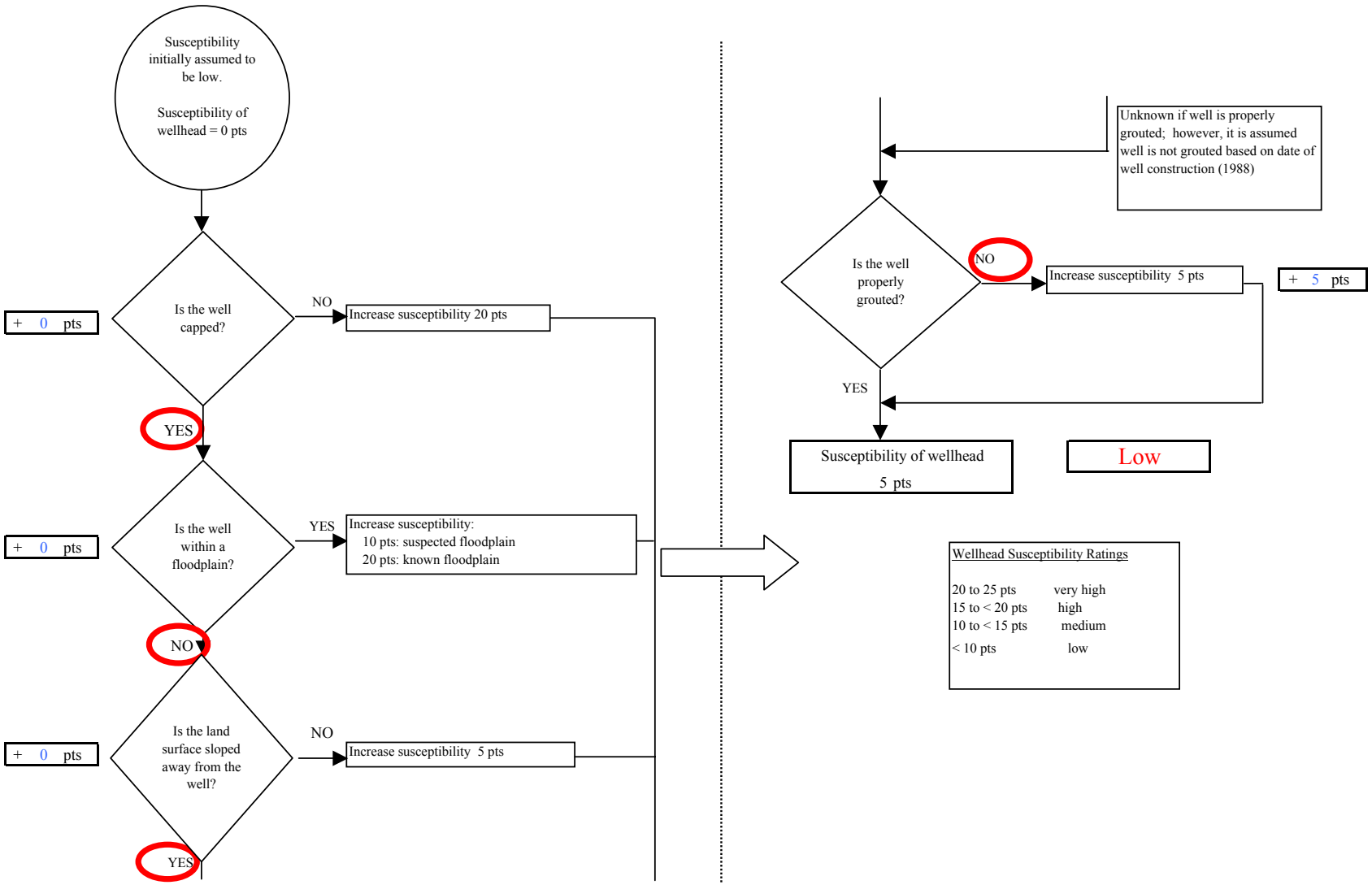
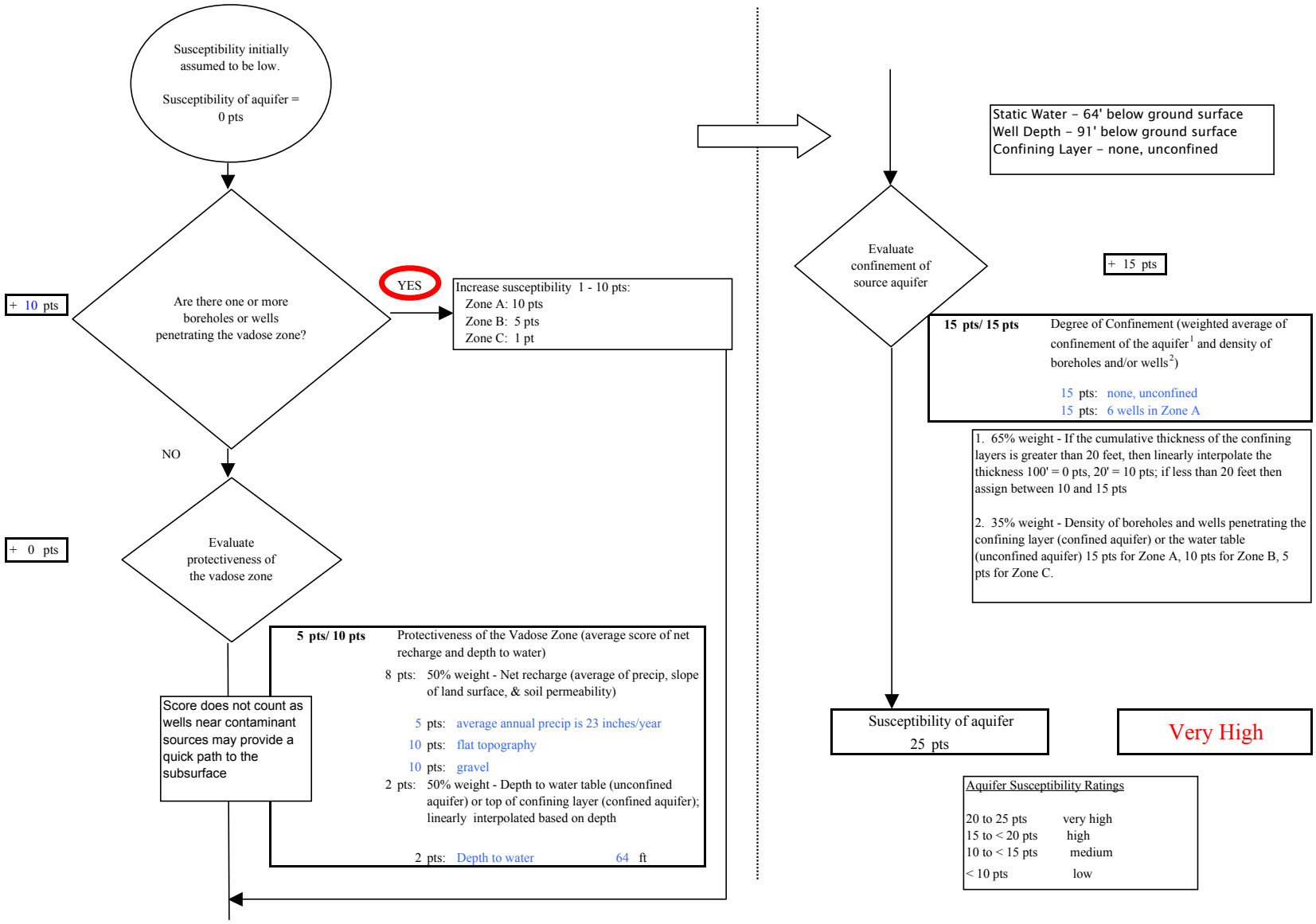
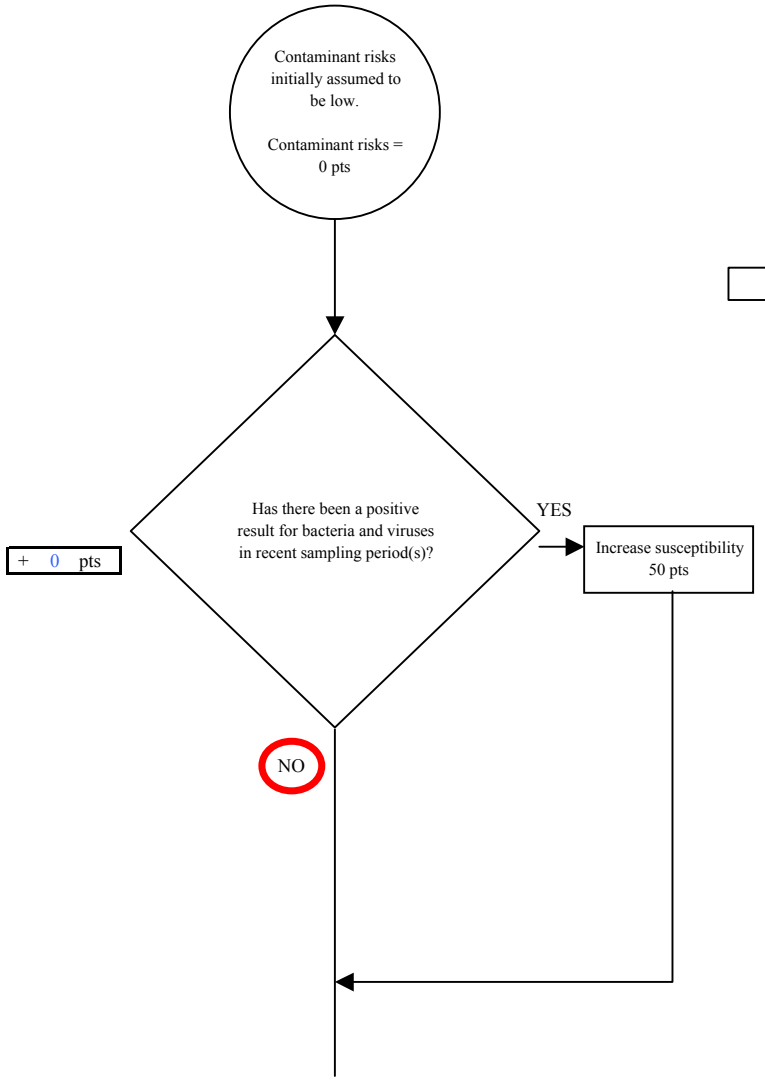
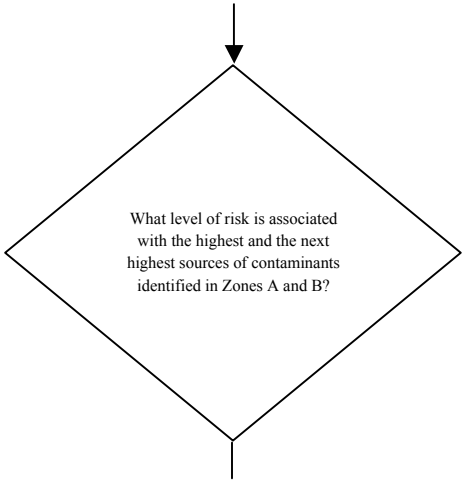


***Chart 2. Susceptibility of the aquifer Zapadni Bay Harbour (PWS No. 263029.002)***



## *Chart 3. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Bacteria & Viruses*




+ 10 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

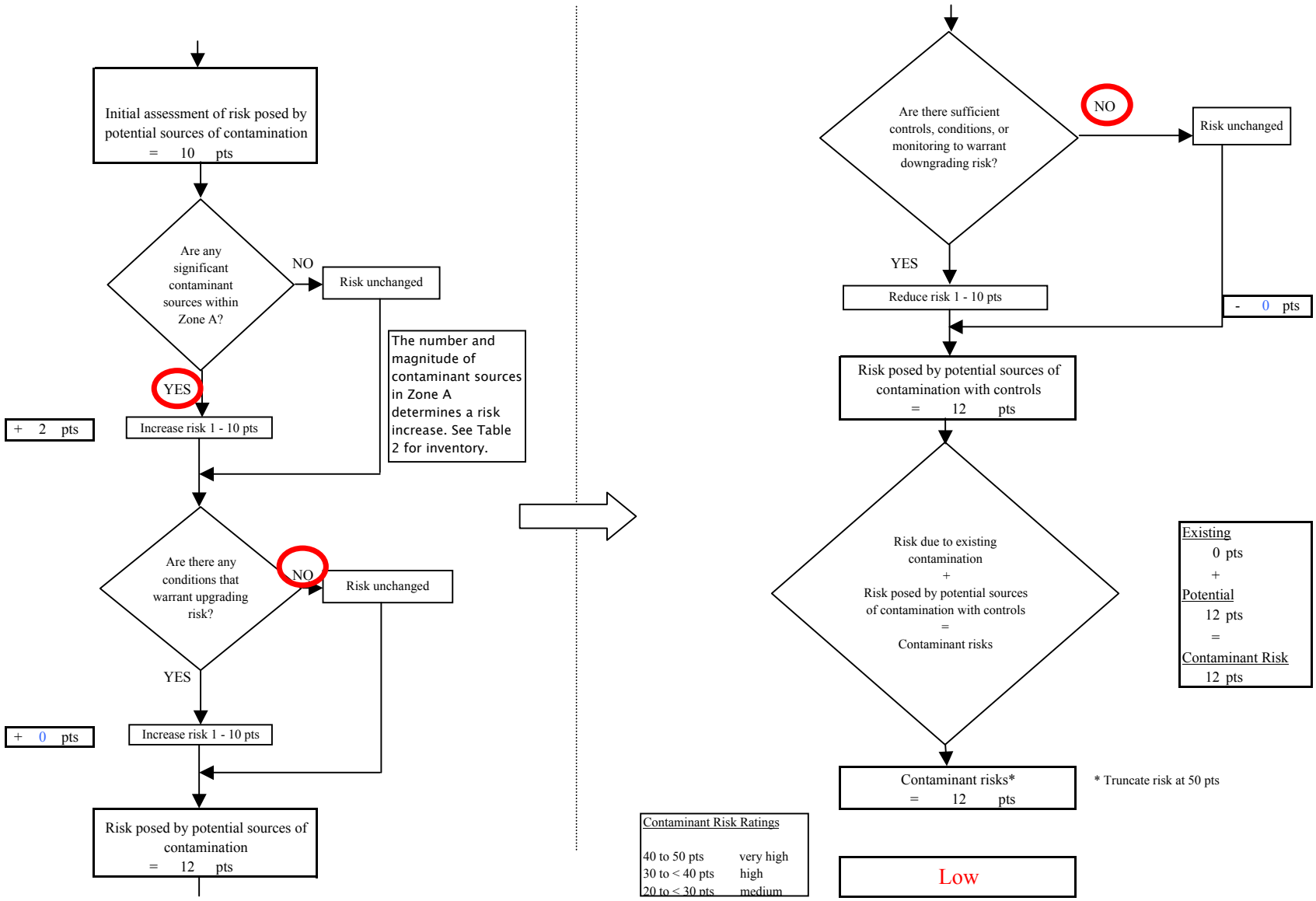
| | Zone A | Zone B | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 1 | 1 | 2 |

| | **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 3. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Bacteria & Viruses***



## *Chart 4. Vulnerability analysis for Zapadni Bay Harbour (PWS No. 263029.002) - Bacteria & Viruses*

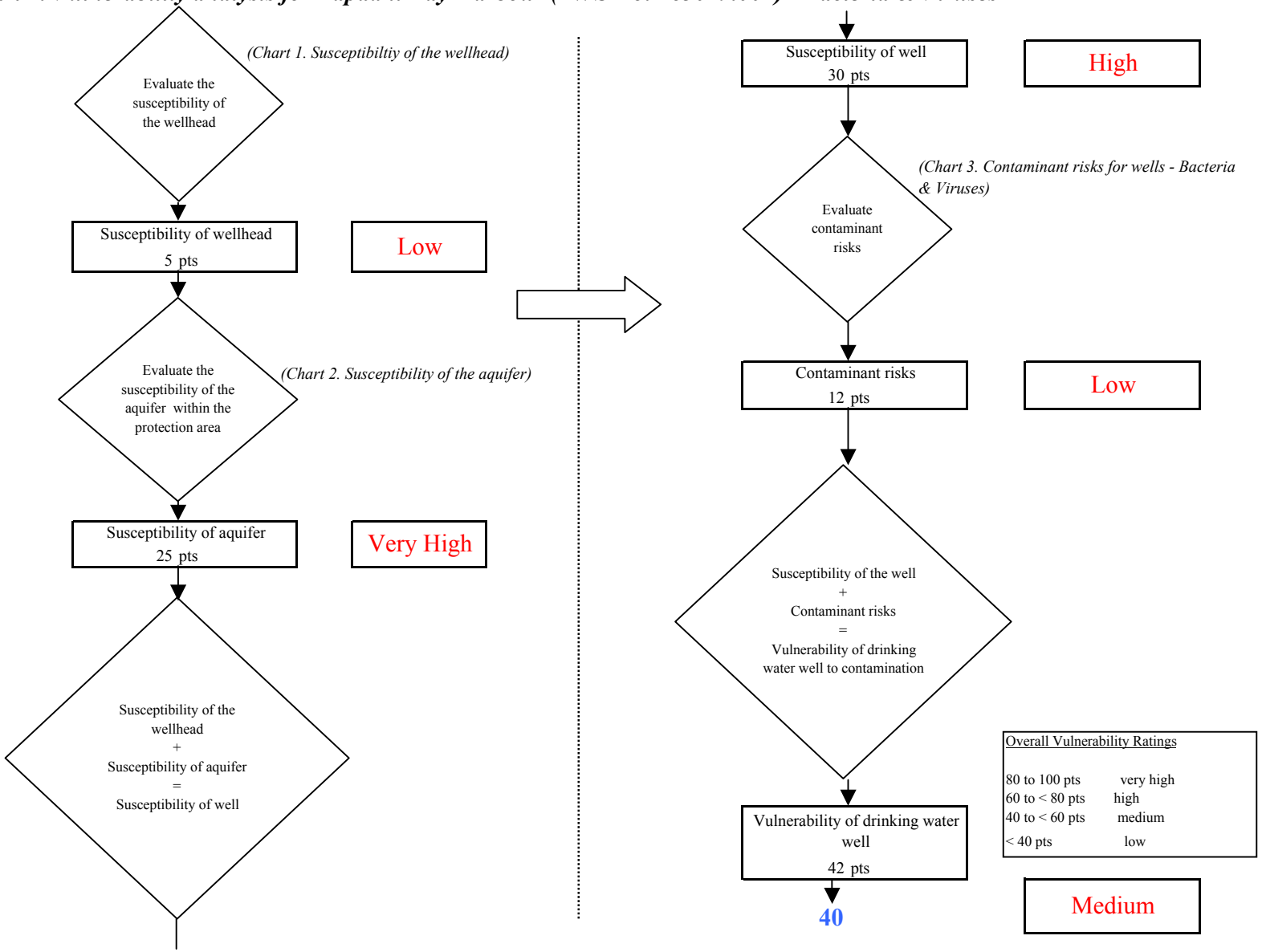


***Chart 5. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Nitrates and Nitrites***

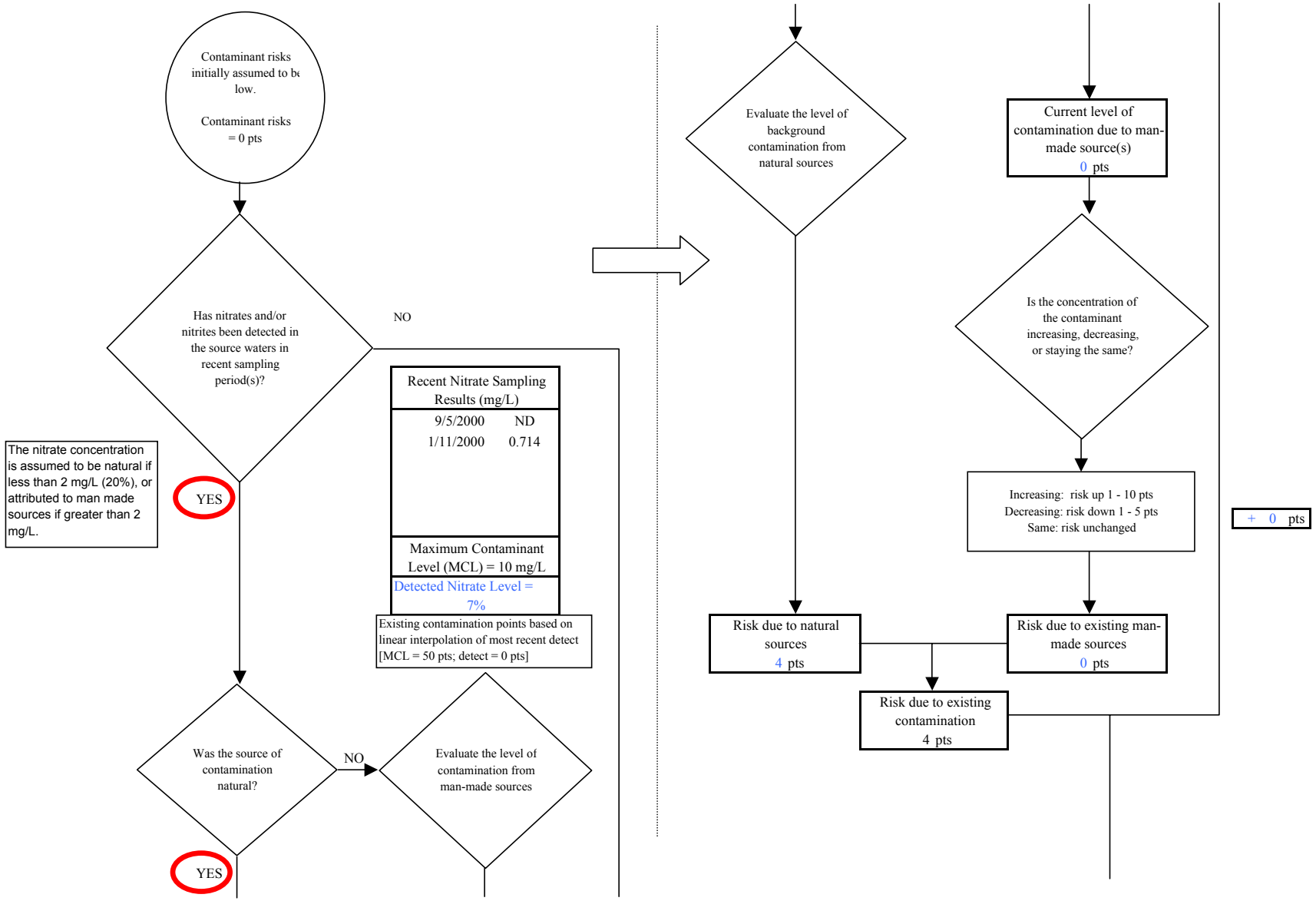
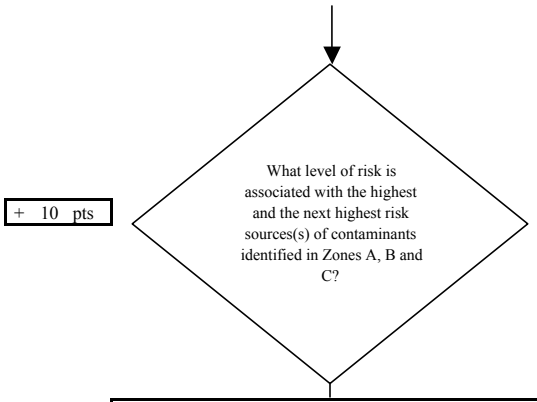


***Chart 5. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Nitrates and Nitrites***




+ 10 pts

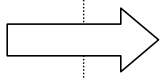
Risk Levels for Contaminant Sources identified in Zones A, B and C

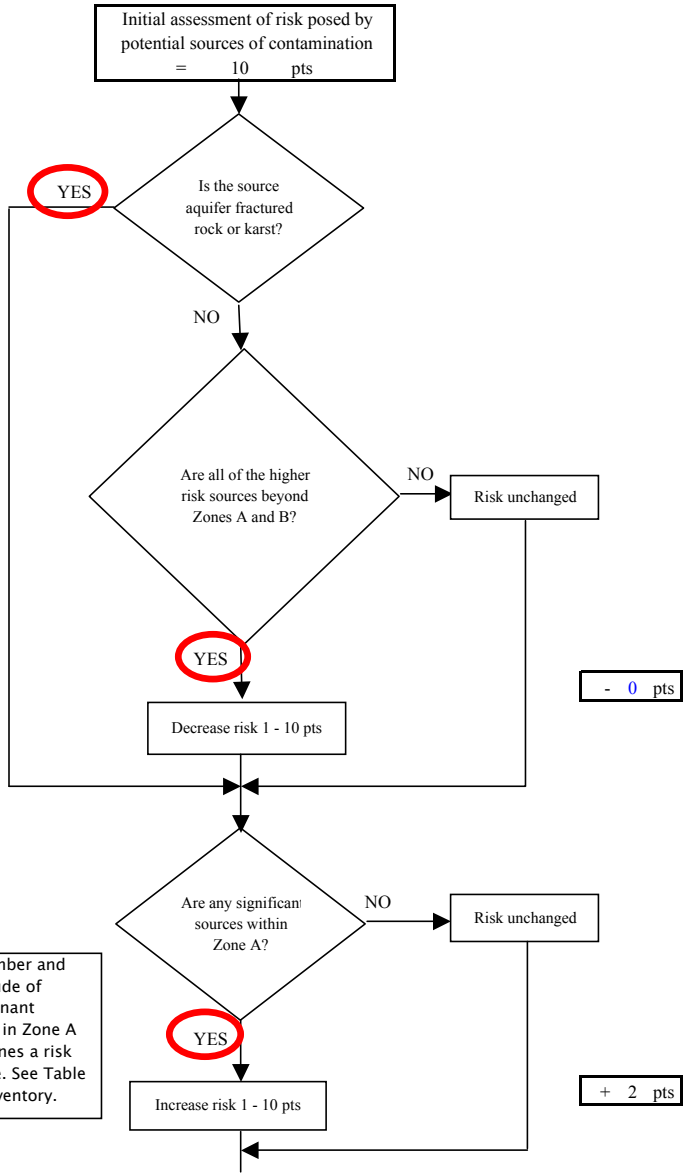
| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 1 | 1 | 2 |

| | **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

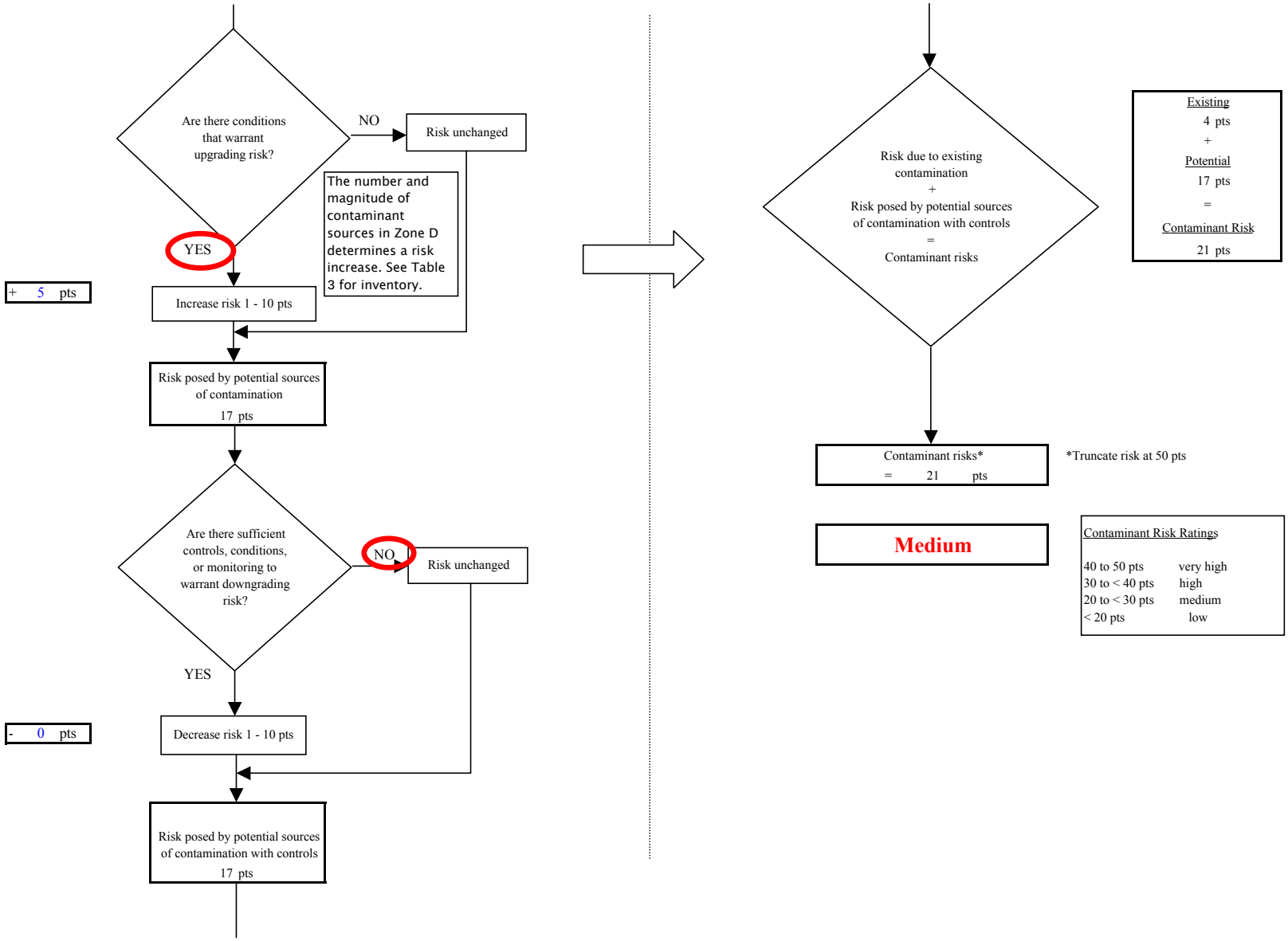
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individua contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.






The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 3 for inventory.

***Chart 5. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Nitrates and Nitrites***



## *Chart 6. Vulnerability analysis for Zapadni Bay Harbour (PWS No. 263029.002) - Nitrates and Nitrites*

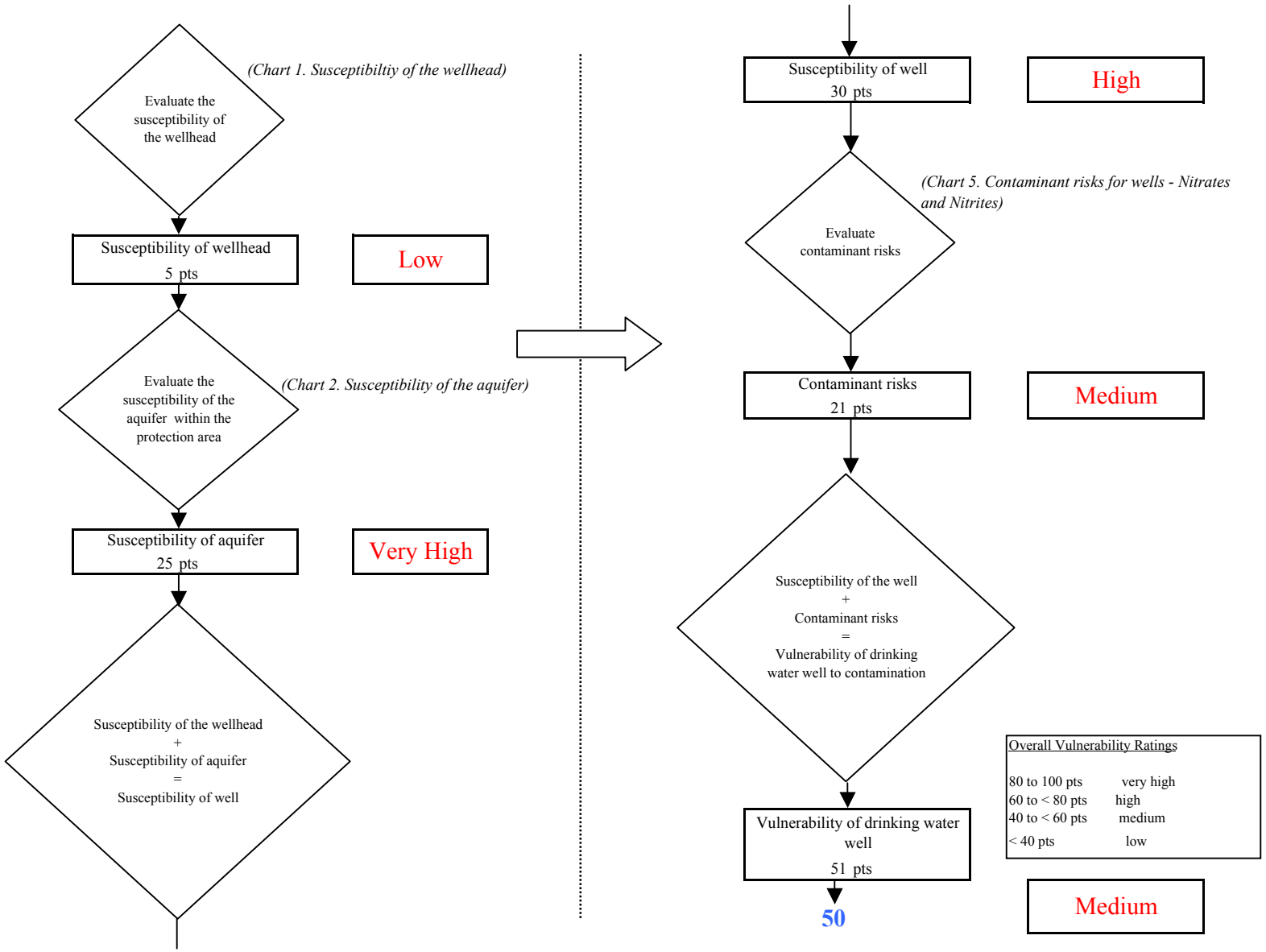
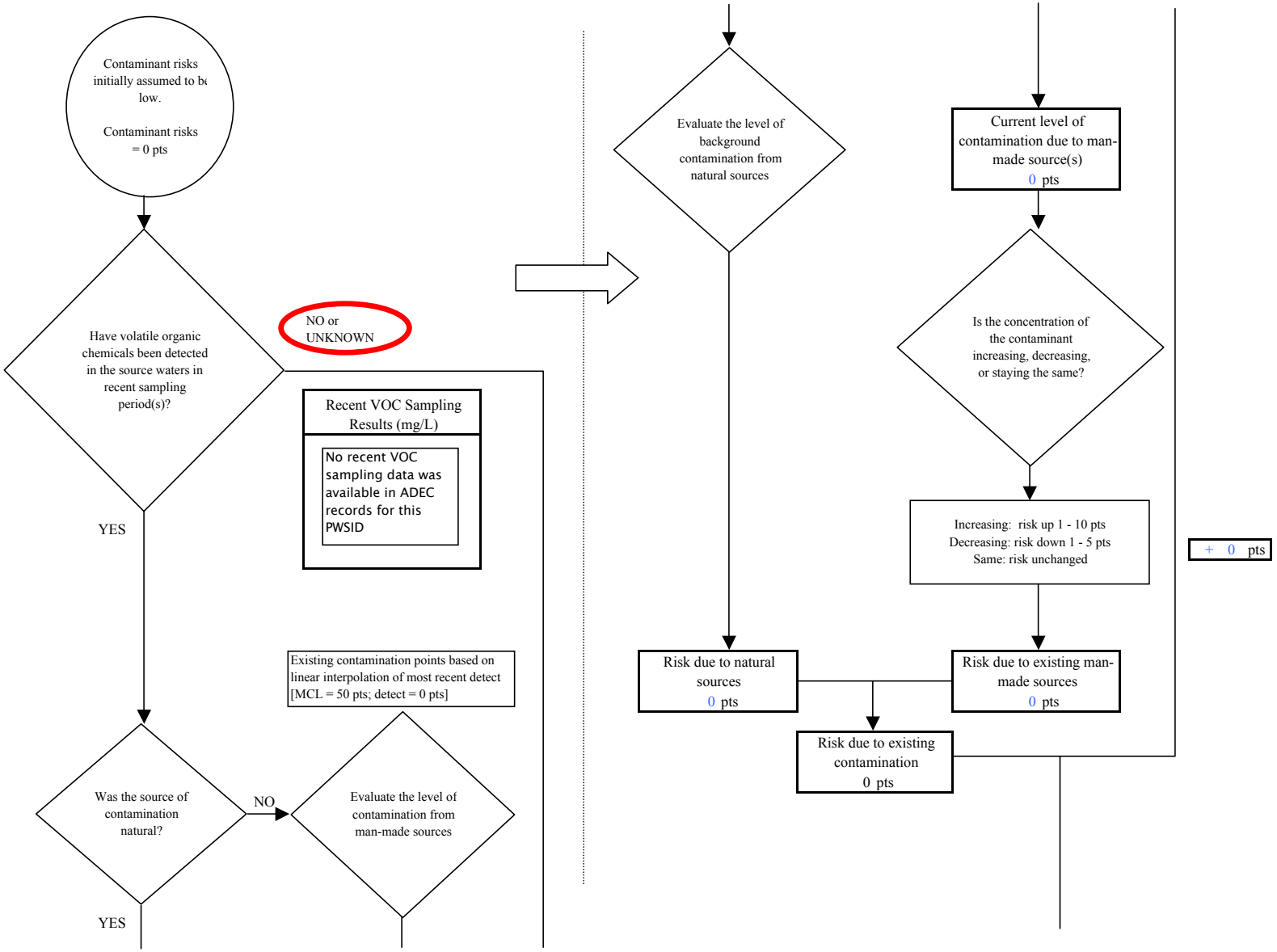


***Chart 7. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Volatile Organic Chemicals***



## *Chart 7. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Volatile Organic Chemicals*

+ 10 pts

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

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

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

| | **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 individua contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO → Risk unchanged

YES

Decrease risk 1 - 10 pts

0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

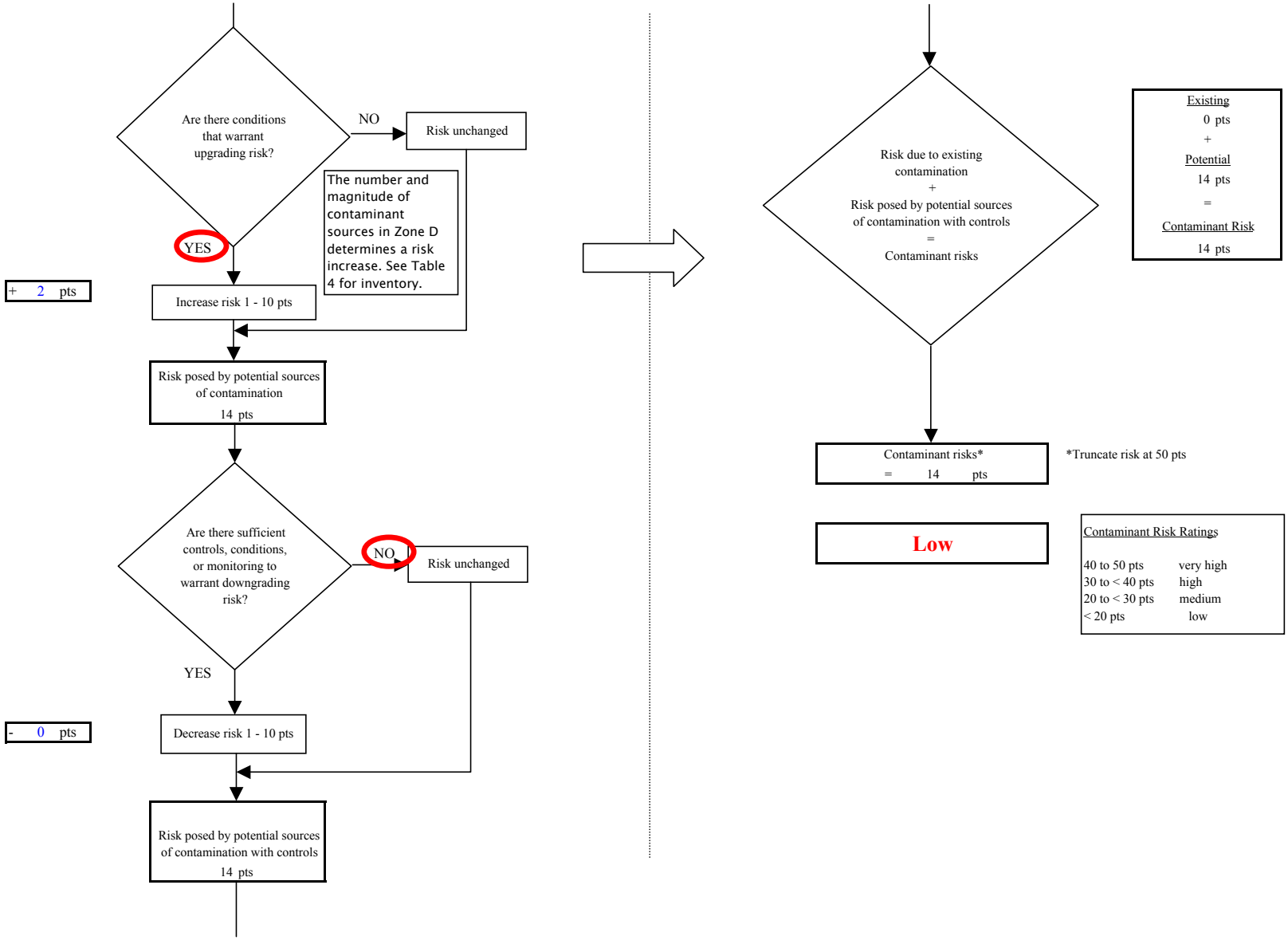
YES

Increase risk 1 - 10 pts

+ 2 pts

The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 4 for inventory.

***Chart 7. Contaminant risks for Zapadni Bay Harbour (PWS No. 263029.002) - Volatile Organic Chemicals***



## *Chart 8. Vulnerability analysis for Zapadni Bay Harbour (PWS No. 263029.002) - Volatile Organic Chemicals*