E&B Oil Development Project

City of Hermosa Beach

Planning Application

Appendix I

Quantitative Risk Analysis Preliminary Summary

E&B Natural Resources

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BERCHA GROUP

PRELIMINARY SUMMARY REPORT

E&B Oil Development Project
Quantitative Risk Analysis

For:

E&B Natural Resources Management Corporation
Bakersfield, California, USA

By:

Bercha International Inc.
Calgary, Alberta, Canada

November 7, 2012

EXECUTIVE SUMMARY

A. Introduction

E&B Natural Resources Management Corporation (E&B) is proposing the development of the E&B Oil Development Project (the Project) on a site within the City of Hermosa Beach. The project provides for the development of an onshore drilling and production facility that would utilize directional drilling techniques to access crude oil and natural gas reserves in the tide lands granted by the State of California to the City. The project is divided into four phases as follows:

- Phase 1: Site Preparation
- Phase 2: Drilling and Testing
- Phase 3: Final Design and Construction
- Phase 4: Development and Operations

Only Phases 2 and 4 are dealt with in this report, because these are the only phases which include hydrocarbon drilling and production operations.

To support the design and regulatory process, E&B has commissioned Bercha International Inc (Bercha) to carry out a quantitative risk analysis (QRA) to assess public safety and environmental risks in the vicinity of the Project. The public QRA considers only acute risks to people; it does not cover chronic health risks. The environmental QRA only considers acute environmental risks offsite.

B. General Description of the Work Completed

The work was carried out utilizing standard techniques of risk analysis, including data acquisition, hazard scenario development, frequency and consequence analysis, and risk assessment, as well as the evaluation of risk acceptability utilizing generally accepted individual and collective risk thresholds.

C. Summary of Results

Both individual and collective risks were evaluated. Acceptability of individual specific risks is determined from the 1 in 1 million per year criterion; at or above 1 in 1 million the risk is deemed Significant; below, it is deemed Insignificant. Collective risks are measured against the Santa Barbara Risk Spectrum thresholds, shown for Phase 2 in Figure 1. It can be seen that the Phase 2 plot on the risk spectrum is entirely in the Insignificant region. Figure 2 shows the resident individual specific risk contours for Phase 4, while Figure 3 shows the associated risk spectrum plot. This spectrum shows the risks from the process facility and the pipeline, as well as their integrated risk. All the Phase 4 risks are in the Insignificant region. Environmental risks for the transportation of oil by trucks in Phase 2 and by pipeline in Phase 4 were also assessed and found to be in the Insignificant region using the Santa Barbara Environmental Risk Matrix.

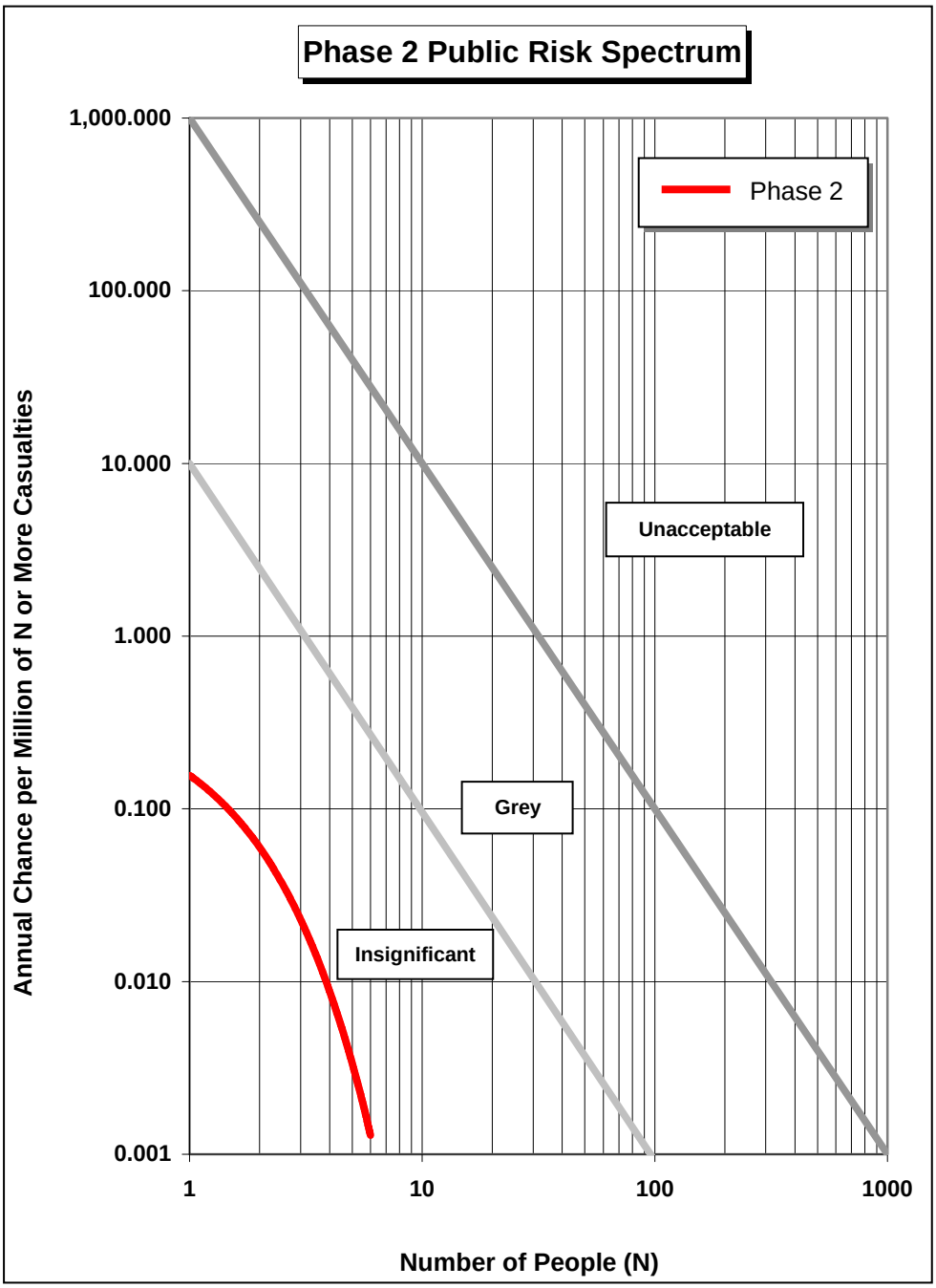

Figure 1
Phase 2 Public Risk Spectrum

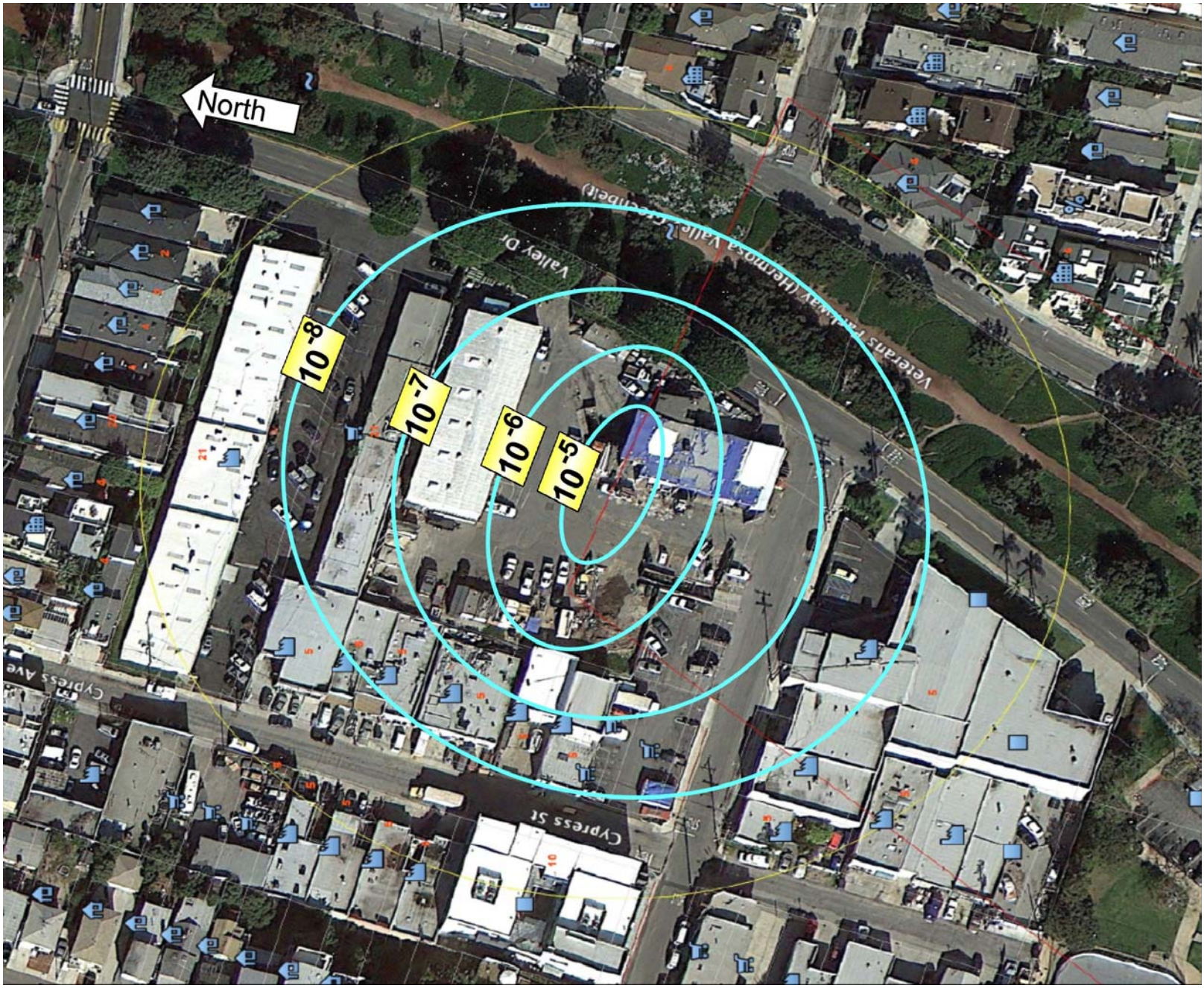

Figure 2
Phase 4 Resident Individual Specific Risk Contours

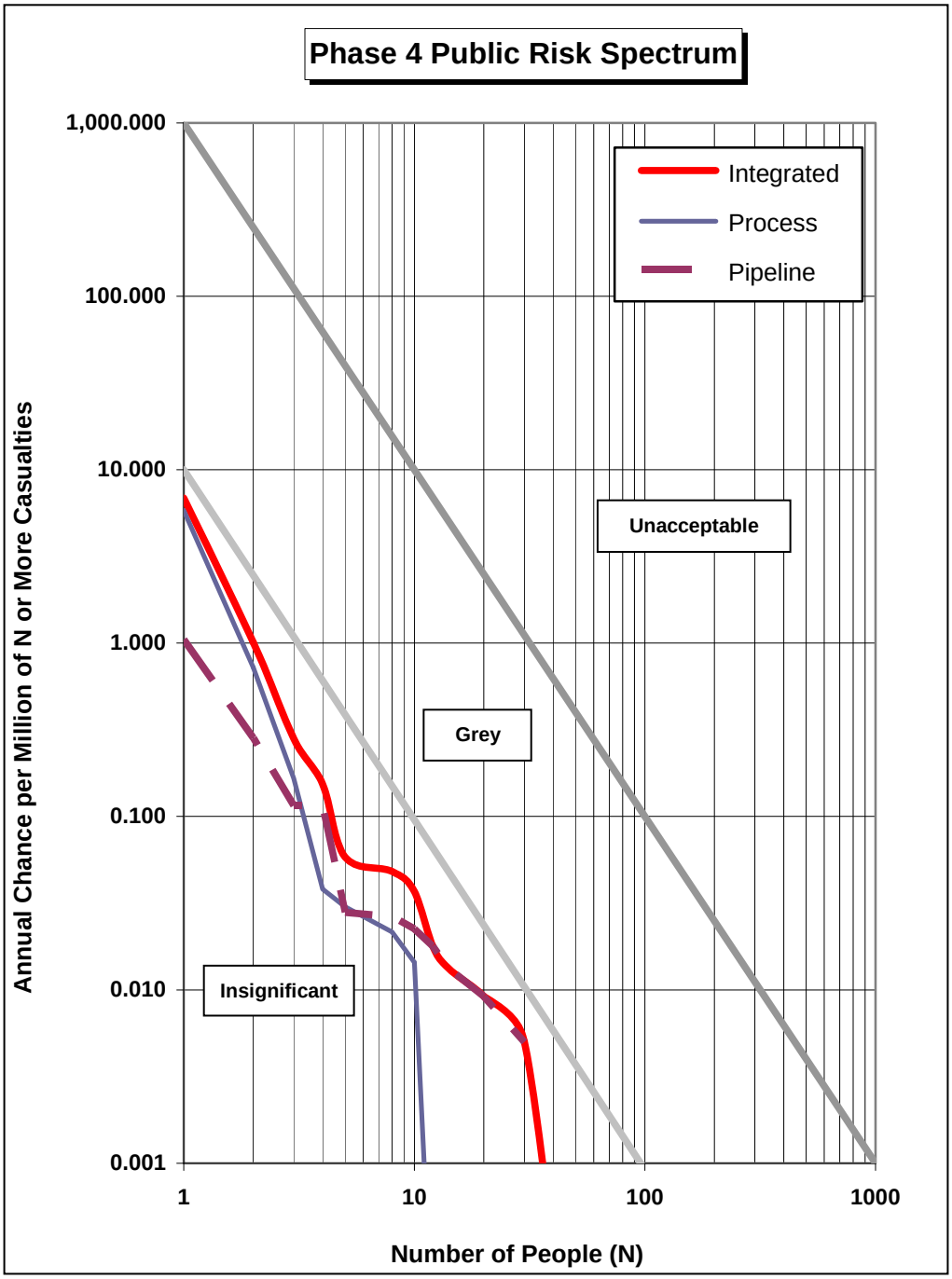

Figure 3
Integrated Phase 4 Public Risk Spectrum

The high level results include annual individual and collective risks, as well as cumulated risks over the project life. Table 1 summarizes the salient results, including risk acceptability according to the individual and collective risk thresholds adopted for the project.

In summary, it can be concluded that all risks to the public and environment are acceptable, as they are in the Insignificant risk region.

Table 1
Summary of Hermosa Beach Oil Project Risks

COMPONENT	TYPE OF RISK	MAXIMUM VALUE	ACCEPTABILITY	DESIGN FEATURES INCLUDED
PHASE 2	Maximum offsite resident individual specific risk	1/100,000,000 per year	Insignificant	• Industry standard measures • Automatic isolation valves • Perimeter wall
	Annual collective risk of 1 or more fatalities	2/10,000,000 per year	Insignificant	
	Annual collective risk of 10 or more fatalities	0.0	Insignificant	
	Trucking risk of maximum 160 bbl spill	2/10,000 per year	Insignificant	• State-of-art trucking
PHASE 4	Maximum offsite resident individual specific risk	1/10,000,000 per year	Insignificant	• Industry standard measures • Automatic isolation valves • Perimeter wall
	Annual collective risk of 1 or more fatalities	8/1,000,000 per year	Insignificant	
	Annual collective risk of 10 or more fatalities	6/100,000,000 per year	Insignificant	
	Cumulative 35 year resident individual specific risk	4/1,000,000 for project	Insignificant	
	Oil pipeline risk of maximum 178 bbl spill	2/10,000 per year	Insignificant	• State-of-art pipeline

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GLOSSARY OF TERMS AND ACRONYMS

Acute Risk = Risk that has an immediate adverse effect due to a single exposure to an accident such as a gas explosion.

AIChE = American Institute of Chemical Engineers

BRISC = Bercha Risk Integration Software Capability

Casualty = Fatality or severe injury

Chronic Risk = Risk that has adverse effect due to a long-term series of exposures

CBA = Cost Benefit Analysis

Collective Risk = The risk to a specific number of people, usually expressed as the risk to N or more people.

EPA = United States. Environmental Protection Agency

ESD = Emergency Shutdown

ESDV = Emergency Shutdown Valve

Hazard = A condition with a potential to create risks such as accidental leakage of natural gas from a pressurized vessel

IRI = Individual Risk, annual risk to an individual located at a specific location continuously for one year (24 hrs/day, 365 days/yr) as a result from a nearby project or facility

ISR = Individual Specific Risk, the actual risk per year to an individual resulting from a specific facility or project considering the actual time and exposure by the individual in the zone of influence of the project

MOP = Maximum Operating Pressure, the pressure at which a pipeline or vessel can be operated considering design conditions

NACE = National Association of Corrosion Engineers

Natural Gas = Hydrocarbons which are used as a source of energy and normally are in a gas phase at standard conditions of pressure and temperature

NGL = Natural Gas Liquids

OISR = Outdoor Individual Specific Risk

P&ID = Piping & Instrumentation Diagram

PFD = Process Flow Diagram

PRV = Pressure Relief Valve

Public Safety = Protection of the general public from acute, immediate effects caused by a single exposure to an accident resulting in severe injury or fatality.

Risk = A compound measure of the probability and magnitude of adverse effect.

Risk Spectrum = A graphical depiction of a cumulative distribution relating probability and number of casualties.

ROO = Ratio of Occurrence

Sour Gas = Natural gas containing significant amounts of hydrogen sulphide (generally more than 50 ppm)

Sweet Gas = Natural gas with no significant amounts of hydrogen sulphide

TRACE = A multi-purpose consequence analysis software modelling system developed by DuPont and sold by Safer Systems

SECTION 1

INTRODUCTION

1.1 General Introduction

E&B Natural Resources Management Corporation (E&B), the Applicant, is proposing the development of the E&B Oil Development Project (the Project) on a 1.3-acre project site located at 555 6th Street in the City of Hermosa Beach. The project site is bounded on the east by Valley Drive and on the south by 6th Street, approximately seven blocks to the east of the beach and the Pacific Ocean. The project site is owned by the City and is currently used as their City Maintenance Yard, as shown in Figure 1.1.

The Project provides for the development of an onshore drilling and production site that would utilize directional and horizontal drilling techniques to access the crude oil and natural gas reserves in the tidelands granted by the State of California to the City and in an onshore area known as the uplands. A natural gas pipeline following a route within the linear road and treed strip, shown in Figure 1.2, is proposed to export produced natural gas. The Project would utilize the latest technology and operational advancements related to safety and efficiency in order to provide an oil and natural gas development project that would be accomplished safely and provide benefits to the community.

The project is divided into four phases as follows:

- Phase 1: Site Preparation
- Phase 2: Drilling and Testing
- Phase 3: Final Design and Construction
- Phase 4: Development and Operations

Only Phases 2 and 4 are dealt with in this report, because these are the only phases which include hydrocarbon drilling and production operations.

To support the design and regulatory process, E&B has commissioned Bercha International Inc (Bercha) to carry out a quantitative risk analysis (QRA) to assess public safety at the vicinity of the Project. The public QRA considers only acute risks to people; it does not cover chronic health risks, while the environmental QRA only considers acute environmental spill risk along oil transportation routes.

This report is termed Preliminary Summary Report as is summarizes the findings of the QRA which is being finalized for the proposed project. The QRA Final Report will include input data, calculation details, citations of references, and other supporting documentation, as well as the final QRA results.

1.2 The Risk Analysis Process

What is risk? **Risk** is a compound measure of the probability and magnitude of adverse effect. That is, risk is a description of the chances of something bad happening and how bad it will be. It is important to keep in mind that there are always these two elements of risk; namely, the probability or likelihood and the size or magnitude of the associated damage or loss. An example risk is a probability of 1 in 1 million per year of a specific individual casualty.

Figure 1.1
Facility Site

Figure 1.2
Pipeline Route

Risk Analysis is an orderly process through which one can assess risk as well as methods of reducing the risk. When the risk analysis quantifies risks it is called Quantitative Risk Analysis (QRA). The five principal steps and various sub-steps of the Risk Analysis process are illustrated in Figure 1.3. The five principal steps are **Hazard Definition**, **Frequency Analysis**, **Consequence Analysis**, **Risk Assessment,** and **Risk Mitigation**.

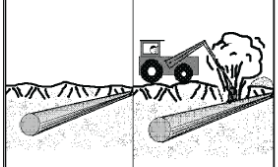
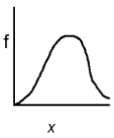
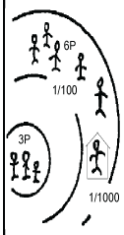
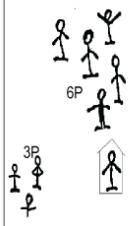
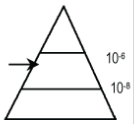
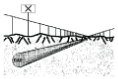
STEP	HAZARD DEFINITION		FREQUENCY ANALYSIS	CONSEQUENCE ANALYSIS		RISK ASSESSMENT			RISK MITIGATION
	SYSTEM DATA	SCENARIO DEVELOPMENT	FREQUENCY ASSESSMENT	DAMAGE CRITERIA	EFFECT FOOTPRINTS	RECEPTORS	RISK EVALUATION	RISK ACCEPT-ABILITY	RISK MITIGATION
QUESTION	WHAT IS IT?	WHAT CAN HAPPEN?	HOW OFTEN?	HOW DANGEROUS?	WHERE/WHEN IS THE DANGER?	WHO CAN BE AFFECTED?	HOW LIKELY AM I TO BE AFFECTED?	IS THE RISK ACCEPTABLE?	WHAT CAN BE DONE TO REDUCE THE RISK?
EXAMPLE	 BURIED CRUDE OIL PIPELINE	LOSS OF CONTAINMENT	 • AEUB statistics					 RISK PYRAMID	 • ROW control • Monitoring
STUDY PROCESS	System parameters	Hazard scenario definition	• Statistics • Fault trees	Susceptibility to: • Thermal • Overpressure • Toxic effects	Prediction of dispersion or ignited gas behavior	Population distribution (time/location)	Combine results of all previous steps	Evaluation of risks	Mitigation Evaluation
RESULT	Problem input quantification	Size, time, orientation, description	• Frequency • Orientation • Magnitude • Duration	Critical levels	Damage map isopleths	Time/space distribution	Individual and Collective Risk	Risk Tolerance / Intolerance	Residual Risk

Figure 1.3
The Risk Analysis Process

In **Hazard Definition**, essentially one determines the characteristics of the situation (**System Data**) which can pose a danger to the public, and how the danger is likely to come about. The latter is called **Hazard Scenario Development.** For example, in Scenario Development, for the case of a natural gas pipeline, we would assess the ways in which the pipeline can fail, and how much hazardous material could be released.

In **Frequency Analysis** one determines how often it can happen. Thus, we assess how often the accident is likely to happen, in terms of number of accidents per year or per million years.

In **Consequence Analysis**, one models the consequences. First one finds the relative likelihood of different outcomes of the release, using event trees. This is called **Consequence Evolution**. That is, for the natural gas release, what is the relative likelihood of ignition and non-ignition? And if ignition happens, what are the **Damage Criteria**, or levels of effect which can cause harm. Next, by quantifying hazard distances, one maps the **Hazard Footprints** or **Effect Footprints** in which damage to people could occur if they were present.

In the **Risk Assessment**, the results of the hazard analysis and the consequence analysis are melded with the presence of people or **Receptors**, in areas where they could be hurt and at the times when such damaging events could occur. The results are then integrated into **Risk Evaluation** to provide measures of risk. Measures of risk to people are primarily **Individual Risk** and **Collective Risk**. The **Risk Acceptability** is then investigated by comparison to regulatory or community-used risk thresholds and discussion with stakeholders.

Finally, if the risks are of concern, the proactive portion of the risk analysis is performed through the definition of ways of reducing the risks and assessing just how much risk reduction can be achieved if different **Risk Mitigation** measures are applied. Following the definition of risk mitigation measures, and their effect on the unmitigated risk, the residual or mitigated risk results for both individual and collective risk can be assessed.

The risk analysis process described above typifies the steps in assessing acute risk to people and the environment; assessment of chronic or long-term cumulative risks follows a similar pattern but employs somewhat different terminology within a toxicological framework. Assessment of chronic risks is not within the scope of this risk assessment.

1.3 General Description of the Work Completed

A quantitative risk analysis (QRA) of the proposed Project has been conducted. This QRA was conducted in response to the project applicant's request for a public safety risk assessment, an environmental risk assessment for the oil transportation operations, as well as to support Project design optimization and risk mitigation.

The scope of work consisted of the following principal tasks:

- Data acquisition
- Hazard scenario development
- Frequency analysis
- Consequence analysis
- Risk assessment
- Conclusions and recommendations

The work spanned both the proposed Phases 2 and 4 of the proposed project.

1.4 Outline of Report

Following this brief introduction, successive Sections of this preliminary summary report outline the public safety risk analysis, environmental risk analysis, and conclusions of the work.

SECTION 2

PUBLIC SAFETY RISK ANALYSIS

2.1 General Description of Public Safety Risk Analysis

Public safety risks, measured as both individual risks and collective risks were evaluated for the principal operational phases of the proposed project; namely, Phase 2 and Phase 4. This section describes the public safety risk analysis and results, while the next section discusses the environmental risks from the oil transportation operations. In the balance of this Section 2, following a brief discussion of public safety risk thresholds, risks from Phases 2 and 4 are described, followed by a discussion of risk potential associated with the possible low levels of hydrogen sulphide in the produced natural gas.

2.2 Public Safety Risk Thresholds

Risk is a combined measure of the probability and magnitude of effect. Risk thresholds are a term generally used to designate the levels of risk, which are acceptable in certain situations. Possible measures of risk include individual risk, risk expectations, and risk spectra. Individual risk is simply the probability that a given individual will become a casualty as a result of the project over a period of exposure of 1 year. Collective Risk expectation can be described by the use of a risk matrix which relates various discrete levels of likelihood of occurrence and severity of consequences to people or the environment. A more rigorous assessment of collective risk, a risk spectrum, gives a continuous relationship between the probability of occurrence and a quantitative measure of the severity of consequences, such as the number of people affected.

2.2.1 Individual Specific Risk Thresholds

Individual risk is usually expressed in terms of an annual probability of death for the exposed person. This individual risk measure is termed Individual Specific Risk (ISR). An annual probability (or chance) of death of 1 in 1,000,000 is often taken as an acceptable level. A distinction is often made between voluntary and involuntary risk; voluntary risk is considered to emanate from activities we undertake by choice such as motor vehicle driving; involuntary risks are those from sources over which we have no control such as tornadoes or living next to an industrial facility. The distinction is somewhat academic, however, as often we have no choice in taking voluntary risk such as driving, as we need to incur it to make a living; similarly, technically, we have the choice of moving to where there are no tornadoes. Figure 2.1 summarizes ISR for a typical North American resident from common everyday sources and activities. It is somewhat surprising that unnecessary medical error risks in North America surpass those associated with motor vehicle accident risks.

A workable set of guidelines for individual risk thresholds is based on Individual Specific Risks (ISR) – the actual risks to which specific individuals are subjected considering time spent at a given location and the proportion of that time spent indoors. There are three principal regions within which public risks are designated, depending on their level or

intensity. The highest region is the Intolerable region, which is simply unacceptable. The next region is the Grey region, in which risks should be reduced in accordance with optimal risk-beneficial activities and subject to regulatory discretion. And finally, there exists the Insignificant risk region, in which risks are always considered acceptable. The following hierarchy of Individual Specific Risk (ISR) levels is proposed herein for third party or public risks:

- Intolerable: $ISR \geq 10^{-4}$
- Grey: $10^{-4} > ISR > 10^{-6}$
- Insignificant: $ISR \leq 10^{-6}$

ISR levels of acceptability for project employees are often up to one order of magnitude higher; that is, the Insignificant level could be $ISR \leq 10^{-5}$.

Another simpler but more stringent ISR criterion used by various communities is the 1 in 1 million per year (10^{-6}/yr) threshold. Above this value of ISR, risk is unacceptable; at or below, it is acceptable.

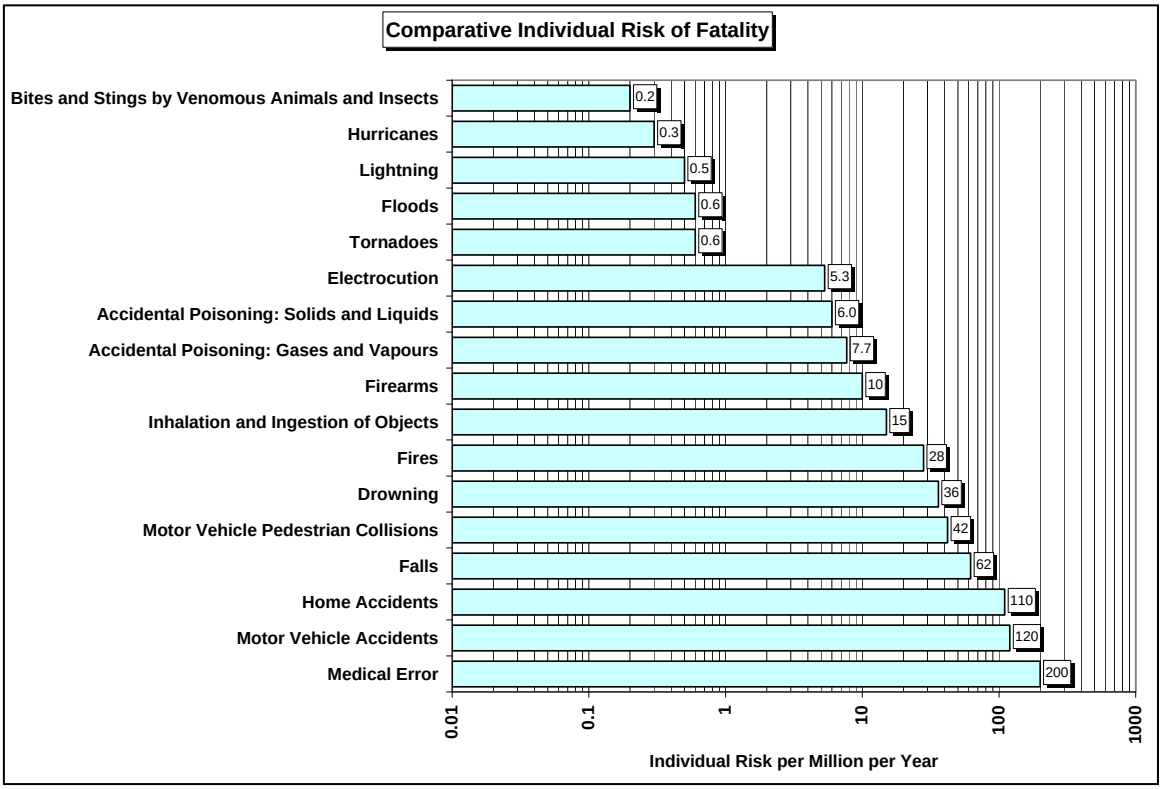


Figure 2.1
Comparative Individual Risks of Fatality

2.2.2 Risk Matrix Thresholds

The risk matrix is a semi-quantitative display of the severity and frequency of different adverse consequences with the areas of increasing significance in terms of risk depicted on Figure 2.2. Events within the shaded area are considered significant and should be mitigated, while those in the unshaded area are considered Insignificant. Numerous forms of the risk matrix have been used worldwide, based on the same principles as the County of Santa Barbara risk matrix, shown in the figure below. The matrix shown includes public safety criteria which were later (1997) superceded by the risk spectrum discussed in the next section.

		SEVERITY OF CONSEQUENCE				
		Negligible: No significant risk to the public, with no minor injuries; less than 10 barrels spilled	Minor: Small level of public risk, with at most a few minor injuries; 10-238 bbl spilled	Major: Major level of public risk with up to 10 severe injuries; 239-2,380 bbl spilled	Severe: Severe public risk with up to 100 sever injuries or up to 10 fatalities; 2,380-357,142 bbl spilled	Disastrous: Disastrous public risk involving more than 100 severe injuries or more than 10 fatalities; greater than 357,142 bbl spilled
FREQUENCY OF OCCURRENCE	Frequent: Greater than once a year					
	Likely: Between once a year and once in one hundred years					
	Unlikely: Between once in a hundred and once in ten thousand years					
	Rare: Between once in ten thousand years and once in a million years					
	Extraordinary: Less than once in one million years					

DIRECTION OF INCREASING SIGNIFICANCE

County defined as significant impacts. Insignificant impacts.

Source: County of Santa Barbara Department of Resource Management, *Environmental Thresholds & Guidelines Manual*, Amended 1990; Shell Hercules Platform EIR, 1983.

Figure 2.2
Santa Barbara Risk Matrix

2.2.3 Collective Risk Spectrum Thresholds

A risk spectrum, relating the probability to the associated expected number of casualties, is often used as a measure of group risk. The risk spectrum is a convenient graphical display of the variation in probability with the magnitude of consequences for a given risk scenario. It is plotted on log-log paper with the vertical axis giving the probability and the horizontal axis, the associated **minimum** number of people affected; that is, the risk spectrum is a probability of exceedance graph giving the probability that *at least N people are at risk*.

Figure 2.3 shows the collective risk of fatality thresholds on an F-N curve or risk spectrum as adopted in the County of Santa Barbara, with a hypothetical project plotted to show how it is used. Note that the numbers on the vertical axis are resented in exponential notation, where, for example, 1.00E-03 = 10^{-3}. The registration of the risk spectrum assessed for a specific project as shown with respect to the above set of collective risk thresholds is an indication of the level of acceptability of project risks. A somewhat higher set of thresholds (up to one order of magnitude) is often used for project personnel.

Finally, either individual or collective risks for an entire project life cycle are called life cycle Cumulative Risks.

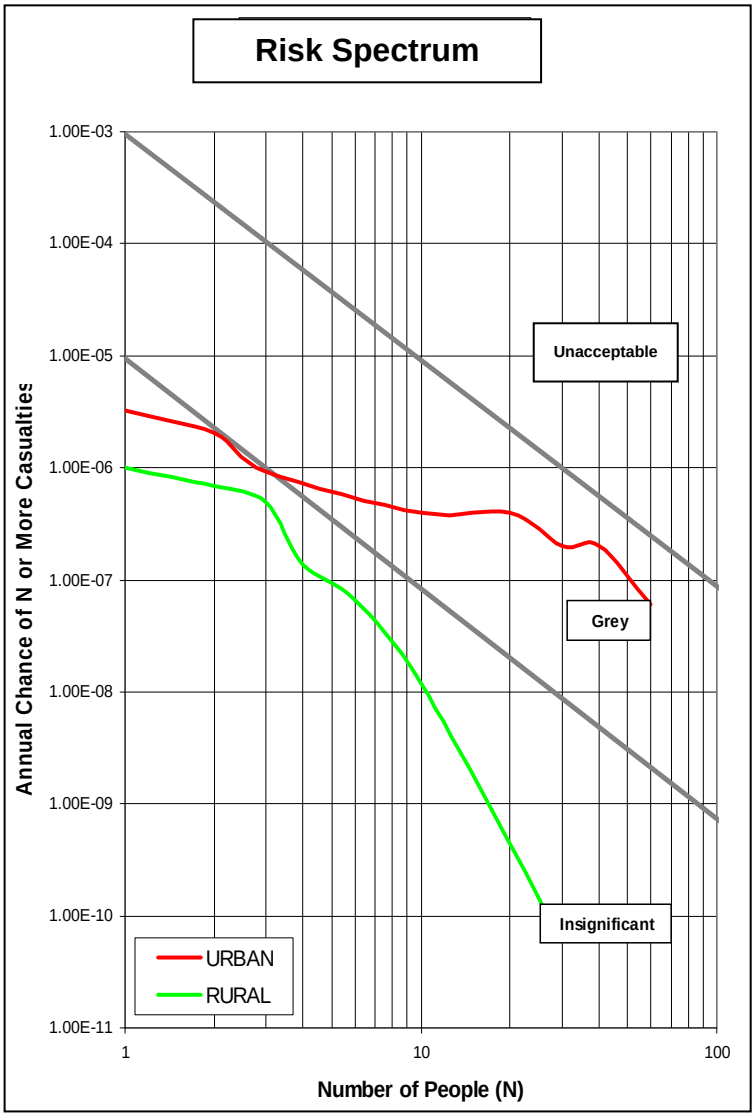


Figure 2.3
Typical Collective Risk Thresholds on a Risk Spectrum

2.3 Phase 2 Public Safety Risks

The Phase 2 operations, and hence risks, extend over a period of one year. Figure 2.4 shows the Phase 2 risk spectrum, while Table 2.1 summarizes the Resident Individual Specific Risks (ISR). The risk distances shown in Table 2.1 are measured from the centre of the Phase 2 process module, and hence reach residents at approximately 120 feet, giving a maximum individual risk to residents of 1 in 100 million (0.01 per million). Thus, the maximum ISR to residents associated with this phase is chances of a casualty of 1 in 100 million per year.

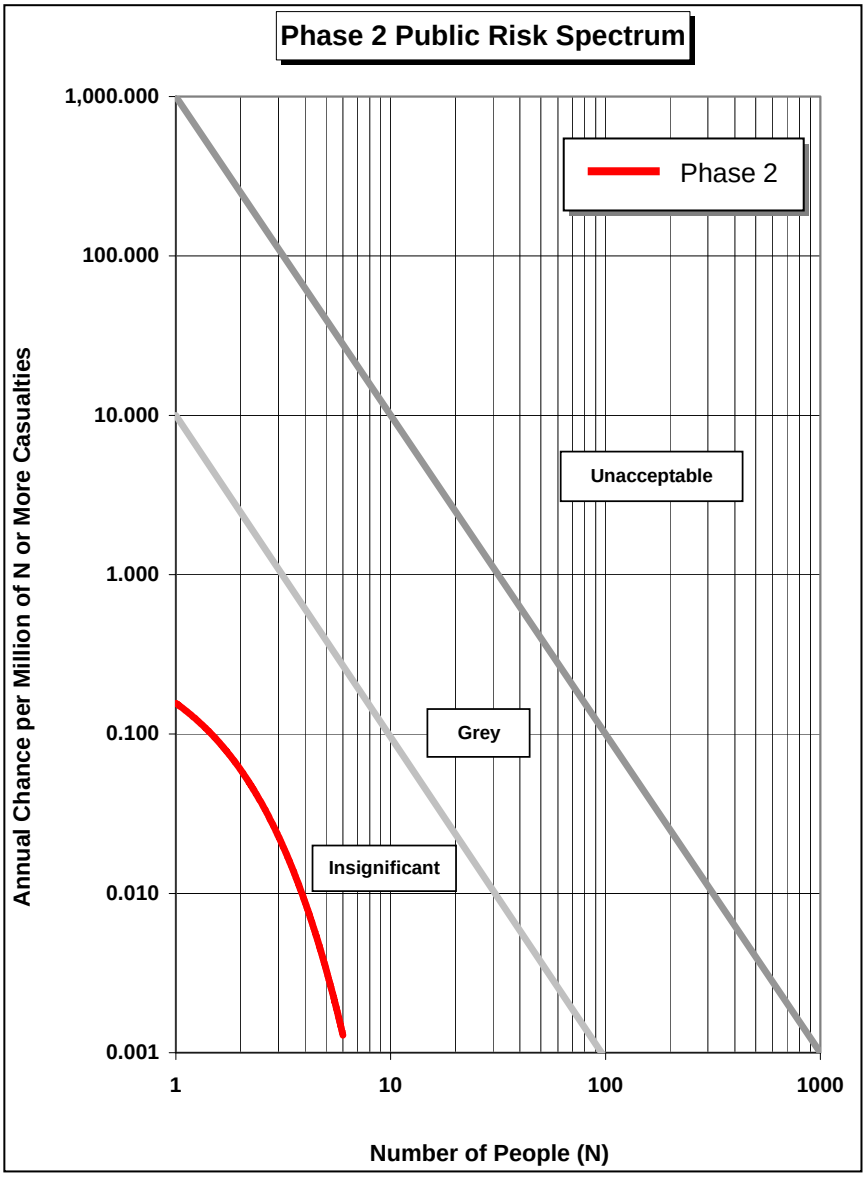


Figure 2.4
Phase 2 Public Risk Spectrum

Table 2.1
Phase 2 Resident Individual Specific Risk

Wind Direction	Annual Resident Individual Specific Risk Distance (feet) (Per Million)					
	100.0	10.0	1.0	0.1	0.01	0.001
N	0	0	0	39	84	129
E	0	0	6	49	91	134
S	0	0	0	41	85	130
W	0	0	18	58	99	139

2.4 Phase 4 Public Safety Risks

Both the individual and collective risks for Phase 4 were assessed. The resident individual specific risk (ISR) contours associated with Phase 4 are shown in Figure 2.5. Table 2.2 gives the Resident individual specific risk (ISR) distances for this phase, with offsite risks commencing at 50 feet, with nearest residents located beyond 120 feet, one can see that the maximum risk to residents is 10^{-7} or 1 in 10 million per year (0.1 per million).

Collective risks for Phase 4 were also evaluated and registered on the Santa Barbara risk spectrum. For this phase, both the process and the gas pipeline collective risks were evaluated and integrated to give the total risk. Figure 2.6 shows the collective risk spectrum components and their integrated total for this phase. Both the components and integrated risk are in the Insignificant region.

Table 2.2
Phase 4 Resident Individual Specific Risk

Wind Direction	Annual Resident Individual Specific Risk Distance (feet) (Per Million)					
	100.0	10.0	1.0	0.1	0.01	0.001
N	0	30	85	140	195	250
E	0	52	103	155	206	257
S	0	34	88	143	197	252
W	0	70	118	166	215	263

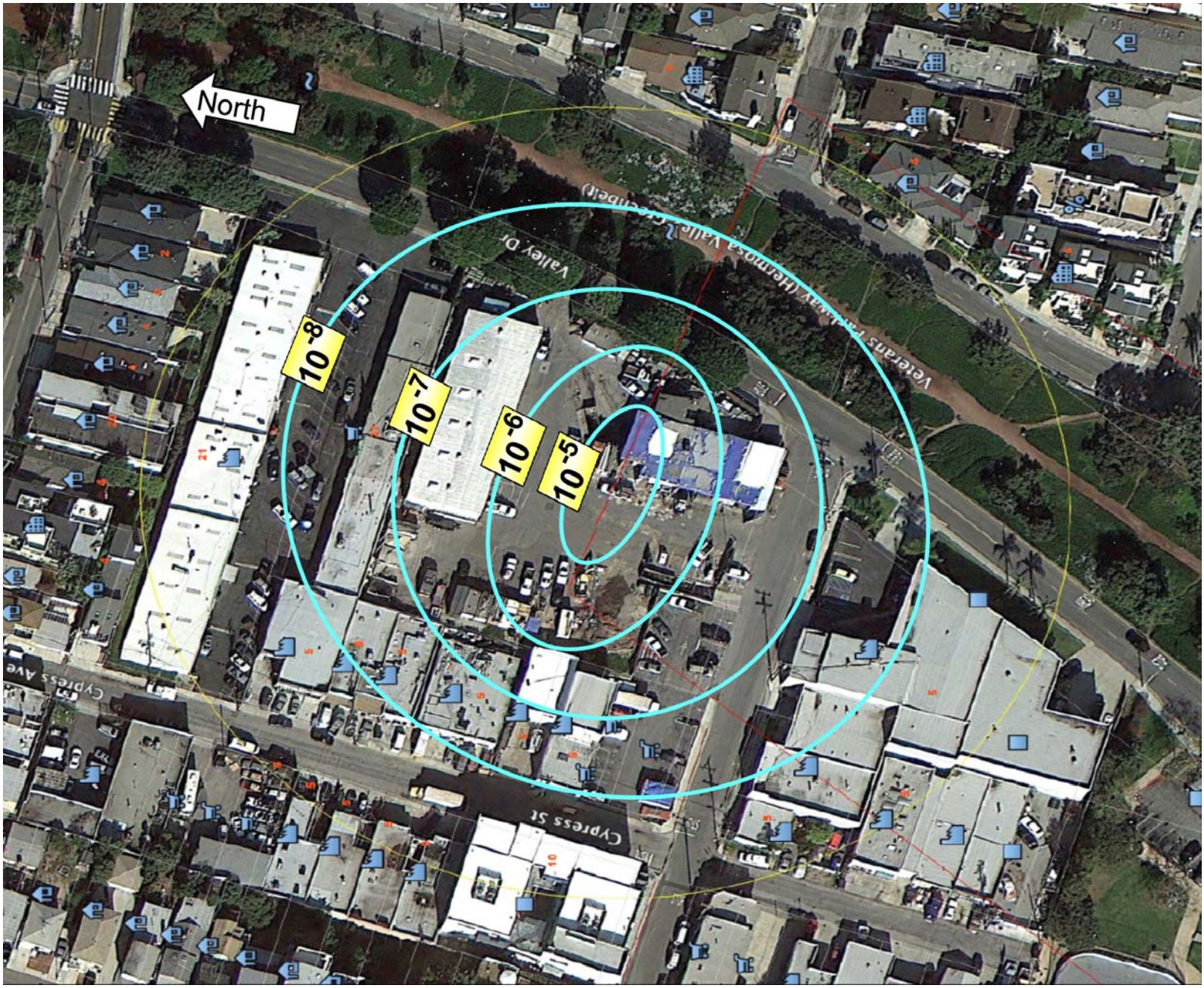


Figure 2.5
Phase 4 Resident Individual Specific Risk Contours

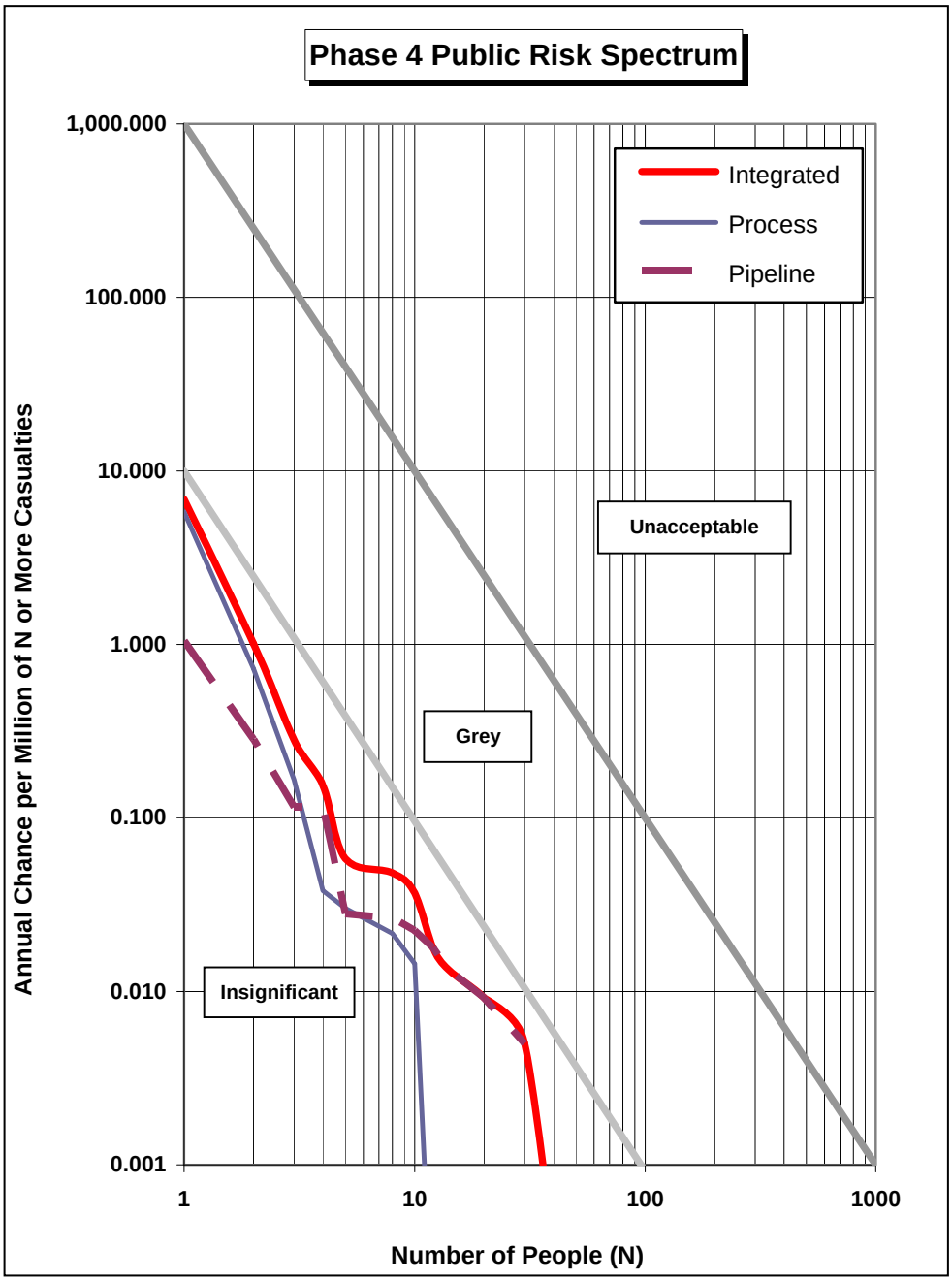


Figure 2.6
Integrated Phase 4 Public Risk Spectrum

2.5 Hydrogen Sulfide (H_2S) Risks

It has been reported by E&B that potential hydrogen sulfide (H_2S) in the order of 0.0 to 6.0 parts per million (ppm) are anticipated to be encountered in the natural gas produced from the subject reservoirs. However, in order to have the capability to treat higher levels, the proposed project has been planned to treat H_2S levels of 15 ppm, and has a maximum design capacity to treat H_2S levels of up to 100 ppm. To provide an assessment that addresses the worst-case scenario, an H_2S level of 100 ppm is considered here. A summary of the background on risks associated with H_2S is provided in the balance of this section.

Hydrogen Sulphide (H_2S) gas is known to be physiologically damaging to humans when ingested usually through breathing in sufficient quantities. In the hydrocarbon industry, H_2S occurs naturally in reservoirs and is produced with methane or natural gas as well as crude oil in varying concentrations. When H_2S is present in a fluid in sufficient quantities, the fluid is termed "sour". Quantitative assessments of the damage from H_2S are available for acute or immediate lethality effects; long term or chronic effects are not completely understood and continue to be a subject of controversy worldwide. The current analysis was restricted to the analysis of acute effects of H_2S. The nature of the damage to a given individual due to exposure to a toxic gas depends on the dosage, which is the concentration and exposure time.

The effects of H_2S on exposed individuals vary depending on exposure time, concentration, and sensitivity of the person. General health effects of H_2S exposure to different concentrations of H_2S in air are summarized in Table 2.3.

Table 2.3
General Health Effects of H_2S

Concentration in air (ppm)	Health Effects
0.01 to 0.3	Odour threshold, minimum concentrations one can smell
1 to 5	Moderate to strong offensive odour; may create nausea, tearing of the eyes, headaches, or loss of sleep following prolonged exposure - effects are moderate.
10	8-hour Occupational Exposure Limit
20	Ceiling Occupational Exposure Limit, and evacuation level
20 to 50	Slight eye and lung irritation - may cause eye damage after several days of exposure; may cause digestive upset and loss of appetite.
100	Eye and lung irritation after several days.
150	Kills sense of smell; severe eye and lung irritation after two days.
500	Serious damage to eyes within 30 minutes; severe lung irritation; unconsciousness and death within 4 to 8 hours.
1000	Fatality within 3 minutes.

The concentrations given in this table are the concentrations at the receptor location; that is they are the concentrations in air that the receptor contacts and inhales. They are not the source concentrations which can be significantly higher but become diluted as the H_2S mixes with air while traveling and dispersing toward the receptor. At low concentrations (0.01 to 0.3 ppm) at the receptor, H_2S creates a nuisance odour similar to that of rotten eggs; the odour prevails until concentrations of 150ppm. As concentration and/or exposure time increases, the severity of the health effects also increases. For example, an exposure to between 20 and 50 ppm may cause eye damage after several days but such a concentration is not considered sour. Concentrations of 200 ppm can cause injury after two or more days of exposure. Acute physiological damage, however, including serious eye damage, occurs for concentrations greater than 500 ppm over a period of approximately 30 minutes, with fatality after several hours of exposure. Concentrations of 1,000 ppm or greater are life-threatening for very short exposures.

To address the possible worst-case identified by the proponent, it is assumed that 100 ppm of H_2S could occur in the produced gas and any accidental releases would be short duration. Concentrations of H_2S at offsite locations would be much lower than 100 ppm, as they decrease with distance from the release point. From Table 2.3, it can be seen that short term exposure to H_2S concentrations of 100 ppm poses no risks of either lethality or injury from short durations of exposure. Thus, H_2S concentrations of potential releases would be well within non-lethal levels at the facility, and even lower offsite. Accordingly, no acute risk from H_2S exposure from the proposed project is possible.

SECTION 3

ENVIRONMENTAL RISK ANALYSIS

3.1 Introduction on Environmental Risks

Environmental spill risks from the project would only occur as a result of offsite oil transportation. All onsite spills with potential for environmental impact would be contained within the site area. Crude oil offsite risks can only result from spills associated with the Phase 2 crude oil trucking and the Phase 4 oil pipeline, which runs approximately 3.55 miles offsite. Oil spills from neither of these sources pose acute risks to the public; only possible environmental impacts.

3.2 Environmental Risk Matrix Thresholds

The Santa Barbara risk matrix was described in Section 2.2, and is repeated here for environmental impacts only in Figure 3.1.

		SEVERITY OF CONSEQUENCE				
		Negligible: Less than 10 barrels spilled	Minor: 10-238 bbl spilled	Major: 239-2,380 bbl spilled	Severe: 2,380-357,142 bbl spilled	Disastrous: Greater than 357,142 bbl spilled
FREQUENCY OF OCCURRENCE	Frequent: Greater than once a year					
	Likely: Between once a year and once in one hundred years					
	Unlikely: Between once in a hundred and once in ten thousand years					
	Rare: Between once in ten thousand years and once in a million years					
	Extraordinary: Less than once in one million years					

County defined as significant impacts. Insignificant impacts.

Source: County of Santa Barbara Department of Resource Management, *Environmental Thresholds & Guidelines Manual*, Amended 1990; Shell Hercules Platform EIR, 1983.

Figure 3.1
Santa Barbara Environmental Risk Matrix

3.3 Crude Oil Trucking

It has been estimated that during Phase 2, crude oil trucks carrying a maximum of 160 barrels (bbl) each would cover a 7.5 mile route approximately 1,400 times, giving a total laden truck total of 10,500 laden-truck miles, as provided by the applicant. This trucking operation is expected to occur within a 10 month duration in Phase 2. With an accident rate of approximately 0.4 per million vehicle Dangerous Goods (DG) miles, this provides an accident rate of approximately 4.2 per 1,000 per year. Assuming that 5% of these accidents involve a catastrophic release, of a maximum of 160 bbl, this gives an accident rate of catastrophic release rate of 0.21 per 1,000 per year, or 2.1 or roughly 2 per 10,000 per year. This level of risk falls into the *Unlikely* frequency of occurrence, and *Minor* level of environmental risk in the risk matrix, placing it into the Insignificant region, as can be seen in Figure 3.2.

		SEVERITY OF CONSEQUENCE				
		Negligible: Less than 10 barrels spilled	Minor: 10-238 bbl spilled	Major: 239-2,380 bbl spilled	Severe: 2,380-357,142 bbl spilled	Disastrous: Greater than 357,142 bbl spilled
FREQUENCY OF OCCURRENCE	Frequent: Greater than once a year					
	Likely: Between once a year and once in one hundred years					
	Unlikely: Between once in a hundred and once in ten thousand years		Crude Oil Trucking			
	Rare: Between once in ten thousand years and once in a million years					
	Extraordinary: Less than once in one million years					

County defined as significant impacts. Insignificant impacts.

Source: County of Santa Barbara Department of Resource Management, *Environmental Thresholds & Guidelines Manual*, Amended 1990; Shell Hercules Platform EIR, 1983.

Figure 3.2
Risk Matrix with Crude Oil Trucking

3.4 Crude Oil Pipeline

A crude oil pipeline of approximately 3.55 miles with a diameter of 8 inches (NPS 8) is proposed for transporting produced oil in Phase 4. A major release or rupture rate derived from the Pipeline and Hazardous Materials Safety Administration (PHMSA) rupture statistics is 5.73 per 100,000 mile-years. With a maximum pipeline length of 3.55 miles, this translates into a rupture frequency of 2 per 10,000 per year. Assuming drainage from approximately ½ mile of pipeline in the instance of a rupture, preceded by flow before isolation for 5 minutes maximum, one can estimate a maximum spill of 178 bbl. Placing this on the risk matrix, one can see that the two per 10,000 per year falls into the *Unlikely* region, but very close to the *Rare* region, and again the spill or 178 bbl falls into the *Minor* consequence area, resulting in a ranking of Insignificance for the pipeline spill potential, as shown in Figure 3.3.

		SEVERITY OF CONSEQUENCE				
		Negligible: Less than 10 barrels spilled	Minor: 10-238 bbl spilled	Major: 239-2,380 bbl spilled	Severe: 2,380-357,142 bbl spilled	Disastrous: Greater than 357,142 bbl spilled
FREQUENCY OF OCCURRENCE	Frequent: Greater than once a year					
	Likely: Between once a year and once in one hundred years					
	Unlikely: Between once in a hundred and once in ten thousand years		Crude Oil Pipeline			
	Rare: Between once in ten thousand years and once in a million years					
	Extraordinary: Less than once in one million years					

County defined as significant impacts. Insignificant impacts.

Source: County of Santa Barbara Department of Resource Management, *Environmental Thresholds & Guidelines Manual*, Amended 1990; Shell Hercules Platform EIR, 1983.

Figure 3.3
Risk Matrix with Crude Oil Pipeline

SECTION 4

ASSUMPTIONS AND CONCLUSIONS

4.1 Principal Assumptions

Inputs characterizing Phases 2 and 4 and associated transportation operations were provided by E&B, and Bercha relied on these inputs. E&B also provided the permanent population distributions.

Certain significant conservative assumptions and approximations were made, resulting in the tendency to overestimate the risks associated with the project. The principal ones among these may be summarized as follows:

- All gas releases were assumed to continue to blowdown until atmospheric pressure is reached within the isolated segment.
- Modeling of ground level releases rather than elevated releases as a basis for flash fire damage assessment was carried out.
- All pressurized releases were assumed to occur in the horizontal direction.

Certain simplifying assumptions to facilitate the work were made, which could result in an understatement of the risks. It is believed that these understatements are not significant, but these assumptions are nevertheless summarized, as follows:

- The well drilling and production well risks were estimated based on preliminary data only.
- Topography was not explicitly considered in consequence modeling.
- Population distributions provided by the proponent were assumed constant over the 35 year project life.
- Wake effect on gas dispersion of the perimeter wall and its interaction with explosion overpressures were not modeled explicitly.

Certain other simplifying assumptions and approximations were made during the conduct of the work in order to make its completion practicable while still providing meaningful results. These simplifying assumptions and approximations may have the effect of either overestimating or underestimating the risk, but to a negligible degree within the context of the present work. Such simplifying assumptions and approximations may be summarized as follows:

- LAX weather was considered representative of the Hermosa Beach site location due to its proximity.
- Subdivision of release sizes into hole and full bore rupture for the gas pipeline was considered representative of all significant release sizes.
- Mitigating effects of the Phase 2 sound attenuation wall and the Phase 4 structural wall were modeled only in terms of their reduction of flammable vapor cloud ignition probabilities.

4.2 Conclusions

Both individual and collective risks were evaluated. Acceptability of individual specific risks is determined from the 1 in 1 million per year criterion; at or above 1 in 1 million the risk is deemed Significant; below, it is deemed Insignificant. Collective risks are measured against the Santa Barbara Risk Spectrum thresholds, shown for Phase 2 in Figure 4.1. Figure 4.2 shows the resident individual specific risk contours for Phase 4, while Figure 4.3 shows the associated Phase 4 risk spectrum. Environmental risks for the transportation of oil by trucks in Phase 2 and by pipeline in Phase 4 were also assessed and found to be in the Insignificant region using the Santa Barbara Environmental Risk Matrix.

The summary results include annual individual and collective risks, as well as cumulated risks over the project life. Table 4.1 summarizes the salient results of the risk, including risk acceptability according to the individual and collective risk thresholds adopted for the project.

In summary, it can be concluded that all risks to the public and environment are acceptable, as they are in the Insignificant risk region.

This report is termed Preliminary Summary Report as is summarizes the finding of the QRA which is being finalized for the proposed project. The QRA Final Report will include input data, calculation details, citations of references, and other supporting documentation, as well as the final QRA results.

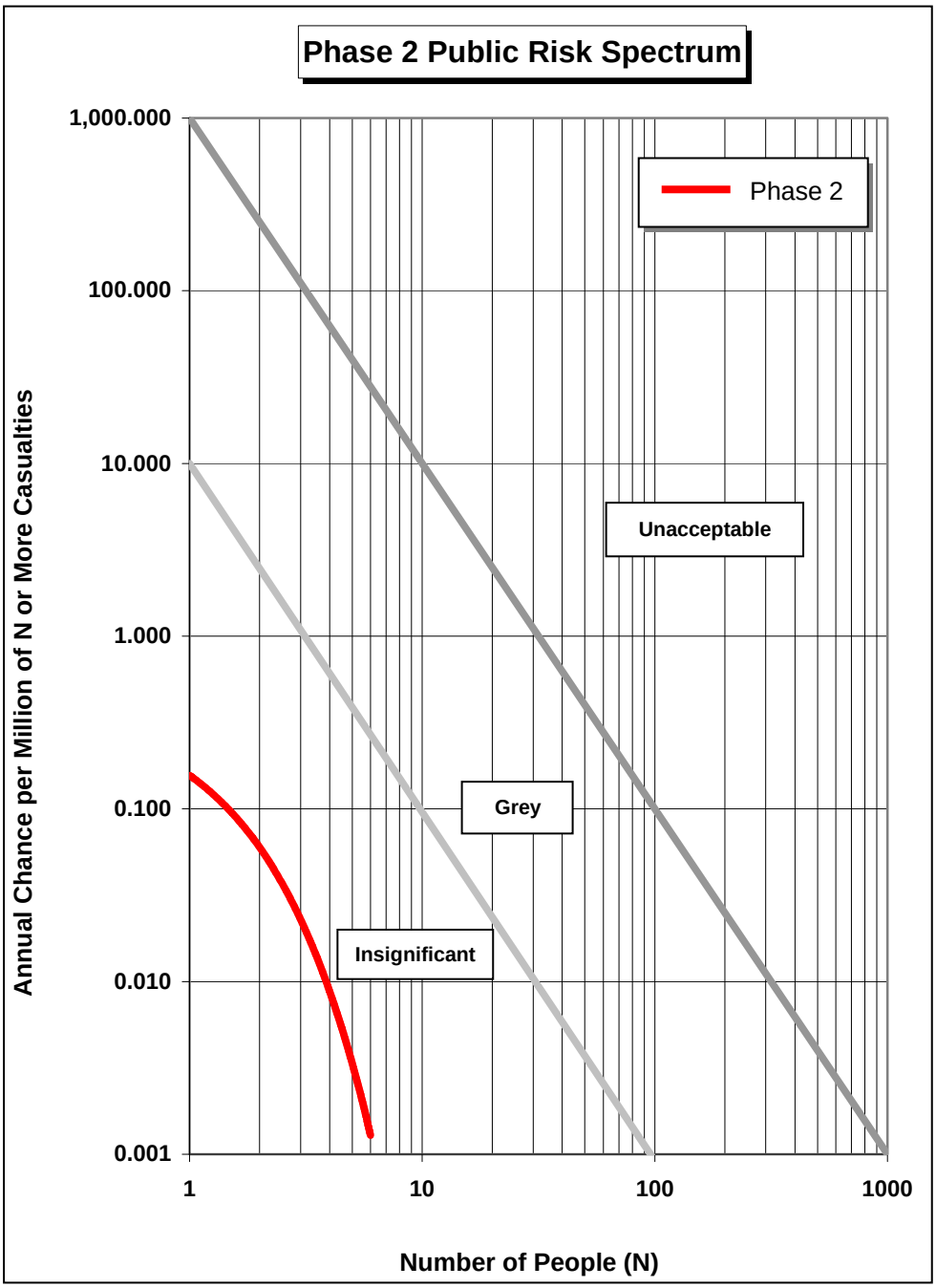


Figure 4.1
Phase 2 Public Risk Spectrum

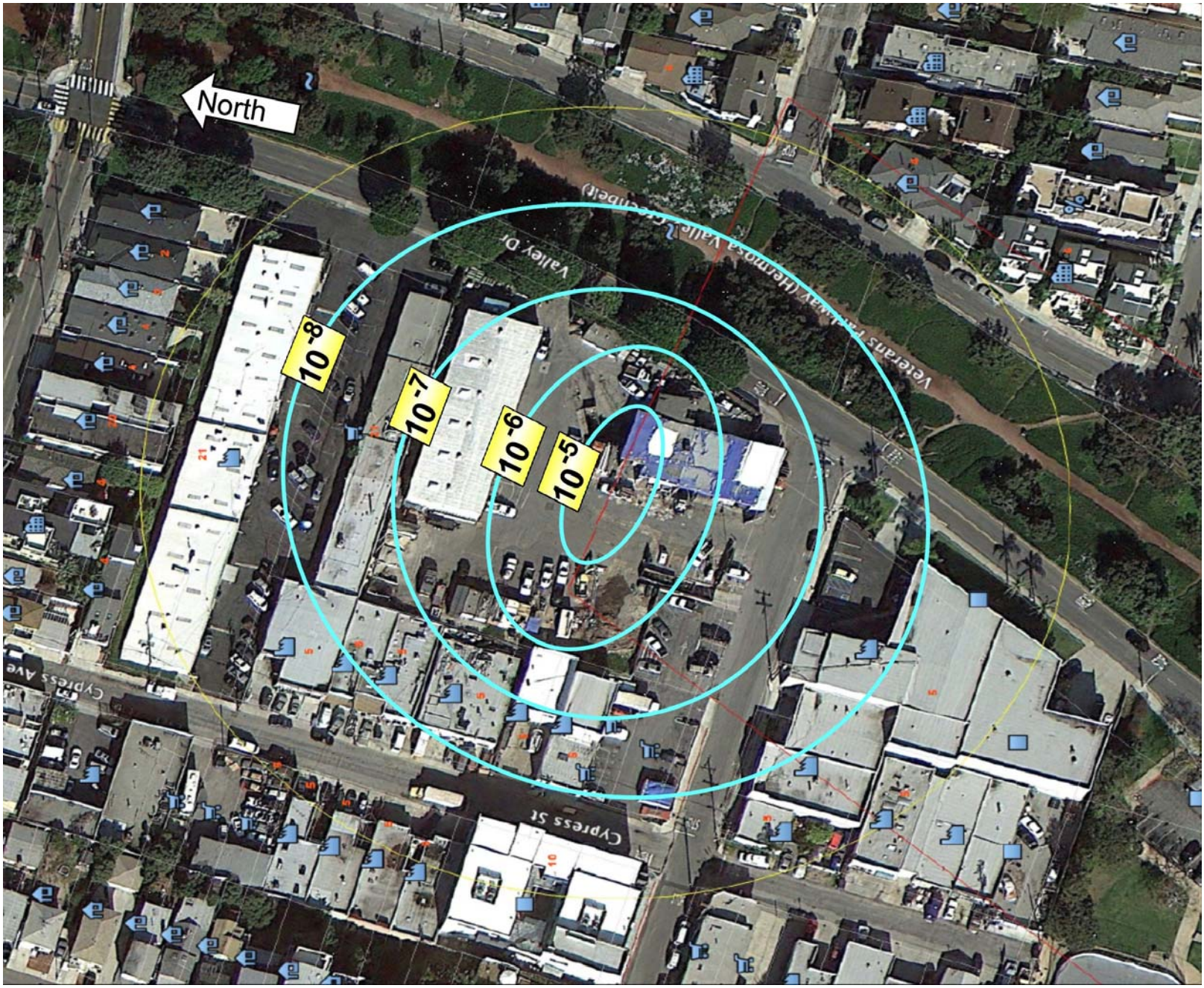


Figure 4.2
Phase 4 Resident Individual Specific Risk Contours

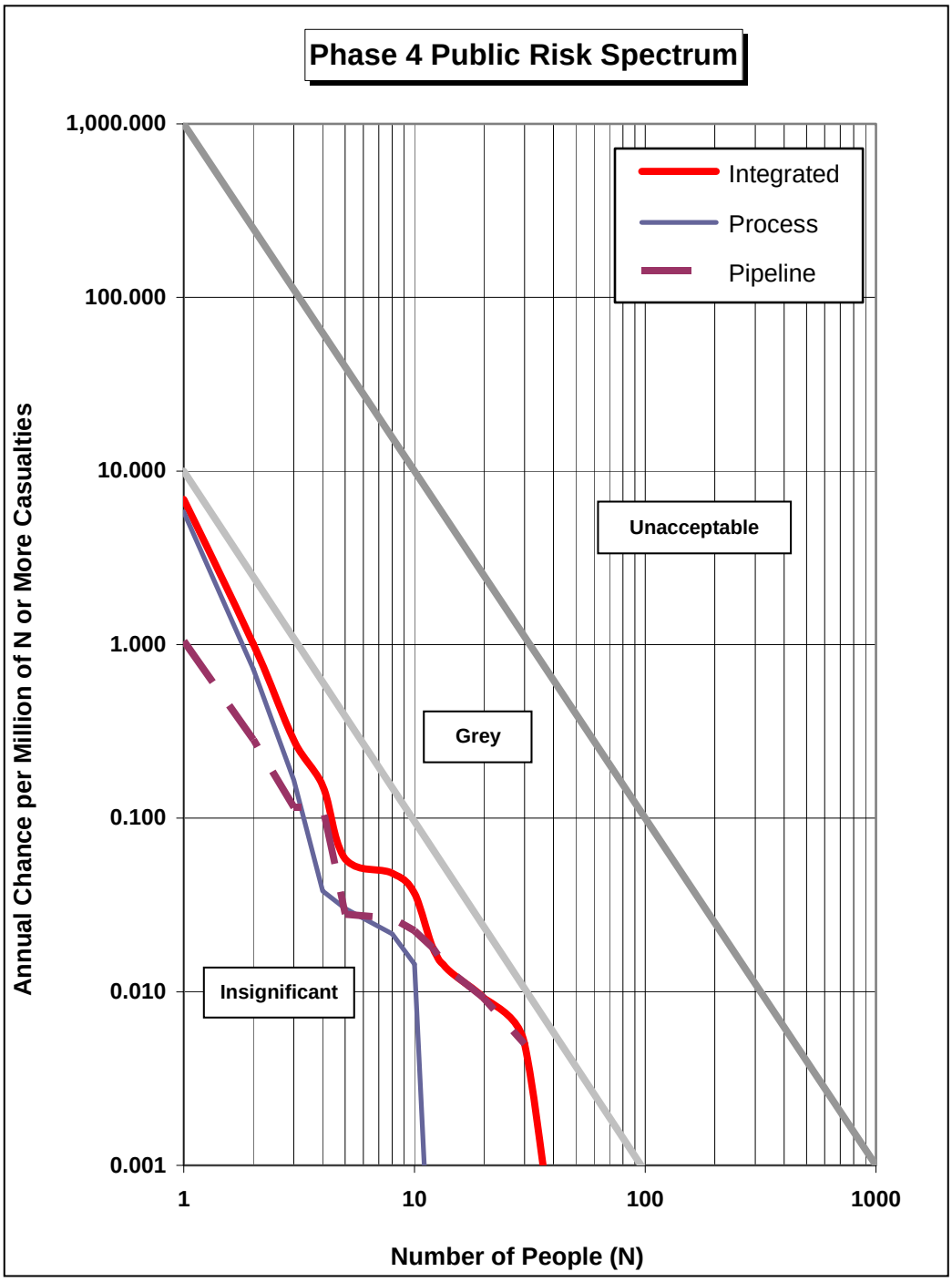


Figure 4.3
Integrated Phase 4 Public Risk Spectrum

Table 4.1
Summary of Hermosa Beach Oil Project Risks

COMPONENT	TYPE OF RISK	MAXIMUM VALUE	ACCEPTABILITY	DESIGN FEATURES INCLUDED
PHASE 2	Maximum offsite resident individual specific risk	1/100,000,000 per year	Insignificant	• Industry standard measures • Automatic isolation valves • Perimeter wall
	Annual collective risk of 1 or more fatalities	2/10,000,000 per year	Insignificant	
	Annual collective risk of 10 or more fatalities	0.0	Insignificant	
	Trucking risk of maximum 160 bbl spill	2/10,000 per year	Insignificant	• State-of-art trucking
PHASE 4	Maximum offsite resident individual specific risk	1/10,000,000 per year	Insignificant	• Industry standard measures • Automatic isolation valves • Perimeter wall
	Annual collective risk of 1 or more fatalities	8/1,000,000 per year	Insignificant	
	Annual collective risk of 10 or more fatalities	6/100,000,000 per year	Insignificant	
	Cumulative 35 year resident individual specific risk	4/1,000,000 for project	Insignificant	
	Oil pipeline risk of maximum 178 bbl spill	2/10,000 per year	Insignificant	• State-of-art pipeline