surface waters and transport southward into the main basin of Puget Sound is likely. A continuous net landward flow occurs at depth in the Strait of Juan de Fuca from the ocean to the heads of various inlet arms. As noted, there is a net seaward flow at the surface. Haro and Rosario Straits show strong surface net flows southward. Water from Haro Strait then flows westward near Victoria and exits through the outer Strait of Juan de Fuca. Rosario Strait water continues south along the west side of Whidbey Island, where it joins the northwesterly flow from Admiralty Inlet. These combined surface flows then cross the inner Strait of Juan de Fuca from Point Partridge to near Victoria, joining the southward flow from Haro Strait. At this juncture, some water heads north toward the San Juan channel, but most continues west toward the outer strait.

5. Puget Sound's main basin shows a strong northerly net flow in surface layers and a southerly net flow at depth. Water from the main basin exits mainly through Admiralty Inlet into the inner strait. A second pathway exits from the Whidbey Basin through Deception Pass into the inner strait. The mean surface flow of Hood Canal is also northward into Admiralty Inlet.

6. Downwelling over sill zones is a factor influencing oil dispersion. Spilled oil constituents could be mixed downward and enter the circulation at depth within the Strait

of Juan de Fuca. Admiralty Inlet has considerable downwelling. Downwelling could cause spilled oil to be retained at depth for a considerable period. Given split mean flows, oil retained at depth could move in a different direction than a surface slick.

7. Currents in the area between Port Williams and Protection Island are complex and poorly understood. There is a high degree of variability over space and time. Currents are weaker than in the main channel, and seem to move generally eastward.

8. The principal forces moving oil from a spill in Port Angeles Harbor into the Strait of Juan de Fuca and Puget Sound include surface currents, winds, and net circulation at depth. Factors include a net westward midchannel surface movement in the Strait of Juan de Fuca, the subsequently described nearshore countercurrent, and westerly winds which reinforce the countercurrent. Sufficient spread of oil would drive oil into the high energy sill zones (Green Point - Victoria and Admiralty Inlet) resulting in possible downwelling and transport at depth into inner waters. Depending on time of year, strength and direction of surface currents, winds, and the extent to which spilled oil enters sill zones and is circulated at depth, a spill at Port Angeles could result in either a westward or eastward general trajectory.

9. Near surface water in Port Angeles Harbor can have a residence time of several days to a week. Just outside the harbor, however, a countercurrent exists. The mean near-shore countercurrent flow is east along the shore towards Dungeness Spit, reaching a velocity of 35 centimeters per second. This is an exception to the general pattern in the main channel of the Strait of Juan de Fuca.

Wind Effects

10. Another important factor in oil dispersion is wind effect. Westerly winds oppose drift out of the inner strait. Wind effects can also modulate the mean circulation of surface waters. Because of topography and orographic (mountain-related) effects, winds tend to be up and down the western portion of the Strait of Juan de Fuca. Generally, winds from the east occur more frequently in the summer. Near Port Angeles, the most typical year-round winds throughout the year are from the west. Complex wind circulation patterns often occur over Admiralty Inlet; south winds coming up Puget Sound often collide with west winds directed up-strait. Local winds and sea breezes blowing from the land over the water can influence oil spill trajectories.

11. Finding the proper relationship between wind and currents is critical to predicting oil spill trajectories.

The Pacific Marine Environmental Laboratory (PMEL) model used by Northern Tier is the best available. This model assumes that wind generated movement is three percent of wind speed in the direction of the wind--an assumption which the designers of the model are not sure is accurate (Stewart PFT p. 22). Empirical evidence indicates that the correct wind factor varies between one and five percent, depending upon local geography, meteorology and sea state (Raj PFT p. 22). Local winds, which are difficult to predict, can also influence the movement of an oil slick. In the PMEL model, winds from the west blowing up-strait often almost exactly counteract the mean estuarine flow. Thus, even a small change or error in the wind factor can dramatically alter the predicted location of an oil slick.

12. The PMEL model does not include a factor for the coriolis force (counterclockwise spin), which may be a significant omission for longer trajectories. It does not consider cross channel non-tidal currents, current reversals, or the complex mean estuarine flow in the eastern strait. The PMEL model only tracks the oil until it first hits shore; refloat is ignored. The standard PMEL deviation is as large as eight kilometers for 12 hours of tracking. (See Raj PFT pp. 22-24.)

13. In general, PMEL studies showed that movement in any direction is possible depending on wind conditions, tidal phase and the strength of any mean currents. Oil

spilled in the main channel of the Strait of Juan de Fuca could affect the entire Strait (both north and south shores), the San Juan Islands, Whidbey Island, and some Pacific Ocean shores. A single spill would not likely impact all of these areas, but it could hit any one, or some combination, depending upon the size of the spill, time of year, weather, and location. Spill sites west of Port Angeles generally showed east to west movement. Sites outside and north of Ediz Hook in the Port Angeles area showed east and west movement. Southern Puget Sound (below the Tacoma Narrows) would not likely be impacted by oil.

14. Superimposing the size of slicks from major oil spills on proportionally-scaled maps of Puget Sound reveals the extensive area which can be impacted.

Possible Spill Trajectories

15. The fate of oil spilled in Port Angeles Harbor is difficult to predict. Spilled oil would likely be dispersed over much of the harbor, though containment and recovery of minor spills would be easier there than in the main channel of the Strait. The relatively long harbor residence times sometimes experienced by surface water may aid containment. Conversely, under the influence of the natural surface spreading of oil and of transport caused by surface currents and prevailing westerly winds, a sizable spill could be expected to result in oil exiting

the harbor. Spreading, and the near shore mean eastern flow imply that the ecologically important areas of Dungeness Spit, and Sequim and Discovery Bays could be affected. Drift cards released in the vicinity of Port Angeles in April, 1978, primarily went eastward, and were recovered along Dungeness Spit, western Whidbey Island and the San Juan Islands. Drift cards released from the Port Angeles vicinity in July, 1980, were recovered from Dungeness Spit west to the Pacific, some as far away as Grays Harbor. The vast majority of recovered drift cards released from Port Angeles had moved eastward. (Storie).

16. Oil spilled from Port Angeles Harbor or Admiralty Inlet could reach the area southeast of Dungeness Spit in a relatively short time. Oil spilled west of Port Angeles could affect the southeast side of Dungeness Spit very quickly under westerly winds or other meteorologic conditions. Oil spilled in the far eastern Strait could go in any direction, including westward out of the Strait, southward to Dungeness Spit, and northward to the San Juan Islands. Entrainment of oil in the deeper water column strata due to downwelling and vertical mixing could occur, resulting in the transportation at depth into the main basin of Puget Sound. (Long, TR 34130).

17. Drift card studies mimic oil spills to a similar but uncertain extent. While drift cards have indicated migration from Port Angeles Harbor to Dungeness Spit is probable, the

trajectory of a small product spill in May of 1979 raises some question. Despite mild winds from the west and more flood than ebb tidal currents, this spill migrated out of the harbor west to the mouth of the Elwha River. On the other hand, another Port Angeles harbor spill in June, 1981, migrated eastward along Dungeness Spit and the Quimper Peninsula. (Frazier).

18. The chances of spilled oil reaching the Pacific Ocean without beaching decrease as any assumed spill point is moved eastward in the Strait. The southward and northward components of any trajectory would tend to transport oil ashore. The chances of a spill adversely affecting the most susceptible biological communities increase as the assumed spill point is moved eastward. (Long, TR 34131-32).

19. If an oil spill occurred between Port Williams and Whidbey Island, a spill could go east or west, and could enter Puget Sound. The likelihood of oil entering Puget Sound increases with distance eastward along the proposed submarine pipeline. Depending on location of a spill, oil could also disperse throughout the San Juan Islands. A Saratoga Passage spill might well be contained within the Whidbey Basin.

Underwater Oil Spills

20. Northern Tier did not model an underwater oil spill. The state of the art of subsurface oil spill trajectory modelling is in its infancy. Knowledge is not available. Research on underwater trajectories has been minimal. Estimating the trajectory of a spill from a break in a submarine line involves not only the problems of surface trajectories, but also problems associated with subsurface oil movement.

21. Oil released from a break in the Admiralty Inlet line would initially be released under pressure. Some would probably become attached to suspended sediments. It could also form oil-in-water and water-in-oil emulsions. It is possible that oil entrained in the water column and on the surface may move in two or three directions simultaneously. Most of Admiralty Inlet, the San Juan Islands, and the Strait of Juan de Fuca are probable impact points for oil from a major submarine spill. It is also possible, although less probable, that oil could drift south into the main basin of Puget Sound, perhaps moving in subsurface cells as a result of downwelling across the sill at Admiralty Inlet.

22. Significant impact points from any submarine spill in Saratoga Passage include the Skagit Delta, Penn Cove, and the eastern and western shores of Possession Sound.

Terrestrial Spills

23. Neither ERT nor OIW performed trajectory studies for the transportation of oil spilled at river crossings. (Haury). The investigation of oil spills from terrestrial pipelines consisted of a review of the technical literature. (Alsup).

24. A terrestrial pipeline leak could have a significant effect if it occurred in a water-saturated zone, in an area of very permeable materials above the water table, over an aquifer recharge zone, or in any other environmentally sensitive area. (Alsup, TR 14353).

25. If terrestrially-spilled oil reaches the ground surface, it will flow downhill until absorbed into the ground. When the volume of oil impinging on a soil is greater than the soil's ability to absorb such oil, surface flow will result. If oil leakage occurs on a surface of low permeability, a slight surface penetration could be expected, and the leakage would flow over the surface in a downslope direction until exhausting the volume by spreading or until meeting a physical barrier. (TR 14356 Alsup). Oil leakage from the terrestrial pipeline could travel laterally or downward depending upon the subsurface arrangement of permeable zones, the amount of leakage, and the length of time the leaking occurred. The leakage from the terrestrial pipeline could reach the water table through vertical

migration or through a combination of horizontal and vertical migration. (Alsup, TR 14358; Ex. 175).

26. Oil moving through soil is influenced by gravity and capillarity. Permeability of the soil is the most important factor in determining ground movement. Soil retention capacity is also significant. There is greater lateral spreading in lower permeability soils because of capillary action (TR 14354-57 Alsup). It may be expected that oil migration through western Washington soils would be more rapid than through eastern Washington soils, because of generally higher rainfall in Western Washington, and resultant entrainment.

27. Subsurface flow of oil will stop when the threshold of residual saturation (retention capacity) is reached, or when an impermeable layer of soil is reached by vertically migrating oil. Oil could reach a water table. It would initially spread out over the surface of the capillary fringe above the water table. (TR 14357-58 Alsup).

28. The dispersion of oil in a trench backfill depends primarily on the materials in the trench, topographic relief along the trench line, and the leakage rate. If backfill were more permeable than surrounding soil, some leaked oil would remain in the trench.

III. D. 3. RESOURCES AT RISK

1. The coastal waters of the State of Washington and its inner waters, including the Strait of Juan de Fuca and Puget Sound, contain diverse, rich, marine resources. These resources include economically important species of salmon, shellfish, bait fish, bottomfish and clams. Economically important species are harvested commercially and recreationally, and some species are cultured. Puget Sound supports fish runs yielding an annual commercial and recreational production, (excluding Puget Sound, south of the Tacoma Narrows) of 289,584,520 pounds valued at $299,908,580.* These species have secondary economic importance in that they promote tourism. They serve important ceremonial, subsistence, and religious purposes for Indian citizens. These resources also have an intrinsic value, as an amenity to the citizens and visitors of Washington State.

2. Based on historic spill costs, an oil spill in the Strait of Juan de Fuca or Puget Sound could cost, at minimum, between $5.00 and $20.00 (current dollars) per gallon spilled. This cost range includes lost oil, costs of clean up, loss to commercial and recreational fisheries, loss to the state's tourist industry, and loss of use of the public's beaches and lands. Costs in Puget Sound would tend toward the higher figure

*Unless otherwise indicated, all production figures and dollar values are expressed as the mean annual averages for the years 1974-78.

because of cleanup difficulties and biological richness. Based on the applicant's own estimate, the cost to the State of Washington of oil spilled from the proposed Northern Tier Pipeline (assuming no hookup) would range from $165,000 to $638,000 yearly, in current dollars. A major tanker accident inside the Strait of Juan de Fuca or surrounding waters could cause economic damages in excess of $200 million.

3. The state's waters support many valuable species which are not commercially harvested. These species support a delicate web of relationships among species, including food chains. Loss of non-harvested species can result in losses of commercially and recreationally taken species. Additionally, non-harvested species, for example, marine birds and mammals, have aesthetic value and can provide non-consumptive uses such as observation and photography.

4. Fishing gear of all types is subject to fouling from contact with crude oil.

Shellfish

5. Economically important shellfish in the vicinity of the proposed Northern Tier pipeline include clams (hardshell and softshell); oysters (Pacific, Olympia); mussels; scallops (pink, rock, weathervane); abalone; sea urchins; sea

cucumbers; octopus; squid; crabs (Dungeness, rock); and Pandalid shrimp.

6. Shellfish species support important recreational and personal use fisheries in Puget Sound and the Strait of Juan de Fuca, and Washington coastal waters.

7. Average annual commercial production of all shellfish in Puget Sound and the Strait north of the Tacoma Narrows is 13,695,724 lbs., valued at $9,684,562 (ex-vessel). Average annual production figures for commercial ocean shellfish are approximately 22,200,000 lbs., valued at $13,890,000 (ex vessel).

8. The embryonic and larval stages of many shellfish drift in the upper water column. There are some shellfish larval forms in the water column during every month of the year; however, the majority of the species are spring and summer spawners. Oil spill effects outside adult spawning beds can therefore have detrimental consequences on shellfish stocks.

9. Shellfish are especially vulnerable to spilled oil. Many shellfish populations are long-lived and sporadic in recruitment. Because of sporadic recruitment, it may take years for a population to recover after a loss.

10. Pandalid shrimp stocks and related fisheries in Port Angeles Harbor exist in close proximity to the proposed docking and unloading facility. These shrimp are an isolated population depending on successful year-class survival and recruitment from within, rather than outside of the harbor.

11. Dabob Bay produces the majority of oyster seed used on the west coast of the United States. Dabob Bay would potentially be subject to oiling from pipeline operation.

12. Recreational fisheries utilize most shellfish resources at or above sustained yield levels. Recreational effort, therefore, cannot easily be shifted to other species or areas.

Marine Fish

13. The Pacific herring is a major forage fish linking zooplankton and predatory animals such as salmon. There are extensive herring spawning grounds throughout the Strait of Juan de Fuca and Puget Sound. There are presently three commercial herring fisheries in Washington State: the Strait of Georgia sac-roe fishery which yielded 2,000 to 4,000 tons annually from 1974-78 at $274 to $952 per ton (the largest dollar value ever reported was $1,700 per ton in 1979); the northern Puget Sound general purpose fishery; and the Puget Sound bait fishery. The

sac-roe fishery has the largest participation of Indian fishermen exercising treaty rights. This fishery must be conducted during the herring spawning period.

14. Pacific herring deposit eggs in intertidal and shallow subtidal zones throughout Puget Sound, in the southern Strait of Georgia and the San Juan Islands. Herring larvae are dispersed by tidal currents. Juvenile herring are the most abundant pelagic fish in Puget Sound nearshore waters. Adult herring migrate biannually. Spawning herring adults, larvae and eggs are especially susceptible to oiling.

15. There are several surf smelt spawning stocks near the proposed Northern Tier site. Each surf smelt spawning stock is genetically distinct and vulnerable to localized extinction. Spawning and incubation take place in upper intertidal zones. Mean annual surf smelt landings in Puget Sound and the Strait are 70,031 lbs., valued at $20,944 (ex-vessel).

16. Economically important species of Puget Sound and the Strait of Juan de Fuca bottomfish are found in the vicinity of the proposed Northern Tier site. Species include Arrowtooth flounder, Butter sole, Dover sole, English sole, Rock sole, Sand sole, the Pacific halibut, Sand dabs, Rockfish, sablefish, sea perch, Pacific Tomcod, Sculpin, skates, Starry flounder, Greenling, Lingcod, Pacific cod, Pacific hake and Walleye pollock.

The 1978 production and values for commercial and recreational catches of bottomfish were 32,847,000 lbs. and $2,964,449 (ex-vessel). The potential bottomfish harvest in Puget Sound is about 36,915,000 lbs.

17. Recent commercial harvest levels of bottomfish from Washington coastal waters have averaged 24,446,000 lbs. annually. The current coastal recreational bottomfish harvest from coastal waters is about one-half million pounds. The estimated total value of the coastal bottomfish fisheries is at least $10.2 million (ex-vessel).

18. During the transition from larvae to juveniles, fish are especially susceptible to environmental perturbations. Juveniles of most important bottomfish species live in intertidal and subtidal zones. Juvenile bottomfish, adult nearshore fish, and fish associated with kelp beds, are vulnerable to major oil spills at all times of the year.

19. The areas on the Washington coast most vulnerable to oil spills are the coastline north of Destruction Island, Willapa Harbor and Grays Harbor. The northern coast is a critical habitat for lingcod, rockfish, greenlings and sculpins, species especially vulnerable to oiling.

Anadromous Fish

20. Chinook salmon are generally found in the larger rivers and tributaries. The Elwha, Skagit, Stillaguamish, Snohomish, and Green Rivers produce important natural runs. Major hatchery runs occur in Bellingham-Samish Bay, southern Puget Sound and Hood Canal. Major Canadian runs, most destined for the Fraser River, traverse northern Washington waters on their spawning migration. Some natural and hatchery stocks do not migrate to the ocean, but spend their entire life inside Puget Sound and the Strait of Juan de Fuca. Important natural and hatchery runs of other salmon and anadromous trout species occur in the rivers and streams which flow into Puget Sound and the Strait of Juan de Fuca.

21. Recreational salmon fishing occurs throughout the marine waters of Washington. Important fishing areas exist in the vicinity of the proposed terminal and underwater crossings.

Recreational Salmon Catch

Area	Average		High	
	Number	Value	Number	Value
Coastal Waters	800,000	$42,000,000	1,200,000	$64,000,000
Strait of Juan de Fuca	100,000	$10,000,000	200,000	$13,000,000
Puget Sound	+200,000	$15,000,000	300,000	$21,000,000

Commercial salmon fishing occurs throughout Puget Sound and the Strait of Juan de Fuca.

Commercial Salmon Catch*

Area	Average Number	Average Value	High Number	High Value
Strait of Juan de Fuca		$ 2,000,000		$ 3,600,000
West Beach	85,000	640,000	158,000	1,137,000
Point Roberts - San Juan Islands	3,900,000	27,000,000	5,300,000	38,000,000
Bellingham Bay	133,000	2,400,000	220,000	3,600,000
Skagit Bay	74,000	700,000	146,000	1,200,000
Port Susan - Port Gardiner	88,000	1,000,000	125,000	1,400,000
Dicovery Bay - Admiralty Inlet	110,000	1,200,000	244,000	2,900,000
Southern Puget Sound	263,000	3,100,000	473,000	6,100,000
Hood Canal	165,000	1,700,000	475,000	4,500,000

The Port Susan-Port Gardiner area is unique in Puget Sound and southern British Columbia in that a small even-year pink salmon run occurs. Makah and Tulalip fishermen use these fisheries.

22. The average annual commercial catch for those areas of Puget Sound and the Strait of Juan de Fuca potentially affected by the Northern Tier proposal is over 5,000,000 salmon of all species, valued at about $39,800,000. The high year for those areas was nearly 7,100,000 salmon valued at nearly $59,100,000. With the large increase in the number of salmon hatcheries now under construction or recently put into production, the catch and values should greatly increase.

23. Commercial salmon fishing occurs throughout the Washington coastal area. During the period 1974-1978, the ocean troll fishery showed an average catch of 1,256,000 salmon

*Salmon production & value figures are expressed as mean annual averages for years 1974-78 except for pink salmon figures which are from mean annual aver. for odd-no. years 1973-77 with a high of 2,025,000. The average value at 1979 prices was $19,205,000 with a high of $30,175,000.

24. Treaty Indian fishermen may take fish from the State's marine waters for subsistence and ceremonial purposes. These fish are not included in the commercial and recreational catch statistics previously presented. In 1978, for coastal areas from Grays Harbor north and for Puget Sound, the tribes estimated they would catch 11,100 chinook, 24,300 coho, 24,600 chum, and 7,100 sockeye.

25. A Canadian recreational salmon fishery occurs throughout the area potentially affected by the Northern Tier proposal. It is concentrated in the Strait of Juan de Fuca and Georgia Strait. The Canadian troll fishery, primarily off the west coast of Vancouver Island, is a major salmon fishery from spring through fall. Canadian salmon fishermen conduct an intensive commercial salmon fishery in the outer Strait of Juan de Fuca.

Canadian Salmon Fishery*

Category	Average Number	Average Value	High Number	High Value
Sport	833,000	$52,796,000	1,312,000	$ 79,664,000
Commercial - West of Vancouver Island	4,807,000	66,992,000	7,938,000	97,100,000
Commercial - Strait of Juan de Fuca, Georgia Strait	3,200,000	25,000,000	5,100,000	41,200,000

26. All Puget Sound and many Canadian salmon runs pass through the Strait of Juan de Fuca. These runs, in addition to supporting locally valuable fisheries, contribute to virtually every salmon fishery in the ocean from northern California to southeastern Alaska. It can be assumed that the adult migration routes retrace the earlier routes of juvenile seaward migration.

Total Juan de Fuca Salmon Runs

Average Number	Average Value	High Number	High Value
14,413,400	$ 194,419,000	22,942,800	$286,016,900

27. Total annual average salmon catch of runs from the Skagit, Stillaguamish and Snohomish rivers is as follows:

*Canadian production and value figures are expressed in U.S. dollars as the mean annual averages for the years 1972-76

	Catch--# of Fish		Value	
	Average	High	Average	High
Skagit	875,000	1,445,400	$12,396,000	$17,862,000
Stillaguamish	144,600	229,100	1,908,000	3,355,000
Snohomish	640,800	912,300	10,722,000	15,080,000

The average annual catch of steelhead from the Skagit, Stillaguamish, and Snohomish Rivers totals 32,100 fish. The annual net economic value of this recreational fishery is $1,796,000 (Exhibit #823).

28. Risks to salmon from oil vary depending on the life-stage, duration of exposure, and the geographic area. Salmon resources at risk include intertidal and stream rearing areas, spawning areas, and areas used by juvenile and adult migrants. In the Strait of Juan de Fuca, the greatest potential risk is to nearshore migrating juvenile salmon. An oil spill would not ordinarily be lethal for migrating adults, but could cause damage through delay. (See Section III.D.4 Non-Human Impacts).

29. Admiralty Inlet and Skagit Bay are high risk areas. Skagit Bay is an important rearing area for juveniles and the migration route for Skagit River juveniles. In most years, the Swinomish Tribe operates a Skagit Bay stationary fish trap that would be especially susceptible to fouling from oil. All southern Puget Sound, Hood Canal, and Stillaguamish-Snohomish stocks must pass through Admiralty Inlet as juveniles and adults. Important commercial and recreational fisheries are conducted in the Inlet.

30. In most other areas, the same risks exist as in the Strait of Juan de Fuca but at a lower level.

Aquaculture

31. Washington is the major producer of farmed oysters on the Pacific coast. It is a major clam producer. Some of the nation's most productive clam farms are located in Puget Sound. A new industry, mussel culture, has begun at Whidbey Island and promises expansion. Washington is also a leader in state and federal salmon hatcheries for restocking public waters and in private aquaculture ventures. There is a substantial private salmon farming industry using floating net pens or cages in Puget Sound and the San Juan Islands. Farming of "yearling" salmon exceeds a million pounds a year and is expected to expand rapidly.

Aquaculture Values*

Species farmed	Dollars per year
Oysters	$ 25,000,000
Clams	10,000,000
Mussels	250,000
Salmon	4,000,000

*These values are based on figures from the years 1972-76 but do not represent mean annual averages.

32. Puget Sound has much unrealized aquaculture potential. Its bays and estuaries are protected from oceanic storms. Its waters have high natural productivity. Its depth, cleanliness, good circulation, moderate temperature, salinity, and lack of ice also contribute to this potential. Oyster production, clam farming, mussel production, and salmon culture could reasonably expand. Several additional marine shellfish species could be grown in Puget Sound aquaculture systems.

33. Puget Sound kelp are important carbohydrate producers; they also provide a spawning substrate, a fish habitat, and food and chemicals for man. Seaweed species are grown for commercial purposes in Puget Sound and the Strait of Juan de Fuca. The market for carrageenin, extracted from the seaweeds Iridaea and Gigartina, is about 2-3,000 dry tons per year at a market price of $600-1,000/ton. Any protected location in the Strait of Juan de Fuca and almost anywhere in the Puget Sound is suitable for the culture of Porphyra, especially areas that have moderate to high currents. Porphyra has significant commercial potential.

34. Aquaculture expansion in Washington can provide additional employment and income for this region. The increased threat of oil spills associated with the applicant's project could hamper investment in, and development of, the

aquaculture industry in Washington. An oil spill could kill some species and could taint aquaculture products, making them unmarketable.

<u>Marine Birds and Mammals</u>

35. There are many species of marine birds at Smith-Minor Islands, Cape Flattery, Protection Island and Jamestown. Protection Island is the most significant of these areas. Protection Island is also the major nesting area for marine birds in Puget Sound. Diving birds found in the Jamestown/Protection Island area are known to be highly susceptible to the effects of spilled oil. (See Long, TR 34119-20; Ex. 674, 675, 676 and 677).

36. The eastern portion of the Strait has the majority of the harbor seals and pupping sites in the area, particularly at Smith-Minor Islands, Dungeness Refuge, and Protection Island. Northern Sea Lions and California Sea Lions are abundant at Race Rocks on Vancouver Island. Killer whales frequently travel through the eastern Strait, Admiralty Inlet and San Juan Islands. (Long, TR 34121; Ex. 678.)

Freshwater Fish

37. Many of the streams crossed by the proposed terrestrial pipeline route in the Cascade Mountains region support freshwater species such as cutthroat trout, rainbow trout and mountain whitefish. The Snoqualmie River is occasionally stocked with coho or chinook salmon for recreational fishing. (TR 15181-82 Yuill; Applic. III, sec. 2.5.4.3). (See Section III.H - Habitat and III.K - Rivers and Streams Impacts on Fish).

38. In eastern Washington, the waterways of major significance traversed by the terrestrial pipeline are the Yakima River, Columbia River, Crab Creek, Rocky Ford Creek and Rock Creek. These rivers support salmon, trout, bass and carp. No salmon or trout spawn in the Columbia or the Yakima at the corridor crossing point. (TR 15182 Yuill; Applic. III, 2.5.4.2). (See Section III.H - Habitat)

III. D. 4.a. NON-HUMAN IMPACTS

Interaction of Oil and Water

1. Petroleum is a naturally-occurring complex mixture of organic compounds formed from the partial decomposition of animal and plant matter over geological time. No two samples are exactly alike. Petroleum may exist as a gas (natural gas); as a liquid (crude oil); as a solid (asphalt, tar, bitumen); or as any combination of these three states. Crude petroleum contains tens of thousands of different chemical compounds. The hydrocarbons (50-98 percent of crude oil), include cyclic and open-chain paraffins, naphthenes, olefins, and aromatic compounds with molecular weights from 16 to considerably more than 20,000. The non-hydrocarbon compounds include the chemical interaction between hydrocarbons and sulfur; nitrogen; or oxygen (acids, ketones, phenols); and trace metals. Each petroleum compound can have a different physiological impact on each of the individual species of an ecosystem. It is therefore impossible to say unequivocally that one petroleum material will always have the same effect as another. Each oil spill is unique; the variables associated with a spill are specific only to the one time and place of that spill.

2. Many factors determine the degree and duration of damage from a petroleum spill. These include: (a) the

chemical composition and physical properties of the petroleum; (b) the quantity of the petroleum and the duration of the spill; (c) seasonal, oceanographic, and meteorological conditions; (d) nature of the exposed biota; (e) habitat type and substrate; (f) geographic location; and (g) type of cleanup used. Other stresses contributed by human activities may act synergistically with components of spilled petroleum, thereby increasing the damage to certain species. An effect on one part of the marine environment frequently manifests itself in another part because of the interrelated nature of a marine ecosystem.

3. Once petroleum is lost into the sea, it immediately starts to undergo chemical and physical changes. The weathering processes occur simultaneously and are interrelated. The processes are: spreading, evaporation, dissolution, agglomeration and sinking, emulsification, microbial modification, photochemical modification, biological ingestion and excretion. Of these factors, evaporation is the most noticeable and rapid. Evaporation alone can remove about 30-50 percent of hydrocarbons in a typical crude oil spill in the sea surface within ten days. Spreading is a random phenomenon, aided by wave action, winds and currents. In restricted water, shear-produced turbulence will mix the oil downward into the water column and will permit its deposition on shorelines. Dissolution starts immediately upon contact of the oil with water and may be self-sustaining. Biological and photochemical oxidation

of the components of the oil produce additional surface-active, polar compounds which are more soluble in seawater.

The disintegration and dispersal of bulk oil slicks into water include such phenomena as the formation of macroparticles (droplet dispersion and water-in-oil emulsions), microparticles (colloidal dispersions and oil-in-water emulsions), and mixtures of soluble hydrocarbons in water.

Petroleum and seawater emulsions can be of two types: oil in seawater and seawater in oil (e.g., tarballs and "mousse"). During large spills, thick layers of oil persist for long periods and large aggregates of emulsions can be produced. These emulsions are fairly stable. Bulk oil returned in the emulsions retains initially toxic characteristics for lifetimes approaching that of the emulsions. The transport of emulsions can increase the area and duration over which a spill is felt. Microbial degradation of oil is the most important process involved in weathering and the eventual disappearance of petroleum from the marine environment; this process, however, may take years.

4. All of these processes would occur in Washington State marine waters; however, some of the processes could become more important to the weathering of petroleum in certain oil spills due to local conditions. For example, the spreading and

stranding of surface-borne slicks would be influenced by shorelines and islands. Percentages of oil stranding on beaches would increase with the amount of shoreline within the oil's trajectory. Self-cleaning by natural forces in the marine environment (e.g., wave action, scouring, erosion, seasonal beach movements) is determined largely by the magnitude of the physical forces present in different types of shoreline habitats. On high-energy shorelines (like rocky headlands), self-cleaning can be rapid. Conversely self-cleaning is a very slow process (approaching 10-15 years) in low-energy environments such as mudflats, salt marshes, tidal rivers, and some sandy beaches. In low-energy shore areas, oil can remain buried in intertidal beaches for years or decades, often retaining its high-boiling aromatic hydrocarbons. Self-cleaning may only redistribute the oil from a high-energy environment into a low-energy sink where it can become immobilized. In some cases where the oil is not buried in low-energy beaches, it can become associated with the vegetative fringe of the mudflats and low-energy lagoons (METULA and AMOCO CADIZ spills). This vegetative fringe acts like a sponge to collect oil on each tidal exchange and can be accentuated if the oil comes in on unusually high tides.

Sediments have a proven potential for long-term release of entrapped pollutants back into the nearshore environment. Once incorporated in certain sediments, petroleum tends to degrade quite slowly as observed on spills in Chedabucto

Bay (ARROW), coastal Maine, West Falmouth, Alert Bay (Canada) and the Strait of Magellan (METULA).

Oil and Biological Populations

5. The transition of an ecosystem from a severely altered state immediately following a major oil spill to a stable one may require many years. However, stability does not necessarily mean a return to the same conditions that prevailed prior to the pollution incident. The cove inshore from the TAMPICO oil spill did not reach ecological stability until ten years later, and the stable population compositions before and after the spill were different. The time required for the re-establishment of a species in a disturbed environment often substantially exceeds the time required for that species to develop to maturity. Recolonization after a spill does not necessarily warrant the conclusions of no impact to the environment. Should additional pollution stresses (subsequent oil spills or other human-induced degradation) occur in time frames shorter than that required for complete recovery, the overall result can be progressive degradation of the marine environment.

6. Observations from historic oil spills suggest that serious long-term effects could be expected from a major spill in the unique biological regimes of Puget Sound or the Strait, due to extensive tidal excursions, slow flushing of

certain restricted water bodies, high turbulence and mixing in channels, and the long length of convoluted shoreline with a variety of valuable intertidal and subtidal habitats. Serious effects could be also expected if a major spill contacted beaches or bays on Washington's coast.

7. Concentrations of oil toxic to marine life were measured 89 days after the initial spillage from the AMOCO CADIZ. Zooplankton populations have experienced substantial decline after major oil spills. Many species of fish were observed to be missing from one oil-impacted area. Individuals of other species were observed to exhibit pathological and physiological changes. Small spills also have had lasting effects on local animal and plant communities.

8. If oil is stranded and remains on a beach, the aggregate immediate mortality due to smothering, or assimilation of toxic amounts of petroleum hydrocarbons, in the intertidal region can be expected to be high.

In subtidal areas adjacent to oiled beaches, immediate mortalities of fish and shellfish would be lower and would depend upon the concentrations and persistence of dissolved and emulsified oil.

Species Vulnerability

9. The most vulnerable intertidal food fish and shellfish are clams, oysters and mussels, shrimp, Dungeness crabs, and incubating spawn of the Pacific herring and surf smelt. These organisms' vulnerable early life stages are spent in habitats where substrates are stable and hydraulic energy relatively subdued. Such habitats have a high vulnerability to oil spills.

10. Chum and pink salmon juveniles have a specially high vulnerability as well because they are almost inextricably dependent upon the food and predator protection offered by the beach shallows when they are small. Some species of zooplankton and phytoplankton also have heightened vulnerability to oil because they tend to live near or migrate close to the surface, and oil will tend to be concentrated in the upper water column.

11. Flatfish embryos and larvae may be particularly vulnerable to floating oil and to the saltwater-soluble fraction of oil associated with an oil slick, because the eggs of many flatfish species incubate at or near the surface of the water column. The latent effect of killing embryos could be lesser recruitment of that year class into the fishery. A spill

could kill larvae from surf smelt or Pacific herring and Dungeness crab. See Section III.D.3 - Resources at Risk.

Physiological Impact of Hydrocarbons

12. Marine organisms readily accumulate petroleum hydrocarbons into tissues when exposed through diet, the water column or sediment. The extent of accumulation depends on species, hydrocarbon structure, route of administration, and environmental conditions. Once ingested or absorbed, petroleum compounds can be concentrated in vital organs at higher levels than in the environment. In various exposed marine fish, aromatic hydrocarbons have been identified in all tissues and organs. Flatfish especially tend to accumulate significant concentrations of petroleum hydrocarbons in their bodies when exposed to petroleum-rich sediments. Hydrocarbon accumulations in brain tissues of marine fish may be associated with severe behavioral or physiological changes. The retention of petroleum hydrocarbons in the eyes of marine fish may result in morphological changes. Invertebrates (crustacea and molluscs) also readily accumulate hydrocarbons in all tissues and organs from surrounding water when exposed for more than a few hours.

13. Petroleum in the marine environment has the potential to alter significantly the normal life processes of a variety of organisms. Petroleum compounds bring about a variety

of long-term biochemical, physiological, behavioral, and pathological changes. The metabolism of hydrocarbons by marine fauna results in limited and variable detoxification. However, certain metabolized hydrocarbons, such as benzopyrene, can be converted into mutagens and carcinogens. Metabolites may be more damaging than the hydrocarbons themselves. Various serious sublethal effects may occur.

14. Studies evaluating effects of waterborne petroleum on salmon homing were conducted at a field site in the Puget Sound area. When monoaromatic hydrocarbons were introduced into salmon "home stream" water at concentrations greater than 700 parts per billion (ppb), the chemicals disrupted salmon upstream migration past a dam located at tidewater. At hydrocarbon concentrations of two to three parts per million, upstream movement of early migrating coho salmon past the dam was completely inhibited and for salmon migrating late, upstream movement was reduced by 50 percent. This phenomenon occurs because adult salmon avoid even low concentrations of hydrocarbons. A delay of only a few days can be extremely damaging because salmon stop feeding on their spawning ground migration and must finish their life cycle on a fixed store of energy. When that store has been depleted, the fish dies whether it has completed spawning or not.

15. Virtually no normal sand sole embryos or larvae were recovered from exposure to a slick of fresh or weathered Prudhoe Bay crude oil (hydrocarbon concentrations in the water of 300 ppb and greater); a number of different anomalies were observed. Similarly, very few normal animals at these developmental stages were obtained after exposure at 64 ppb to the weathered saltwater-soluble fraction of crude oil.

In another study, English sole were exposed to sediment-associated Prudhoe Bay crude oil for four months. Compared to control sole residing on clean sediment, the oil-exposed sole took up substantial amounts of petroleum hydrocarbons, developed liver abnormalities, lost weight, and had a higher mortality rate.

16. An oil spill in Puget Sound or the Strait would also adversely affect aquaculture. In addition to other effects, tainting might prevent marketing of the cultured product. See Section III.D.3 - Resources at Risk-Aquaculture.

17. Because marine ecosystems are built upon complex interrelationships of species, an effect on one species frequently results in effects on others. The more susceptible species can be selectively eliminated while the more resistant ones can flourish almost unchecked. Thus, elimination of a few species can alter food webs and change community structure.

Fishery Impacts

18. If an oil spill occurs, fisheries operating in the affected area will be curtailed, either because fishermen will not be able to fish without soiling their gear, or because of closures ordered by public agencies to assess the potential hazard. Acceptance of seafood products can be expected to diminish because of public health concerns. The hydrocarbon concentrations at levels too low to produce other observable effects can cause taint and result in an unacceptable product.

For major fisheries, values total nearly $300 million annually (1974-1978 average) in Washington State.

19. An oil spill could upset some fishery harvest and management strategies. If the commercial fisheries for adult salmon in the Strait of Juan de Fuca or in river mouth areas were curtailed, many more salmon than needed could escape to the spawning grounds and hatcheries.

20. Spills in various locations affected by the project could impact Tulalip fisheries.

21. Treaty tribes are prohibited from moving to another fish run in a different area and resuming the harvest. To the extent that a fish run migrating through a usual and

accustomed fishing area is destroyed or caused to avoid the area, the treaty fishery is likewise damaged. (TR 36393 Somers).

22. A large spill in one of the major rivers of the Puget Sound region could block adult anadromous fish migration, cause egg or larvae mortality, and damage spawning and rearing habitat.

23. Since smaller streams are often more important as spawning and rearing habitat than larger rivers, an oil spill in a small stream could prevent use of significant habitat downstream or upstream. There are a finite number of smaller streams which provide habitat for the fisheries. Significant habitat deterioration has already occurred. The loss of the fishery supported by a single small stream is significant if viewed alone, and becomes even more significant if viewed in light of the cumulative repercussions. Also, an oil spill in a small stream can be expected to reach larger streams and result in impacts there. (TR 36400-36401 Somers).

24. The occurrence of construction-related oil spills can reasonably be expected to occur if the Northern Tier project is constructed. (34278-89 Kay). Spills which reach rivers can cause damage to fish and fishery habitat. (34288-89 Kay).

25. Oil spills reaching freshwater would behave similarly to oil spills on marine waters. (TR 15196-97 Yuill, App. III, Sec. 2.5.4.2)

26. Oil spills occurring in wetlands may produce long-term adverse effects. Containment and cleanup of a major spill would be very difficult. Depending on the magnitude of the spill, recovery could take many years.

27. East of the Cascade Divide, impacts to fish could occur from spills entering the Yakima or Columbia river systems.

Bird and Mammal Impacts

28. Historically, large numbers of water birds have been killed or otherwise harmed by oil spills. Operation of the tanker unloading facilities at the marine terminal has the potential of adversely affecting large numbers of birds in the Strait of Juan de Fuca and Port Angeles Harbor through oil spills. Species that generally live on the sea, diving for food, resting on the surface of the water or floating on debris, are the most susceptible, frequently becoming coated with oil. The effect of oil on water birds can be considered in three broad categories: physical effects, loss of food and disturbance of habitat. (TR 15348 Reed; Applic. III, Sec. 2.5.2.1).

29. Adverse effects on individual birds can come from direct or indirect contact with oil. Long-term problems, many related to reproduction, may result from the oiling of individual birds. (TR 15349-50 Reed; Applic. III, Sec. 2.5.2.1). The importance of oil-spill-related bird losses depends on the overall population viability of the species affected. (TR 15350-51 Reed; Applic. III, Sec. 2.5.2.1).

30. Oil spills could affect any of the important water bird areas in the Strait of Juan de Fuca.

31. In the Strait, critical bird habitats most likely to be fouled by a large oil spill are mud flats, marshes, shallow water eel grass beds, kelp beds, and reefs. (TR 15354-55 Reed; Applic. III, Sec. 2.5.2.1).

32. There are no effective ways of cleaning birds or critical habitats after they have been fouled. Under the most rigorous cleanup procedures, only about 10% of birds captured and treated remain alive. (TR 15355 Reed; App. III, Sec. 2.5.2.1).

33. Very little research has been done to determine the long term impacts of oil on marine mammals. (Gornall, TR 33702-03). Seals have experienced eye irritation from spills. Few other direct impacts on marine mammals have been documented.

The greatest impacts on these species would be the fouling of resting habitats, changes in proportional time spent on water and land, changes in group relationships, and possible contamination of food sources. In general, losses of fish for marine mammals would not be significant. Also, these mammals may feed in other areas temporarily until food and other habitat conditions recover. Other species, such as the killer whale, harbor porpoise and gray whale, could be exposed to an oil spill, but would probably avoid the contaminated areas. (TR 15345-46 Reed; Applic. III, Sec. 2.5.2.1).

Economic Impacts

34. A major oil spill from a tanker or submarine pipeline associated with the Northern Tier facility could cause economic damage in excess of $200 million (1981 dollars). (Sorenson, TR 41776, 41767, Ex. 845 at p. 12). Washington state fisheries are far more valuable than the fisheries in Brittany, France, where the AMOCO CADIZ spill caused a total economic loss of $350 million. (Sorenson, TR 41775-6, 41761). The value of Washington state salmon fisheries alone is $200 million per year. (Ex. 845 at 11).

35. Costs associated with oil spills include loss of the ship and cargo, clean up, government and environmental costs, property value reductions, recreational value losses,

tourism losses and commercial and sport fishing losses. In addition, there may be intangible losses based on aesthetics, health and morale which are not readily assigned a dollar value. (Sorenson, TR 41756-8).

Existing Risk

36. Up to 45,000 barrels of petroleum may enter Puget Sound and associated waters per year from existing operations.

37. Puget Sound, the Strait of Juan de Fuca and Port Angeles Harbor have an existing risk of oil spills presented by tank vessels carrying crude oil and petroleum products and conducting transfer operations, and by other vessels.

38. There is a probability of one or more oil spills from existing tankers and barges in transit to Puget Sound ports or at berth. There is a present probability of oil spills in Port Angeles Harbor.

39. In western Washington, the existing probability of one or more storage tank spills is high. (TR 13835 Johnson)

40. There are presently no submarine oil pipelines in the Strait of Juan de Fuca or Saratoga Passage.

41. There is a current possibility of pipeline spills in Washington. Based on historical accident data for pipelines in Washington, the present risk of spills is very small (Applic. III, Sec. 1.11.5). Construction of the pipeline system would introduce oil spill risk to areas where no risk currently exists, as well as increase existing oil spill risk.

III. D. 4.b. HUMAN HEALTH

1. Northern Tier performed an analysis assessing the effects on human health of ingesting water and seafood contaminated with oil. The analysis assumed that the oil would be present in levels too low to be tasted in seafood or drinking water. The analysis reviewed the chemicals that would be present in the oil to determine whether they were likely to pose significant health risks. Estimated, worst-case exposure levels were assumed. (TR 15613-14, 15682-85 Karch).

2. The analysis concluded that human neurotoxicity is unlikely to occur as a result of ingesting contaminated water or seafood. It further concluded that lifetime ingestion of oil contaminated fish and seafood was not likely to result in teratogenic (causing fetal malformation), fetotoxic or other effects on the brain or kidneys. (TR 15682-87 Karch).

III. D. 5. PROTECTIVE MEASURES AND CLEANUP

1. For the foreseeable future, major oil spills are beyond the response resources that can be brought to bear in a timely manner. (TR 33452; 33570-71; 33199-201).

2. Protective and mitigative measures for oil spills are outlined in the Draft Oil Spill Contingency Response Plan (also referred to herein as the "contingency plan"). (Applic. II, Sec. 6.5.4) This document is necessarily preliminary. Volume I of the contingency plan deals with general provisions. Volume II deals specifically with the Port Angeles District. There is also a preliminary document for Selected Sites, Central and Eastern Washington, which deals primarily with river and stream crossings.

3. The plan is not an action plan that could be used by an on-scene commander in the event of a spill; rather it constitutes an outline of the general requirements of what such a plan would be. (Bennett, TR 33195; Hatfield, TR 33161-62) Appendix A exists only as a title.

4. The contingency plan contains an appropriate structure for this stage of development. Changes, expansion and refinement in the plan will be required prior to the start

of operations to reflect changes in details of design and proposed operational parameters. (TR 16060 Castle)

5. Procedures for notifying agencies and others, and for starting cleanup and containment response, in an efficient and acceptable manner should be devised.

6. Small spills will be handled by local Northern Tier operating groups familiar with each area. (TR 16063 Castle)

7. A centralized management team will be responsible for coordination and implementation. All personnel participating in a response organization will be specifically trained in their individual duties and responsibilities, and will be subject to periodic training classes and field exercises. (TR 16065 Castle) Volume II of the Plan, Section 404 identifies potential sites to be protected against spills. (TR 16123-24 Foget)

8. After determining the areas of potential impact, the characteristics of potential spill locations were used to select compatible protection techniques. Specific clean-up actions often cannot be predetermined, because selection of proper clean-up techniques depends on factors which vary from spill to spill. A series of decision guides for clean-up is

included in the contingency plan. (TR 16125 Foget) Flow charts describe response procedures. (Castle, TR 16064)

9. Volume II, the Port Angeles District Plan, contains a Natural Resources Inventory with condensed information on the ecology of specific areas, group/species abundance, and seasonal importance. (Castle, TR 16068)

10. Northern Tier will respond to spills from inbound or outbound vessels as requested by the responsible party, the Clean Sound Cooperative, or the Federal On-Scene Coordinator. (TR 16551 Castle; Oil Spill Contingency Plan, P. 102-1(2)) On the strength of a verbal request, Northern Tier will respond to an oil spill incident for an initial 24-hour period. Beyond that period, Northern Tier's response would require a written contract. If the Federal On-Scene Coordinator requests Northern Tier's help in responding to any incident, Northern Tier will honor that request. (TR 16622, 16659-60; Oil Spill Contingency Plan, Vol. II)

11. Northern Tier will maintain an inventory of strategically located equipment for containment and recovery of operational oil spills, and will provide an immediate response to spills within each district area of interest. (TR 16118 Foget)

12. The applicant will provide the following equipment at the tanker berth area: a 4,000-foot back fence boom installed under the dock at the tank barge location, along with 700 feet of permanent boom to be attached to ships and barge hulls at the water level on either side of the loading manifolds; approximately 4,000 feet of heavy-duty fence boom to enclose every tanker prior to offloading operations; a boom boat for deployment of booms; and two disc-type mini-skimmers. (TR 16126-27 Foget)

13. The following major equipment (some of which may be supplied and/or operated by the Clean Sound Cooperative) will be available at Port Angeles for immediate response to oil spills: two self-propelled skimmers; 7,000 feet of curtain boom with tension cables at top and bottom; 1,000 feet of fast deployment compactible boom and a 1,600-foot fast deployment boom; a fast response boom deployment boat; an 18 to 20-foot work boat with trailer and motor; a 5,000 to 7,000 barrel tank barge; and additional equipment and supplies. (TR 16127-28 Foget)

14. The following equipment will be stored at Green Point: 7,300 feet of curtain boom; two small portable floating skimmers and one portable belt-type skimmer; 1,000 feet of curtain boom and 1,000 feet of fast response boom; two small work

boats with outboard motors; twelve bird-scaring devices; additional equipment and supplies. (TR 16128-29 Foget)

15. A skimmer, boat, and boom will be maintained by Northern Tier at each pump station. (TR 16860 Foget) For each river containment site, one hundred feet of suction hose will be provided to be used with a skimmer or pump, in addition to suction hoses used on the vacuum trucks. (TR 16881 Foget)

16. High current booming material, and low-current booming material and sorbents, will be on hand for containment work in rivers.

17. The Clean Sound Cooperative is an unincorporated mutual assistance joint venture composed of 15 oil and oil transportation companies doing business in the State of Washington. The cooperative owns or has available from its members a wide range of oil spill containment and clean-up equipment.

18. Northern Tier will endeavor to become a member of Clean Sound Cooperative and will use that organization's equipment and personnel for large marine oil spill incidents or those requiring long-term manpower, supplemented by local contractors, if necessary. (TR 16064 Castle)

19. If it joins Clean Sound Cooperative, Northern Tier will become approximately a 60% member of the organization, based on its percentage of the total oil and oil transportation industry in the state. (TR 16711-18 Weichert)

20. Present equipment and technology will not provide the capability to recover significant amounts of oil in the event of a large spill at either Port Angeles Harbor, the approaches to Port Angeles, the Strait of Juan de Fuca or at the submarine pipeline crossing of Admiralty Inlet or Saratoga Passage. (TR 33199) Even if massive amounts of oil spill equipment were present, it would be difficult to prevent pollution of the coastline unless ideal, combined conditions of light wind, little current, small waves, and good visibility were sustained throughout the entire oil spill clean-up operation. (TR 33200-1).

21. Oil spill containment and open water clean-up attempts in marine waters and rivers generally fail. (TR 33196-7) The history of clean-up of large tanker spills shows that relatively little of the spilled cargo is successfully intercepted or recovered. (Bennett, TR 33197-8) Any conditions such as strong currents, tidal action, winds, waves, fog and/or the onset of darkness would hinder recovery of spilled oil. (TR 33197; Hatfield, TR 33164).

22. Containment and clean-up of oil spills would be very difficult in the Strait of Juan de Fuca because: (1) the tidal currents in these waters are swift and sustained; (2) the area experiences both high wind and frequent fog conditions; (3) the distances between mid-channel and the shore, between the Port Angeles berths and the shore, or from the submarine pipeline crossings to the shore, are relatively short and leave little time for containment prior to oil reaching shore; and (4) the movement of tidal currents in the Strait of Juan de Fuca and Puget Sound is complex and changing, so that any containment or clean-up operations would require continuous readjustment and modification. (TR 33198-99) Open water clean-up and control near Cape Flattery is not feasible. (Bennett, TR 33501-2)

23. The Clean Sound Cooperative's personnel and equipment should be able to respond effectively to the great majority of small spills and to many spills of moderate (1,000 to 5,000 barrel) size. Though effective overall response to a major spill is not possible, Clean Sound's personnel and equipment, even then, would provide marginal assistance and protection.

24. The Clean Sound Cooperative is able to provide initial response personnel to operate its equipment. Clean

Sound's contractor has some personnel available at one hour's notice. (TR 16087, 16743-44 Weichert).

25. Within 12 hours after a major spill in the Strait of Juan de Fuca, 50,000 to 60,000 feet of boom could be obtained through all local sources presently available to the applicant. (TR 16786-87 Weichert). Additional boom from other federal and out-of-state sources could be made available at varying times. (TR 16085-86 Weichert).

26. Even if on scene, and immediately available the largest oil skimmers now available have limited capability of recovering oil in open water. (TR 33199) Skimmers can recover oil in a Sea State 2, but that capability in Sea State 3 is limited. (TR 33211, 33572-3, 33538, 33478-9) In the Strait of Juan de Fuca, conditions above Sea State 2 are common and occur frequently (20% to 30% of the time) throughout the year. (TR 33211, 33459) Sea State 2 is the U.S. Coast Guard description for sea conditions having large wavelets where crests begin to break and is characterized by a gentle breeze, with wind velocity ranging from 6.5 to 10 knots; an average wave height of 0.6 to 0.88 feet; a significant wave height of 1.0 to 2.2 feet; and wave frequency of 0.8 seconds to 6.0 seconds. (TR 33212)

27. Oil spill booms allow oil to escape underneath beginning at 3/4ths knot current with virtually no containment at currents greater than 1.2 knots. (TR 33200, 33467) Wind and wave action compound the problems of boom containment.

28. Some booms set at an angle to divert or cascade oil to a sacrificial beach may be able to prevent escape underneath the boom up to 1.5 to 2 knots of current in limited circumstances, but effective diversion requires precise placement of booms and anchors. This can generally be done only with predetermined and preanchored boom locations. (TR 116370-71, 16380, 16589, 16643 Foget; 33495, 33529, 33469, 33472-3 Bennett; Ex. 639) Pre-setting of booms is not considered feasible for protecting the waters of the Strait of Juan de Fuca or Puget Sound. (Ex. 639; TR 33581).

29. The limited effectiveness of booms and skimmers on open water containment and clean-up apply to any spill size. (TR 33214)

30. Boomed oil may be released due to risks of fire and explosion around the vessel. (TR 33213, 33462-3)

31. The usefulness of diversion booming in rivers is dependent on current speed. (TR 16916-17 Foget)

32. Free drifting booms in open water can reduce the escapement problem by floating with the current, making relative speed of the current to the boom very small, and as long as current direction is constant, concentrating the oil somewhat. (TR 16591-92 Foget)

33. The equipment applicant proposes to acquire will be sufficient to provide an initial response to most small spill situations.

34. The double booming proposed by Northern Tier during tanker unloading operations would be capable of containing most operational spills at berth, especially given the protected nature of Port Angeles Harbor.

35. Oil spills from the submarine pipelines could not be contained while below the water surface. After surfacing, oil would likely be scattered and difficult to contain even in calm conditions. Further, the oil reaching the surface would escape from booms when currents exceeded 3/4ths of a knot and containment would be virtually impossible at currents exceeding 1.2 knots. The strong currents of Admiralty Inlet at the submarine crossing would make containment virtually impossible even when the oil reached the surface. (TR 33212).

36. No substantial containment is likely of oil spills from pipeline crossings of rivers due to delayed response time after leak detection, and lack of equipment deployment along the various rivers and the common existence of swift currents.

37. Inability to contain and clean up open water spills leaves beach or shoreline clean-up as the only alternative. (TR 33201) The Washington coastline between Cape Flattery and Port Angeles has extensive areas which are inaccessible for the large numbers of workers and equipment needed to attempt shoreline recovery of beached oil. (TR 33201-02) Clean-up on those sections of the coast which are inaccessible by land would not be practical and oil will have to be degraded and dissipated through wave and water action. (TR 33202-03) Some areas of the coastline of the Strait of Juan de Fuca and Puget Sound have high energy waves which will dissipate and degrade oil. Other portions of that coastline contain inlets, pools, estuaries and protected areas where the oil will not be washed by high energy waves and oil may be refloated due to tidal actions. (TR 33202-03) Such refloating creates new drifting oil slicks which can contaminate new areas or recontaminate beaches which have been previously cleaned up. (TR 33204).

38. Where the oiled coastline is accessible, oil recovery is a lengthy task requiring large numbers of laborers

and equipment. (Ex. 638 (slides); TR 33201, 33211-12) Where the oil beaches on sandy or gravel areas, the top portions of the beach are removed and hauled away for disposal. (TR 33211, 33518) For rocky areas and other shorelines which cannot be dug up and hauled off, clean-up is limited to shoveling oil, mopping rocky areas and ladling, skimming or sucking oil at the shoreline edge. (Ex. 638 (slides); TR 33203, 33212). The Mitsushima oil spill in the Inland Sea of Japan involved 200,000 people, 102,885 drums for oil/water mixture disposal, and over 38,000 ships and boats for clean-up. (Hatfield, TR 33207; Ex. 636, pp. i and 21) The AMOCO CADIZ involved a total of 6,500 people and 90 tank trucks, 140 vacuum trucks, 300 dump trucks, and over 60 bulldozers, backhoes, frontend loaders and other heavy machinery. (Ex. 637, pp. 268-272; TR 33205). There may be significant impacts to vegetation, fish and wildlife associated with the clean-up methods described in Findings 21 through 38.

39. There are significant logistical problems associated with the influx and massing of manpower and equipment required to attempt beach clean-up. (Ex. 638 slides) (TR 33164, 33167-69).

40. Spills of between a few gallons and several hundred gallons which typically occur during cargo transfer can

take between six hours and six days to clean up and one or both berths may be shut down during clean-up. (Bayliss, TR 26012).

41. The costs of clean-up vary with the size and circumstances of a spill. Direct costs of major oil spills can be massive. The AMOCO CADIZ and the Inland Sea spill in Japan each cost approximately $200,000,000 to clean up. (TR 33215; Hatfield, TR 33171).

42. A study of clean-up efforts in waters bordering the Strait of Juan de Fuca revealed an average direct clean-up cost of $26 per gallon (in 1978 dollars) or $1092 per barrel. (Hatfield, TR 33171; see also Bayliss, TR 26093; Bennett, TR 33571, Sorensen, TR 41801).

43. U.S. law requires tankers to carry oil spill liability insurance in the amount of $150 per gross ton, which is $0.75 per gallon. (TR 33571; FWPCA, 33 U.S.C. subsection 1321).

44. Direct clean-up costs do not include indirect governmental costs, damage to public and private property, damage to resources and habitat, and general environmental damage. (TR 33172) The litigation of the AMOCO CADIZ involves approximately $2 billion worth of claims. (TR 33216).

45. Recovery from international compensation funds has been characterized by litigation and payments far below the costs of clean-up and environmental damage. (TR 33218, 33520-22, 33555).

46. The Limitation of Liability Act, 46 U.S.C. 183, may preclude or limit recovery against vessels for oil spill damages.

47. NTPC proposes to carry a minimum of $35,000,000 spill liability insurance. The Federal Water Pollution Control Act sets an upper liability limit of $50,000,000 for oil spill cleanup and restoration of natural resources. (Oliver PFT (1) p. 34). This limit can be reduced to $8,000,000 by Presidential order. (NTPC application Vol. III, p. 8-18 & 19).

48. The main control methods for terrestrial spills in forested and agricultural lands are impoundment and the use of absorbents. Site-specific control recommendations for terrestrial spills have not been developed (Oliver PFT (1) p. 24.).

III. E. TRIBAL CONCERNS

1. The Council has considered the effect which certification of the proposed project would have upon Indian tribes of the state of Washington. Two of the tribes, the Makahs and the Tulalips, sought and obtained intervention status, and actively participated in the proceedings. Other Indian tribes were invited by the Council to express their views. Review of the effect of certification upon the Indian treaty fishing rights of Western Washington Indian tribes is mandated under U.S. v. Washington, 443 U.S. 658, 61 L.Ed.2d 823, 99 S.Ct. 3055 (1979); U.S. v. Washington, (Phase II) Civil No. 9213, Western District of Washington.

2. The following federally recognized Indian tribes have treaty fishing rights in waters potentially impacted by the Northern Tier Pipeline project:

General Fishing Area	Tribes
Coastal	Quinault, Hoh, Quillayute Makah
Strait of Juan de Fuca	Makah, Lower Elwha Klallam
Hood Canal	Port Gamble Klallam, Suquamish and Skokomish
Stillaguamish Snohomish	Tulalip and Stillaguamish

Skagit	Swinomish, Sauk-Suiattle and Upper Skagit
Nooksack-Samish	Lummi and Nooksack
Yakima	Yakima

3. In addition, several tribes in South Puget Sound have fishing rights to anadromous fish which must pass through Admiralty Inlet in the Strait of Juan de Fuca on their migrations to and from the ocean.

4. Annual salmon and steelhead catches by the various tribes in the project area are substantial. These fish are taken with marine and river gill nets and to a lesser extent with beach seines, purse seines, reef nets, and traps.

5. All of the treaty tribes in the project area depend on fishing and related services as a source of employment and personal income. (U.S. v. Washington; Phase II, Civil No. 9213, W.D. of Wash.; TR 27376-501 Johnson; TR 36358-830 Somers)

6. A major oil spill within the Strait of Juan de Fuca from a tanker, or from an oil pipeline rupture, or from a rupture of the pipeline in a river or stream which constitutes part of the usual and accustomed fishing places for the Indian

treaty tribes also poses a threat to the treaty fishery. The possibility of tanker spills exists today.

Makah Tribe

7. The Makahs are a federally recognized Indian tribe residing on a reservation on the northwest tip of the Olympic Peninsula.

8. By treaty, the Makahs have reserved the right to fish in their usual and accustomed areas. By case law, that right permits the Makahs to take 50 percent of the fish within those waters.

9. Currently, only 28 percent of the Makah tribe is fully employed. Water resources are essential to the Makahs, who are almost wholly dependent upon commercial fishing and tourism associated with fishing and beaches. There are virtually no alternative employment opportunities in the area. Seafood is the mainstay of the tribal diet.

10. The Makahs have lived from the sea for at least 1,000 years. Spill impacts would reduce their sources of food and livelihood and would diminish their way of life and culture.

11. A spill affecting any fish run in Western Washington would work to the detriment of the Makahs. It is not clear that lost marine species could be successfully replaced through artificial means. Any replacement would be only over the long term. The Makah economy would be hard-pressed during any long-term curtailment of fishing activities.

12. When fishing gear is fouled with oil, fish will avoid it. Cleaning gear requires great effort and lost fishing time. If badly contaminated, it must be discarded.

13. The project will result in increased tanker traffic in tribal fishing areas. The risk of collision with tribal vessels and net damage will increase.

14. Archaeological research is ongoing on the Makah reservation. An oil spill reaching Makah tidal areas would interfere with the carbon-dating processes for Makah artifacts subsequently unearthed in tidal areas.

Tulalip Tribes

15. The Tulalip Tribes of Washington is a present-day tribal entity which is a political successor in interest to certain tribes which were parties to the Treaty of Point Elliott. The Tulalip Tribes is recognized by the United States as a cur-

rently functioning Indian tribe maintaining a tribal government on the Tulalip Indian Reservation in Snohomish County, Washington. The tribe is organized pursuant to the Indian Reorganization Act, 48 Stat. 987, 25 USC subsection 476. (See United States v. Washington, Compilation of Major Post-Trial Substantive Orders, 459 F.Supp. 1020, 1039.) (TR 36374-75 Somers). The Tulalip Tribes is an entity, (recognized as such by the United States) which has the full civil and criminal jurisdiction, powers, and immunities of a sovereign tribe. (TR 36375 Somers).

16. The Tulalip Reservation is located approximately five miles north of the city of Everett, Washington. It is bounded on the east by Interstate Highway 5, to the south by the Snohomish River (Steamboat Slough) and Port Gardner, and to the west by Puget Sound. The reservation encompasses approximately 36 sections. There are approximately 1,350 registered tribal members. Approximately 800 of these live on or near the Reservation. The major means of employment and livelihood for many tribal members and their families living on or close to the Reservation is fishing. (TR 36375-76 Somers).

17. As political successor in interest to "certain parties to the Treaty of Point Elliott," 459 F.Supp. at 1039, the Tulalip Tribes have treaty fishing rights at their usual and accustomed places outside of reservation boundaries. (459 F.Supp. at 1041.) (TR 36376 Somers).

18. These treaty fishing rights are the right to take the lesser of 50 percent of the "harvestable" fish from the usual and accustomed areas or a sufficient quantity of fish to provide the tribes with a moderate livelihood. U.S. v. Washington, 384 F.Supp. 312 (W.D. Wash. 1974); Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658, 685-87 (1979). (TR 36376 Somers). The Tulalip Tribes' allocation is currently set by the District Court at 50%. (Id.; 36382 Somers; judicial notice). No evidence in the present record indicates that the Tulalip Tribe's moderate living needs may be satisfied by a less than 50% allocation.

19. The Tulalip Tribes have both marine and freshwater fishing areas defined as follows:

> "Beginning at Admiralty Head on Whidbey Island and proceeding south, those waters described as Admiralty Bay and Admiralty Inlet, then southeasterly to include the remainder of Admiralty Inlet including Mutiny and Useless Bay, then northeasterly to include Possession Sound and Port Gardner Bay, then northwesterly to include the waters of Port Susan up to a line drawn true west of Kyak Point and Holmes Harbor and Saratoga Passage up to a line drawn true west of Camano on Camano Island." 459 F.Supp. at 1059.

The freshwater areas were provisionally defined as the Snohomish River system, including tributaries and freshwater lakes, and the Snoqualmie and Skykomish River systems. 459 F.Supp. at 1060. These findings are provisional, subject to future expansion or limitations. 459 F.Supp. at 1060. The Stillaguamish River system and its tributaries provide vital fisheries habitat for the species of anadromous fish which are harvested by the Tulalips. (TR 36379-80 Somers).

20. The treaty fishing right of the Tulalip Tribes is a communal right held by the Tribes for the benefit of its members. 384 F.Supp. at 406. (TR 36380-81 Somers). The treaty fishery has economic, social, religious and cultural significance to the Tulalip Tribes and many of its members. The salmon fishery is a focal point of Tulalip culture. The salmon fishery also has great economic significance to the Tulalip Tribes and many of its members. The Tulalip Tribes' annual salmon catch since 1974 was as follows:

SPECIES	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
Sockeye	4,888	2,780	13,279	43,894	24,665	53,285
Chinook	1,285	2,759	8,344	7,632	9,333	12,289
Pink	-0-	17,859	-1-	6,060	-24-	35,257
Coho	69,207	39,213	30,118	59,617	75,459	37,744
Chum	21,026	2,009	22,162	4,913	17,772	3,653
Steelhead	2,306	4,209	2,453	7,017	7,133	9,882
Total	98,712	68,829	76,457	129,133	134,386	152,110

21. The Tulalip Tribes actively regulates the treaty fishery and derives tribal income therefrom. This income sup-

ports tribal government activities and provides services to tribal members. (TR 36381-82 Somers)

22. The Tulalip fishing season takes place from approximately July through the end of January, and later in some cases. The Tulalip Tribes has fisheries on chinook, sockeye, pink, coho, and chum salmon, and steelhead, in approximately that order. In addition, a spring chinook fishery used to take place but due to near extinction, has not taken place for many years. (TR 36382 Somers).

23. The tribal ceremonial and subsistence fishery for salmon is now counted as a part of the Tulalip Tribes' 50% allocation under Phase I, but is not included in the fisheries catch shown in Finding 20 above. (TR 36382 Somers).

24. In addition to the commercial, ceremonial and subsistence salmon harvests, sizeable harvests of subsistence shellfish and non-salmonid marine fish take place in Port Susan, Port Gardner, on the Stillaguamish and Skagit flats, and in Admiralty Inlet. (TR 36383 Somers).

25. The natural fisheries resource available for harvest by the Tulalip Tribes has declined over the years due to environmental degradation and increased fishing pressure.

III. F. WATER QUALITY

1. Low levels of organic and industrial wastes and petroleum-related hydrocarbons exist in the surface water in the Port Angeles area. (TR 9227 Kantz).

2. At the terminal site, pile driving and pipeline trenching will produce suspended sediments, resulting in increased turbidity levels. These increases will be temporary. Net sediment transport will generally be less than 40 miles (Kantz).

3. The Green Point site proposed for the onshore storage facilities now contributes a minor amount of runoff and base flow to Siebert Creek. (TR 9228-29 Kantz).

4. Construction of the tank farm will cause a temporarily increased amount of sediment to be carried to Siebert Creek and the Strait of Juan de Fuca. Settling ponds will be used to minimize this input. (TR 9232 Kantz).

5. During operation of the onshore storage facilities, dikes around the tanks and holding basins will control runoff and minimize potential sedimentation and oil contamination impacts on surface water. Water effluent from oil-water

separators located at the site will cause minor and limited effects when discharged in nearby coastal waters. It should not be discharged in Siebert Creek. (Applic. III, Sec. 2.3.3.1).

6. Water quality in Saratoga Passage is affected by inflow of fresh water from rivers. Waters in the Passage are often strongly stratified, because the fresh water mixes only slightly with the denser sea water which enters from the Strait. No industrial discharges affect water quality in the northern section of Saratoga Passage, but various municipalities and naval bases discharge treated sewage effluent to these waters. (TR 9236-37 Kantz).

7. Sediment samples collected from the Strait of Juan de Fuca and Saratoga Passage show low values of chemical oxygen demand, oil and grease, sulfides, and concentrations of heavy metals. The chemical properties of these sediments are not expected to cause a detrimental impact on water usage in the Strait or in Saratoga Passage. (TR 9241 Kantz).

Excavation and Dredging

8. Excavation of the submarine pipeline trench would disturb bottom sediments, suspending sediments during construction. Amounts of sediment disturbed and extent of dispersion are site-specific and will vary because of differences in currents, bottom substrates, excavation methods, and trench-

ing. Suspended sediment levels will likely increase more in shallow areas than in deep areas except at Ediz Hook, where Type A soils (loose, sandy or silty soils) occur at the greatest depth. The greatest suspended sediment impacts should occur near active dredging operations. Turbidity effects are greater with the jetting trench construction method than with the post-plowing method. (TR 9237-40 Kantz).

9. Dredging in the main channel along the Strait would encounter somewhat finer sediment than in the land approach areas. Transport of disturbed particles is highly unpredictable because of the complex dispersion processes in this part of the Strait. Currents could transport sediments great distances. (TR 9238-39 Kantz).

10. In the main channel of Saratoga Passage, construction of the trench for the submarine pipeline by the jetting method will produce more turbidity than the post-plow method. (See Section II.A.2.a.(1) for a description of these trenching methods.) Transport of sediment in this part of the Passage could be up to several miles, but the concentrations will be low because of high dilution. Sediments in the eastern part of the Passage are particularly likely to produce turbidity. (TR 9420 Kantz).

River and Stream Crossings

11. Streams, creeks, and rivers crossed by the pipeline route in the Puget Sound region (from Green Point to North Bend) include those in the Dungeness River drainage and the Stillaguamish and Snohomish River Basins. (TR 9243-44 Kantz). In the Cascade Mountain region (North Bend to Yakima River Basin), most of the streams crossed by the proposed pipeline are tributaries to the South Fork of the Snoqualmie River or the Yakima River. The proposed pipeline route crosses fewer perennial flowing streams in the Eastern Washington region (Yakima River Basin to the Idaho border) than in the other regions. The route also crosses the Columbia River, which has greater flow and lower levels of total dissolved solids than do streams in the region. The great majority of streams crossed by the route enjoy excellent water quality. (TR 9246-47 Kantz).

12. The construction activities proposed by Northern Tier will be accompanied by stripping of vegetation and topsoil, extensive grading and general reworking of the landscape. Two major concerns are erosion and sedimentation from improper construction controls and techniques (Snyder PFT 6-7). Problems that will arise if proper techniques are not followed include sediment buildup, which reduces the flow-carrying capacity of streams and promotes delta formation in lakes where weeds can thrive in the shallow water. The natural aging process of a

lake can be accelerated by deposits of nutrient-laden soil particles, leading to algal blooms.

13. A thorough knowledge of all soils along the route is essential. Erosion-sedimentation control measures employed will depend on the soil types involved. Limited soil data are available for counties through which the pipeline is proposed to cross. (Snyder, PFT 10).

14. Rapid installation and stabilization at stream crossings are critical and, with seasonal constraints, construction should be guaranteed to occur only during low flow periods. Special emphasis must be given to replacement of riparian vegetation using proper species and accepted techniques. Stringent erosion-sedimentation control is also necessary to insure that water quality is maintained. All the small streams and their tributaries and natural drainage swales must be protected. Small streams play a major role in the state's fishery production programs. Swales carry seasonal water to perennial streams, thereby also carrying any available sediment or other pollutants. Some small streams and swales are in very steep terrain with high erosion potential.

15. Crossings of marshlands or wetlands also require special attention. Reclamation of wetlands should pro-

ceed in ways that will not induce drainage. (See Section III.H. Habitat-Wetlands.)

16. The construction of access and maintenance roads can cause major erosion-sedimentation damage.

Ground Water

17. Ground water is an important resource used for domestic, irrigation, livestock, municipal, and industrial purposes. Both pipeline construction and operation can degrade ground water quality. Ground water is the only source of potable water in some areas. Because of the importance of ground water, and because its location and the characteristics of aquifers affect its vulnerability to pollution, a detailed ground water inventory is necessary. Similar concerns exist for surface waters.

18. Sediments beneath the bottom of Port Angeles Harbor and Ediz Hook were probed at a depth greater than that to be affected by project construction. The probes showed no significant ground water. There are no known public water supply wells in the vicinity of Ediz Hook. (TR 8512-13 Veatch).

19. At the tank farm site, a shallow discontinuous perched water condition occurs above a clay-silt layer beneath the site. The water level in these perched zones ranges in

depth from about five to ten feet. Northern Tier did not bore deeper than 55 feet. (TR 8513-14 Veatch).

20. Ground water studies of areas just to the east of the onshore storage site indicate that the regional water table is at or below sea level beneath the site. (TR 8514 Veatch)

21. Data on the chemical quality of the ground water at Green Point are not available. Regionally the water is generally of good to excellent quality. (TR 8414-15 Veatch).

22. At the tank farm, the significant regional ground water table probably does not receive recharge from the local surface due to the impermeability of the glacial tills beneath the site. The discontinuous perched aquifers will probably be affected by direct contact in places and by changes in surface permeability resulting from construction. These aquifers are not significant. (TR 8492 Alsup).

23. Activities associated with construction of the tanker unloading facilities and unloading pipelines are not expected to affect ground water resources. (TR 8492 Alsup).

24. Construction activities at the marine terminal will not affect public water supplies. There is one well ap-

proximately 1,500 feet from the tank farm site operated by Clallam County Public Utility District No. 1. No construction impacts are anticipated on that well. (TR 27953 Kitz; Applic. III, Secs. 2.3.2.3 and 2.3.3.3).

25. Impact to ground water or public water supplies from an oil spill in the area of the marine terminal is not expected. (Applic. III, Sec. 2.3.2.2.)

26. Northern Tier may not be able to depend upon Local Utility District #1 for water supply on the Green Point tank farm. Such water supply may only be available if the District has a surplus. (TR 27959 Kitz).

27. There are no ground water resources to be impacted by the construction or operation of the submarine portion of the pipeline. (TR 8486).

28. The important aquifers along the proposed pipeline corridor in the Puget Sound region generally occur in outwash deposits. Glacial till and bedrock, common in the region, do not contain major aquifers because of their very low permeability. (TR 8518 Veatch).

29. The ground water resources of significance in the Cascade Mountains region are confined to the Quaternary glacial drift or alluvial deposits. (Applic. III, Sec. 1.3.4.2).

30. The primary aquifers along the corridor route in the Eastern Washington region are contained in the Quaternary sediments and basalt formations. (TR 8520-21 Veatch).

31. Typical chemical quality of ground water in Western Washington is rated good to excellent. The chemical quality of water along the Eastern Washington route is generally good.

32. The proposed pipeline route passes near many communities in Washington. Most of these communities obtain their water supplies from ground or surface water sources in the immediate locality. A majority of public systems rely on ground water.

33. It is important in planning construction of a pipeline to know the depth to aquifer and the nature of the surrounding materials. This should be ascertained along the corridor.

34. Where the pipeline crosses a shallow aquifer in unconsolidated materials so that the bottom of the trench is below the water table, pollution of ground water and some loss of water may occur. (Grimstad).

35. If, during construction, the impermeable strata underlying a perched water table were to be pierced, the water in the perched aquifer would have access to the lower zone. (Grimstad PFT p.5).

36. Where the trench is within ground water, impermeable backfill material may impede natural water movement, and permeable material may cause the ditch to act as an infiltration trench. Fill material must be of the same permeability as the material adjacent to the trench to prevent alteration of water movement. If no special efforts are taken to compact the backfill, it will be more permeable than the surrounding material (Grimstad PFT pp. 5-6).

37. Oil spilled in permeable soil will move laterally and down until it encounters a less permeable stratum, if such exists. (TR 35511).

38. To correct the most dangerous situation where the ditch is constructed in permeable material and the fill is also permeable, would require an impermeable barrier between

the ditch and the aquifer to prevent downward movement of spilled oil. (Grimstad PFT pp. 9-10).

39. The pipeline will cross shallow aquifers throughout the State of Washington. From existing records, their specific locations are unknown.

40. Sufficiently detailed and up-to-date information on shallow wells does not exist. Therefore, actual field work should be done prior to pipeline construction.

41. Insufficient information has been provided to reach firm conclusions concerning the potential effects of the pipeline upon ground water in eastern Washington. Corridor maps should be prepared which show near-surface geology; water level contours relative to a base level for the unconfined aquifers; depth to the water table below the land surface for unconfined aquifers; and depth to top of aquifer for shallow confined aquifers. Work should include examination of wells in the corridor to determine depth of the well, static water level, depth of the aquifer, pump capacity size, and any history of water problems.

42. Potential ground water contamination was not a factor in identification of the sites contained in Exhibit 198,

"OSCRP (Oil Spill Contingency Response Plan) Planning, Selected Sites, Central and Eastern Washington." (TR 16437).

Island County

43. Ground water supplies on Whidbey Island and Camano Island are, for all practical purposes, finite. While on a long-term basis ground water supplies are being recharged, usable ground water supplies will be lost, if consumption, run-off and/or loss by saltwater intrusions or other contamination, cause this recharge rate to be exceeded. (Thorsen Prefiled Testimony page 9).

44. A continuous "blanket" of glacial till of sufficient depth would help protect ground water supplies from potential oil contamination from the proposed pipeline.

45. Adequate information does not exist to determine the extent of continuity of glacial till on Northern Camano Island and Northern Whidbey Island. (Thorsen Prefiled Testimony page 10).

46. The existence of glacial till on Northern Whidbey and Camano Islands cannot be relied upon to protect ground water for the following reasons: (1) The till or other glacial drift originating from the last two glacial episodes occurs, in places, fairly close to the surface of the ground,

but a given exposure of till on an upland surface is not necessarily the last, or youngest, till. Correlating particular till units in an area of multiple tills is made difficult by the fact that till tends to cut underlying materials and "drape over" the preglacial landscape. (2) Even where the existence of a middle till can be ruled out, there may be gaps or holes in the upper till. Blocks of till, ten feet or more in diameter are abundant, particularly on North Whidbey Island. (3) It is difficult, if not impossible, to determine the thickness of the glacial till on upland surfaces. On flat or gently rolling upland surfaces, the till cover may be continuous but thin. Oil from a pipeline spill or rupture could reach aquifers through perforations. (Thorsen Prefiled Testimony, pages 10 and 11.)

47. The term "till window" refers to a situation where sheetlike deposits of glacial till surround places without the till. The till's absence in the "windows" could be caused by the till having been removed by erosion or the till never having been deposited. (TR 32950).

48. Because glacial till generally has a relatively low permeability in comparison to other geologic materials, "windows" in the till deposits can be areas where underlying aquifers receive more recharge, from water infiltrating the land surface, than the aquifers receive in till-covered areas. (TR 32950, 32951).

49. Oil spilled in areas where till is absent and where the surficial deposits are more permeable than till generally, would have more opportunity to seep downward than it would in till-covered areas. (TR 32951).

50. The applicant has not supplied sufficient information to predict adequately where till windows may be located along the proposed pipeline route on Whidbey and Camano Islands.

51. The geologic mapping that has been done to date on Whidbey and Camano Islands might have missed till windows as large as several hundred feet across. (TR 32973).

52. An examination of soil log holes and borrow pits throughout Island County shows that layers of glacial till vary greatly in depth and thickness. (TR 35510).

53. Insufficient information exists at the present time to determine the extent to which ground water resources are at risk at the landfall areas of the proposed pipeline in the vicinity of Point Partridge and Polnell Point on Whidbey Island, and Brown Point on Camano Island. (TR 32937.)

54. More than half of the data concerning soil log holes in the vicinity of the proposed pipeline corridor on file with the Island County Health Department do not show any indi-

cation of glacial till in the six-to-twelve foot area beneath the surface of the ground, but rather indicate only the existence of more permeable materials. (TR 34972-34974).

55. The applicant has not presented sufficient evidence to establish that the proposed pipeline across northern Whidbey and Camano Islands would be located over areas of low permeability. Adequate evidence in this regard would have included the results of studies involving several test borings in the vicinity of the proposed pipeline corridor to define relatively permeable lenses or strata or other local phenomena, so that route realignments could have been made where necessary and possible, to avoid moderate to highly permeable surficial strata.

56. Island County is currently trying to protect its ground water by seeking federal designation of its aquifer as a sole source aquifer. Island County is also actively promoting use of the Water Systems Coordination Act to define critical water service areas. (TR 35512).

57. If an aquifer becomes contaminated, cleanup is difficult. Mitigative measures have limited utility. (TR 35512).

58. High pumping rate wells would encourage, and possibly cause, salt water intrusion into the aquifers, parti-

cularly if such wells were installed near shoreline areas. (TR 35512).

59. There is a potential for breaching confined (artesian) aquifers in the Point Partridge-Sierra area of Whidbey Island and other areas adjacent to the proposed landfall sites. Trenching near the shorelines could breach one of these aquifers. (TR 35513).

60. Breaching of a confining layer of a confined or artesian aquifer during marine excavation allows a concentrated flow of water through the breach, across the confining layer. The volume and direction of this flow depends in part upon the hydraulic gradient. The hydraulic gradient is the difference in head between the aquifer and the adjoining body of water. (TR 32947).

61. The proposed pipeline route passes through or in close proximity to several existing subdivisions in Island County which depend upon local ground water as a source of drinking water. (TR 35513).

62. Significant ground water recharge occurs in proximity to the proposed pipeline route along west Whidbey Island and through north Whidbey Island (TR 35514).

63. The proposed pipeline would intersect a wetland area, north of Crescent Harbor, which could be a major recharge area. (TR 35514).

64. Recharge areas in the vicinity of the proposed pipeline route in Island County have not been identified by the applicant. (TR 35514).

65. Information necessary to address the issue of protection of ground water adequately that has not been provided by the applicant includes: test borings along the proposed route for the purpose of defining and describing the aquifers in terms of rate and direction of flow; identification and description of ground water recharge areas in terms of rate of recharge; and base line data to indicate current conditions in the aquifers. (TR 35543).

66. There are significant aquifer recharge areas along the proposed pipeline corridor for approximately three miles on north Whidbey in the Swantown and Crescent Harbor areas. Ground water in these areas would be in immediate contact if oil was spilled from the pipeline. (TR 34918).

67. The presence of petroleum hydrocarbon contaminants below toxic levels precludes ground water use as potable water because of taste and odor problems. Inhibitory effects

on plant growth have been detected at concentrations of 0.5 percent oil in soil, with a 100 percent kill of plants at a .4 percent concentration of oil in soil. (Canning Prefiled Testimony, page 13).

68. Construction and operation of the proposed pipeline, if oil leaks occur, could damage the ground water system on Whidbey Island. (TR 32963).

69. Trenching activities at the proposed Brown Point landfall site may cause incursions of salt water into the fresh water system. (TR 32963).

70. The aquifer in the vicinity of Brown Point on Camano Island supplies a large proportion of the total fresh ground water that is used in that part of the island. (TR 32975).

71. Much recharge to the ground water system in the Puget Sound lowland area, including Whidbey and Camano Islands, occurs as slow, widespread percolation through glacial till. (TR 32998).

72. The ground water or aquifer system on Whidbey Island and Camano Island is valuable in comparison to ground water systems in the mainland areas, because there is no readily and economically available alternative supply of fresh water,

except for a pipeline which brings water from the Skagit River to the city of Oak Harbor and the Naval Air Station on Whidbey Island. (TR 32998).

73. A significant part of Oak Harbor's water supply is from ground water. (TR 35511).

74. In Island County, perched aquifers are used for domestic purposes. These shallower aquifers may recharge a principal aquifer. (TR 35510).

75. The likelihood of an oil spill occurring which would reach Whidbey Island ground water is low; the adverse consequences of such an event could be severe.

Snohomish and King Counties

76. In Snohomish County, of 48.8 miles of pipeline route, 12.2 miles are in alluvium of variable permeability with 11 of these miles having a depth to the principal aquifer of less than 50 feet. Of the remainder of the route, 11.2 miles are recessional outwash, glacially-deposited sand and gravels of high permeability. (TR 8519-8520).

77. Hydrogeological reconnaissances to determine possible impacts on ground water were not done for counties other than Island or Snohomish. (TR 8654).

78. None of the information recommended on page 22 of Exhibit 179, CONCAWE, (Conservation of Clean Air and Water - Europe Oil Companies Study Group - March 1979 Report), Protection of Groundwater from Oil Pollution, as necessary in site surveys to assess risks of pollution to aquifers and to define measures for reducing or preventing such risks is contained in the OSCRP. (TR 16480). The information necessary includes climatological information on water balance and recharge rates of aquifers; knowledge of natural groundwater flow, water entries and discharges; studies of the geological structure of substratum, thicknesses and cross-sections; and information concerning behavior of the aquifer derived from surface surveys and well tests. Good knowledge of these conditions is necessary to understand the steps to take before and after a spill. (Exhibit 179, p. 22; TR 16481).

79. Additional information required to allow assessment of the possible risks to ground water from pollution by oil, and to define measures for reducing or preventing these risks, includes: general idea of the risks of pollution; evaluation of risks of propagation of the pollution; direction of potential migration; and specifications of a hydrodynamic protection system. This and the information listed in finding 78 above, should be obtained over a larger area than that to be protected and must be available before adequate preventive or

remedial steps are taken. (TR 37682-37683; Exhibit 179, page 22).

80. Pipeline trench construction through flood plains is likely to encounter shallow ground water. (TR 37672-38017).

81. Numerous wells in King County supply water from shallow perched water tables within the Vashon till. (TR 37674). Many King County wells along the pipeline route are from 15 to 80 feet deep and vulnerable to surface contamination. (TR 38010).

82. Northern Tier's consultants made no recommendations for King or Snohomish County changes in routing due to aquifers. (TR 8536). No deep regional aquifers have been shown along the pipeline route in King County. (TR 37730)

83. The floodplain area of the three forks of the Snoqualmie River near North Bend is susceptible to oil contamination of ground water from a pipeline leak, due to very permeable coarse alluvial river gravel and sand with no underlying glacial till.

84. A shallow ground water table approximately ten feet below the surface is known to exist near the pipeline

centerline in the Snoqualmie floodplain. Deep burial of the pipeline as recommended by Northern Tier would create a 16.5 foot deep trench throughout a two-mile floodplain, and would intercept the ground water table. (TR 37676).

85. A relatively high geohydrologic gradient in the floodplain near North Bend will increase the risk of oil migration into and within ground water. (TR 37678).

86. A large leak may migrate out of the ditch into adjacent alluvium in a day's time, and go undetected for several days, or until the taste of contamination is noticed in nearby wells. (TR 37681).

87. The exact number of shallow wells and springs in the floodplain area of the Snoqualmie River is currently unknown. (TR 37682).

88. The North Bend area has been considered as one of the two largest potential sources of ground water to meet the water supply needs of the rapidly growing Bellevue-Redmond area. (TR 37683)

III. G. AIR QUALITY

1. Ambient air quality effects from construction will be limited to transient, local increases in pollutant concentrations in the vicinity of these activities. No significant impacts will occur.

2. Most of the air emissions related to the operation of the Northern Tier system result from tanker operations. Other sources include the onshore storage facility tanks and the steam plant at Ediz Hook.

3. The fuel consumption rates and emission factors utilized by the applicant in its air quality analysis were reasonable best estimates of actual operating emissions.

4. The ITT-Rayonier plant in the vicinity of the monitors at 3rd and Chestnut and 4th and Baker is primarily responsible for violations of the federal 24-hour sulfur dioxide (SO_2) standard, as well as the state 24-hour and one-hour standards. The Department of Ecology has determined that covering of ITT's spent sulfite liquor holding pond will eliminate the measured SO_2 violations and consequently eliminate projected violations of the state one-hour standards to which Northern Tier might contribute.

5. Operation of the Northern Tier facility as proposed should not cause federal ambient air quality standards for SO_2 to be exceeded. No violations of the Washington annual standards for SO_2 are predicted to occur. The incremental impact from the proposed project will not result in any new violations of the state 24-hour standard.

6. The predicted annual average of total suspended particulates (TSP) concentrations due to the combined emissions of Northern Tier and existing sources in Port Angeles are below state and federal standards. The maximum annual concentration from the proposed marine terminal is below the federal and state significance levels for TSP and will not cause a violation of the standards.

7. The proposed terminal facilities will not cause violations of the applicable federal and state standards for ambient concentrations of nitrogen dioxide (NO_2).

8. No violations of the applicable federal and state ambient air quality standards for ozone (O_3) are predicted. Recent U.S. Coast Guard regulations prohibiting most hydrocarbon emissions during ballasting will probably reduce ambient ozone levels even further.

9. The regulations in Finding 8 only apply to nonattainment areas and consequently do not apply to Port Angeles. Northern Tier has, however, committed to such practices, and this commitment could be enforced in a certification agreement condition.

10. Neither federal nor state ambient air quality standards for carbon monoxide are exceeded by existing sources in the Port Angeles area. No violations are predicted for the combined effects of existing sources and Northern Tier.

11. No significant fugitive dust emissions are connected with the operation phase of the proposed Northern Tier system.

12. The operation of the proposed Northern Tier facilities in the Port Angeles area will not cause an adverse health impact due to emissions of SO_2, TSP, NO_2 or O_3.

13. The following air emission levels and operating standards are appropriate for the operation of the proposed Northern Tier facility:

A.

	lbs/hr.	lbs/day	tons/yr	Report Abnormal Operations when over:
Particulates		500	24	360 lbs/day
SO_2		5000	250	4000 lbs/day
Hydrocarbons (O_3)	80	1000	300	40 lbs/hr

B. Stack emissions in excess of 1000 parts per million (ppm) of sulfur dioxide or when opacity is greater than 20% for more than three minutes in any hour are violations of WAC 463-39-040.

C. Northern Tier will maintain a supply of not more than 0.45% sulfur fuel which will be used for all ship operations while at berth, excluding the time necessary for steam vessels to connect to the low sulfur fuel supply after arriving at berth. Unloading operations for steam vessels will begin only after the connection has been made. Diesel engine-powered ships will be required to burn either low sulfur diesel fuel or 0.45% residual fuel in their auxiliary steam plants during all at-berth and in-port operations. An unloading operation should be curtailed or shut down if tanker emissions threaten an ambient air quality standard.

D. No ballasting emissions or purging operations shall occur within the harbor except in instances of a documented emergency.

III. H. HABITAT

1. Wildlife habitat must be composed of feeding areas, cover areas, and available watering sites. (Perry p. 17). The destruction or disturbance of habitat reduces carrying capacity. All habitat elements are necessary to support wildlife on a year-round basis. Loss of key habitat segments causes wildlife losses over entire home ranges. (Oliver (1) p. 8).

2. Approximately 200 acres of agricultural land will be cleared in the rights-of-way in Clallam and Island Counties. Crop land could lose one season of productivity. Reclaimed pasture land may not be available to livestock for two years. About 98 acres of forest land will be removed from production. (TR 9496 Reyes-French). In Snohomish and King Counties, construction will require clearing of about 166 acres of farm land and 503 acres of forest land. (TR 9497 Reyes-French).

3. Within the Cascade Mountain region, 537 acres of forest land are susceptible to removal. If the final pipeline centerline right-of-way coincides with transmission line rights-of-way, resource loss will be lower. Forest land and grass land/shrub land will be disturbed by pipeline construction in this region. The steep topography combined with a deep

snow pack results in a high-to-moderate erosion hazard in some areas of the Cascade region, especially near Snoqualmie Pass. (TR 9497-99 Reyes-French).

4. Approximately 974 acres of grass land, shrub land and 863 acres of crop land will be affected by pipeline construction in eastern Washington . Effects of construction on crop land will be temporary. Productivity losses on range land will depend on soil quality and available soil moisture. A large portion of the pipeline route (from Crescent Bar to Sprague) gets less than 12 inches of rain per year. Where there are shallow rocky soils and low rainfall, there will be slow recovery (five years or more). Erosion hazard from wind and rain in this region is most significant in the Columbia River area and in the steep hills near the Idaho border. (TR 9499-9500 Reyes-French).

Eastern Washington Habitat

5. Cliffs are unique and critical habitats to wildlife. They occur in numerous locations in the pipeline corridors in eastern Washington. Cliffs, rocky outcroppings, and talus slopes are essential as nesting sites and as feeding and reproductive habitats for many species.

6. The Columbia River canyon provides excellent habitat for predatory birds by providing secure sites for nest-

ing, thermal updrafts for hunting, habitat for prey sources, and isolation from disturbances. Species of major concern are peregrine falcons (a federally listed endangered species), prairie falcons, and golden eagles. Other predatory birds are present. (Friesz, p. 23).

7. Rocky Ford Creek and the upper end of Moses Lake provide a marshy riparian wildlife habitat area with year-round open water. It is particularly important to water birds. It also contains muskrat and beaver habitat. (Friesz, p. 24-25).

8. Sprague Lake and the Cow Creek system are a heavily vegetated and productive habitat for wildlife. (Friesz, p. 30).

9. Numerous ponds are located in the channeled scablands within one mile of the centerline between the western Spokane County line and Rock Creek Canyon. Most of these ponds support waterfowl production in years of normal precipitation, and all serve as feeding and resting areas supporting diverse wildlife. (Pineo, p. 5).

10. The pipeline route crosses Rock Creek Canyon, a significant geological feature of the channeled scablands. (Pineo, p. 5). The canyon and its drainage sustain deer, quail

and other fauna. (Pineo, p. 6). Blasting in Rock Creek Canyon would be necessary for a buried crossing. (Pineo, p. 12)

11. Gelbert Mountain is isolated, timbered, mountainous terrain, a critical habitat for many species found on it. (Pineo, p. 9).

Habitat Management Areas

12. Habitat Management Areas (HMAs), whether managed for big game, upland birds, waterfowl or other classes of wildlife, provide critical habitat necessary to support animals in the area. Critical habitat provides the necessities for survival during periods of life or death stress on a population. (Perry p. 35).

13. The Colockum HMA is a wildlife management and protection area. It is one of the state's most important sites for hunting, trapping, and nature appreciation. About 98,000 man-days of recreation took place on the Colockum HMA last year. Upland game birds and big game are the main species hunted. (Friesz p. 22, Perry p. 51).

14. The Colockum is a key winter range for big game, especially elk. The Colockum provides high quality winter range including: favorable south slopes, high food potential, vegetative and topographic cover, and large areas with few or

no roads. It has a high per-mile support capacity for elk and deer. Elk and deer use the Colockum all year long. Periods of peak use, depending on weather, extend from October through June. A Colockum area that overlaps the NTP corridor has been recognized as one of few calving areas. (Oliver cross p. 32918-20, Perry p. 33-38, 51)

15. Other animal species inhabit the Colockum. Of 103 rare, threatened, or endangered plant species in Washington State, 61 are found in the Colockum HMA. (Perry p. 28).

16. The proposed right-of-way segment in the Colockum HMA will result in a direct habitat alteration of 142 acres. The loss may continue past the project life because of the extremely long recovery time for vegetation in this area. A road along the NTP right-of-way in the Colockum HMA would reduce elk use. Damage to vegetation would lower the carrying capacity significantly for upland game birds. (Oliver p. 9, Perry p. 31, 32, 34, 35).

17. A spill into any one of the drainages on the west side of Colockum Pass would introduce oil into waters serving local irrigation districts and into the Yakima River. (Oliver p. 24).

18. The Gloyd Seeps HMA is a 10,111 acre waterfowl, upland bird and fishing area located in Grant County. The area is an important site for hunting, trapping, fishing and wildlife appreciation. (Friesz p. 28, Oliver(1) p. 16).

19. Within Gloyd Seeps, Crab Creek and numerous springs form a series of lakes, ponds, channels and marshes, providing habitat for upland game birds and pelicans. (Friesz p. 28)

20. The pipeline corridor crosses the Skagit HMA. This area provides important habitat to waterfowl, marine birds, predatory birds, and many other species. (Jeffrey p. 2).

Game Fish

21. Game fish species found in western Washington streams to be crossed by the pipeline include cutthroat trout, steelhead, Dolly Varden, rainbow trout, eastern brook trout, and whitefish. Fish occurring in lakes and ponds on or near the pipeline alignment in western Washington include bass, crappie, perch, cutthroat trout, and eastern brook trout. (Pfeifer, Attachment B). The net or mean value for steelhead in these streams averages 1.8 million dollars annually, and the gross economic value averages 3.3 million dollars annually. (Pfeifer, p. 3).

22. Sport fishing is a popular and productive activity in many eastern Washington lakes, streams and watercourses along the Northern Tier route. Anglers spend more than $115,000,000 per year (variable year dollars) in this region to fish for trout, whitefish, and many other game species. Eastern Washington waters which support substantial recreational fisheries include the Yakima River and its branches, the mid-Columbia, the Columbia Basin Project, Rocky Ford Creek and Moses Lake, the Potholes Reservoir, Crab Creek, Sprague Lake, and Rock Creek and Bonney Lake.

23. There is potential environmental damage to streams during construction. The main long-term concerns for impacts to fish are (1) siltation* and (2) oil spills. (Eldred, p. 11, 20).

Sedimentation Impacts

24. Sedimentation is the introduction of small particles of earth into a body of water. It occurs when soil-bearing surface water runs into a stream or lake, or when the fine particles within the stream bed are dislodged or stirred up into the current by disturbance. Sediment from outside the stream is often the result of bare or sparsely vegetated soil and decreased surface soil permeability. The amount of sediment generated is a function of excavation and size of bed material.

*Siltation is the introduction of very fine, small particles of earth into a body of water. Siltation is a form of sedimentation and perhaps the most damaging to fish.

Sediment transport and flushing ability depend on current speed and particle size. (Eldred, p. 11, 12).

25. The detrimental effects of sediment on aquatic resources can be measured in direct mortality or reduced production depending upon concentration and time of exposure. High turbidity and high concentrations of suspended sediment affect the feeding and consequent growth of juvenile salmonids. Heavy suspended sediment concentrations can kill fish directly by damaging their gills. The blanketing effect of sediment and its instability can reduce invertebrate composition and quantity, reduce hiding cover and living space, and directly affect fish reproduction. Within the salmonid nest environment, sediment affects survival by inhibiting intragravel water flow or by acting as a physical barrier to fry emergence. A lack of adequate intragravel water flow may result in suffocation of developing eggs or embryos where oxygenated water is prevented from bathing the eggs. Metabolic byproducts are not carried away when intragravel flow is inhibited; and toxic effects from these byproducts can result in mortalities. (Pfeifer, p. 4, 5).

26. The damage attributable to sediment depends upon the degree to which sediment will be left in the stream in relation to pre-project conditions, and the total number of game fish which will be affected, either directly by egg or