Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Whittier Access Tunnel Drinking Water System, Portage, Alaska PWSID # 218582

May 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 857
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.

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Source Water Assessment for Whittier Access Tunnel Source of Public Drinking Water, Portage, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Whittier Access Tunnel is a Class B water system (non-community), consisting of one well near the tunnel The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Whittier Access Tunnel public drinking water source include a railroad corridor, road, above ground fuel tanks and a large capacity septic system. This identified potential and existing sources of contamination is considered as source of volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water source for Whittier Access Tunnel received a vulnerability rating of **Medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals and inorganic chemicals and **Low** for other organic chemicals. This assessment can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Whittier Access Tunnel to protect public health

WHITTIER ACCESS TUNNELPUBLIC DRINKING WATER SYSTEM

The Whittier Access Tunnel public water system is a Class B (non-community) water system. The system consists of one well near the tunnel from Portage to Whittier Alaska. Portage is located in Municipality of Anchorage.

This area lies within the southcentral hydrologic region and the Cook Inlet sub-region. Surface water and groundwater flow is abundant in this area. Based on the USGS, Water Resources Division, groundwater database, groundwater in this area is designated as having existing beneficial uses for domestic and commercial applications.

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. Many homes and businesses in the area rely on individual wells for their water supply. Most of these wells are shallow with depths of 30 feet up to 100 feet. Static water levels in many of these wells are between 4 feet to 20 feet below the surface.

The mountains in this area are composed of the Valdez Group, a widely distributed flysch in southcentral Alaska. The group is predominantly dark gray mudstone, siltstone, argillite, and slate, with sandstone (mostly greywacke) interbeds. The rocks are locally calcareous and highly deformed, showing cleavage development, disrupted beds, and folding. Where sedimentary features are preserved, the sandstones are typically turbidites (Crossen, 1992).

Various surficial deposits are found in the general area. The origin of these deposits is predominantly glacial, with components of alluvial, colluvial, and lacustrine deposition (Winkler, 1992). The glacier ice mass deposited silt, sand, gravel, cobbles and boulders during multiple glacial advancements and recessions. The soils deposited during the glacial advancements were consolidated by the weight of the ice. During the recessional phase of glaciation, soils consolidated by the ice mass were probably eroded to some degree by melt water, and unconsolidated alluvial materials were deposited.

According to the well log the well is 60 feet below the surface and encounters a confining layer from 30-40 feet bls. The static water level at the time of drilling (1999) was 25 feet bls. The Sanitary Survey for this system was not available. Due to it recent construction, it is assumed that the well is grouted, sealed and sloped away from the wellhead. All of which, provide protection from contaminant entering the source waters at the casing.

The system operates year-round and serves 60 non-residents through 1 service connection.

WHITTIER ACCESS TUNNEL 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. 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.

The protection areas established for wells by 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 outline of the immediate watershed and an analytical calculation was used to determine the size and shape of the protection area for Whittier Access Tunnel. The input parameters describing the attributes of the aquifer for the analytical calculation were adopted from Groundwater (Freeze and Cherry 1979). Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area (Please refer to the Guidance Manual for Class A 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 of the water 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 protection area for Whittier Access Tunnel is limited by its immediate watershed and includes only Zone A (See Map 1 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 Whittier Access Tunnel protection area. 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 Map 2 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 7 in Appendix B contain the ranking of inventoried potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals and other organic chemical

VULNERABILITY OF WHITTIER ACCESS TUNNEL DRINKING WATER SYSTEM

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, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

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

- Natural susceptibility; and
- Contaminant risks.

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 well for Whittier Access Tunnel appears to be completed in a semi-confined aquifer. Well logs indicate that a thin confining layer is present from 30-40 feet bls. This layer may provide a protective barrier from the movement of contaminants to the subsurface. However, confining layers are often discontinuous. In areas where the protective layer is not present, contaminants may enter the aquifer uninhibited though direct infiltration of precipitation.

Table 2 shows the Susceptibility scores and ratings for Whittier Access Tunnel.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	15	High
Natural Susceptibility	15	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	30	Low
Nitrates and/or Nitrites	31	Low
Volatile Organic Chemicals		Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	29	Low
Synthetic Organic Chemicals	25	Medium
Other Organic Chemicals	12	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 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	45	Medium
Nitrates and Nitrites	45	Medium
Volatile Organic Chemicals	50	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	45	Medium
Synthetic Organic Chemicals	40	Medium
Other Organic Chemicals	25	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is high with large capacity septics and roads presenting risk to the source. (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. Bacteria and viruses have not been detected during recent water sampling of the system. 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 high with capacity septics and roads presenting risk to the source. (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Sampling history for Whittier Access Tunnel well indicates that low concentrations of nitrate have been detected. Existing nitrate concentration is approximately 0.23 mg/L or 2% of the Maximum Contaminant Level (MCL) of 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. Nitrate concentrations have varying from 0.126 mg/l to 0.295 mg/L within the past five years. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L, or 20% of the MCL, and are derived primarily from the decomposition of organic matter in soils (Wang, Strelakos, Jokela, 2000). The levels detected are considered safe for human consumption.

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 high with a large capacity septic system, above ground fuel tanks, a road and the railroad corridor creating risk for the source.(See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Volatile organic chemicals have detected low concentrations of dichloromethane during recent a sampling of the well. Dichloromethane is a common laboratory chemical and is often detected is samples due to cross-contamination. The level detected is 18% of the MCL and considered safe for human consumption. 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 is medium with a large capacity septic system, above ground fuel tank, a road, the railroad corridor and existing contamination creating risk for the source. (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Barium and thallium have been detected at low concentration levels. The concentration levels detected are below the MCL and are considered safe for human consumption.

After combining the contaminant risk for heavy metals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is medium with large capacity septic systems and the rail corridor creating risk for the source. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to synthetic organic chemicals of the well is medium. (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

Other Organic Chemicals

The contaminant risk for other organic chemicals is low with the large capacity septic system, road and the railroad corridor creating risk for the source. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is low. (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals have been sampled for within the past 5 years.

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 Whittier Access Tunnel 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 Whittier Access Tunnel drinking water source.

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ACKNOWLEDGMENT

Source Water Assessments in the Portage area were jointly prepared by ADEC-Drinking Water Protection Program and URS Corporation. The Drinking Water Protection Program would like to thank URS Corporation for their efforts in researching the area.

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APPENDIX A

Whittier Access Tunnel
Drinking Water Protection Area Location Map
(Map 1)

Whittier Access Tunnel Well

Portage Lake

Whittier

Map 1- Whittier Access Tunnel

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 750 1,500 3,000 4,500 6,000 Feet

1:21,217

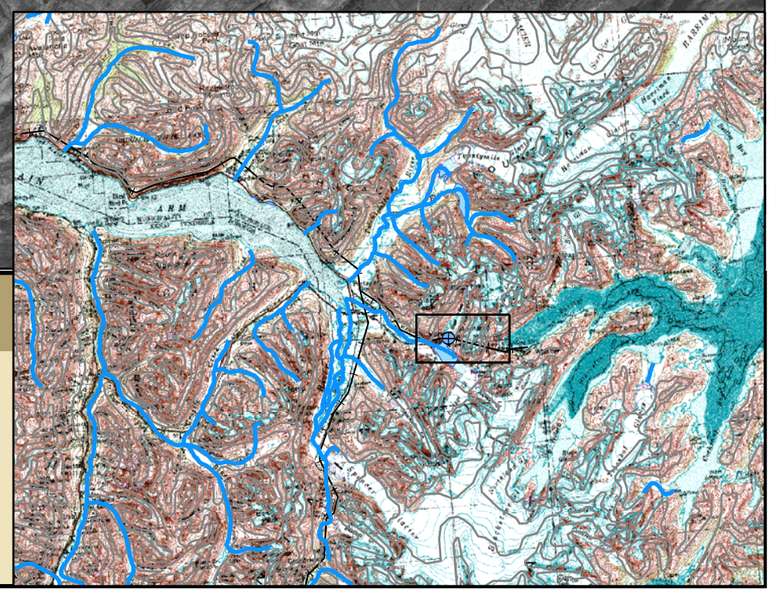
Data Sources:
USGS- 1:63,000 Background
MOA-WMS-Lake and aerial photo
DOT:Roads
RDI: Railroad and rivers.

Watershed delineated from USGS 63K topo maps and aerial photo.

N
W E
S

Legend

- Whittier Access Tunnel
- Zone A Protection Area
- Railroads
- Roads
- Lakes
- Rivers



APPENDIX B

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel (Tables 1-7)

Table 1

Contaminant Source Inventory for ***Whittier Access Tunnel***

PWSID 218582.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	2	
Tanks, gasoline (above ground)	T10	T10-01	A	2	
Tanks, gasoline (above ground)	T10	T10-02	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	2	
Rail corridors	X30	X30-01	A	2	

Table 2

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel
Sources of Bacteria and Viruses

PWSID 218582.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel Sources of Nitrates/Nitrites

PWSID 218582.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	

Table 4

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel
Sources of Volatile Organic Chemicals

PWSID 218582.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Tanks, gasoline (above ground)	T10	T10-01	A	Medium	2	
Tanks, gasoline (above ground)	T10	T10-02	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Rail corridors	X30	X30-01	A	Medium	2	

Table 5

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 218582.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Tanks, gasoline (above ground)	T10	T10-01	A	Medium	2	
Tanks, gasoline (above ground)	T10	T10-02	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Rail corridors	X30	X30-01	A	Low	2	

Table 6

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel
Sources of Synthetic Organic Chemicals

PWSID 218582.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Rail corridors	X30	X30-01	A	Medium	2	

Table 7

Contaminant Source Inventory and Risk Ranking for Whittier Access Tunnel
Sources of Other Organic Chemicals

PWSID 218582.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Rail corridors	X30	X30-01	A	Low	2	

APPENDIX C

Whittier Access Tunnel
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Whittier Access Tunnel Well
X20-01
T10-01
D10-01
T10-02
X30-01

Map 2- Whittier Access Tunnel Potential and Existing Source of Contamination

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 800 1,600 2,400 3,200 Feet

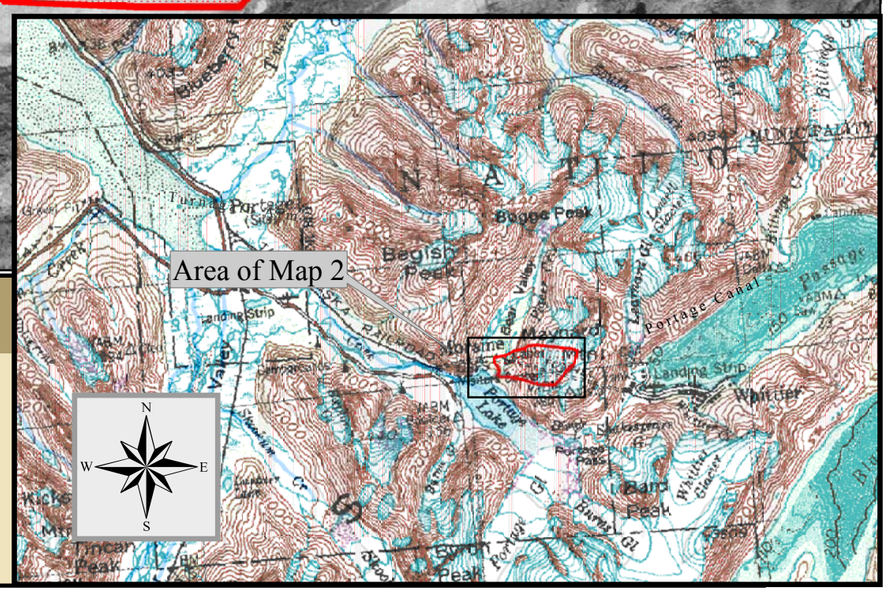
1:9,708

Data Sources:
USGS- 1:63,000 Background
MOA-WMS-Lake and aerial photo
DOT:Roads
RDI: Railroad and rivers.

Watershed delineated from USGS 63K and aerial photos.

Legend

- Whittier Access Tunnel
- Zone A Protection Area
- Large Capacity Septic Tank (D10)
- Above Ground Fuel Tanks (T10)
- Railroads
- Roads
- Lakes
- Rivers



APPENDIX D

Vulnerability Analysis for Whittier Access Tunnel Public Drinking Water Source

(Charts 1-14)

Chart 1. Susceptibility of the wellhead - Whittier Access Tunnel

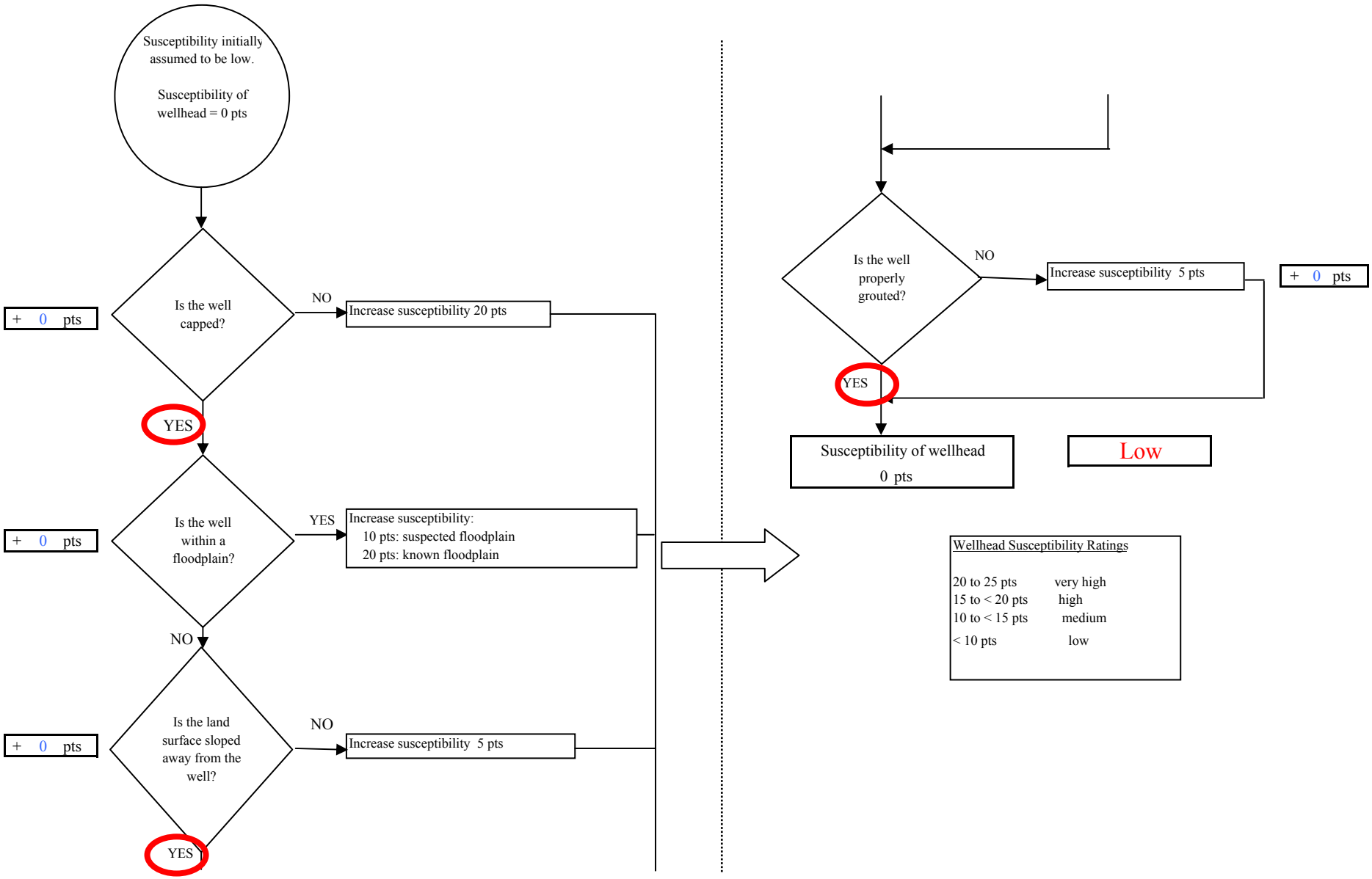


Chart 2. Susceptibility of the aquifer - Whittier Access Tunnel

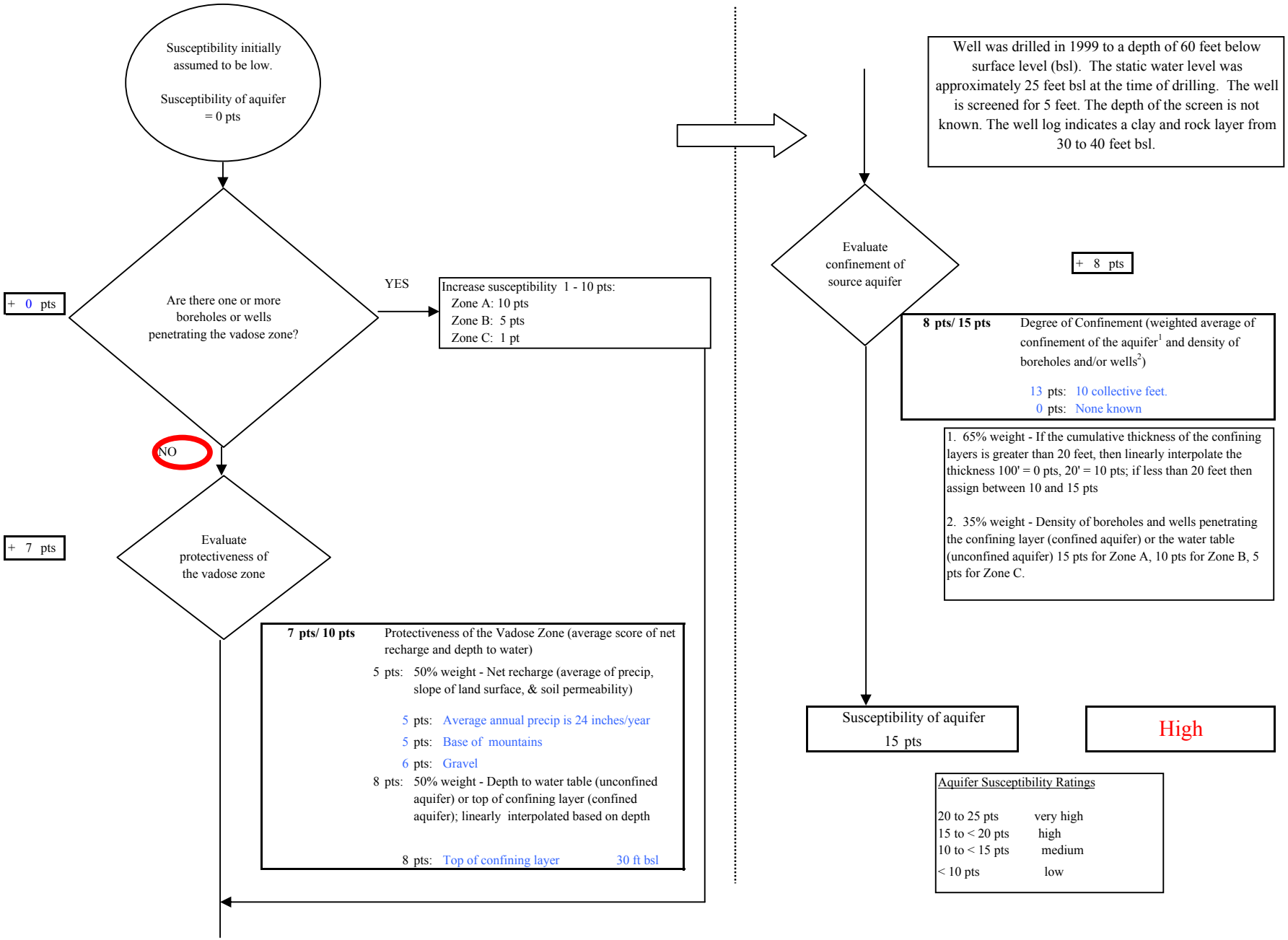
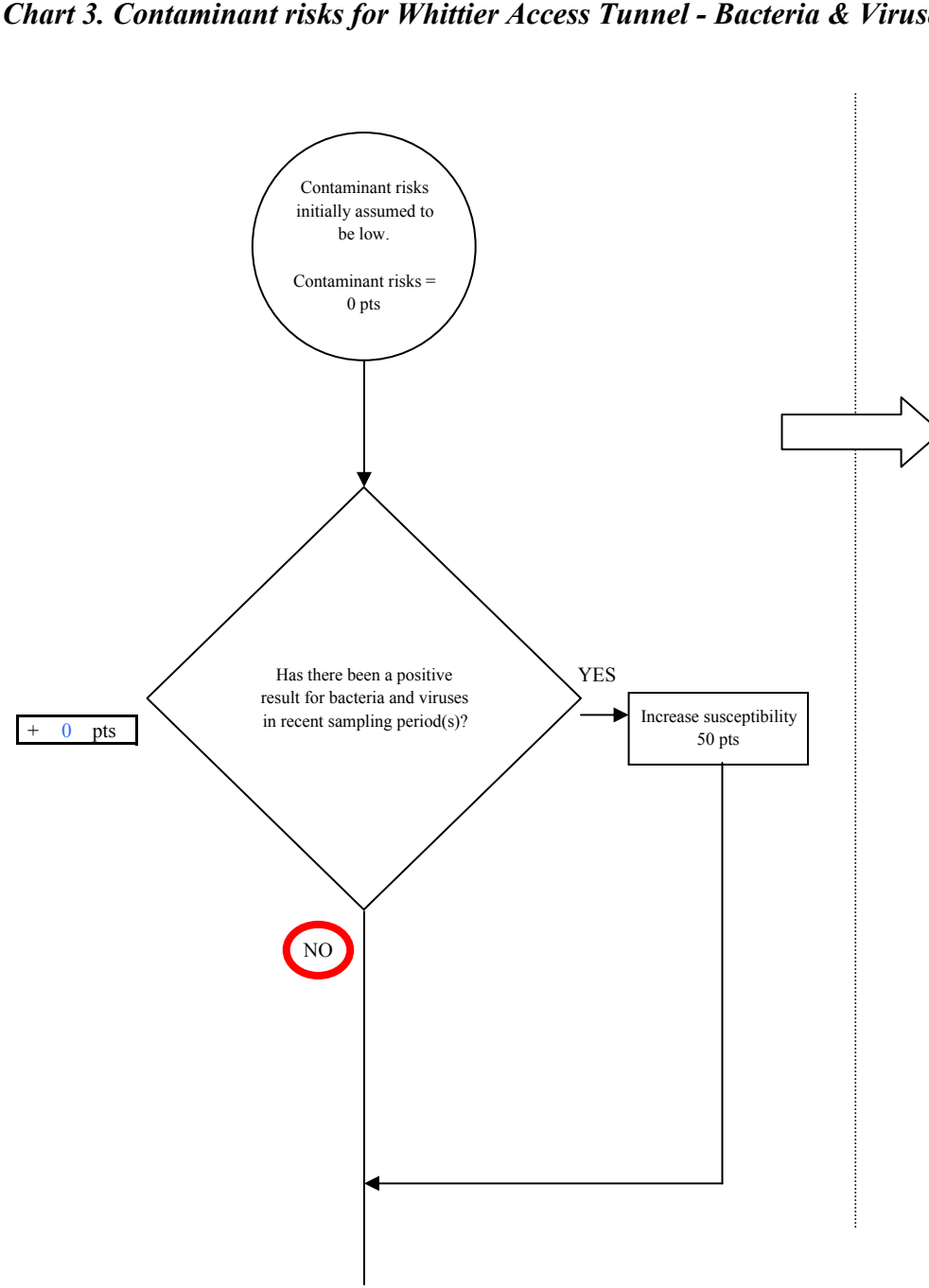
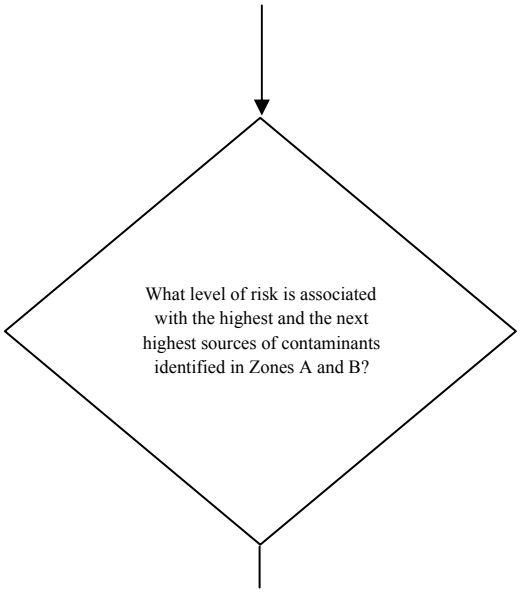


Chart 3. Contaminant risks for Whittier Access Tunnel - Bacteria & Viruses





+ 30 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)	1	0	1
Medium(s)	0	0	0
Low(s)	1	0	1

0 Pts	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 30

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 Whittier Access Tunnel - Bacteria & Viruses

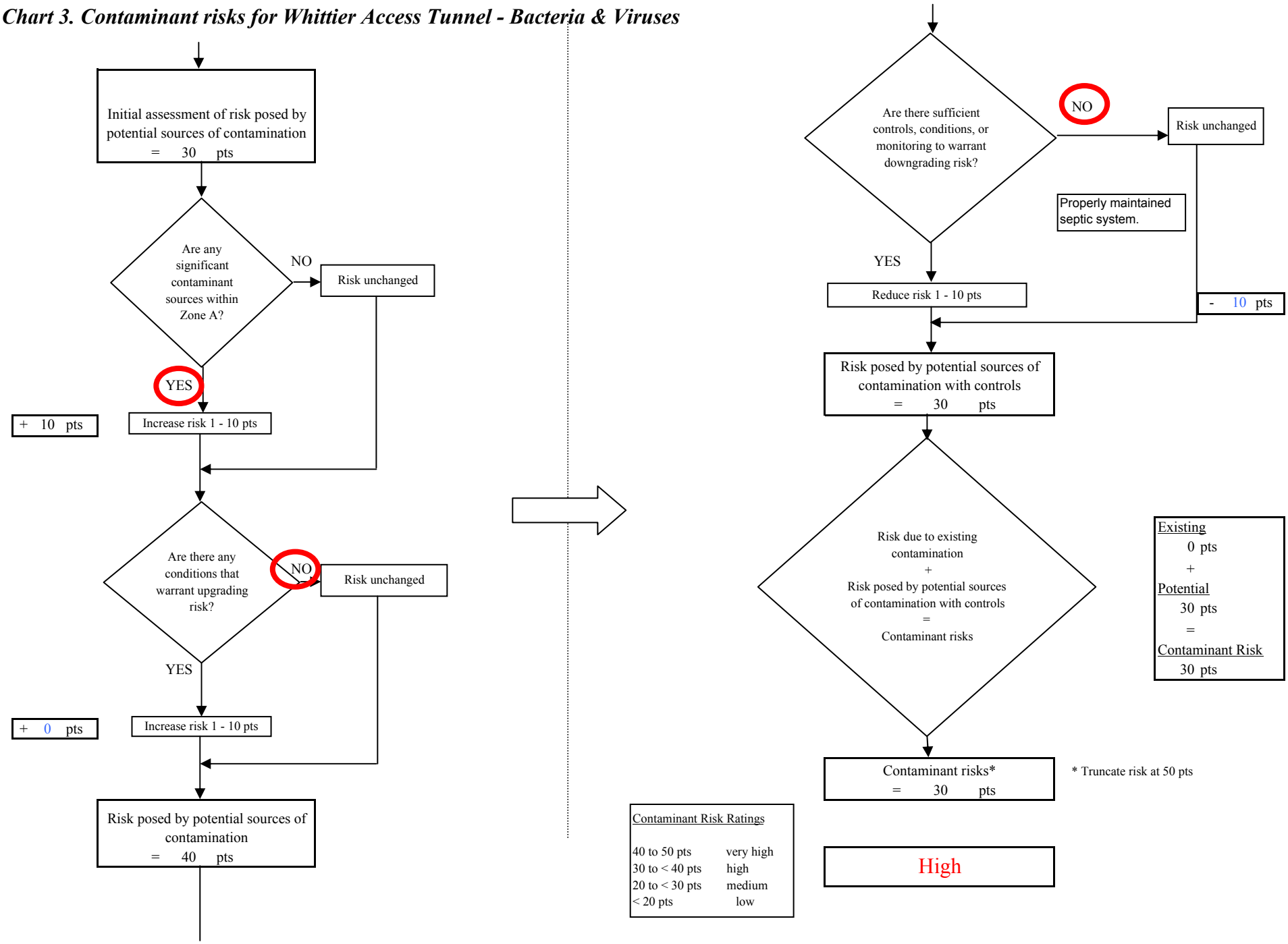


Chart 4. Vulnerability analysis for Whittier Access Tunnel - Bacteria & Viruses

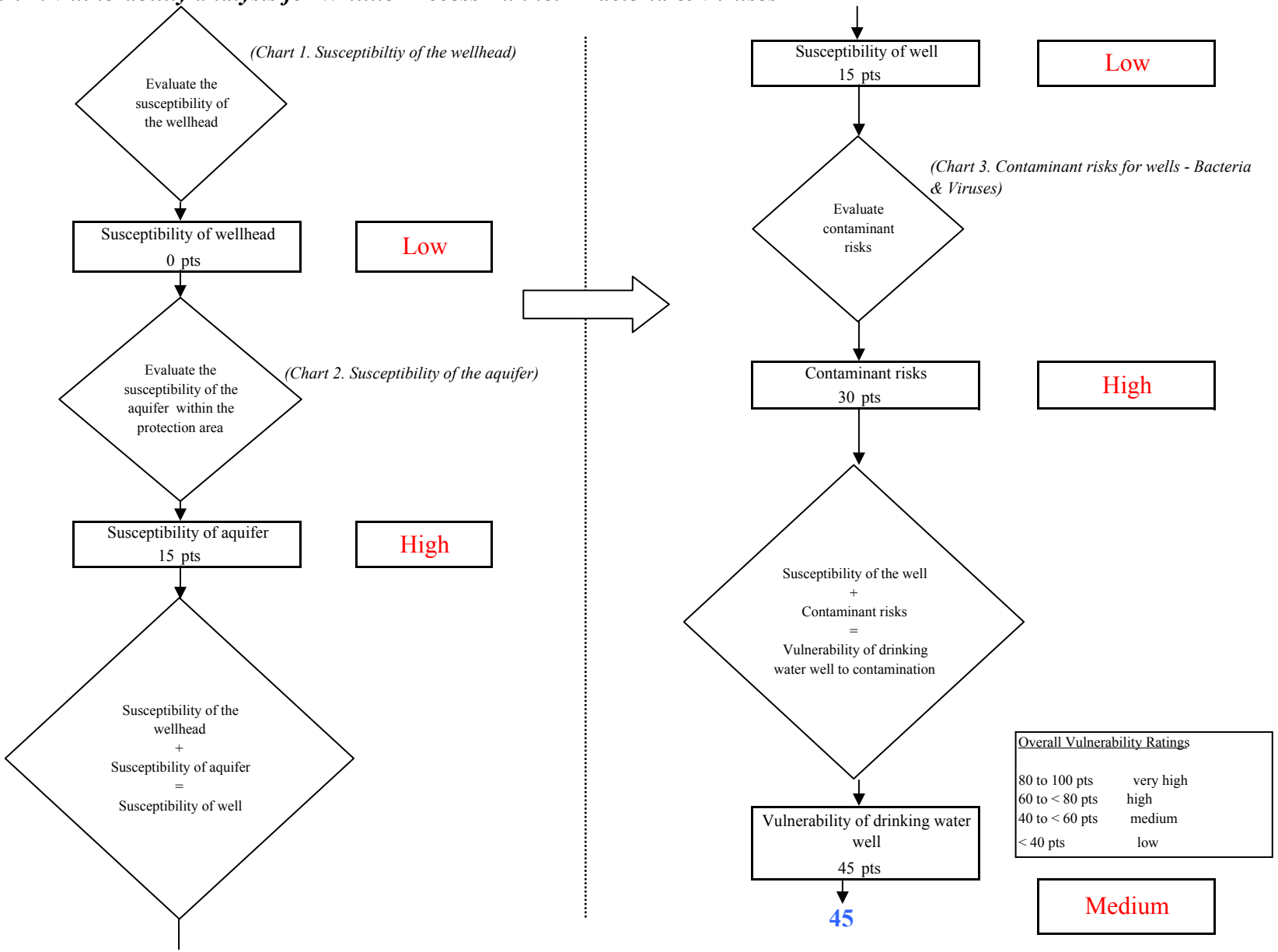


Chart 5. Contaminant risks for Whittier Access Tunnel - Nitrates and Nitrites

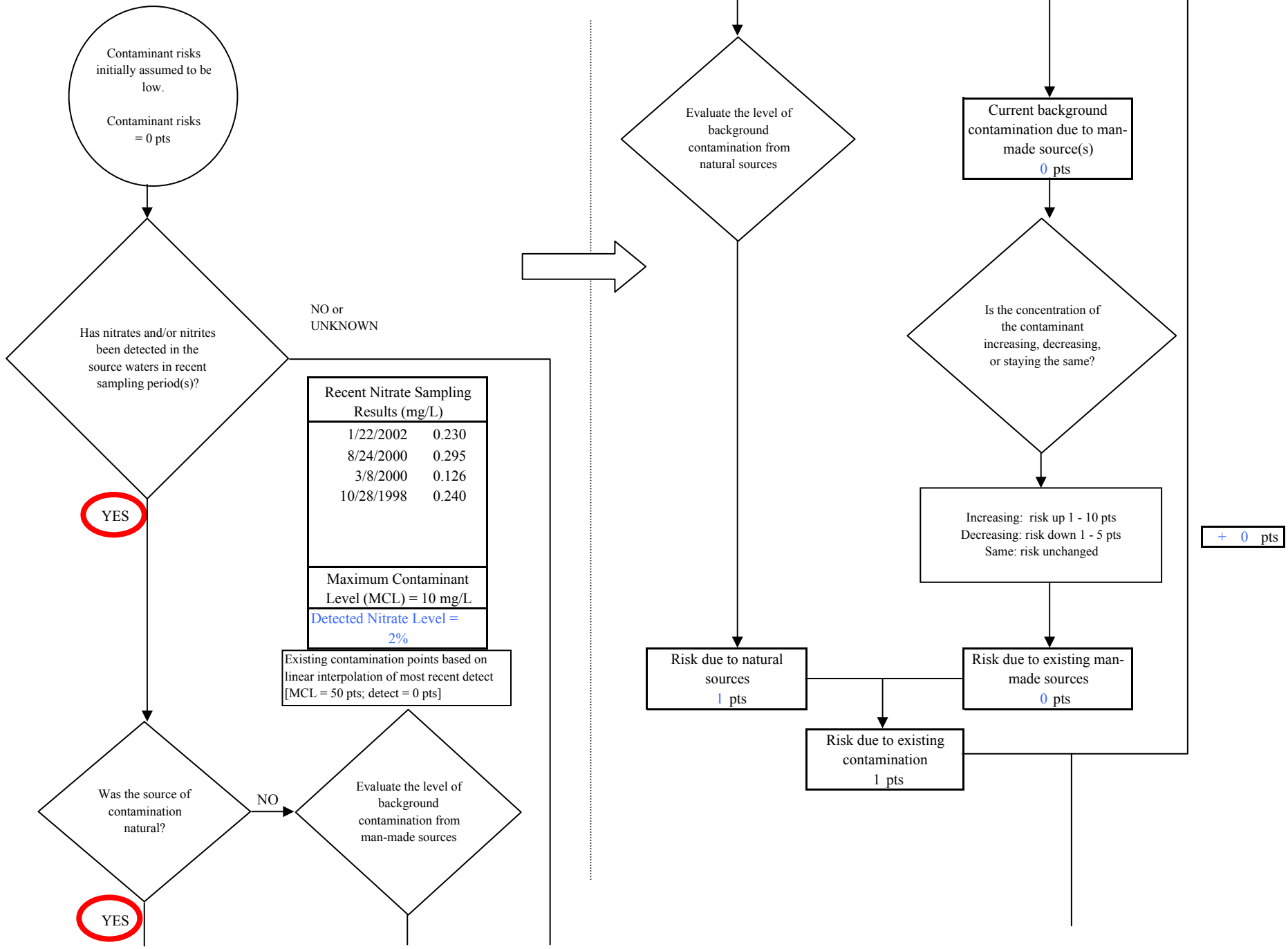


Chart 5. Contaminant risks for Whittier Access Tunnel - Nitrates and Nitrites

+ 30 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)	1	0	1
Medium(s)	0	0	0
Low(s)	1	0	1

	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 30

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.

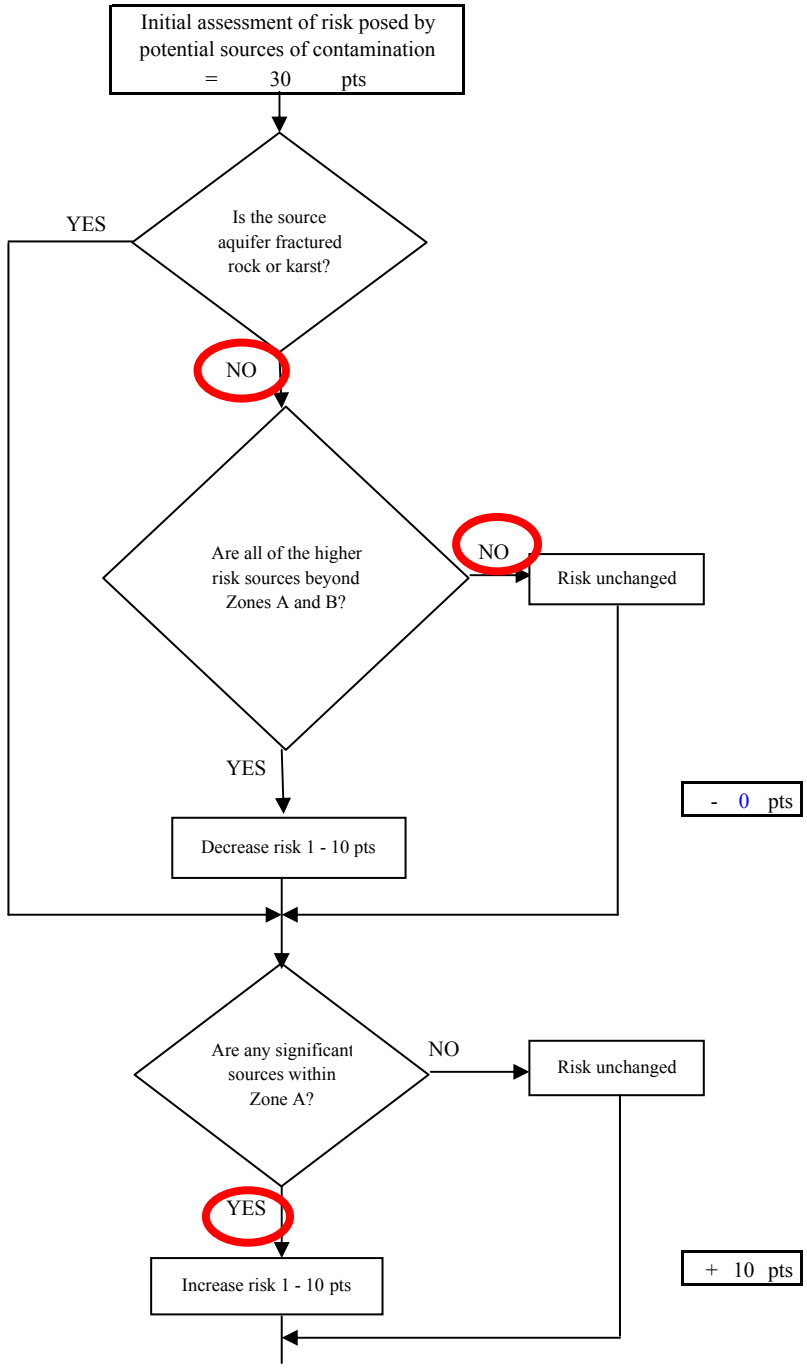
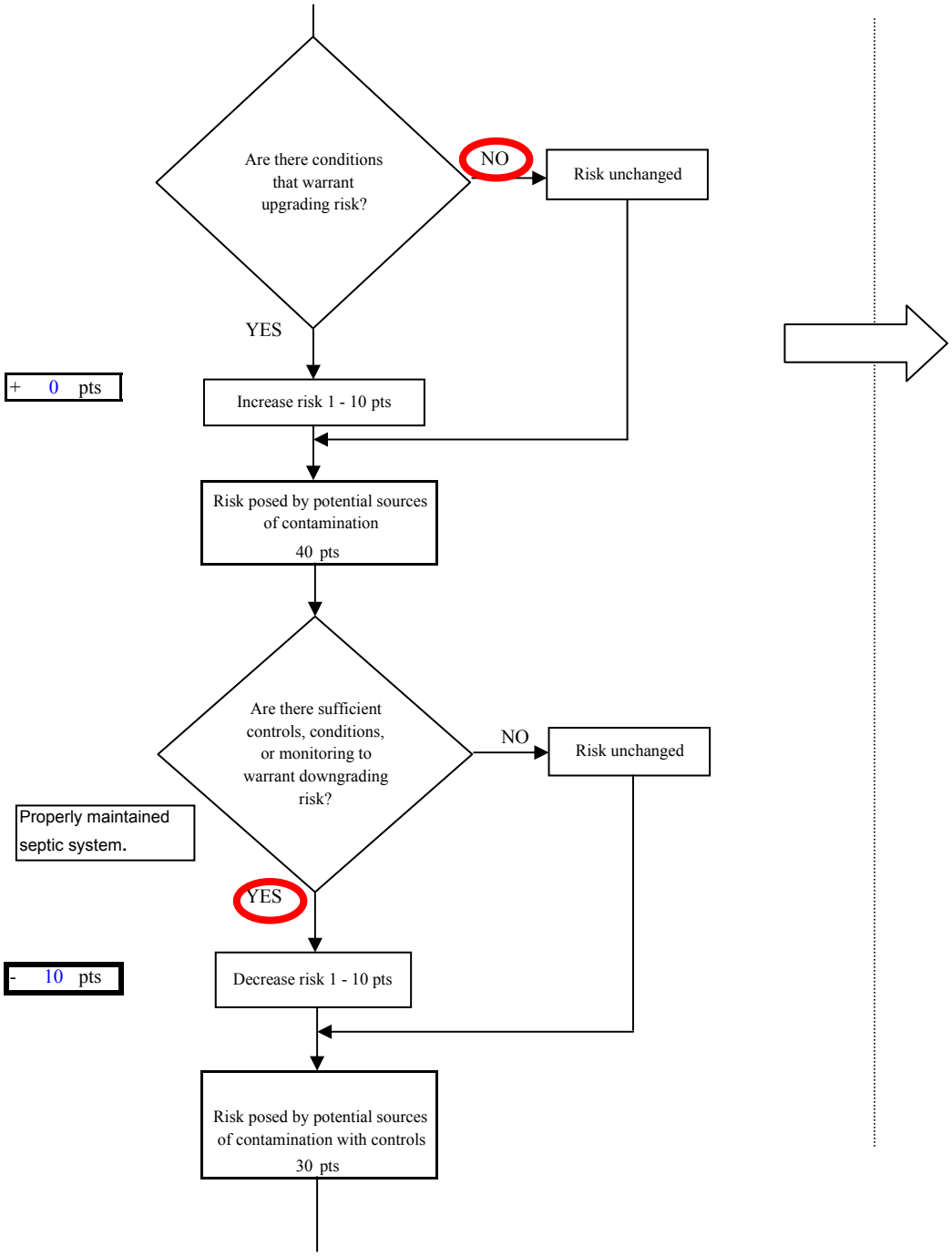


Chart 5. Contaminant risks for Whittier Access Tunnel - Nitrates and Nitrites



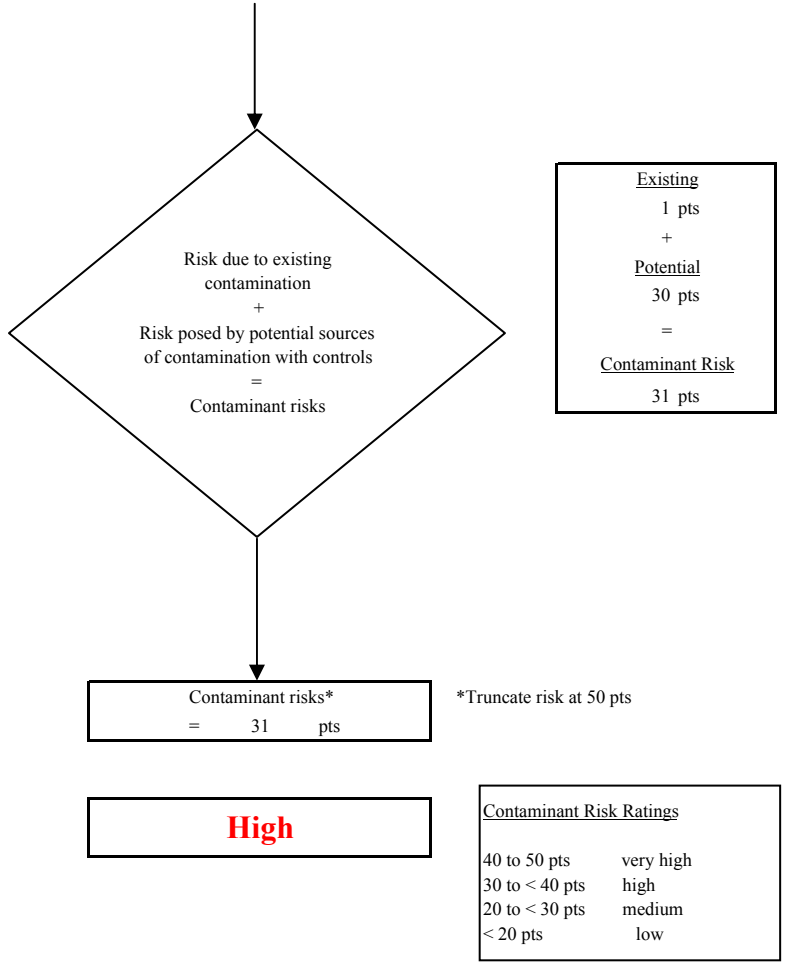


Chart 6. Vulnerability analysis for Whittier Access Tunnel - Nitrates and Nitrites

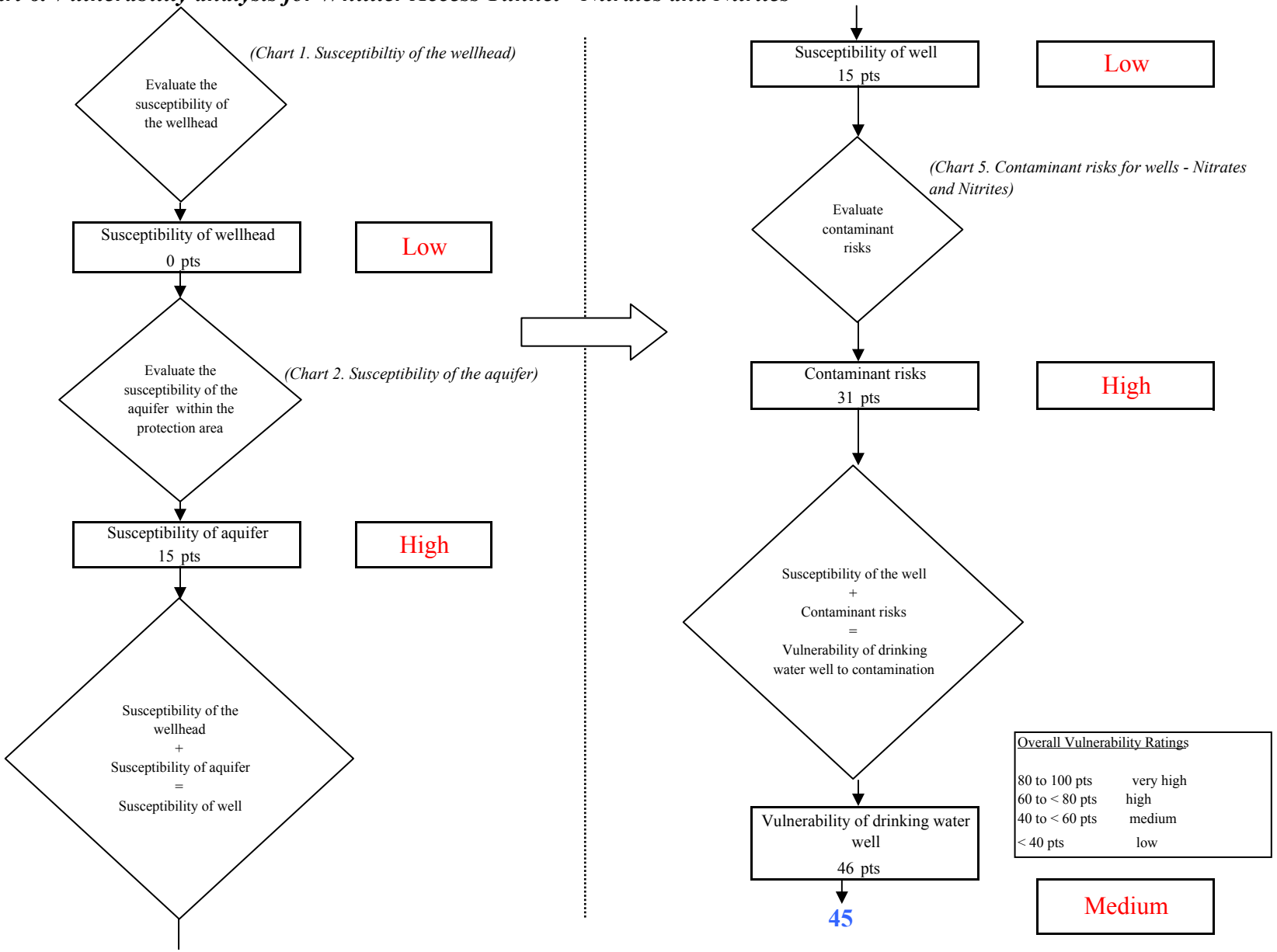


Chart 7. Contaminant risks for Whittier Access Tunnel - Volatile Organic Chemicals

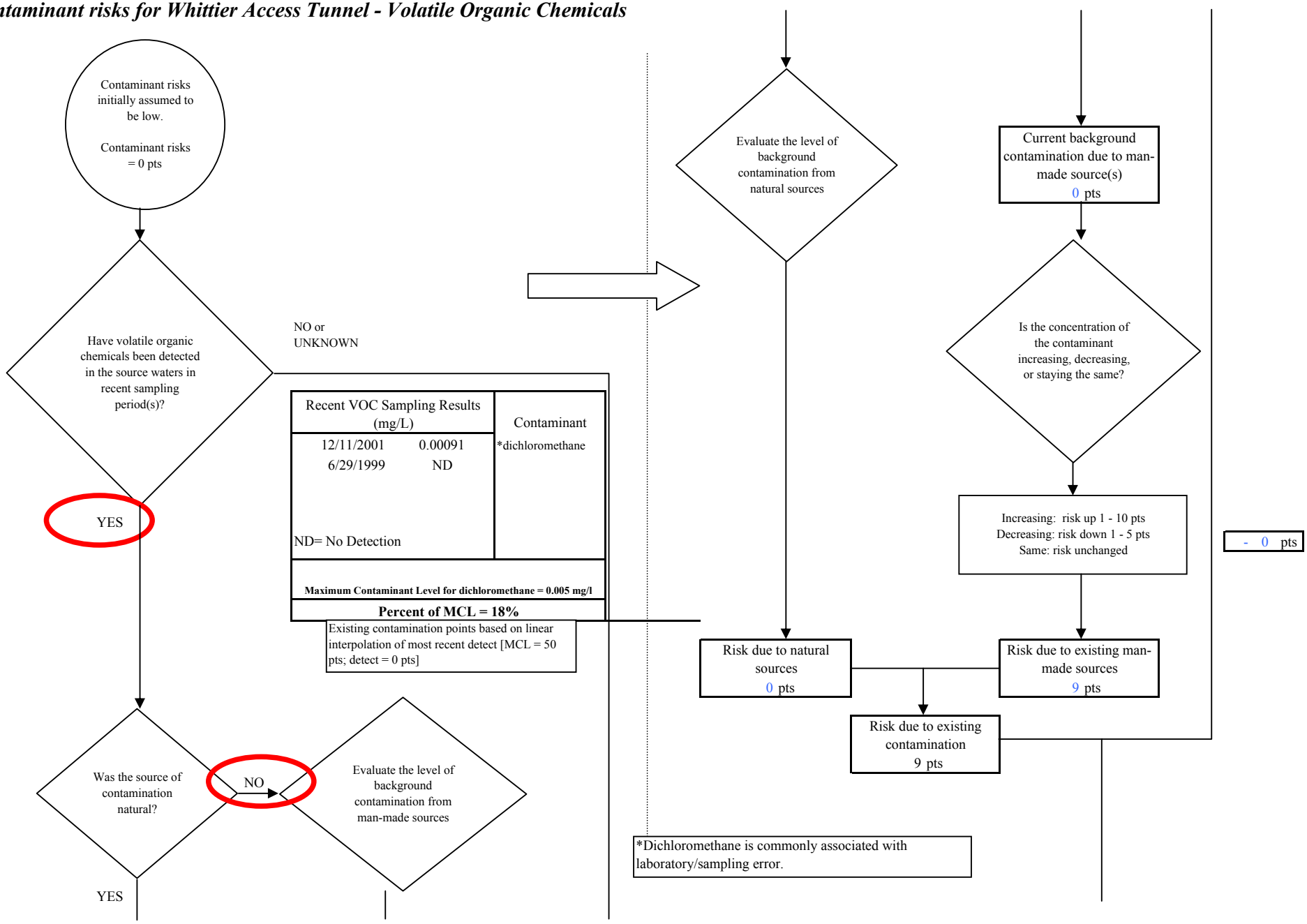


Chart 7. Contaminant risks for Whittier Access Tunnel - Volatile Organic Chemicals

+ 25 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)	3	0	3
Low(s)	2	0	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 25

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.

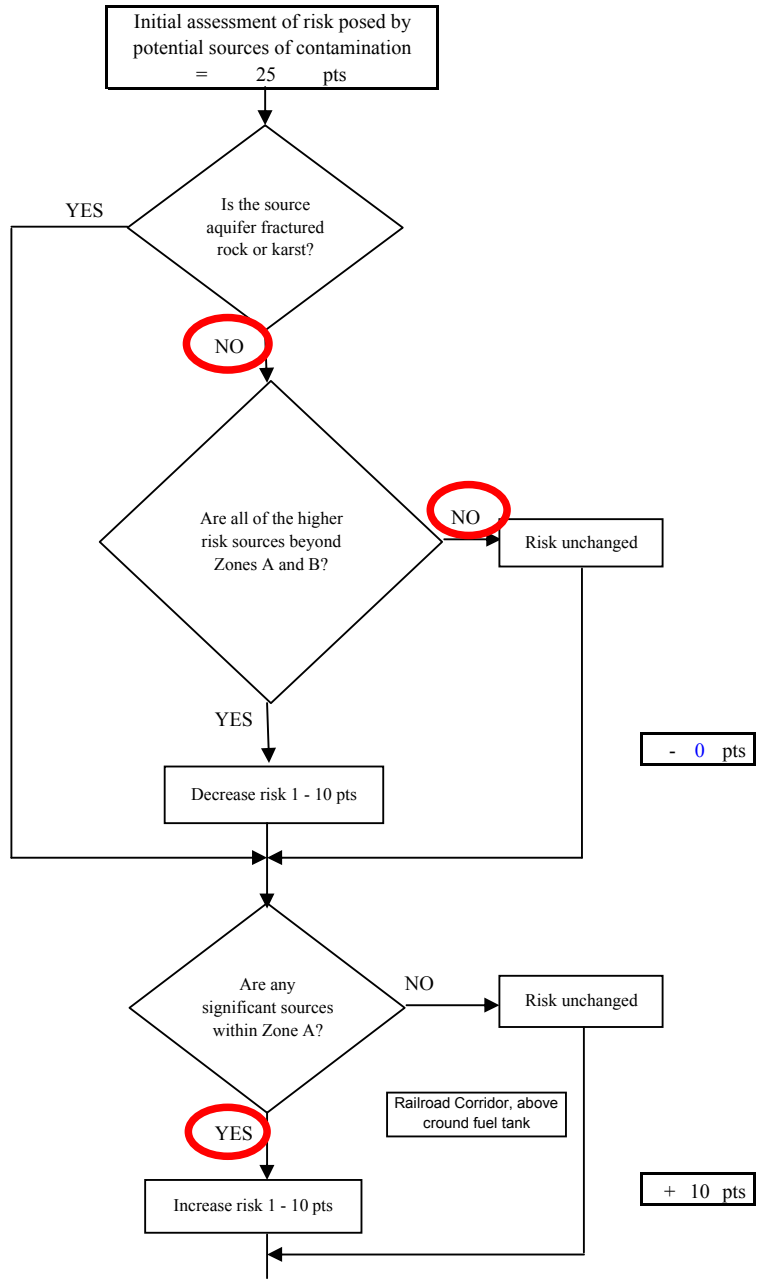


Chart 7. Contaminant risks for Whittier Access Tunnel - Volatile Organic Chemicals

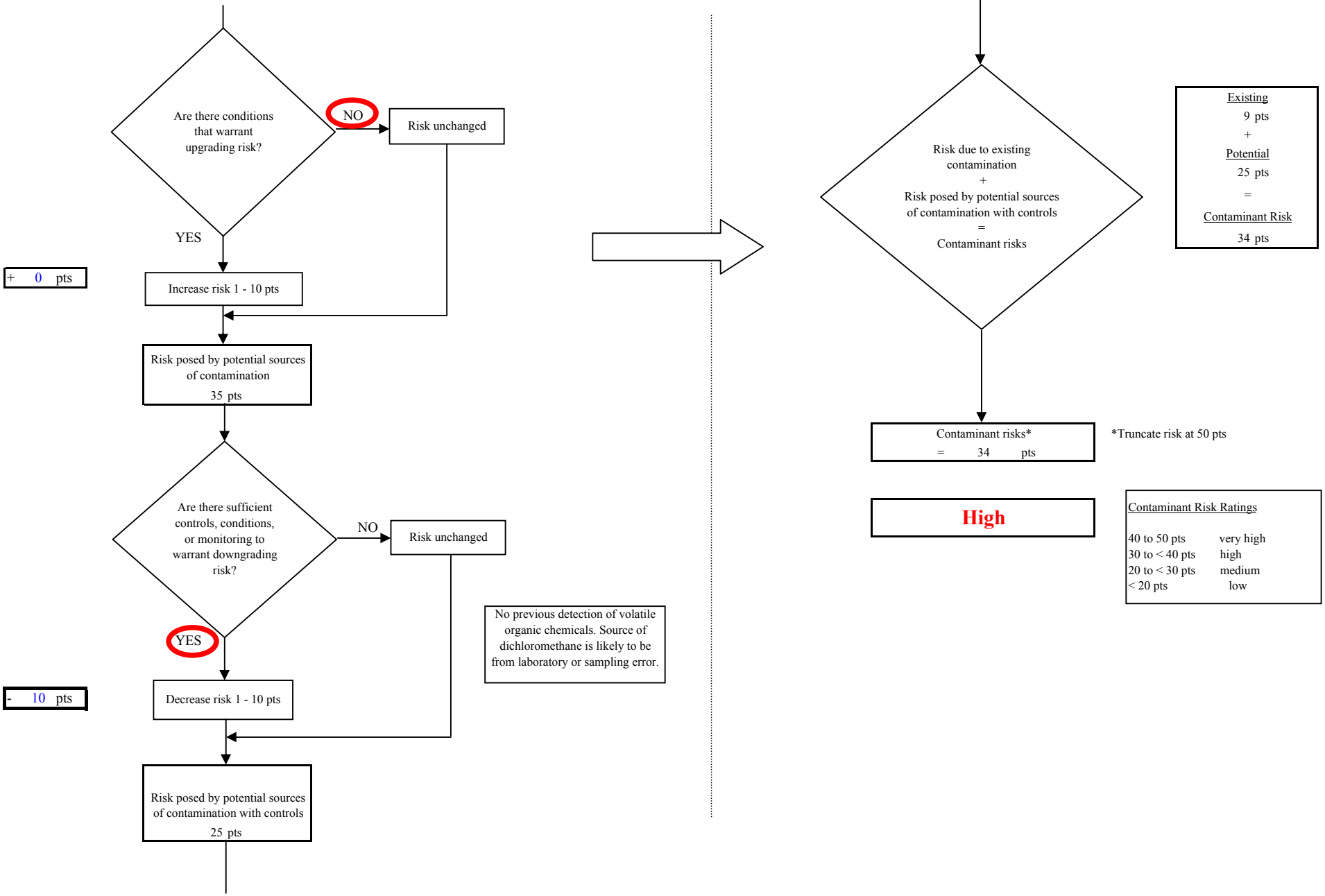


Chart 8. Vulnerability analysis for Whittier Access Tunnel - Volatile Organic Chemicals

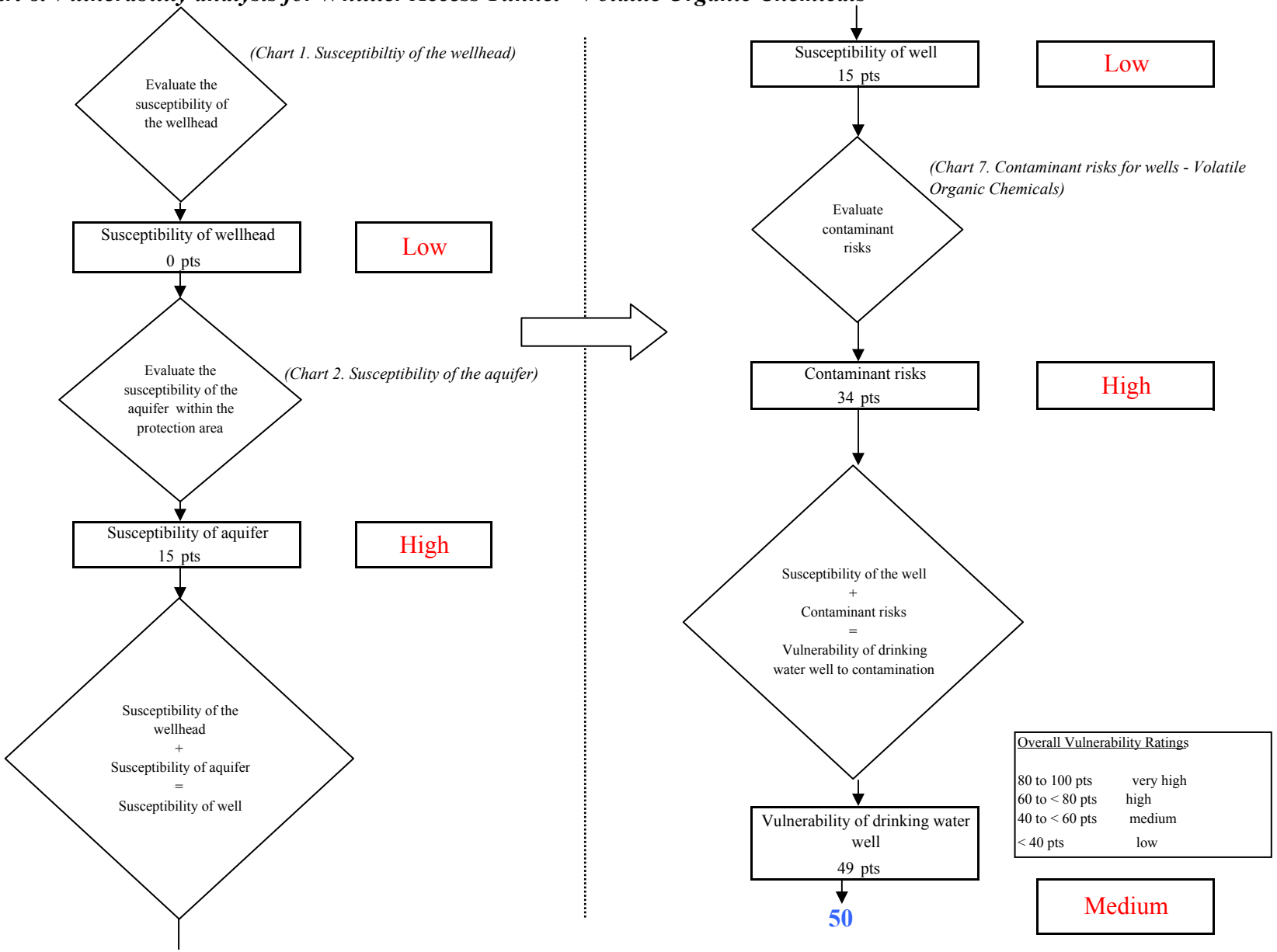


Chart 9. Contaminant risks for Whittier Access Tunnel - Heavy Metals, Cyanide and Other Inorganic Chemicals

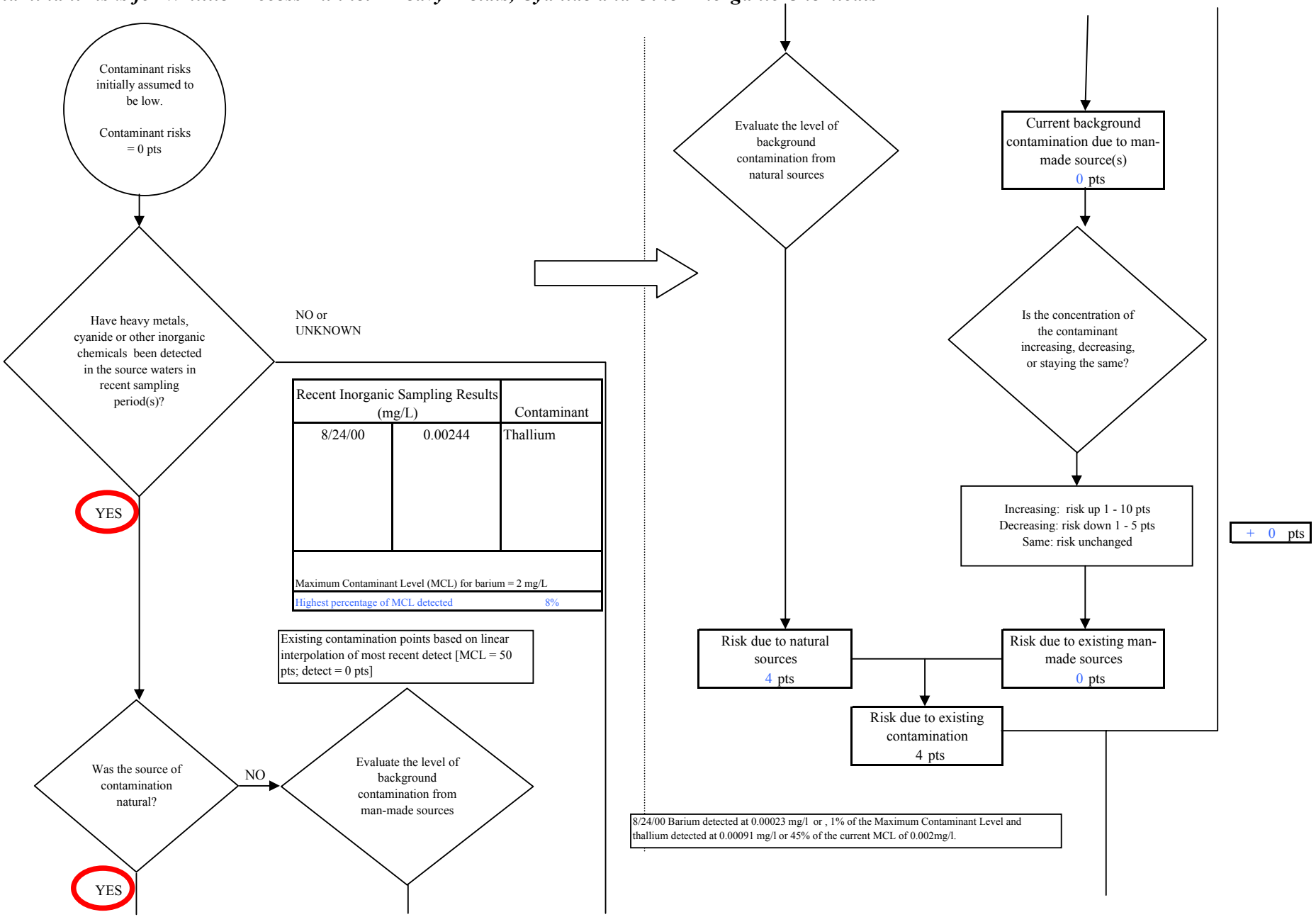


Chart 9. Contaminant risks for Whittier Access Tunnel - Heavy Metals, Cyanide and Other Inorganic Chemicals

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

	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

railroad corridor

YES → Increase risk 1 - 10 pts

+ 5 pts

Chart 9. Contaminant risks for Whittier Access Tunnel - Heavy Metals, Cyanide and Other Inorganic Chemicals

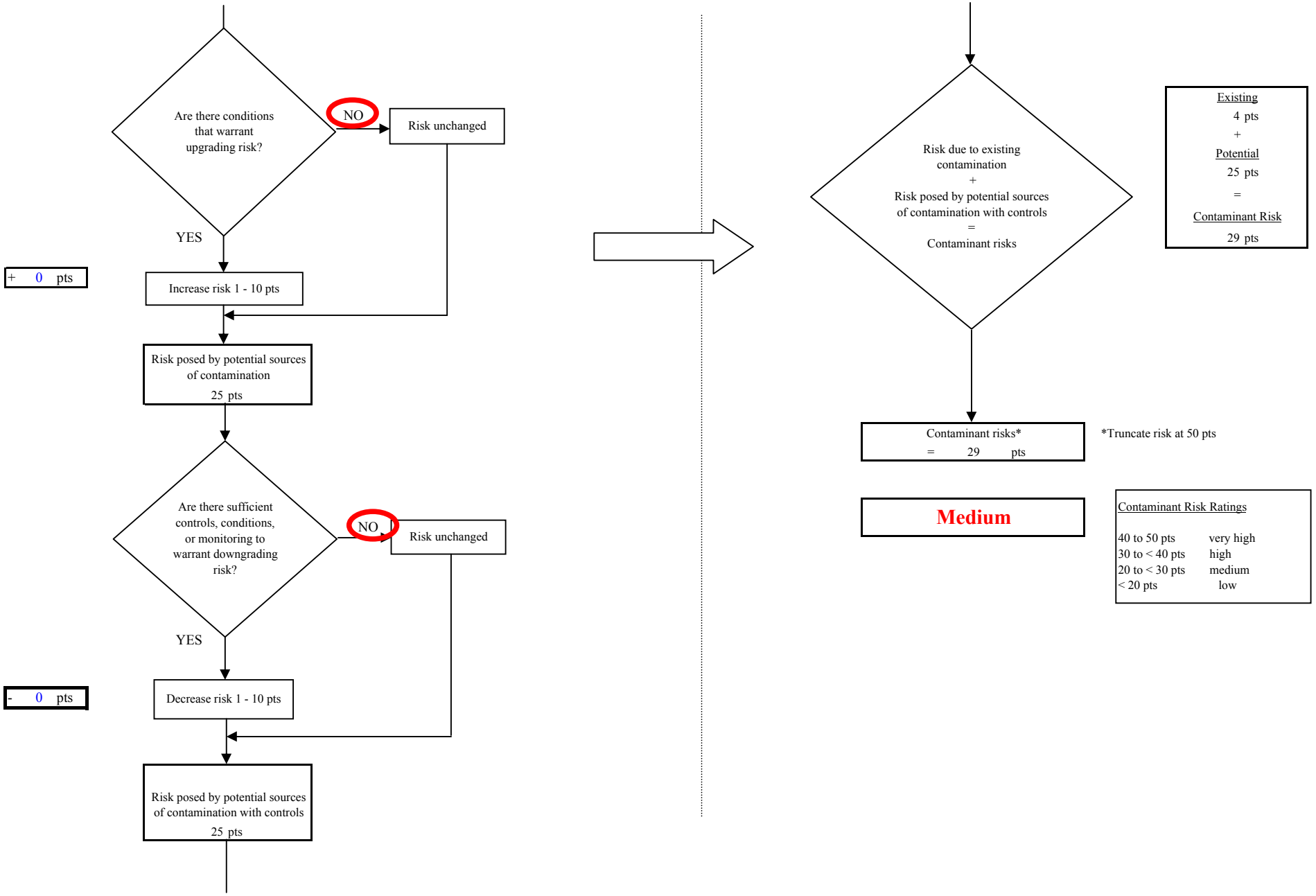


Chart 10. Vulnerability analysis for Whittier Access Tunnel - Heavy Metals, Cyanide and Other Inorganic Chemicals

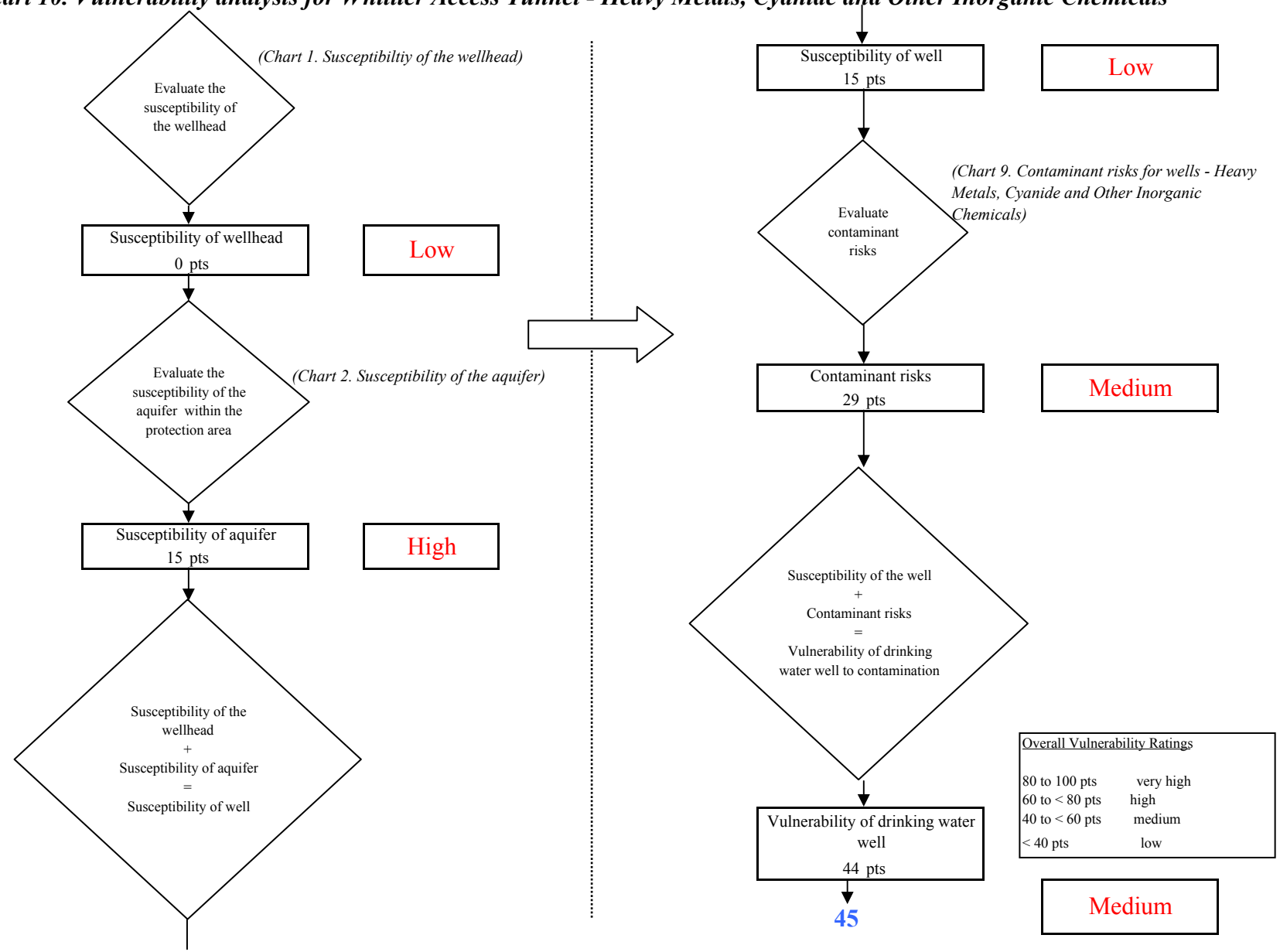


Chart 11. Contaminant risks for Whittier Access Tunnel - Synthetic Organic Chemicals

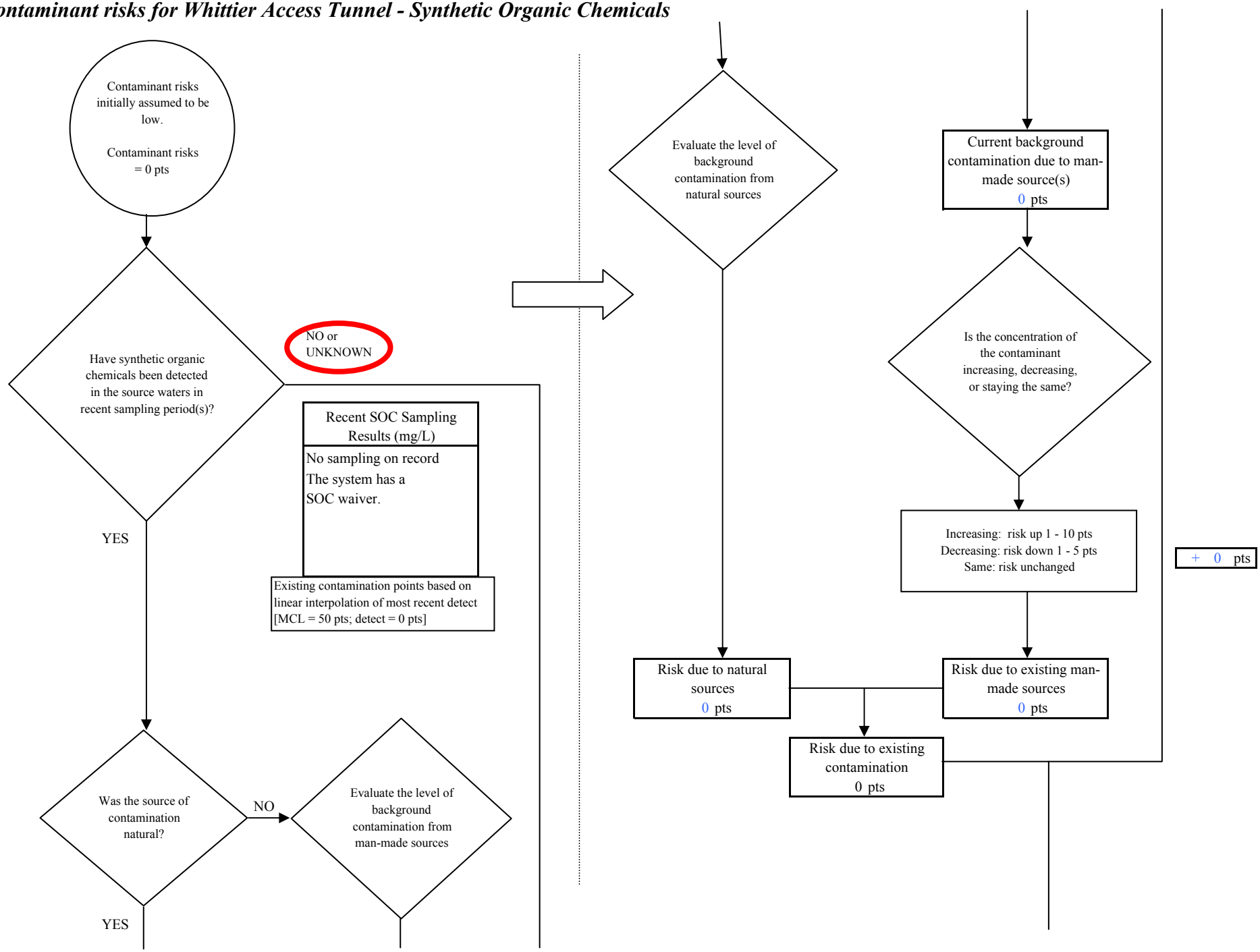


Chart 11. Contaminant risks for Whittier Access Tunnel - Synthetic Organic Chemicals

+ 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)	1	0	1
Low(s)	1	0	1

	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

Railroad Corridor

Increase risk 1 - 10 pts

+ 5 pts

Chart 11. Contaminant risks for Whittier Access Tunnel - Synthetic Organic Chemicals

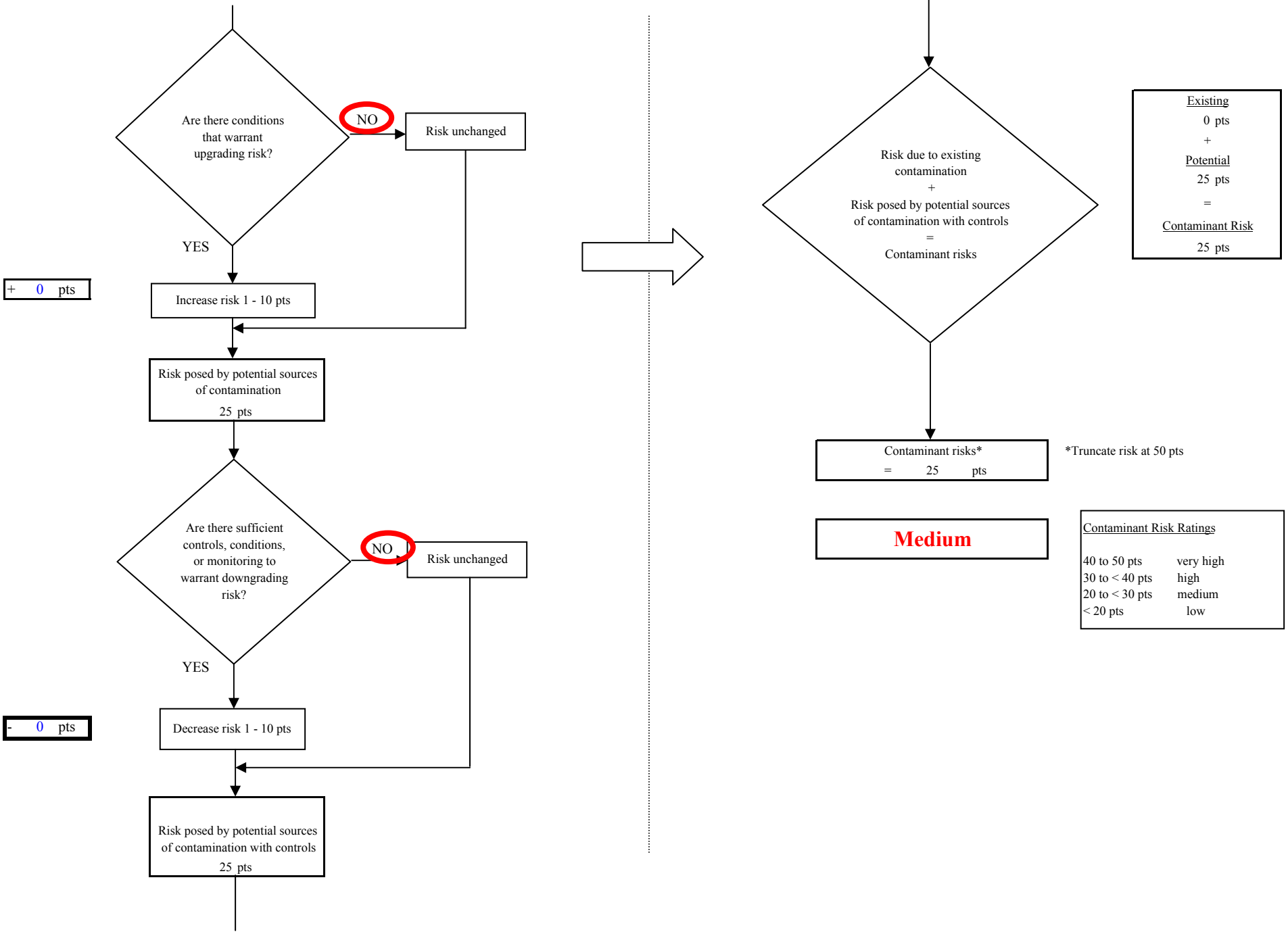


Chart 12. Vulnerability analysis for Whittier Access Tunnel - Synthetic Organic Chemicals

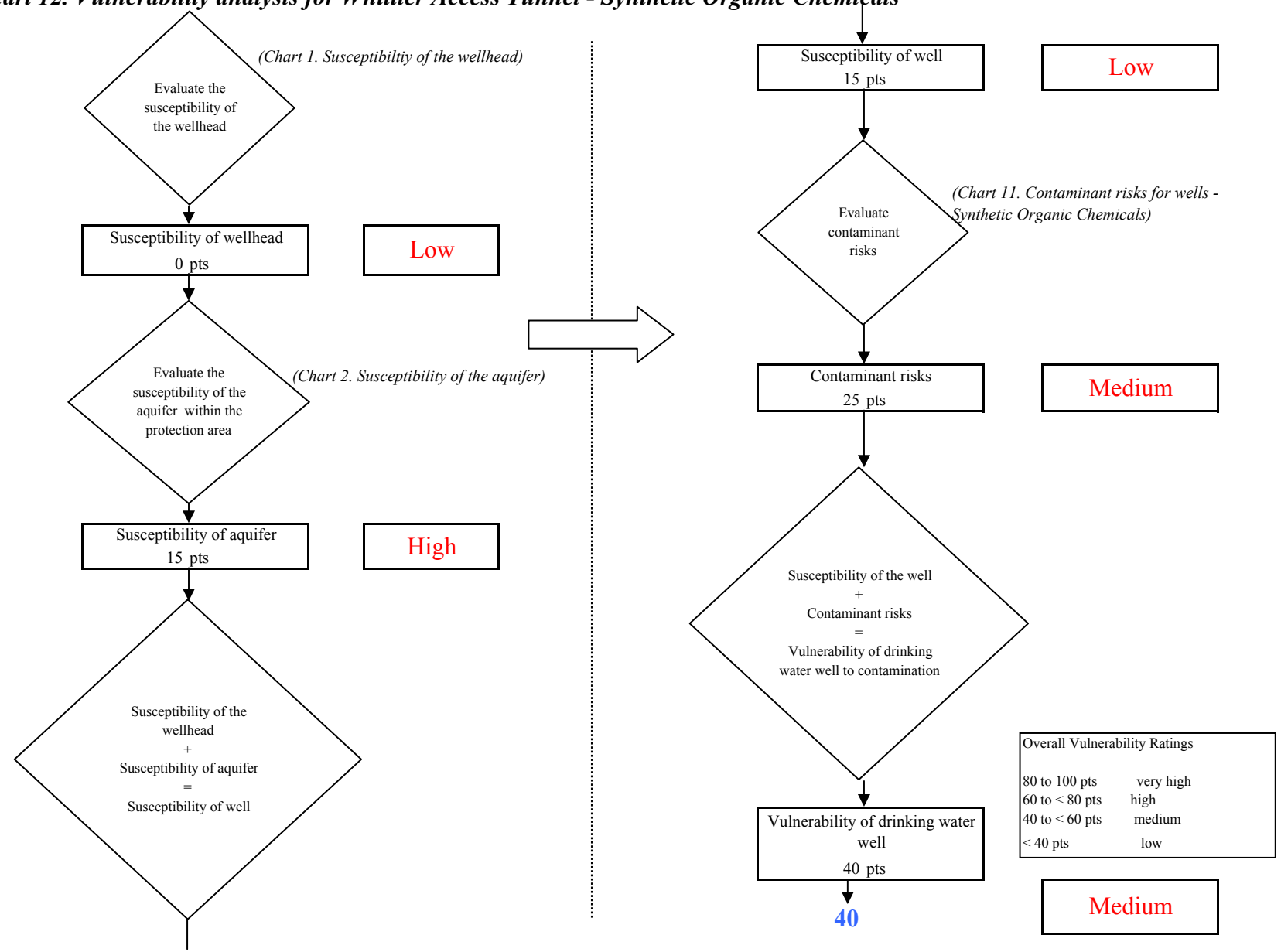


Chart 13. Contaminant risks for Whittier Access Tunnel - Other Organic Chemicals

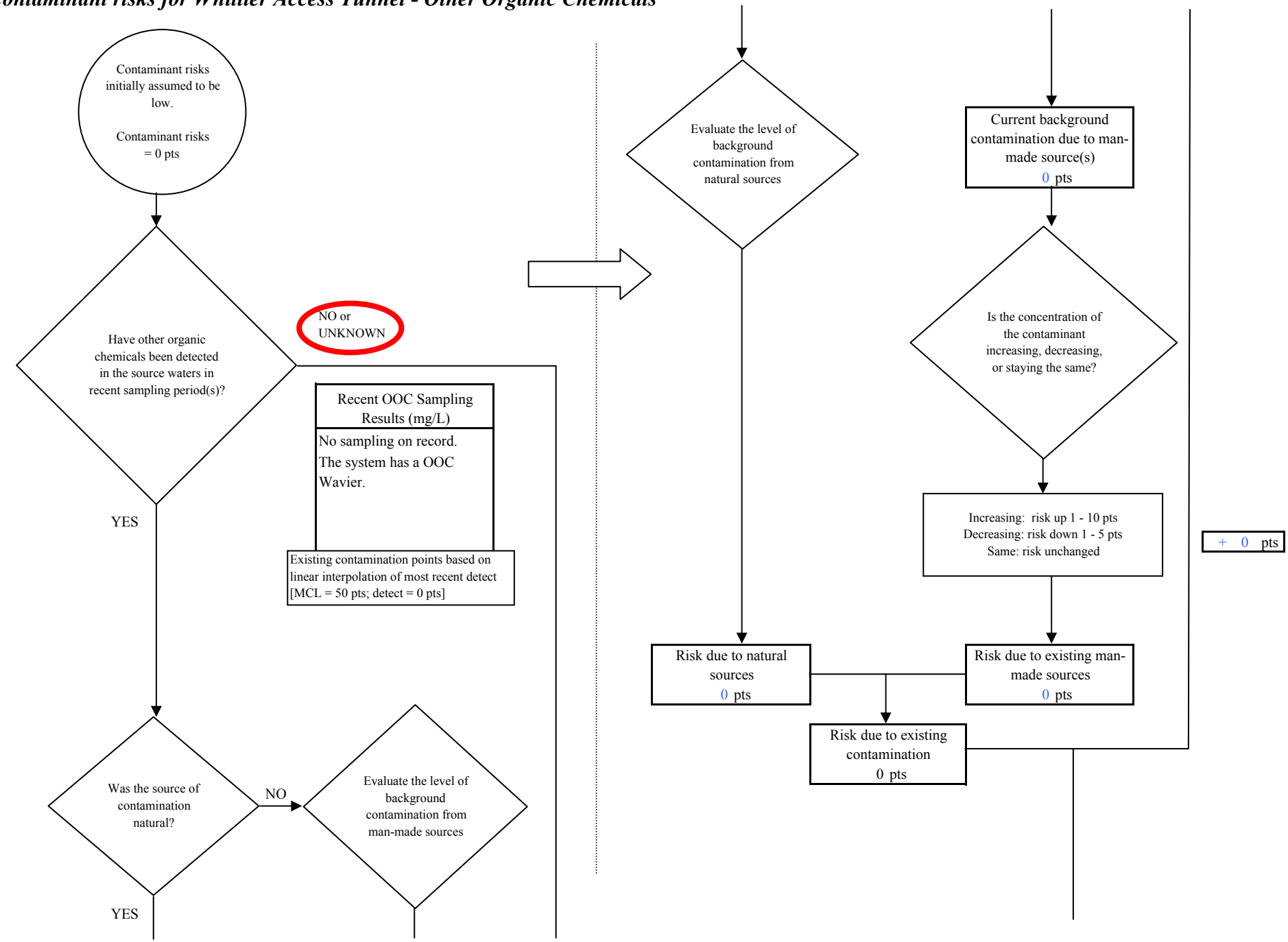
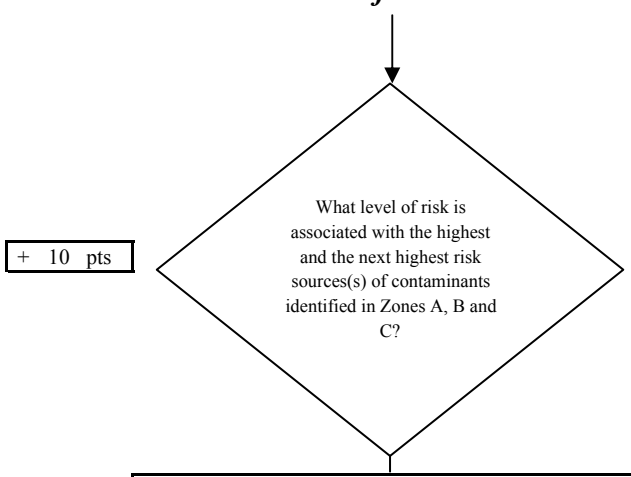


Chart 13. Contaminant risks for Whittier Access Tunnel - Other Organic Chemicals



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)	3	0	3

	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.

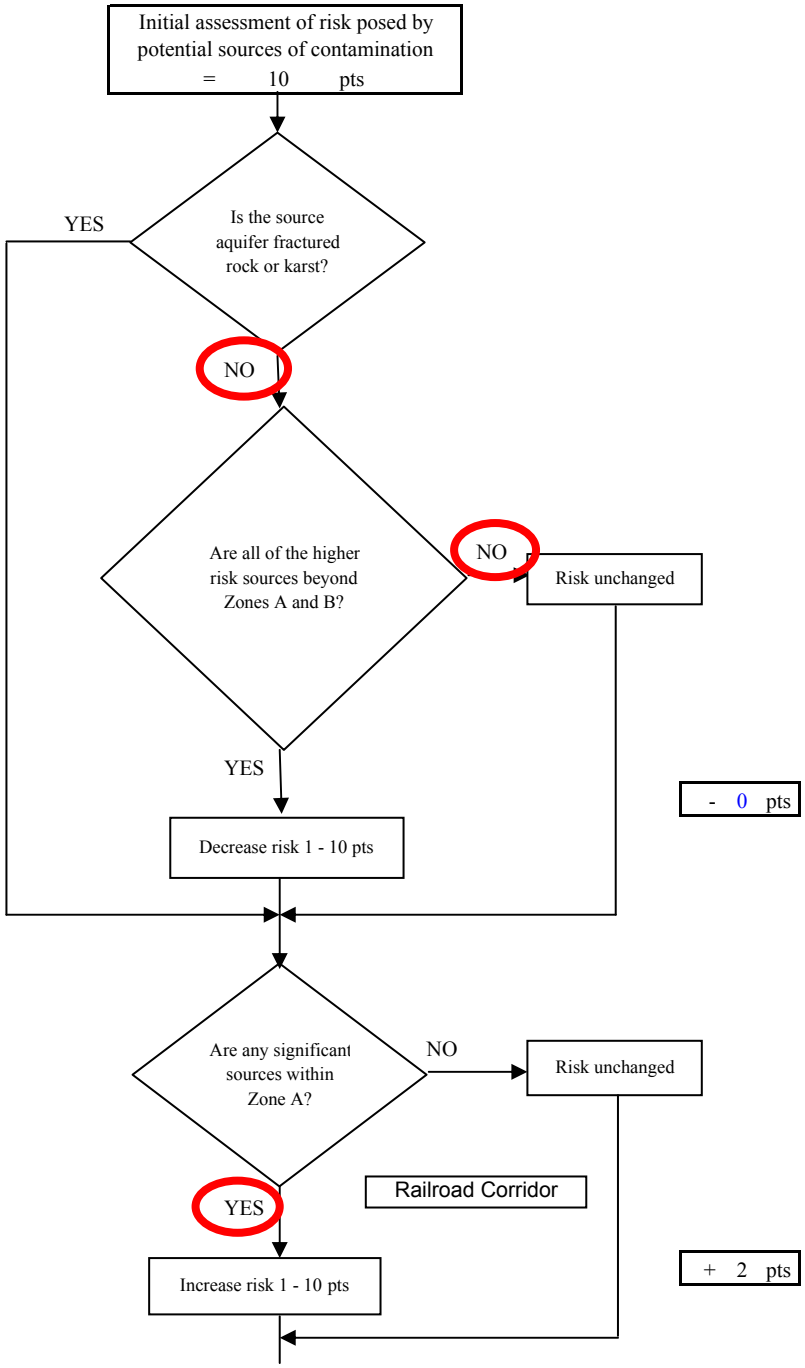
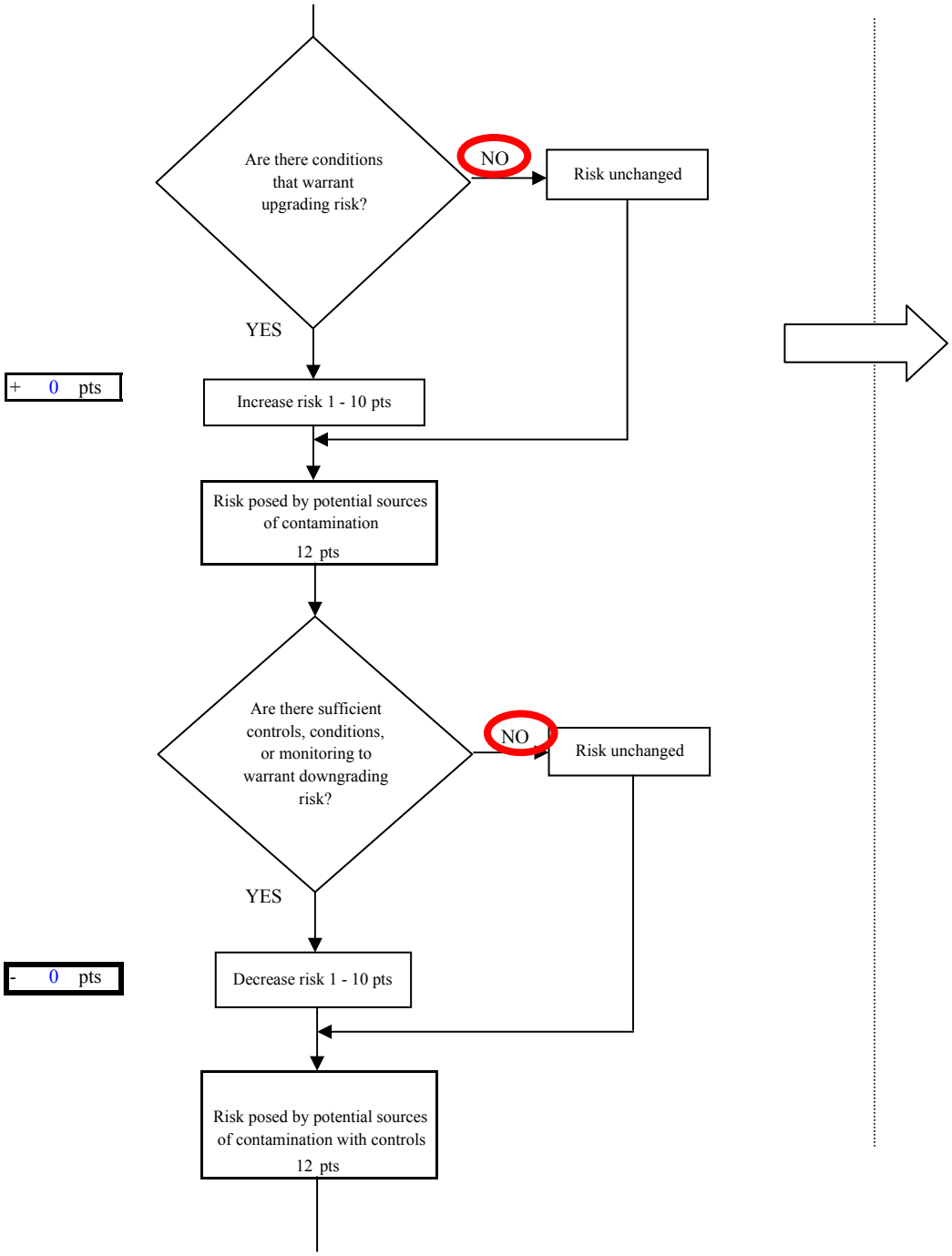
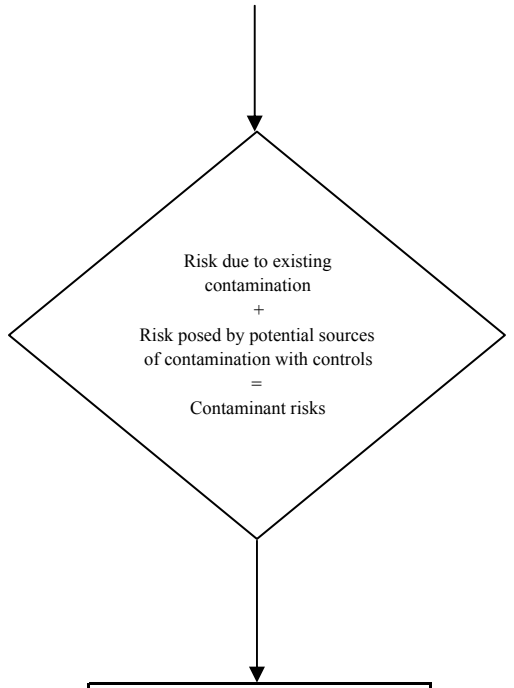


Chart 13. Contaminant risks for Whittier Access Tunnel - Other Organic Chemicals





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 Whittier Access Tunnel - Other Organic Chemicals