RISK ASSESSMENT STUDY

FOR

CROSS CASCADE PIPELINE

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I. EXECUTIVE SUMMARY

This report provides an assessment of the spill risks associated with the proposed Cross Cascade Pipeline. The spill risks of the proposed pipeline are quantified in terms of both frequency and volume. The risks of the pipeline are then compared to the risks of the existing transportation system. Specifically, because Olympic proposes that its pipeline will eliminate river barging and certain truck traffic, the risks of the pipeline are compared to the spill risks associated with river barging and trucking. The study concludes that the proposed Cross Cascade Pipeline is far riskier than the existing system.

The report begins with a description of the methodology developed for quantifying the spill risks of pipelines. This methodology was created by the author of this report as a consultant for the Environmental Protection Agency. By reviewing pipeline industry databases, I was able to calculate that, on average, there are 1.3 spills per 1,000 miles of the typical pipeline. I was also able to determine which factors had the strongest influence on the frequency and volume and developed correction factors to take into account these variables.

The report also includes a review of databases developed subsequent to the development of my formula for the EPA. That review confirms the validity of the methodology I developed for the EPA. Olympic used this methodology in its analysis (though it made mistakes in its application).

The appropriate method for quantifying spill risk is to consider both volume and frequency of spills. Considering frequency of spills in isolation can be very misleading because spill sizes can vary tremendously (from less than one gallon to more than 1,000,000 gallons). Unless volume is included in the analysis, very misleading conclusions could be reached.

The Mastandrea/EPA formula is then applied to the proposed Cross Cascade Pipeline. The expected frequency and volume of spill is determined. Those figures are then compared to the estimated frequency and volume of spills from the existing truck/barge system.

The Cross Cascade Pipeline is projected to have 54 spills in the first 50 years of operation. The annual average amount of product spilled increases from 13,512 gallons in the first years to almost 30,000 gallons per year in the latter years (reflecting increased spill risks as the pipeline ages). The cumulative total estimate of product spilled over the first 50 years of the pipeline's life is almost 1,000,000 gallons.

The expected volume of product spilled from the pipeline is far larger than the expected volume that would be spilled if the existing transportation system were maintained. In contrast to the million plus gallons expected to be spilled by the pipeline in the first 50 years of operation, if barges and trucks were to transport that same amount of product, they would be expected to spill 210,987 gallons in that same 50 year period.

In other words, the pipeline is expected to spill 500 percent more product than the existing system.

Looking at frequency alone, the pipeline would have fewer spills. But the pipeline's spills are on average far larger than the truck/barge system spills. The higher spill frequency for the truck/barge system is because trucks have a higher frequency of spills than pipelines or barges. But looking at frequency alone is very misleading because those more frequent truck spills are, on average, far smaller in size. In other words, the pipeline probably will have fewer spills, but those spills will be much larger and, in total, release far more product into the environment.

The foregoing conclusions are based on the assumptions made by Olympic concerning the expected reduction in truck traffic if the pipeline were constructed. I did not test the facility of these assumptions and projections and simply incorporated them into my analysis. If the projected decrease in truck traffic does not materialize, the comparative risk assessment would tip even more heavily in favor of the existing system.

The report offers a critique of Olympic's risk analysis. (Olympic concluded that construction of the pipeline would reduce the risk of product spills.) Numerous flaws are identified in Olympic's analysis which led to its erroneous conclusion. Olympic's calculations were based exclusively on frequency of spills, ignoring volume. Because pipeline spills on average are larger than spills from the competing truck/barge system, Olympic's failure to include spill volume calculations skews the analysis in favor of the pipeline.

Second, even in its limited analysis of frequency alone, Olympic made errors. For instance, Olympic overstated the frequency of truck spills by utilizing a general trucking database instead of a database specifically for petroleum trucks (which shows a lower frequency of accidents than for the universe of all trucks).

Third, Olympic's comparison of the frequency of truck spills versus pipeline spills was invalid because Olympic considered only the frequency of larger spills (2,100 gallons or more) for pipelines, but compared that to the frequency of all spills (no lower threshold) for trucks. That is not a valid comparison.

The foregoing two errors by themselves result in a nineteen-fold overstatement in the frequency of truck spills relative to pipeline spills.

Fourth, Olympic cut its risk analysis off after 20 years. Spill risks associated with pipelines increase significantly as the pipeline ages. If Olympic had continued its analysis beyond 20 years, the increasingly risky nature of the pipeline would have had a substantial influence on Olympic's own analysis. It is extremely rare (perhaps unheard of) to plan the construction of a major pipeline (over $100,000,000 construction costs) with plans to take it out of service after just 20 years. Spill risk assessments of this type typically utilize a far longer range view. By terminating the analysis after just 20 years, Olympic has significantly understated the relative risks of the pipeline, by a factor of up to 5 in later years.

Fifth, Olympic erred in failing to consider the dramatic drop in barge spill frequency since the passage of the Oil Pollution Act (OPA) in 1990. Olympic utilized a pre-1990 database, overstating the barge risk. Olympic also failed to account for the benefits of the barge fleet converting to double-hulls. Already, 65 percent of the product shipped on Tidewater's barges are in double-hulled vessels. By 2015, 100 percent will be in double-hulled vessels (as required by OPA 90). The National Research Council has concluded that "the projected number of spills for double-hulled tankers is one-fourth to one-sixth of the number of spills projected for single-hulled tankers." The study also documented that when a double-hulled tanker does leak, it will typically leak less volume than a single-hulled tanker.

The report also includes several calculations of interest in assessing the spill risk associated with the pipeline. The report presents the maximum spill size from the pipeline. If the valves can be remotely or automatically closed, the maximum spill would be 607,651. If the valves require manual operation, this figure increases to 984,216.

The report also calculates the maximum leak volume that can go undetected. This calculation is a function of time: various leak detection systems that are more sensitive need a longer time frame to operate. In the short-term, Olympic's leak detection system cannot detect a spill smaller than 3,150 gallons per hour. Over a 24 hour period, Olympic's leak detection system might be able to detect leaks as small as 0.4 percent of flow but even this results in more than 30,000 gallons lost each day without detection. Over a period of a month or more, Olympic's leak detection capabilities might be as good as 0.2 percent of flow. But that still means that the amount of undetected for a month could be as high as 453,600 gallons.

The annual undetected leak could exceed 2 million gallons.

Olympic is not utilizing the best available leak detection systems. Systems with far greater sensitivity are available. For instance, hydrocarbon sensing cables can detect virtually the first gallon of product which leaks from a pipeline and detect it within a matter of minutes or hours at most.

Calculations of the leak rates from various hole sizes are presented. For instance, it is calculated that a one inch hole would produce a leak of more than 48,000 gallons per hour. A hole of only 0.01 inches would produce a leak of almost five gallons per hour.

The report includes a review of various instances in which Olympic's Revised Application reveals that Olympic is not proposing to use state-of-the-art technology to avoid and detect leaks. There are a wide variety of technologies on the market and being used by other pipeline companies which are superior in terms of avoiding leaks and detecting leaks. In addition to the hydrocarbon sensing cables already mentioned, other options include annual hydrostatic tests, other leak detection technologies, double-walled pipes, and superior internal inspection devices. If the pipeline were to be approved, these and other options are recommended for possible inclusion.

II. RISK ASSESSMENT METHODOLOGY

The risk assessment methodology is presented for pipelines, tanker trucks, and barges in Sections 2.1, 2.3 and 2.4. The fuel transportation mode split used in this analysis is presented in Section 2.2. The mode split is similar to the one presented in the spill risk report (Ref. 1) of Olympic's application for the proposed Cross Cascade Pipeline for comparison purposes of risk assessment. Comparison of risk results using these methodologies and the mode split are presented in Section III.

Oil spill risk analysis provides two main sources of information for review and evaluation of a proposed pipeline and other modes of product transportation (vessels and tanker trucks):

1. **The expected frequency and volume of spills,** i.e., how often will spills occur and how much product will be spilled.

   (The number and volume of spills are projected over the estimated life of the pipeline. Projected spill volume normally include the average spill size, volume spilled over the life of the pipeline, maximum spill sizes, and the maximum spill volume that can go undetected.)

2. **Potential environmental and safety impacts once the oil escapes.**

The risk assessment methodology provided in Section II examines the expected frequency and volume of spills for the proposed pipeline and the No Action Alternative.

2.1 PIPELINES

In 1983, I prepared a study for the Environmental Protection Agency entitled “Petroleum Pipeline Leak Detection Study” (Ref. 2). The study included a statistical review of petroleum pipeline leak databases. The EPA study resulted in formulas which allows calculation of the spill risks of any petroleum pipeline, and is used for the CCP analysis in this report. The formula begins with the statistically derived risk of a spill of at least 2,100 gallons (50 barrels) from a “reference” pipeline -- a one mile stretch of a ten inch refined product pipeline used full time for one year. To calculate the risk of a spill from a different pipeline, various adjustments must be made to account for variables like the age, diameter of the pipe (larger diameters generally leak less often but leak larger quantities on average), length, frequency of use, and the duration of use (in years). An adjustment must also be made if releases smaller than 50 barrels are to be addressed. Simplified tables and figures were provided so that an operator can estimate the spill potential of his own pipeline.

The formula is now widely used. The Application's risk assessment by Dames & Moore used the formula but used it incorrectly resulting in spill frequencies that are 4.5 times too low for the CCP. Dames & Moore failed to calculate the expected spill volume at all. The authors of the draft EIS for the proposed Cross Cascade Pipeline used the formula but they used it incorrectly too. The DEIS calculates the risk of spill to be less than if the formula were used correctly and fails to calculate expected spill volume at all. Risk of spills for pipelines are also calculated in the “Comparative Risk Assessment of the Proposed CCP” by Investigations Imperative for the Washington State Attorney General (Ref. 4). This document is in reasonable agreement with the Mastandrea/EPA formula.

A brief description of the Mastandrea/EPA formula used to determine the estimated spill risk (spill frequency and spill volume) over a 50 year period for the proposed Cross Cascade Pipeline is provided in this section. The basic formulas are presented in Section 2.1.1. Subsequent confirmatory evidence of the formula is presented from the State of California Fire Marshal report (1993) (Ref. 5), current Office of Pipeline Safety data bases on interstate pipelines, and other sources is presented in Section 2.1.2. A discussion of the computation of leak rates for various leak hole sizes, maximum potential spill size, and undetected leak potential from the CCP is provided in Sections 2.1.3 though 2.1.5.

The spill risks of the proposed Cross Cascade Pipeline was based on the formula that determines the risk (frequency and volume of spills) of product accidently spilling from the pipeline. The basic formula is outlined in diagrammatic form in Figures 2-1 and 2-2.

FIGURE 2-1.

FIGURE 2-2

The Mastandrea/EPA formula for calculating the frequency of spills is:

Fstc = Fst x CFf = Fst x (CFa x CFd x CDss x CFl x CFu) 10^{-3} SPILL/MILE/YEAR

where: Fstc = Spill frequency of CCP corrected for its design parameters and use
Fst = Historical reference pipeline spill frequency for average spill size is 1.3×10^{-3} spills/mile/year
CFa = Spill frequency correction factor for age
CFd = Spill frequency correction factor for diameter
CFss =Spill frequency correction factor for spill size less than 2,100 gal
CFu =Spill frequency correction factor for length
CDl = Spill frequency correction factor for use

The formula for calculating the volume of spills is:

Vstc = Vst x CFv = Vst x (CFa x CFd x CFl x CFu) (GALLONS/MILE-YEAR)

where: Vstc =Spill volume of CCP corrected for its design parameters and use
Vst =Historical reference pipeline spill volume for average spill volume is 1.3 barrels/mile/year or 55 gallons/mile/year
CFa = Volume correction factor for age
CFd =Volume correction factor for diameter
CFl =Volume correction factor for use.

The methodology of the formulas, data bases used, correction factors, and other pertinent information are presented in Section 2.1.1.1. Risks estimates using these formula for the estimated CCP spill frequency and spill volume over a 50 year period are presented in Section 3.1.

2.1.1 Description and Development of Formula

The pipeline oil spill risk formulas were based on a comprehensive research and evaluation of the U.S and foreign pipeline systems, pipeline losses and factors on the predictability of pipeline losses. Background information was obtained and the methodology developed in the three year comprehensive study for the U.S. EPA report (Ref. 2).

The pipeline risk assessment methodology used is outlined in diagrammatic form in Figures 2-1 and 2-2. The portion of the formulas used for the proposed Cross Cascade Pipeline and reported here involved the following five separate divisions:

(1) <u>Reference pipeline</u> (average petroleum pipeline in the United States).
(2) <u>Spill causes</u> for the reference pipeline.
(3) <u>Spill risk</u> (frequency and volume of spills) for the reference pipeline.
(4) <u>Correction factors</u> for the specific pipeline (Cross Cascade Pipeline)
(5) Computation of the <u>estimated frequency and volume of spills</u> for the for the Cross Cascade Pipeline.

The formulas are described briefly in the paragraphs that follow.

First, a reference pipeline was developed based on a thorough review and evaluation of the pipeline systems in the U.S. and foreign countries. The reference pipeline in the United States was a segment of the typical petroleum pipeline, i.e., a 1 mile section of a 25 year old, 10 inch diameter pipeline operated at capacity. The data bases consulted (References 6-14) included reports of crude oil and refined products pipeline mileage in the United States published by the U.S. Department of Interior (Bureau of Mines) from 1971 to 1977 and transport statistics from the Interstate Commerce Commission from 1965 to 1976.

Second, an analysis of nationwide spill data was carried out. Cause of spills, relationship of pipeline parameters and accidents and other relationships were examined. Failure modes were grouped into three main causes of failure: line pipe faults, outside forces, and other causes. The main data bases (References 15-27) consulted included the U.S. Department of Transportation (Office of Pipeline Safety) from 1969 to 1977 and Stitching Concave Oil Pipelines Special Task Force for the years 1971 to 1977.

Estimates were developed for the reference pipeline spill risk, i.e., the mean frequency and volume of pipeline systems spills on a per-mile and per-year basis for each major cause of spills. An overall frequency and volume of spills for the reference petroleum pipeline was obtained by adding the losses by cause of spills. Measures of relative risk were also evaluated based on the product of spill frequency and volume (for leaks, ruptures and average spills) for the reference line. Spill risk estimates for the reference model were developed from spills reports from References 9 to 16 for the years 1969 to 1977.

Next, a set of correction factors were developed to adjust the reference pipeline to a specific pipeline with characteristics different than the reference pipeline. Correction factors were developed based on records of pipeline spills for significant pipeline parameters., e.g., diameter, age, etc. Correction factors are important because review of the databases reveals that these parameters have a strong association with spill risk. As these parameters change, so does the spill risk.

Finally, reference pipeline valves are multiplied by the correction factors for mean spill frequency and volume. This results in the spill estimates (volume and frequency) for the specific pipeline in question.

A brief discussion of the reference pipeline is provided in Section 2.1.1.1. Actual correction factors for the proposed Cross Cascade Pipeline are developed in Section 2.1.1.2. Calculations of the frequency and volume of expected spills are presented in 2.1.1.3. Results of the computation of the CCP spill risk are provided in Section 3.1.

2.1.1.1 Reference pipeline

Based on a statistical review of the databases, it was calculated that the mean frequency of spills (Fst) for the reference pipeline is approximately 1.3 x 10^{-3} spills/mile year (i.e., 1.3 spills per 1,000 miles of pipe per year). The mean volume of spills is 1.3 barrels/ mile-year (i.e., 1.3 barrels (54.6 gallons) of product spilled per mile per year; or 1,300 barrels (54,600 gallons) spilled per 1,000 miles per year) (Ref. 2).
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The assumptions for the reference line are shown in Table 2-1. The following in-service inspection and leak detection methods are assumed:

- ? Biweekly visual inspections by air or ground patrol for indications of a spill-- (required by U.S. regulation)
- ? Periodic inspection of the cathodic protection system -- (required by U.S. Regulations)
- ? Continuous monitoring of line pipe pressure deviations at pump stations and central control centers for smaller diameter lines
- ? Continuous monitoring of line pressure deviations, flow deviations, and volume comparison for large diameter lines
- ? Meter proving
- ? Voluntary One-Call system

Table 2-2 provides the proposed Cross Cascade Pipeline specifications used in this report.

TABLE 2-1. ASSUMPTIONS FOR TYPICAL REFERENCE SECTION OF PIPELINE

Age:	25 years
Diameter:	10 inches
Length:	1 mile
Commodity:	Crude oil
Flow velocity:	7 feet per second
Flow rate:	63,000 gallons per hour
Operating pressure:	600 psi
Material:	Steel pipe
Construction:	Butt weld joints
Line elevation:	Horizontal
Corrosion control:	Coated with cathodic protection
Pump station shutdown time:	2 minutes
Mainline valve closure time:	72 minutes (manual)
External environment:	Low risk - onland - sparsely populated - not near water

TABLE 2-2. CROSS CASCADE PIPELINE SPECIFICATIONS

ITEM		DIMENSION	14 INCH Thrasher-Kittitas	12 INCH Kittitas - Pasco
Length	L	Miles Feet	120 633,600	107 564,960
Pipe wall thickness	w	Inches	.281	.250
Pipe grade	G		API 5l X52	API 5L X52
Volume per mile	V	Barrels Gallons	926.4 38,909	678.3 28,487
Volume/Line	V/ L	Barrels/Miles Gallon/Miles	110,497/119.3 13,182,292/119.3	82,511\107.2 3,465,462
Average pipe cross sectional area	A	FT(squared)	.984	.721
Range of overall throughput Q=AV	Q	Barrels/day Barrels/hr Gallons/day Gallons/hr	24,000 - 180,000, 1,000 - 7,500 1,008,000- 7,560,000 42,000 - 315,000	12,000 - 96,000 500 - 4,000 504,000 - 4,032,000 21,000 - 168,000
Average Throughput First 10 Years (per application)	QA	Barrels/day Gallons/day Gallons/hr	Up to 100,000 (estimate at 10 years) 4,200,000 175,000	Up to 100,000 (estimate at 10 years)
Maximum Throughput (Initial Pump Configuration)	QA	Barrels/day Gallons/day Gallon/hr	110,000 4,620,000 192,500	110,000 4,620,000 192,500
Average velocity	V	Ft/sec	6 Feet/Sec	6 Feet/Sec
Pump stations	PS		Thrasher* - MP 0 North Bend* - MP 37.4 Stampede - MP 67 Kittitas* - MP 124	Beverly Burke - MP 154 Othello - MP 189.5
Valves			1. Thrasher- MP 0 2. Snoqualmie R.,E. MP 8.10 3. Snoqualmie R,W MP 9.30 4. Cherry Creek, N MP16.19 5. Cherry Creek, S MP23.42 6. Tolt River (Top of hill) MP24.56 7. Tolt River (East side) MP31.86 8. Snoqualmie R., MP34.06 9. North Bend Sta. MP37.32 10. North Bend Sta. MP37.34 11. S. Snoqualmie River, West MP39.42 12. N. Side Homestead Rd MP44.29 13. Near Exit 47 of I-90 MP54.80 14. Stampede Sta. MP67.07 15. Cabin Creek MP73.90 16. West side Cle Elum MP87.56 17. Yakima R., E. MP 95.26 18. Yakima R., W. MP 96.19 19. Currier Creek, N MP 108.73 20. Kittitas Station MP123.89	21. Kittitas Station MP124.09 22. Park Creek E. MP 129.82 23. Columbia R., W. MP 148.39 24. Columbia R., E. MP150.35 25. Beverly Station MP 154.08 26. Unnamed Stream MP 178.53 27. LowerCrab Crek N. MP181.69 28. Othello Station MP189.15 29. Pacso Metering Sta.MP231.01
Test Pressure	TP	Psi	1800	
Maximum elevation	E	Feet	2,742	2,591
Maximum distance between valves	MD	Miles	15.16	41.8
Maximum Operating Pressure	MOP	PSI	1440	

*Pump stations constructed at outset. Other pump stations to be added later to increase throughput capacity. See Revised Application at 2.3-26.

2.1.1.2 Correction factors

The spill potential of a petroleum pipeline (crude, product, etc.) can be estimated by applying correction factors for the specific pipeline to the values developed for the reference line. These factors correct for the significant variations (e.g., age, diameter, etc.) between lines. They are intended to provide a simple and practical means of accounting for these specific variations when estimating the expected frequency and volume of spills.

Many factors influence the frequency and volume of spills from a pipeline. Analysis and evaluation of available spill data indicate, however, that only a few factors vary in such a manner as to significantly affect the incidence of spills between different lines. The significant factors that affect spill frequency include:

? age,
? geometry (diameter, wall thickness),
? use,
? length,
? minimum spill size.

The most significant factors that affect the volume of spills include:

? age,
? diameter,
? use and
? length.

The relationships of these factors with pipeline specifications and operation are shown in Figures 2-3 and 2-4.

Correction factors computed for the CCP are provides in Table 2-3. These correction factors are based on the pipeline specifications in Tables 2-1 and 2-2 and the correction factor curves provided Figures 2-3 and 2-4.

Figure 2.3. Correction Factors for Spill Frequency

Figure 2-4. Correction Factors for Volume of Spills

TABLE 2-3. ANNUAL SPILL VOLUME AND SPILL FREQUENCY CORRECTION FACTORS APPLIED TO THE PIPELINE REFERENCE MODEL FOR THE CROSS CASCADE PIPELINE

PIPELINE VARIABLE		NOMINAL VALUE		CROSS CASCADE PIPELINE CORRECTION FACTORS	
		HISTORICALREFERENCE MODEL	CROSS CASCADE PIPELINE	ANNUAL SPILL FREQUENCY	ANNUAL SPILL VOLUME
Age (Years)	CFa	25	0-5 5-15 15-25 25-35 35-45 45-55	0.3 0.5 0.6 1.4 2.1 2.8	0.6 0.7 1.0 1.1 1.2 1.3
Diameter (Inches)	CFd	10	12 14	0.6 0.5	1.5 2.1
Length (Miles)	CFl	1	107 (a) 120 (b)	107 120	107 120
Line Elevation (Feet)	CFle	Horizontal	Depends on Location on Line	None	1 (c)
Pressure (Psig)	Pp	1000	1440	None	1 (d)
Pumping Station Shutdown Time (Minutes)	CFps	2	2	Not Applicable	1.0
Spill Size (Gallons)	CFss	>2,100 <2,100 (e)	>2,100 <2,100 (e)	1 4.5	None None
Usage (Percent)	CFu	100	100	1	1
Valve (Mainline) Closure Time (Minutes)	CFmc	72	10	None	1

Note: (a) 12 inch diameter line section based on information in DEIS; Revised Application value is slightly different.
(b) 14 inch diameter line section based on information in DEIS; Revised Application value is slightly different.
(c) Depends on location of pipeline, a correction factor of 1 is used for the overall CCP
(d) Correction factor depends on location of pipeline, a correction factor of 1 is used for the overall CCP
(e) Correction factor for spills of less than 2,100 gallon have a range of 21 gallons to 2,100 gallons.

2.1.1.3 Calculation of the frequency and volume of spills

The calculation of the frequency and volume of spills is obtained from the CCP specifications, the correction factors for the CCP, and the formulas presented in Section 2.1.1. Result of these calculations are given in Tables 2-4 through 2-7. The results are discussed and summarized in Section 3.1

Table 2-4. Projected Project Failure Rates Per Mile

			Pipeline Age					
			0-5 years	5-15 years	15-25 years	25-35 years	35-45 years	45-50 years
Segment	**Dia. (in)**		**Failure Rate per Mile per Year**					
Thrasher - Kittitas	14	Leaks Ruptures	7.3×10^{-4} 1.62×10^{-4}	1.5×10^{-3} 3.3×10^{-4}	1.8×10^{-3} 0.4×10^{-3}	4.1×10^{-3} 0.9×10^{-3}	6.1×10^{-3} 1.4×10^{-3}	8.2×10^{-3} 1.8×10^{-3}
Kittitas - Pasco	12	Leaks Ruptures	8.8×10^{-4} 2.0×10^{-4}	1.8×10^{-3} 3.9×10^{-4}	2.1×10^{-3} 0.5×10^{-3}	4.9×10^{-3} 1.1×10^{-3}	7.4×10^{-3} 1.6×10^{-3}	9.8×10^{-3} 2.2×10^{-3}

Note: "Leak" is defined as a release of less than 2,100 gallons (50 barrels) but greater than 21 gallons (0.5 barrels).

"Rupture" is defined as a release of 2,100 gallons (50 barrels) or more.

Table 2-5. Estimated Spills per Year for the Proposed Project

Segment	Length (Miles)		Pipeline Age: 0-5 years	5-15 years	15-25 years	25-35 years	35-45 years	45-50 years
			Spills per Year					
Thrasher - Kittitas	120	Leaks	0.0870	0.1760	0.210	0.491	0.737	0.983
		Ruptures	0.0195	0.0390	0.047	0.109	0.163	0.218
Kittitas-Pasco	107	Leaks	0.094	0.188	0.225	0.523	0.789	1.050
		Ruptures	0.021	0.042	0.050	0.116	0.175	0.234
Total Expected Spills per Year (Leaks + Ruptures)			0.221	0.440	0.533	1.240	1.86	2.485
Expected Recurrence Interval (Years)			4.50	2.30	1.87	0.81	0.54	0.41
Probability of One or More Spills per Year			22%	44%	53%	125%	186%	240%
Cumulative Total Expected Spills to End of Period			1.105	5.45	10.78	23.18	41.78	54.03

Note: "Leak" is defined as a release of less than 2,100 gallons (50 barrels) but greater than 21 gallons (0.5 barrels).
"Rupture" is defined as a release of 2,100 gallons (50 barrels) or more.

TABLE 2-6. PROJECTED PROJECT SPILL VOLUME FOR PROPOSED CCP (RUPTURES ONLY)

			Pipeline Age					
			0-5 years	**5-15 years**	**15-25 years**	**25-35 years**	**35-45 years**	**45-50 years**
Segment	**Dia. (in)**		**Gallons Spilled per Mile per Year**					
Thrasher - Kittitas	14	Spills >2,100 gal	68.8	80.3	117.7	126.1	137.4	149.0
Kittitas - Pasco	12	Spills >2,100 gal	49.1	57.1	81.9	90.1	98.3	106

TABLE 2-7. SPILL VOLUME PER YEAR FOR PROPOSED CCP (RUPTURES ONLY)

		Pipeline Age					
		0-5 years	5-15 years	15-25 years	25-35 years	35-45 years	45-50 years
Segment	**Length (Miles)**	**Spill Volume* per Year**					
Thrasher - Kittitas	120	8,255	9,631	13,759	15,135	16,480	17,882
Kittitas-Pasco	107	5,257	6,112	8,763	9,639	10,515	11,392
Total Expected Spill Volume per Year		13,512	15,743	22,522	24,777	26,995	29,274
Cumulative Spill Volume (Gal)		67,560	224,990	450,210	697,980	967,930	1,114,300

Note: * Volume spilled for spills 2,100 gallons or more.

2.1.2. Subsequent Confirmation Evidence of Formula

Key components of the Mastandrea (EPA) risk formula have been confirmed by analysis of more recent databases. The formulas in the Mastandrea (EPA) report published in 1982 used spill incidents data bases from the years 1960s and 1970s. The confirmation evidence is available from at least three separate and independent sources using results from three separate and independent spill incident data bases for data in the 1980s and 1990s.

2.1.2.1 Confirmation of Fst = 1.3 X 10^{-3} spills per mile-year

OPS PIPELINE FAILURE DATA

OPS data from years 1986 through 1997 show that the accident rate for spills of greater than 2,100 gallons averaged .00135 spills/mile-year. See Table 2-7. This is essentially the same accident rate as the historical reference pipeline spill frequency (Fst = .0013 spills/mile-

Table 2-8. Pipeline Failure/$ Property Damage/ Product Released Rates

Source: OPS DATA

Year	Miles of PL	Accidents	#Gallons Spilled	Accidents/mi	$PD/mile	Gallons Released/mi
1986	153,462	209	9,215,346	.001362	104.44	60.05
1987	125,859	237	13,131,468	.001883	104.41	104.33
1988	152,547	193	4,798,542	.001265	212.49	31.46
1989	150,488	163	5,089,518	.001083	58.57	33.82
1990	149,008	180	2,295,846	.001208	105.50	15.41
1991	150,425	216	2,343,508	.001436	251.21	15.57
1992	152,595	212	2,887,164	.001389	253.29	18.92
1993	165,781	230	2,440,536	.001387	174.17	14.72
1994	155,208	244	4,718,700	.001572	363.73	30.40
1995	153,566	188	22,307,746	.001224	211.76	145.26
1996	154,863	195	4.037,922	.001259	320.96	20.07
1977	154,863	179	4,699,674	.001154	320.39	30.29
1986-1977				.001350		43.45

OLYMPIC PIPELINE

The DEIS states on page A-2 that the existing Olympic pipeline, based on actual performance, had a spill probability of 1.3 x 10^{-3} spills/mile/year for spills greater than 2,100 gallons from years 1965 through 1996.

CALIFORNIA STATE FIRE MARSHAL REPORT (Ref. 5)

The California report confirms the spill probability of U.S. hazardous interstate liquid pipelines of 1.3 x 10^{-3} spills/mile/year for spills greater than 50 barrels for the period from years 1986 to 1989. The value is the same as the spill frequency (Fst) for the reference pipeline used in the Mastandrea formula.

2.1.2.2 Confirmation of Correction Factor for Spill Size CFss

pipelines were 10.2 inches. Average spill size was 408 barrels (17,136 gallons) and the average mean spill size was 5 barrels (210 gallons).

The California report also showed that California regulated pipeline had 514 spills averaging 17,186 gallons per spill during this 10 year period. This resulted in **8,807,712 gallons spilled over the 7,800 miles in 10 years**. Approximately 112 gallons was spilled each year for each mile of pipeline.

2.1.3 Formula for Computation of Leak Rate as a Function of Hole Size

The amount of the product that can leak out of a leak hole at various operating pressures is needed information in a risk assessment. The size of the break or leak hole in a pipeline is critical in determining the amount of spillage out of the pipeline over time. This information is important when considering the sensitivity of leak detection and inspection equipment, estimating spill volume for spill scenarios of interest, and computing or estimating the leak volume when a leak is detected. Corrosion leaks or cracks can be as small as .001 inches in diameter and still create serious problems if they go undetected for long periods of time. Damage from outside forces normally results in large breaks (2 inches in diameter or more) or severing the line.

Computation of leak rates as a function of hole size from an operating pipeline can be done using relatively simple equations and certain pipeline operating parameters. Table 2-9 provides leak rates as a function of hole size for the CCP based on the formulas in Tables 2-10 and pertinent CCP specifications in Table 2-11. Table 2-12 provides pertinent CCP operating characteristics needed for the calculations.

TABLE 2-9. LEAK RATES AS A FUNCTION OF HOLE SIZE FOR CCP

Pressure (psi)	Leak Hole Diameter (inches)	Leak Rate (gallons per hour)
1440	4.00	770,608*
1440	2.00	196,556
1440	1.00	48,163
1440	0.10	481
1440	0.01	4.81
1440	0.001	0.048
1440	0.0456	100
1440	0.01444	10
1440	0.00456	1

TABLE 2-10. EQUATION FOR FLOW THROUGH A SHARP EDGE LEAK ORIFICE

$$Q = Av = C_d \times A_0 \times (2gh)^{½} = C_d \times A_0 \times (2g \times P/p)^{½}$$

Where:

Q = flow in ft^3/sec
A = jet cross section area, ft^2
A = orifice area, ft^2
BPH = barrels per hour
Cd = flow coefficient - 0.61 for sharp edge orifice
d = orifice (break or leak) diameter in inches
g = 32.2 ft/sec^2
h = fluid head, ft.
GPM = gallons per minute
P = fluid pressure, lbs/ft^2
p = fluid density, lbs/ft^3
v = jet velocity, ft/sec = $(2gh)^{½}$

For Q in GPM, orifice diameter d in inches and head feet;

$$GPM = \frac{C^d \times d^2 \times (64.4)^{½} \times (h)^{½} \times 449}{4\,(144)} = 19.6 \times C_d \times d^2 \times (h)^{½}$$

since 1 ft^3/sec = 449 GPM

TABLE 2-11. CROSS CASCADE PIPELINE OPERATING PARAMETERS AND SPECIFICATIONS

ITEM	VALUE
Average pipe inside diameter, D	14 inches/12 inches
Pump station spacing (miles), Maximum/Average (initial configuration)	107/77
Average pipe cross section area, A	.984/.721
Maximum operating pressure, P	1440 psig
Pressure head for gasoline (SG = 0.74, p = lbs/ft^3) h = P/p = 1440 (144/46)	4507 feet
Average velocity of liquid in pipe, v	6 ft/sec
Average throughput, Q = Av = 1.06 ft^2 x 6 ft/sec x 3600/ 5.61 ft^3/barrel	4,081 Barrels per hour
Average valve spacing, miles (14 inch/12 inch)	6.5/13.4

2.1.4 Maximum Potential Spill Size

The volume of a pipeline spill is the volume from the time the leak or rupture occurs until the leak stops. The actual sequence of a spill after it starts is as follows:

1. Leak detection and confirmation time - leak continues
2. Pump shutdown - leak continues
3. Isolate leaking line segment after pump shutdown - leak continues
   - location of failure
   - mainline valve closure.
4. Drainage out of pipeline from point of release from static head pressure until static head reaches zero at the point of release.

The maximum potential spill size is based on the following seven conditions:

? Major break or rupture of the pipeline
? CCP operations
? CCP specifications
? Leak detection time
? Leak location equipment

-- Break at the low point in the Cascades with the distance between the high and low point of 13 miles.
-- Approximately mid-way between pump stations about 50 miles
-- Between valves, elevation drop between high and low point of approximately 1000 feet
-- Manual operation of the mainline valve requiring 72 minutes.
-- Remote operation of the mainline valve requiring 10 minutes.

A 4-inch diameter hole is characteristic of a large break in the line but is not so large as to be considered a severing of the pipe.

Spill volume are computed for each of the spill sequences. This results in an **estimated maximum spill size** of approximately:

? **984,216 gallons if the mainline valve requires manual operation, and**
? **607,651 gallons if the mainline valve can be closed remotely in 10 minutes.**

2.1.4.1 Volume during leak detection and confirmation

This type of leak would discharge gasoline at the rate of

$$GPH = 19.6 \times C_d \times d^2 \times h^{1/2} \times 60$$
$$= 19.6 \times .61 \times 16 \times 67.1 \times 60$$
$$= 770{,}608 \text{ gallons per hour}$$

This discharge rate is higher than maximum throughput and would result in a large friction pressure drop which would normally alleviate the high discharge rate situation. Since this break is about midway to the pump station and the increase in the velocity is small the pressure drop would remain relatively high until the pumps are turned off.

Assuming the pressure wave travels 3,000 feet per second, it would take about 1.4 minutes to detect a rupture. Therefore the leakage for 1.4 minutes would be:

770,608 gallons/hour x 1.4 minutes/60 = **17,980 gallons**

2.1.4.2 Volume during pump shutdown

Assuming pump shutdown time of 2 to 2.5 minutes and account for pressure decrease during shutdown, leakage would be approximately:

616,456 gallons/hour x 2.25 minutes/60 = **23,118 gallons**

2.1.4.3 Volume during isolation of leaking line segment - location of failure, mainline valve closure

Assuming mainline manual valve closure requires 72 minutes for closure, the following could leak out:

(a) Leak rate for static head (neglecting friction)

19.6 x .61 x 16 x 31.75 x 60 = 364,418 gallons per hour

(b) Leakage for 72 minutes

364,418 gallons per hour x 72/60 = **437,301 gallons.**

If the mainline valve can be closed automatically and remotely in 10 minutes, the leakage would be

364,418 gallons per hour x 10/60 = **60,736 gallons**

2.1.4.4 Volume after mainline valve closure to total stoppage of discharge of fluid from line

After mainline valve closure, drainage will occur out of the line because of the remaining static head of the pipe, 14 inch diameter, and the static head of 1000 feet, due to elevation of the line.

Using the static head of 1000 feet, draining would continue out of the pipe between the two mainline valves until the line fill leaks out. Since it is assumed that the spacing between the mainline valve is 13 miles (38,909 gallons/mile) and there is a 13 mile distance from the upstream valve to the rupture location, then:

13 miles x 38,909 gallons/mile = **505,817 gallons**.

A spreadsheet depicting the maximum drawdown in various pipeline segments is attached as Appendix A. The spreadsheet should be used in conjunction with the sensitive site information in Exhibit B and the chart of potential draindown (after pump shutdown and main valve closure) in Exhibit C.

2.1.5 Formula for Leak Volume That Can Go Undetected

The leak volume that can go undetected results from one or more small holes or cracks sections of the pipeline are installed in gravel bottoms or sandy bottoms, the leak propagation problems is worse.

There are thousands or examples of undetected leakage from pipelines and storage tanks nationwide that existed for months and years. The problem has been reduced significantly for underground tanks and piping due to Federal Regulations in the late 1980s. The problem persists with pipeline because there has been no significant regulations since the late 1960s and early 1970s.

Once leakage is detected, the source of the leak may still be unknown for long periods of time. These is often a problem of discriminating between pipeline leaks and adjacent or nearby heating oil tanks, gas stations tanks or commercial oil tanks, There are significant problems with visual inspection for leakage for sections of the CCP that are underwater or leak into groundwater. If a leak occurs, the oil can spread by currents and groundwater movement. Thus, the origin of the leak may be difficult to find and wide dispersion of petroleum may cause confusion as to what pipeline or other source caused the leak.

2.1.5.1 Formula for computation of undetected leak volume

Maximum undetected leak volume (LV ud) is equal to the time interval that the leak can go undetected (Tud) in hours times the maximum leak rate that can go undetected (LRud) in gallons per hour.

LVud (gallons)= Tud (hours) x LRud (gallons/hour)

The leak rate that can go undetected decreases with time due to leak detection and monitoring systems and methods available for the CCP. These include the following:

1. Sensitivity of the CCP SCADA with computer enhanced PLDS leak detection for short term leaks (minutes, hours, days)
   - Abnormal pressure and flow change leak detection
   - Line volume overages and shortages
2. Batching leak detection procedures
3. Over-short accounting for long-term leaks (weekly, monthly)
4. Hydrostatic testing

Assumptions for the CCP are as follows:

Pipe diameter	14 inches
Flow rate	315,000 gallons per hour
Flow velocity	6 feet per second
Pressure	1440 psi

pumps or compressor stations. (No sensors along the pipeline).

2.1.5.2 Maximum short-term undetected leakage

Assuming an average system leak detection sensitivity of 1% of throughput and a response time of 15 minutes, a short term leak of 3,150 gallons could go undetected each hour.

315,000 gallons/hour x 1% = **3,150 gallons per hour.**

If an average system accuracy of 0.5% is achieved, the short term leak detection accuracy would be **1,575 gallons per hour.**

Variations in the pipeline operating and flow conditions often cause false alarms. To account for this (reduce false alarms), set points are typically raised. This often results in a decrease in the leak sensitivity to 1% to 5% of flow or more and typically limits leak detection to only larger spills.

Use of computer assisted leak detection with pressure and temperatures sensors located along the pipeline between the pump stations is expected to improve the leak detection performance to better than 1% of flow to perhaps $\pm$0.25% of flow but OPL has not presented details of its computer aided leak detection system including the locations of the pressure and temperature sensors, if any, along the pipeline. If OPL fails to include additional temperature and pressure sensors along the pipeline between pumping stations, short-term undetected leakage could range from 1% to 5% of flow.

2.1.5.3 Duration of maximum short-term undetected leakage (3,150 GPH)

A leak may be detected at pump stations using volume comparison or over/short metering. However, at a product flow velocity of 6 feet per second, and leaking midway between pump stations located 83.4 miles apart (i.e., between the North Bend and Kittitas pump stations), a **leak of 3,150 gallons per hour could exist for at least for 10 hours,** i.e., the time it would take for the reduced flow and volume levels from the leak to reach the pump station monitoring system and be detected.

This time for detection is based on the following assumptions:

- -- flow velocity of 6 feet per second
- -- leak midway between pump stations, i.e., 41.7 miles from volume balance or other over-and-short monitoring
- -- ideal over/short metering at pump stations with $\pm$ 0.2% accuracy.

If the line has significant line pack[1] or excess flow fluctuation in the line, the indicated leak detection time would be considerably longer. Installation of additional sensors along the pipeline would reduce the leak detection time.

2.1.5.4 Maximum undetected leak each day (24-hour period)

Assuming the most modern instrumentation, i.e., flow meters, temperature transducers, pressure transducers, computers, etc., a total error for the CCP was computed for a 24-hour segments using

$$\text{Total system error} = (E_1^2 + E_2^2 ....E_N^2)^{1/2}$$

for each of the leak detection system components, i.e., pressure gauges, flow gauges, temperature gauges, etc. a leak detection sensitivity of about +/- .2% of throughput assuming all instrumentation functioned to manufacturer specifications.

Assuming a daily throughput of 7,560,000 gallon, the daily leakage that can go undetected by the leak detection is

Daily undetected leakage:

7,560,000 gallons/day x 0.4% = **30,240 gallons**

The indicated value does not take into account slack line (line pack) volume error. The addition of slack line volume error would increase the daily undetected leakage.

A daily spillage of 30,240 gallons could go undetected for at least the 7 days between visual inspection of line patrol if the leak surfaces. Since batching is expected to occur more frequently than once a week, the undetected leakage would be based on batching leak sensitivities (described in the next section).

2.1.5.5 Maximum undetected leakage per batch

Ideally, assuming batching occurs every third day and that the metering accuracies are +/- .2% are possible, a leakage of

Leakage per batch:

3 days x 7,560,000 gallon/day x .2% = **45,750 gallons**

or more would go undetected.

Small leaks less than 635 gallons per hour or more could exist indefinitely, days, months, years. This leak rate is only 0.2% of throughput. Such a leak rate cannot be detected reliably by any known pipeline leak detection system on a daily basis. Considering such factors of line transients, startup, shutdown, pumping changes, line pack, varying temperature and pressure along the pipeline route, etc., detection of a leak of better than 0.2% per day is unrealistic.

2.1.5.6 Maximum undetected leakage per month

Assuming monthly long-term over/short accounting, it is expected that leakage of 0.1 to 0.2% of throughput may be detected by normal accounting procedures. However, because of line temperature effects, and other factors, a leak of 0.2% could go undetected by accounting procedures.

Assuming accounting accuracies of 0.2%, **monthly undetected leakage** of

7,560,000 gallon/day x 30 days x 0.2 = **453,600 gallons**

or more would go undetected on a monthly basis or **620 gallon per hour**.

It is expected that small leak of this size may be detected by some other means, e.g., visual inspection, groundwater pollution. For instance, Olympic's Renton spill in 1985 went undetected for a year or longer until it surfaced hundreds of feet away in the Cedar River and was noticed by a fisherman.

2.1.5.7 Maximum continuing undetected leak

Using a 0.2% detection limit, leaks of 620 gallons per hour can go undetected indefinitely. One way to minimize this problem is to conduct annual hydrostatic tests. (Olympic is not proposing annual hydrostatic testing, only once prior to initial startup.) Hydrostatic tests

Thus a leak of 87,600 gallons per year could not be detected except by other special leak detection methods not proposed by OPL (e.g., hydrocarbon testing cables).

2.1.6 CCP Annual Spill Volume Based on Spilled-to-Shipped Statistics

An alternative to the Mastandrea/EPA methodology for estimating the annual spill volume for the CCP is through the use of spilled-to-shipped ratios. Spill volume can be estimated based on the volume shipped through the pipeline. Additionally, these ratios give an indication of the changes in spill volume for an increase or decrease in shipped volume.

These ratios do not provide a correction for pipeline characteristics such as diameter and age, but do demonstrate the effects on spill risk from varying the overall volume of oil transported.

The spilled to shipped ratio in the 1982 EPA study shows a spilled to shipped ratio of 2.8 x 10-5 for the period from year 1971 to year 1975. Assuming the maximum throughput of 180,000 gallons per day, the annual spill volume would be:

CCP volume spilled per year = 2.8 x 10-5 spilled x 180,000 barrels/day x 365 days
= 1,642 barrels (68,964 gallons)

The volume spilled per barrels shipped each year is provided in Table 2-12 based on the OPC demand estimates for the CCP (see Page 8 of OPL's risk analysis report).

TABLE 2-12
ANNUAL VOLUME SPILLED BASED ON SPILLED-TO-SHIPPED FOR CCP

EASTERN WASHINGTON PRODUCT DEMAND 1999-2019

	1999	2004	2009	2014	2019
Total Forecasted Demand BPD	88,305	95,130	102,482	110,402	118,935
Annual Volume Spilled (Gallons)	37,904	40,833	39,276	47,388	51,051

2.2 TIMEFRAME FOR RISK ANALYSIS

The risk comparison in Part III of this report covers a period of 50 years instead of the 20 years in the OPL risk analysis report. The growth rate for the additional 30 years is continued at a 1.5% growth per year. For comparison purposes, the demand forecast by OPL (Table 2-13) is included here. The demand forecast for the 50 years in included in the comparison tables in Section 3.2.

A fifty year analysis is typical for pipeline risk assessments and is consistent with Olympic's plans to operate the proposed pipeline indefinitely. OPL's twenty year analysis is far too short. OPL's short time frame minimizes the relative risk of the pipeline because pipelines get riskier over time as they are subject to deterioration. Competing modes (trucks, barges) tend to have equipment upgrades far more often and thus there is no increase in risk for these modes merely as a function of time.

TABLE 2-13. EASTERN WASHINGTON PRODUCT DEMAND 1999-2019 (PER OPL)

	1999	2004	2009	2014	2019
Total Forecasted Demand (BPD)	88,305	95,130	102,482	110,402	118,935
Truck	13,590	15,324	17,191	19,203	21,370
Barge	39,915	45,006	50,491	56,399	62,764
Subtotal	53,505	60,330	67,682	75,602	84,134
Yellowstone Pipeline	28,500	28,500	28,500	28,500	28,500
Chevron Pipeline	6,300	6,300	6,300	6,300	6,300
Subtotal	34,800	34,800	34,800	34,800	34,800

2.3 MODE SPLIT

The basis of the product transportation mode split for comparing the spill risk for the proposed Cross Cascade Pipeline and the No Action Alternative in this report are the forecasted demands for tanker trucks and barges given in Table 2-1 of OPL risk analysis and shown below. The risk analysis applied in this report applies only to the CCP, barge and tanker truck modes of transportation as was done in the OPL risk analysis. The two existing pipelines, Yellowstone and Chevron, were assumed by OPL to continue to serve Eastern Washington market at their current capacity and would not accommodate any increased Eastern Washington demand. The reasonableness of OPL's mode split assumptions are not tested in this report.

The total number of trips for the No Action Alternative transportation are determined. The trips for the tanker trucks are corrected to account for the large tanker truck capacities of 10,500 gallons instead of 8,000 used by OPL.

tank truck;

(2) Detected and located immediately, and

(3) Attributed to only one system component, i.e., tanker truck, barge unlike complex pipeline systems with numerous failure components, massive size and complexity.

The data base used for this analysis was from the U.S. Department of Transportation for tanker truck accidents and spill data from 1984-1994 **specifically for the transportation of crude oil and petroleum products**. The data base is for all reported spills and no minimum spill size. See Table 2-14 below.

TABLE 2-14
TANKER TRUCK ACCIDENT AND SPILL DATA 1984-94 IN THE UNITED STATED TRANSPORTATION OF CRUDE OIL AND PETROLEUM PRODUCTS WITH TON-MILE TRANSPORTED.

Year	Number of Accidents [1]	Deaths	Injuries	Gallons Spilled	Ton-Miles 2 (billions)
1984	138	1	5	372,929	29.2
1985	171	6	3	463,515	28.7
1986	162	11	4	436,022	29.7
1987	148	7	9	432,400	30.4
1988	140	6	7	458,721	30.5
1989	140	7	2	331,043	30.4
1990	164	5	2	313,397	29.7
1991	162	10	3	345,118	28.8
1992	164	12	6	371,245	28.8
1993	116	13	45	296,544	24.8
1994	113	9	7	205,313	n/a
Totals:	1,618	87	103	4,026,247	291.0
Annual Averages:	147	8	9	366,022	29.1
Gals spilled per accident				2,488	
Gals spilled per billion ton-miles transported 1984-93				13,130	

[1] Data are for accidents and spills by trucks transporting crude oil and petroleum only, and do not include accidents by other trucks, or by tanker trucks transporting other commodities. Source: Letter and enclosed tables from Office of Hazardous Materials, U.S. Department of Transportation, August 18, 1995.

[2] A ton-mile is movement of a ton of cargo one mile. Source: "Annual Report on Shifts in Petroleum Transportation," Association of Oil Pipe Lines, 1973-1993.

The USDOT data shows 13,130 gallons spilled per billion ton-miles (13,130 x 10^{-9} gallon spilled/ton-miles) and 2,488 gallons spilled per accident for the years 1984 to 1993. A ton mile is the movement of a ton of cargo one mile. This converts to 5.172 x 10^{-9} spills/ton-mile. This converts to 1.38 x 10^{-7} spill/truck mile-year using the conversions of 299.7 gallons/ton. This spill rate is 4.77 times lower than the spill rate used on page 10 of the OPL risk assessment (6.6 x 10-7 spills/truck-mile) or 1.38 X 10^{-7} spills/truck mile-year.

The average spill volume for tanker trucks can also be obtained from the 9.3 x 10^{-6} barrels spilled/barrels shipped statistic. The calculation demonstrates that the average spill volume for trucks is approximately 3.7 times **lower** than the average spill volume for the pipeline (shown in Section 2.1.1.6).

The table below provides a computation of the annual expected spills and spill volume for tanker trucks using the tanker truck spill rate of 1.38 x 10^{-7} spills/truck mile-year, the total forecasted demand (specified in Table 2-1 of OPL's risk assessment), and a 1.5% annual growth rate through 2049.

TABLE 2-15
EXPECTED FREQUENCY AND VOLUME OF SPILLS FOR TANKER TRUCKS TRANSPORTING CRUDE AND PRODUCTS

YEAR	1999	2004	2009	2014	2019	2024	2034	2044	2049
	Baseline	5 Years	10 Years	15 Years	20 years	25 Years	35 Years	45 Years	50 Years
Truck Demand BPD	13,509	15,324	17,191	19,203	21,370	23,021	26,716	31,005	33,402
Annual Expected Spills	0.77	0.88	0.98	1.11	1.23	1.33	1.56	1.82	1.96
Annual Expected Volume Spilled (Gal)	1,929	2,189	2,451	2,764	3,077	3,296	3,893	4,528	4,876

2.5 BARGES

The risk assessment methodology for barges is based on the basic OPL risk assessment methodology with adjustments. The major corrections include:

- ? Corrections to account for 100% double hull barge use starting in year 2015 as specified by Federal regulations.
- ? Changes in the use of the spilled to shipped statistics to account for weaknesses in the barge trips and port calls databases used by OPL.

OPL uses outdated worldwide tanker statistics of 40 incidents between 1974 and 1989, all exceeding 42,000 gallons to predict barges spills of any size. The DEIS uses outdated worldwide tanker statistics from 1974-1980 containing spills over 42,000 gallons or greater. Neither the DEIS nor OPL account for the risk reduction effects of double hull barges in their risk calculations nor that all barges will be double hull starting by 2015.

Risk assessment methodology presented here for barges is obtained from Dickins (Ref. 28). Spill statistics from 1992 to 1996 are used since this data more accurately reflects marine spill statistics due to the sharp drop in spill incidents following the introduction of Oil Pollution Act in 1990. A 1997 report by the Washington State Department of Ecology (Ref. 29) infers this reduction in spills for the State of Washington.

Dickin's analysis looks at two ranges of spill sizes deliberately chosen to allow direct comparison with the pipeline reporting standards and spill analysis conducted in this study. The two size ranges are: spills between 21 and 2,100 gallons (referred to as leaks in the pipeline analysis), and spills over 2,100 gallons (referred to as ruptures in the pipeline analysis).

2.5.1 Barge Spill Frequency

Barge spill frequency is estimated by first obtaining the spilled-to-shipped ratios for domestic barges. First a tabulation was done for the number of spills over 2,100 gallons which occurred from tank barges in US domestic trade between 1992 and 1996 using records developed by the US Coast Guard for the American Waterways Operators. The number of spills in each year is divided by the total volume of all petroleum products (including crude oil) moved by US domestic barge traffic (tabulated annually by the US Army) to arrive at the number of spills per ton moved in each of the five years. These rates are then averaged to arrive at an overall base line rate for spills over 2,100 gallons of 0.041 spills per million tons transported, representing current operation with single-hull tank barges. (No double hull barges contributed to the spills examined in this analysis.)

This baseline rate was modified to better reflect the expected rate with double hull barges by using the relative probabilities of zero outflow from single and double hull tank barges of different sizes shown in the National Research Council (1998) study for the US Coast Guard. The influence of double hulls in reducing spill frequency is only applied in accidents involving grounding, collision or structural failure using the relative proportions of these type of accidents can be used directly to calculate the number of smaller spills, but it can be derived by resort to several databases. First, the NRC report shows the number of barge and tanker spills in US waters over 100 gallons for the years 1991 to 1995. Second, the same database used to calculate the spill rate for volume over 2,100 gallons also contains incidents down to 1,000 gallons. Third, the American Petroleum Institute (1998) publishes a record of spills down to 10 gallons and smaller from all vessels, 1987 to 1996. By combining these sources, it is possible to establish trend lines for different vessels showing the rate of increase in spill frequency with reducing spill size. These trends are used here to estimate the number of barge spills in the 21 to 2,100 gallon size range for the period 1992 to 1996. Results show that on average over time, the number of barge spills over 21 gallons and less than 2,100 gallons will be seven times greater than the number of spills over 2,100 gallons. These results are then used in conjunction with the same national tonnage data tabulated by the US Army Corps of Engineers to calculate a national rate for spills between 21 to 2,100 gallons of 0.246 spills per million tons of product transported by single hull barges.

This derived spill rate is then modified as before to reflect double hulls by considering the proportion of incidents in the smaller spill size range (21 to 2,100 gallons) which will involve groundings, collisions or structural failure**.** As the majority of very small spills occur as a result of transfer incidents, the overall influence of double hulls in reducing the number of small spills is much less pronounced than with spills over 2,100 gallons, i.e., only 16.5% of small spills would be influenced by double hulls. Consequently, the single hull rate for small spills is divided by a factor of only 1.16 to arrive at a predicted rate for spills between 21 and 2,100 gallons of 0.212 spills per million tons transported in double hull barges. Again, the higher, single hull spill rate is assumed to apply equally to double hulls involved in other types of accidents (e.g., transfer spills).

2.5.2 Volume Shipped

The resulting single hull and double hull barge spill rates per ton of product moved are applied to the actual tonnage moved in each type of barge upriver from Portland in 1998. Tidewaters's records for that year show a total of 631 million gallons of all petroleum products moved upriver, 65.8% in double hull barges (converted to tons using an average value of 6.72 pounds per gallons). Predicted spill frequencies are calculated for the two spill sizes used in this analysis, 21 to 2,100 and over 2,100 gallons, in each year through 2049 (50 years from 1999 as the baseline).

Two cases are considered. In the first case, the existing (1998) tonnage moved in single hull barges remains constant while the additional product called for to meet an overall 1.5% annual increase in demand is carried in double hull barges up to the year 2014. Beginning January 1, 2015, all product moving upriver is shifted to double hulls reflecting the OPA 90 mandated retirement age for single hull barges smaller than 5000 gross tons, reflecting Tidewaters existing single hull fleet. The annual volume carried in double hulls from 2015 on record over five years of all barge incidents over 2,100 gallons supplied by the American Waterways Operators. Results from this database show that when known coastal spills from ocean going barges are excluded, the average barge spill size for the remaining 50 incidents (including transfers and navigation accidents) is 43,951 gallons. This volume is taken to represent the average volume of spills from single hull barges involved in any type of accident (e.g., transfers, collisions, groundings, etc.). A volume representative of double hull barges involved in the same mix of accidents is calculated as follows: a subset of 31 incidents is created which involve only structural failure, grounding or collision. The average spill volume of these incidents is 58,136 gallons. According to analysis presented by NRC(1998) double hull barges will spill 5.33 times less in accidents where double hulls will act to contain the cargo. Consequently, the predicted average spill volume which would have resulted if double hull barges had been involved in the same 31 incidents is calculated as 58,136/5.33 = 10,907 gallons. The average volume for the remaining 19 incidents (out of the original 50) is 16,181 gallons reflecting the different nature of transfer accidents. A weighted average of the spill volume associated with each incident grouping results in an overall predicted spill size from double hull barges of 12,911 gallons for all spills over 2,100 gallons.

For the smaller spills, a representative volume is derived from the distribution of all marine spills published by the American Petroleum Institute. This national estimate of 173 gallons is not specific to any vessel type, but compares closely with Tidewater's own record of small spills, 21-21,000 gallons, 1986-98, of 121 gallons. It should be noted that Tidewater has had only one marine spill large enough to be considered in the over -2,100 gallon category used in this analysis (3,295 gallons on October 14, 1993). No distinction is made between single and double hull barges for the smaller volume reflecting the relatively small number of grounding and collision type accidents which spill less than 2,100 gallons (16.6%).

Predictions of annual and cumulative volume of oil which could be expected from a barge system operating on the Columbia/Snake Rivers at a risk level equivalent to the US national average are computed by multiplying the calculated spill rates detailed in the preceding answer, and the corresponding average spill volumes outlined here corresponding to each spill size range.

III. RESULTS

3.1 PIPELINE SPILL RISK RESULTS

Results of the spill risk analysis are summarized in Table 3-1 and also shown in Tables 2-4, 2-5,2-6, 2-7, and 2-12. The expected number of spills and volume of spills from operating the CCP is calculated to be:

SPILL INCIDENTS (FREQUENCY)

- First 5 years of operation: 0.221 spills/year (or 1 spill every 4.5 years)
- Years 5-15: 0.440 spill/year (or 1 spill every 2.3 years)
- Years 15-25: 0.533 spills/year (1 spill every 1.87 years)
- Years 25-35: 1.240 spills/year
- Years 35-45: 1.86 spills/year
- Years 45-50: 2.45 spills/year

SPILL VOLUME

- First 5 years of operation: 13,512 gallons/year
- Years 5-15: 15,743 gallons/year
- Years 15-25: 22,522 gallons/year
- Years 25-35: 24,777 gallons/year
- Years 35-45: 26,995 gallons/year
- Years 45-50: 29,274 gallons/year

These spills can occur at any point along the pipeline route. Spill volume varies along the pipeline route depending primarily on valve and check valve spacing, line elevation, and line pressure. Approximately 54 spills greater than 20 gallons and 10 spills over 2,100 gallons are expected over the 50 year life of the CCP. The probability that one or more spills would occur along any specific mile of pipeline during the expected use of the pipeline (50 years) is about 25% for spills greater than 20 gallons and 4.5% for spills greater than 2,100 gallons.

The estimated cumulative spill volume for spills greater than 2,100 gallons along the CCP at 50 years is 1,114,300 gallons and 450,210 gallons at 25 years. The expected average spill size at 25 years is 41,763 gallons and 20,635 gallons at 50 years.

Potential impacts resulting from product releases are examined for the Cross Valley Aquifer. An average of 600 gallons per year (30,000 gallons in 50 years) is projected to leak along the 5 mile section that runs over the Cross Valley Aquifer. Similar volumes of spilled product would be expected along any other five mile stretch of the 14-inch line that crosses any other aquifer. Similar but slightly smaller volumes would be expected on any five mile stretch east of Kittitas (on the 12 inch line). Spill volume from undetected leakage and pipeline breaks and ruptures are presented in Table 3-1. **TABLE 3-1. FREQUENCY AND VOLUME OF SPILLS FROM PROPOSED CROSS CASCADE PIPELINE**

	Year					
	0-5	5-15	15-25	25-35	35-45	45-50
? **SPILL VOLUME (Gallons)**						
- Yearly Total						
-- Overall Length of Pipeline	13,512	15,743	22,522	24,777	26,995	29,274
-- Each Mile						
-- Thrasher - Kittitas	68.8	80.3	117.7	126.1	137.4	149.0
-- Kittitas - Pasco	49.1	57.1	81.9	90.1	98.3	106.0
- Cumulative total to end of period (Gallons)	67,560	224,990	450,210	697,980	967,930	1,114,300
- Maximum Spill Volume	>1,000,000	>1,000,000	>1,000,000	>1,000,000	>1,000,000	>1,000,000
? SPILL INCIDENTS (FAILURE RATE)						
- Yearly Total (Leaks and Ruptures)*						
-- Overall Length of Pipeline	0.221	0.440	0.533	1.240	1.86	2.45
-- Each Mile						
-- Thrasher - Kittitas						
-- Kittitas - Pasco						
- Cumulative Total to End of Period (Leaks and Ruptures)						
-- Overall Length of PIPELINE	1.105	5.45	10.78	10.78	23.18	54.03
-- Thrasher - Kittitas						
-- Kittitas - Pasco						
? **LEAK VOLUME THAT CAN GO UNDETECTED (Gallons)** (assuming maximum flow)						
- Yearly - cumulative	>2,000,000	>2,000,000	>2,000,000	>2,000,000	>2,000,000	>2,000,000
- Yearly - each hour	620	620	620	620	620	620
- Monthly	453,600	453,600	453,600	453,600	453,600	453,600
- 3 days	91,500	91,500	91,500	91,500	91,500	91,500
- Daily	30,240	30,240	30,240	30,240	30,240	30,240
- Short-term Hourly	3,150	3,150	3,150	3,150	3,150	3,150

3.2 COMPARISON WITH OTHER MODES OF TRANSPORTATION

This section compares the spill risk (frequency and volume of spills) for the proposed CCP and the No Action Alternative. The predicted expected spills per year for the CCP and the No Action Alternative are provided in Table 3-2. The predicted cumulative volume of spills for the proposed CCP and the No Action Alternative are presented in Table 3-3.

On average, spills from the pipeline are expected to be far larger in volume than spills from either barges or trucks. The average spill size for the CCP is expected to be about 20,635 gallons for spills of 21 gallons or more over a 50 year period. In contrast, the average spill size for tanker trucks is expected to be 2,448 gallons while the average spill size for barges is expected to be about 3,082 gallons.

Results in Table 3-3 shown that the CCP is expected have about between 1 spill and 1.5 spills per year less than the No Action Alternative, but because on average the pipeline spills are much larger, the overall spill risks associated with the pipeline are about five times larger than the No Action alternative. (This demonstrates the misleading nature of OPL's analysis which computes expected spill frequency but not volume.) Specifically, the proposed Cross Cascade Pipeline is expected to spill approximately **1,114,300 gallons** by the time the Pipeline reaches 50 years (Table 3-2). In contrast, the No Action alternative is expected to spill only **210,897 gallons** in the same 50 year period.

The proposed CCP has five major problems that do not exist with the No Action Alternative are:

- CCP cumulative spill volume is about 4.5 times higher than the No Action Alternative,
- CCP spills can go undetected for days, weeks, months and years while spills from tanker truck and barges are detected immediately,
- CCP spills can occur anywhere along the Pipeline route, many places remote and not easily accessible; spills from trucks and barges are limited to highways and river routes where response time is good and response equipment readily available (e.g., on board).
- No Action spills are surface type spills with significant evaporation resulting in much less volume than actually spilled affecting the environment. In contrast, CCP spills are underground (or underwater) with minimal short-term evaporation and essentially all product spilled affecting the environment.

TABLE 3-2

COMPARISON OF PROJECT/NO PROJECT EXPECTED CUMULATIVE SPILL VOLUME (GALLONS)

YEAR	1999	2004	2009	2014	2019	2024	2035	2044	2049
	First Year	**5 Years**	**10 Years**	**15 Years**	**20 years**	**25 Years**	**35 Years**	**45 Years**	**50 Years**
	EXPECTED CUMULATIVE SPILL VOLUME - GALLONS								
Proposed CCP (Spills 2,100 gallons or more))	**13,512**	**67,560**	**146,275**	**224,990**	**337,600**	**450,210**	**697,980**	**967,930**	**1,114,300**
No Project Alternative									
Tanker Truck (All Spills))	**1,929**	**10,079**	**21,654**	**34,691**	**49,293**	**65,384**	**101,189**	**143,479**	**167,158**
Barge (Spills 2,100 gallons or more))	**1,521**	**9,200**	**17,009**	**24,960**	**27,351**	**29,351**	**34,447**	**43,361**	**43,665**
Barge (Spills between 21 and 2,100 gal	**82**	**88**	**95**	**102**	**105**	**113**	**131**	**152**	**164**
Total - **No Project**	**3,532**	**19367**	**38,758**	**59,753**	**76,749**	**94,848**	**135,767**	**186,874**	**210,987**

TABLE 3-3

COMPARISON OF PROJECT/NO PROJECT
EXPECTED SPILLS PER YEAR

YEAR	1999	2004	2009	2014	2019	2024	2034	2044	2049
	Baseline	5 Years	10 Years	15 Years	20 years	25 Years	35 Years	45 Years	50 Years
	(Expected Spills/Year)								
Proposed CCP (Spills 21 gal or more)	0.221	0.221	0.440	0.440	0.533	1.240	1.240	1.860	2.485
No Project Alternative									
Tanker Truck (All spills)	0.77	0.88	0.98	1.11	1.23	1.33	1.56	1.82	1.96
Barge (Spills 21 gal or more)	0.52	0.56	0.60	0.64	0.64	0.69	0.80	0.93	1.0
Total Tanker Trucks & Barges	1.29	1.44	1.58	1.75	1.87	2.02	2.36	2.75	**2.96**

3.3 EXPLANATION FOR DIFFERENCES BETWEEN OLYMPIC'S AND THIS RISK ANALYSIS

There are many factors which contribute to the different conclusions in Olympic's and this risk assessment. The principal ones are detailed in the following sections.

3.3.1 Olympic's Failure to Calculate Expected Spill Volumes

Essentially Olympic looked at only one-half of the spill risk equation. Olympic calculated the expected frequency of spills but not the expected volume of those spills. Calculating frequency without volume can be very misleading. Unless volume is included, spills of one gallon are treated the same as spills of a million gallons.

In this situation, the problems generated by not calculating spill volume are enhanced because an effort is being made to compare risks between different transportation modes (pipelines versus trucks/barges). The average spill size for each of these modes differs. Treating the typical spill from a tanker truck as equivalent to the typical spill from a pipeline or barge can be very misleading. Because Olympic develops an assumption that the pipeline will cause a reduction in truck traffic, this flaw works to understate the risks of the pipeline and overstates the risks of the existing truck/barge system.

3.3.2 Olympic's 20 Year Time Frame is Unrealistic and Biases the Result in Favor of the Pipeline

As described above, Olympic's risk analysis terminates without explanation after 20 years. This is unrealistic. It is extremely rare (if not unheard of) for a major pipeline to be taken out of service after only 20 years. Such a timeframe is also inconsistent with the economic realities of the project: Olympic is expected to spend over $100,000,000 just in construction costs.

Stopping the risk assessment after just 20 years skews the results in favor of the pipeline. As mentioned earlier, pipelines deteriorate over time and the risk of spill increases. Spill risks do not generally increase for other transportation modes because barges and trucks tend to replace their equipment over time.

Olympic's own risk analysis recognizes that the pipeline, relative to trucks and barges, becomes riskier over time. Olympic's analysis shows about a 240 percent increase in the frequency of pipeline spills between the fifth and twentieth year and only a thirty to fifty percent increase in truck and barge frequency of spills during the same period. (The increase in truck and barge spill is due solely to increased amount of product expected to be transported by

Other witnesses (e.g., Batten and Epstein) have documented the unequal regulatory settings governing pipelines and barges. The benefits of the more stringent barge standards are already showing up in the barge spill statistics. Since OPA 90 went into effect, barge spills have dropped sharply. This post-1990 data is available for use in risk assessments but Olympic chose to use a pre-1990 database instead. This causes a significant overstatement in risks of barging.

In addition to many OPA 90 requirements which are already in effect (and showing up in lower spill statistics), the double hull requirement does not go into full effect until 2015. Nonetheless, there is now enough data to calculate reduced spill risks from the switch to double hulls, as the National Research Council has done. Tidewater has already converted much of its fleet to double hulls, 15-20 years before the statutory deadline. This has resulted in a lower spill risk already. There will be a further reduction when the conversion is complete by 2015. OPL's and the DEIS risk analyses did not account for the use of the double hull barges in their calculations of expected spill frequency for barges.

Although not included as a factor in the spill risk estimates, the stable river environment should reduce the spill risk to lower values than estimated, thus overstating again the risk of barge spills.

3.3.4 Failure to Account for Different Lower Threshold for Pipeline and Truck Spill Databases

In comparing spill frequency for pipelines versus trucks, it is important to assure that a comparison is being made of spills of the same size or range. As mentioned before, the Mastandrea/EPA model focuses on spills of 50 barrels or more. A correction factor has to be employed if the frequency of smaller spills is to be included in the analysis.

Olympic calculated a frequency of truck spills for a spill of any size. Olympic then compared this with the frequency of pipeline spills of 2,100 gallons (50 barrels) or greater. Olympic's failure to either include the smaller spills in the pipeline frequency calculation or to exclude them from the truck frequency calculation results in a grossly unfair comparison. There are far more small spills (1 gallon to 2,100 gallons) than there are larger spills. Olympic included this large number of small spills for trucks but not for pipelines, resulting in an overstatement of the relative risk of trucks versus pipelines by a factor of 4.5.

It should also be noted that Olympic committed a similar error, but in the opposite direction, vis-a-vis its use of the barge data. The data utilized by Olympic for barges involved only very large spills (more than 40,000 gallons). This would tend to understate the frequency of barge spills relative to pipeline spills. But the barge database used by Olympic suffers other problems as described earlier which overstate the barge spill frequency relative to pipelines.

The same forecasted demand for pipelines presented in Table 2-1 used in the OPL risk analysis is used in this risk analysis. The tanker trucks used in this analysis are assumed to hold 8,000 gallons/load to be conservative. However, tanker trucks are generally double trailers and hold a load of 10,500 gallons/load.

One major assumptions used by in the OPL calculation of the frequency of spills for the tanker trucks was corrected in this analysis. The spills per ton-mile/year used by OPL for tanker trucks was 24.7 x 10-9 spills/ton-mile or 4.77 times higher than the spill rate (1.313 x 10-7 spill/ton-miles) used in this risk assessment. The spill rate used for tanker trucks in the OPL risk analysis of 6.6 x 10-7 spills/truck mile-year used on Page 10 of the risk analysis is converted as follows:

6.60 x 10-7 spills/truck-mile x 299.7 gallons/ton /8,000 gallons/truck

= 24.7 x 10-9 spills/ton-mile.

3.3.6 Inappropriate Truck Database Used by OPL

OPL's risk analysis used a statistical data base from the USDOT in 1990 for tractor trailer accidents. This data base in inappropriate for tanker trucks that transport crude oil and petroleum products. The risk analysis is this study used the USDOT data base that is specifically for tanker truck accidents. Results show that the accident rate specifically for tanker trucks transporting crude oil and petroleum products is 4.77 lower than used in the Olympic's risk analysis.

IV. PIPELINE TECHNOLOGY: OPL'S TECHNOLOGY IS NOT STATE OF THE ART

4.1. SPILL PREVENTION AND LEAK AVOIDANCE

OPL proposes to build a standard pipeline with technology that has existed for the past 30 years with little or no improvement. The pipeline is designed for locations of low spill risks and low environmental risks, not a pipeline that is routed under nearly 300 rivers and streams, impacts more than 70 wetlands, traverses sensitive aquifer segments underlining approximately 32 percent of the pipeline corridor, and includes large sections through rugged mountainous terrain.

OPL proposes no special, state-of-the-art program of spill prevention and leak avoidance other than using technology that existed in the industry for the past 30 years. The only spill prevention proposed includes:

4.1.1 Pipeline Design and Testing

OPL PROPOSES

OPL proposes to use <u>single wall</u> American Petroleum Institute (API) 5L X52 pipe.

BETTER TECHNOLOGY AVAILABLE

<u>Recommendation #1</u>

We recommend that OPL use <u>double wall pipe</u> at least in high population areas, at all river crossings, through or near sole source aquifers and major aquifers, and other areas of high sensitivity to leaks and ruptures.

Double-wall pipe is now being used on pipelines in highly sensitive areas. This type of piping is recommended for consideration in the American Society of Mechanical Engineers National Standard ASME code for pressure piping B31,4 (Ref. 30). Section 402.1, page 8 of the reference states:

> Some of the protective measures which the design engineer may provide are encasing with steel pipe of larger diameter, adding concrete protective coating, increasing the wall thickness, lowering the line to a greater depth, or indicating the presence of the line with additional markers.

Double wall pipe is now successfully being installed across the Colville River (Ref. 31) in Alaska. The piping system essentially eliminates all leaks and provides leak detection as well. An excerpt of from Section 2.7.1.2, Page 2-28 of the report is provided here:

> to further prevent a pipeline leak under the Colville River, the sales oil pipeline will be installed inside a high-strength casing pipe. This "pipeline-within-a-pipeline" approach is fairly unique for HDD pipeline river crossings. Simultaneous failure of both the sales oil pipeline and the casing pipe is highly unlikely. If oil leaked from the sales oil pipeline, it would be captured within the space between the outer wall of the sales oil pipeline and the inner wall of the high-strength casing pipe, rather than reaching the subsurface river environment. This design is analogous to secondary containment provided as spill prevention techniques for storage tanks. The same encasement will be used for the utility (mostly like sea water) pipeline and the design fuel line. The

coating. In addition, and in response to comments regarding additional prevention, another 8-inch pipe parallel to and near all of the casing pipes provides the anode portion of a cathodic protection system to prevent corrosion of the casing pipes.

Another example of double wall pipe is the six mile double wall pipeline proposed by Dames & Moore for use at the Hanford Site (Ref. 32), Richland, Washington. (Dames & Moore also serves as Olympic's lead consultant.)

Recommendation #2

Larger wall thickness for the pipeline in sensitive areas where undetected leakage can greater serious hazards or a large spill can create major environmental problems.

The pipeline should be redesigned applying both the double wall pipe and sections of the line with large wall thickness.

4.1.2 Pipeline Design - Cathodic Protection (Rev. App., Page 2.3.-13)

OPL PROPOSES

The location of test points for monitoring the cathodic protection is specified at one mile intervals. This spacing is typical of a conventional pipeline in a low risk area.

BETTER TECHNOLOGY AVAILABLE

The spacing of test points should be much closer, i.e., 10 feet in certain sections. Also, test points should be installed at both sides of all bridge crossings, water crossings, train crossings.

4.1.3 Pipeline Design - Valves (Rev. App., Section 2.3.4)

OPL PROPOSES

OPL makes no provisions for minimizing leakage of the above ground section of block valves located along the pipeline route. Valve spacing in a number of areas could result in spillage of 1 million gallons or more.

BETTER TECHNOLOGY AVAILABLE

The above ground portion of the block valves should have secondary containment such that no leakage will occur from the valve or the valve piping and other connections. Secondary containments is required for gas stations, gasoline tanks, dispensers, etc..

Spacing should be reviewed to limit valve spacing such that the maximum spillage is less that 100,000 gallons.

4.1.4 Pump Stations

OPL PROPOSES

OPL proposes no special means of avoiding leakage into the environment. OPL plans to use Federal regulations at pump stations. Unfortunately, there are no regulations for double wall piping and spill containment at pump stations. OPL has not specified the leak prevention standards it would utilize at pump stations.

BETTER TECHNOLOGY AVAILABLE

Pump stations should adopt the standards that are used in the State of California for gas stations and other facilities handling gasoline. Pump stations should have secondary containment and double wall piping as applicable for aboveground and underground piping, pumps, etc. OPL should develop a plan such that no leaks at these facilities reach the soil.

4.1.5 Inspection Smart Pigs and Caliper Inspection Pigs (Rev. App., Section 2.9.4.1, Page 2.9-6)

OPL PROPOSES

OPL has indicated that such pigs are used on other OPL lines and will be used on the CCP (See Section 2.9.4.1, Page 2.9-6) but has not specified the specific type of inspection pig and caliper inspection pig, nor how often these inspection devices would be used.

It is critical that these pigs be used when the pipeline is initially installed to provide a baseline for all future tests. Also, major problems in the pipeline may be detected before the pipeline is in full operation.

The pigs should be used for the entire line every three years. All problem areas indicate by the pig records should be checked and repaired within six months.

The pigs should also be used if a small leak is suspected but the location cannot be pinpointed.

The leak detection sensitivity of the smart pig has not been specified by OPL. Considering that 0.01 inch diameter hole can result in a 10 gallon per hour leak, the leak detection sensitivity of the smart pig is essential information for determining the ability of the device to detect leaks in highly sensitive areas.

4.2. LEAK DETECTION

4.2.1 Air Patrol Survey of the Entire Line

OPL PROPOSES

OPL proposes to use bi-weekly air patrol to insect for leaks along the line. The aircraft will fly at an elevation no greater than 500 feet. OPL proposes only visual inspection.

BETTER TECHNOLOGY AVAILABLE

Method #1

Inspection should be done both visually and with the aid of forward-looking-infrared (FLIR) technology. FLIR permits identification of potential spills based on temperature "signature" resulting when warm product leaks onto the ground. This method even works in the dark or when visibility is limited. Inspections should also retain video records to compare against previous inspections.

Method #2

Line walker should walk the length of the pipeline using a hydrocarbon portable detector to check for leaks. This test should be done every six months to supplement the air patrol. This type of testing is routinely done by the gas industry annually.

4.2.2 Hydrostatic Testing (Page 2.3-22)

OPL PROPOSES

OPL has not stated the leak detection accuracy for the hydrostatic testing.

OPL has not stated the segments of line that will be tested. The shorter the segment, the higher the accuracy. DOT regulations may be inadequate to determine leakage below a threshold of 40 gallons per hour for this pipeline.

OPL proposes to use hydrostatic testing only once when the line is initially built to check the integrity of the complete line.

OPL has not proposed installing temperature sensors along the pipeline to improve the sensitivity of the hydrostatic test along the pipeline. A leak detection sensitivity of 1-2 gallons per hour are possible, but OPL has never indicated using better technology for hydrostatic testing.

OPL plans only one hydrostatic test when the pipeline is built as required by federal law. OPL does not plan any additional hydrostatic tests such as years.

BETTER TECHNOLOGY AVAILABLE

Annual hydrostatic tests are recommended for the CCP for high risk sections of the pipeline and the complete pipeline should be tested every two years. The State of California requires periodic hydrostatic testing, i.e., 1,3, 5 years, depending on the pipeline and its leak record.

Undetected leaks can exist indefinitely. If a leak of 200 gallons per hour or more goes undetected for a year, over 2 million gallons would escape undetected from the CCP. Frequent hydrostatic testing with a 10 gallon per hour sensitivity can reduce the undetected leakage to 87,000 gallons annually.

Hydrostatic testing techniques with a 1-10 gallon per hour sensitivity are available but CCP has no plans for performing state-of-the-art hydrostatic testing. It is recommended to install additional temperature sensors along the line and test ports every 5 miles for future hydrostatic tests to improve leak sensitivity. Also, procedures should be use to provide a 24 hour test instead of a 4 hour test to greatly improve the leak sensitivity of the hydrostatic test.

4.2.3 Static Pressure Tests or Shut-in Pressure Tests

are monitored and pressure and temperature sensors are located along the line, leak rate of approximately 200 gallons per hour or more may be detectable.

This method has been used on numerous pipelines periodically for the past 30 years. The Yellowstone Pipeline modernization project proposes shut-in testing every 10 days to supplement its continuous monitoring, leak detection system.

4.2.3 Continuous Internal Leak Detection-Monitoring

OPL PROPOSES

OPL proposes to use its SCADA system with its computer aided leak detection subsystem with an estimated leak detection capability of 1% of flow or 3,150 gallon per hour leak sensitivity at maximum flow rate.

BETTER TECHNOLOGY AVAILABLE

Method #1

Better technology is available but not proposed by OPL. Temperature, pressure, flow and density measurements test ports spaced every few miles would vastly improve the sensitivity of the proposed leak detection system to perhaps 0.1% of flow under many operating conditions. This would also be extremely useful for static pressure leak tests when the lines are shutdown and the valves are closed or improved hydrostatic testing results.

In addition to permanent test ports, clamp-on meter leak detection systems are available for the detection of catastrophic leaks.

Method #2

Periodic tests of the monitoring systems along the pipeline should be done to prove the performance of the continuous monitoring system. Blind tests, i.e., operator does not know the location of the leak or the leak size, should be done on a six month basis to insure the system is functioning properly. Results of the blind tests should be reported to the regulatory agency or should be observed by a regulatory agency. These calibration tests can not only provide for checks of the leak detection accuracy and sensitivity but can also be used in the development of response plans for when a leak is suspected.

Method #3

OPL proposes no method. (However, OPL has indicated that it may use oil spill detectors at the Cross Valley Aquifer.)

BETTER TECHNOLOGY AVAILABLE

Method #1

Tracer type hydrocarbon probes can be installed in the soil along the length of the pipeline with spacing of about 10 to 20 feet. A tracer liquid would be injected into the pipeline periodically. Tracer probes would be sampled every 6 months to check for the tracer gas in the probe. Tracer technology has been used to test thousands of underground and above ground storage tanks, piping and pipelines for the past 20 years. The method is 3rd party certified to detect a leak of 0.1 gallons per hour with a probability of detection of > 95% and probability of false alarm of < 5%.

Method #2

Groundwater monitoring wells along the length of the pipeline should be checked for contamination of groundwater. Inspection of the wells should be every six months. Groundwater monitoring wells are installed at most gas stations in California to check for pipeline leaks by checking for groundwater contamination.

Method #3

Leak detection cable or vapor monitoring piping installed along the length of the pipeline. Both methods are routinely used at gas stations and other similar facilities. OPL has tested one type of leak detection cable but has not provided data as to the details of the test results.

Method #4

Oil spill detectors located above all underwater sections of the pipeline

Method #5

Hydrocarbon probes towed over the length of underwater pipeline sections to check for leaks.

Method #6

Acoustic sensors installed on the pipeline or at test ports attached to the pipeline. The

> If abnormal operating conditions occur during pipeline operation, audible and visual alarms will activate, and an investigation will be initiated by system controllers to determine the source of the abnormal condition.

Considering the numerous potentials for false alarms, it is uncertain how long after the "investigation" was "initiated" that a leak existed and the pipeline had to be shut down.

BETTER INFORMATION NECESSARY

OPL must provide a minimum time after a alarm to shut the system down for a leak. This time would be needed to determine the volume of the leak that can go undetected. At this time, the time for immediate shutdown from a break or rupture is unknown.

V. PARTIAL CRITIQUE OF APPLICATION

5.1 DESCRIPTION OF PIPELINE

The proposed Cross Cascade Pipeline Project Revised Application provides information on location, design, operation, inspection, leak detection, inspection and maintenance but does not provide sufficient details about the pipeline design standards, operations, inspections and maintenance, spill prevention and countermeasures to allow for evaluation, comment, and recommendations. Information presented is typical of a standard pipeline which results in high risk. Pipeline spill risks, i.e., frequency and volume of spills, have shown no significant improvement over the past 30 years. While significant advances have been made in the technology, Olympic (like many in the industry) avoids its use. There is no information presented in the application to show that this pipeline is using the state-or-the-art technology that exists to reduce the major spill risk potential from this pipeline.

The spill risk analysis presented by the Applicant is inadequate to properly evaluate the spill risk. Moreover, the spill risk analysis failure to mention major advantages of the No Action Alternative such as lower annual spill volume, immediate detection of leaks and spills. The applicant fails to mention that the maximum spill size for any incident over 99% of the pipeline route is approximately 10,500 gallons by No Action and 1 to 2 million gallons by the proposed pipeline.

5.1.1 Important Information Not Provided At All

OPL has not provided information stating that the testing will be observed and reported by a 3rd party independent testing firm.

OPL has not stated the leak detection accuracy for the hydrostatic testing.

OPL has not stated the segments of line that will be tested. The shorter the segment, the higher the accuracy. DOT regulations may be inadequate to determine leakage below a threshold of 40 gallons per hour.

OPL has not stated that the data and test results will be available for review by the local regulator agencies.

OPL has not made specified whether it has made provision for installing test ports along the pipeline to install test instrumentation to improve the leak detection accuracy of the testing.

OPL has not stated that testing methods and procedures are available to improve the accuracy of the hydrostatic test to about 1 gallon per hour leak detection.

OPL has not stated whether it will use test dyes when the line is being tested underwater so that leaks of the test dye would surface during a test.

OPL has not stated whether it would use divers to check the underwater sections of the pipeline to check for leaks.

Valves (Page 2.3-24)

OPL has not stated how frequently the mainline valves will be inspected, maintained and checked for proper operation per the manufacturer specifications. This should be done a minimum of once every six months.

Pump Station (Section 2.3.5, Page 2.3-26)

The maximum pressure of the pumps has not been specified. This is important in the calculation of the maximum test pressure for hydrostatic testing. The line should be tested at the highest pressure the line is expected to experience under any condition.

The maximum pressure and flow rate the pump will produce if the pipeline is severed and the leak has not been detected has not been provided. This is important information in computing spill sizes for large breaks or ruptures.

OPL does not describe the resultant problem or danger to the line if the station check valve fails to functions.

Pig Launchers

OPL has not stated the location of launchers for launching smart inspection pigs and caliper inspection pigs.

Terminal Facility (Section 2.3.6, Page 2.3-33)

OPL provides no information on measures to contain leakage or spillage of major equipment installed at the site.

OPL provides no information on whether or not it will use double wall piping or secondary containment at its truck loading/unloading rack, and the piping from the rack to the storage tanks.

OPL provides no information on the inspections of the storage tanks for leakage or corrosion.

OPL has not stated the limitations of the pigs on the pipeline.

5.1.2 Important Information Misleading or Wrong

Valves (Page 2.3-24)

OPL is not clear whether all the valves will be remotely controlled. Specifications of the valves are not provided. The valves have not been specified as fire safety valves that will operate at high temperatures. OPL should clearly state that all the valves will be remotely controlled and fire safety valves. In addition, in highly sensitive areas an additional backup valve should be provided.

The second paragraph on this page infers that all of the valves are not remotely controlled. If a valve does not have remote control, the potential for an additional 400,000 gallons of spillage from large pipeline leak or break could occur (See Section 2.1.1.5, Page 24 of this report).

5.2 LEAK DETECTION SYSTEMS

5.2.1 Important Information Not Provided At All

Leak Detection System (Section 2.9.5, ,pages 2.9-10 to 2-912)

OPL provides no information as to the sensitivity of the leak detection system or its ability to detect leaks. OPL indicates detection capabilities of about 1% of maximum flow. However, the leak detection may vary from 1 to 10 percent depending on the location, e.g., mountainous terrain with high elevation changes. OPL has not indicated if the leak detection system will be capable to detect 1% of maximum flow along the entire line or if there are portions of the line where leak detection is much less accurate. OPL has not indicated the effect of changing products and resultant times when leak detection may not be available in certain areas for certain portions of time. A complete description of the leak detection capability along the entire length of the line is required.

OPL has not indicated the repeat reliability of the leak detection system. Can the system detect a 1% leak 99 times out of 100, 50 times out of 100, or once out of 100? This information is critical to evaluating any leak detection system.

Terminal Facility (Section 2.3.6, Page 2.3-33)

OPL provides no information on measures to contain leakage or spillage of major equipment installed at the site. OPL provides no information on whether or not it will use double wall piping or secondary containment at its truck loading/unloading rack, and the piping from the rack to the storage tanks.

It is recommended that leaks of more than 1 gallon (recovered or not) should be reported.

OPL has not stated when the metering will be calibrated. For example, all metering at the pump stations should be calibrated and certified to an accuracy of ± 0.1 %. Monthly calibration of metering should be done once a month using meter proving.

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FIGURES

TABLES