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PORT EXPANSION IN THE PUGET SOUND REGION 1970–2000

by Stewart Borland and Martha Oliver

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INTRODUCTION

Maritime commerce plays a central role in the economic life of the Puget Sound region. The ports contribute to the economic health of the region and during the recent recession have often appeared to be an invaluable source of stability. However, port development and expansion can affect areas with significant ecological value for the natural environment and reduce space available for recreational and aesthetic use. In this context there has been discussion about the extent to which ports can be expected to expand in the future in terms both of tonnages handled and of land utilized. Specifically, suggestions have been made that Puget Sound is well suited for the development of one or more "super-ports" capable of handling the largest deep-draft bulk cargo vessels now being built.

The broad issues posed by current and potential conflicts between the many groups using Puget Sound shorelines for both consumption and production activities are described and analyzed in a forthcoming volume to be published under the sponsorship of the Washington Sea Grant program.[1] While port activities are only one of the productive uses dealt with therein, it was felt that their economic significance warranted a more detailed examination than could be accommodated within the bounds of the larger work.

Although the report of the Pacific Northwest River Basins Commission (commonly called the Puget Sound and Adjacent Waters Study) also addressed itself to the question of port expansion in its Navigation Appendix,[2] its projections had to be based on data available up to 1966. But the years following 1966 were far from being a "normal" period of economic activity in the region. Historically high levels of activity during 1967 and 1968 were followed by a downturn in the trend of real output which defied prediction in the magnitude of its sharpness and severity.[3] Consequently, it was felt that extending the data base by inclusion of the four years up to the end of 1970 would yield valuable insights. This monograph does that and at the same time modifies a number of the analytical techniques employed in the P.S. & A.W. study. As a result, the predictions presented herein differ in several important dimensions from those of the previous study.

The following material is in three parts. In the first section we derive and present a range of projections of traffic tonnages through Puget Sound ports up to the year 2000, broken down by commodity classifications and with separate totals for the major ports of Seattle, Tacoma and Everett. These results are then compared with those obtained in the P.S. & A.W. study and some comments are made concerning the salient differences. Part I concludes by presenting projections of relative shifts in traffic tonnages over the forecast period between the three major ports on the one hand and all the smaller Puget Sound ports on the other.

Part II discusses the land area requirements of port-related commerce, including the demand for land in industrial parks adjacent to terminal facilities but not necessarily providing direct access to the water. Economic activities are first divided into three groups distinguished by the nature of their ties to waterfront locations. Acreage/employment ratios are then utilized to derive anticipated land needs over the forecast period for these broad activity categories in each of the three major ports. The projections of traffic tonnages for each commodity group set out in Part I are translated into terminal land area needs by the application of "efficiency ratios." Lastly, the summed requirements estimates are compared with total acreages of sites currently available, and also with the projections of land needs for water-oriented industry made by the P.S. & A.W. task force.

In Part III(A) the causes and consequences of circumstances in which port-area land is in relatively plentiful supply are analyzed and the effects of public subsidization of port districts on their investment patterns are discussed. This discussion is then related to the ensuing summary of the near-term expansion plans of the three major ports. Part III(B) begins with an attempt to clarify existing usage of the term "super-port," then proceeds to assess the necessity and desirability of this type of development, with special reference to the Nisqually Delta area and to the Port of Everett's plans for Jetty Island.

A few paragraphs of "Summary and Conclusions" precede the Appendix. Tabular material essential to an understanding of the written text will be found immediately following the page on which the data are initially cited. Supported statistical material is grouped in the Appendix.

PART I: TRAFFIC VOLUMES

A. Tonnages by Commodity Group

The primary data source covering movements of cargo by water is the series of annual reports published by the Army Corps of Engineers under the title "Waterborne Commerce of the United States."[4] Information in those volumes permits the calculation of total tonnages handled in a given year for all but the smallest ports, by type of commodity carried. A further breakdown differentiates foreign (import-export) traffic from two categories of domestic traffic. The first of these is called Domestic Coastwise and relates to traffic between any listed port and other U.S. ports outside the defined region. For our purposes this means traffic with American ports not on Puget Sound. Such traffic is actually "foreign trade" as viewed from the standpoint of the regional economy and is therefore included with other import-export traffic in our projections. The second domestic category is called Domestic Internal. This is defined as traffic between the listed port and other ports on Puget Sound. Here both the methods of handling the cargo and the economic forces underlying trends in total volume are systematically different than for Foreign and Domestic Coastwise (F. & D.C.) traffic so that separate treatment becomes essential.

TABLE 1: TRAFFIC PROJECTIONS BY COMMODITY GROUP (ALL PORTS)
(Bracketed figures are from P.S. & A.W. report)

		Actual 4-year Average 1967-1970 Inclusive	Projections to 1980		Projections to 2000	
			P.S. & A.W.	Current	P.S. & A.W.	Current
G. C.	F. & D.C.	2,593	(5,630)	3,440	(7,750)	6,000
	D.I.	805	(1,170)	900	(1,750)	1,000
	Total	3,398	(6,800)	4,340	(9,500)	7,000
For. Prod.	F. & D.C.	5,130	(3,600)	7,500	(5,700)	13,000
	D.I.	7,864	(6,000)	8,000	(6,000)	8,000
	Total	12,994	(9,600)	15,500	(11,700)	21,000
Dry Bulk	F. & D.C.	4,371	(8,100)	7,000	(15,000)	13,000
	D.I.	12,204	(18,200)	19,000	(43,600)	36,000
	Total	16,575	(26,300)	26,000	(58,600)	49,000
Bulk Gr.	F. & D.C.	1,302	(2,200)	1,900	(2,800)	2,900
Bulk Pet.	F. & D.C.	6,530	(14,800)	8,250	(32,300)	9,580
	D.I.	6,623	(6,700)	9,000	(7,700)	11,000
	Total	13,153	(21,500)	17,250	(40,000)	20,580
Liq. Bulk	F. & D.C.	138	(296)	190	(700)	300
	D.I.	17	(74)	30	(190)	30
	Total	155	(370)	220	(890)	330
Totals	F. & D.C.	20,064	34,626	28,280	64,250	44,780
	D.I.	27,513	32,144	36,930	59,240	56,030
	All Cargo	47,577	66,770	65,210	123,490	100,810

There are over 150 individual commodities and closely related commodity sub-groups for which tonnage records are kept in the "Waterborne Commerce" volumes.[5] In order to simplify tonnage projections these were combined into these six commodity groups:

General Cargo	Bulk Grain
Forest Products	Bulk Petroleum
Dry Bulk	Liquid Bulk

Appendix Table A7 lists the individual commodities which are included in each group. The six groups are designed to be internally homogeneous and are differentiated mainly by physical characteristics of the goods which require different methods and equipment to be employed in their handling and storage.

Appendix Table A9 displays results from our time trend analysis of tonnage totals by each of the six commodity classifications. The range of each projection can be seen in Table A8 which identifies the projections as "HI," "LO" and "CURRENT." In addition the two left-hand columns of this table show the actual averages for the four-year period ending with 1970, and the actual 1970 tonnages, for purposes of comparison. "CURRENT" projections are summarized in Table 1, which also sets out (in brackets) the comparable results arrived at by the P.S. & A.W. researchers. In most cases the "LO" projections were derived by extrapolating the linear time trend while the "HI" estimates were arrived at by extending a log-linear relationship. The figures so obtained have been modified in cases where the linear time trend suggests large absolute declines in future traffic not substantiated by other evidence or where the log-linear relationship yields growth rates far in excess of those implied by known constraints on supply. The "CURRENT" figures, however, could be called "best guess-timates" since they were arrived at not by applying any mathematical formula but rather by a judgmental weighting process implicitly affected by our knowledge of the entire set of relevant variables. However, the factors assigned the most weight in this process can be specified:

(a) The extent to which the log-linear functional relationship between traffic volume and time (the basis for most of the "HI" projections) provided a better "fit" to the data than the linear relationship, or vice-versa.

(b) The extent to which the time trend established over the base period employed in the P.S. & A.W. study (1952-1966) was altered by the incorporation of more recent data from the years 1967-1970 and/or by omission of data from the earliest four years of the base period.

(c) Information provided by independently derived projections of closely correlated economic variables. A number of instances in which such correlations were considered significant are discussed in detail.

(d) The significance for the specific commodity group of anticipated changes over the forecast period in such dimensions as technological innovation; emerging constraints on the supply side of the market; and the growth in market demand for principal products contained in the group.

A special problem related to point (d) above was how to take account of the emerging potential for expanded U.S. trade with mainland China since translating that potential into tonnages of specific commodities at this time is next to impossible. Our projections have therefore been based on the assumption that slow growth in U.S. trade with China will offset to some extent the combined effects of an anticipated levelling off in the recent rate of increase of traffic with Japan, together with a decline in that portion of civilian commercial cargo which is related to the level of hostilities in Southeast Asia.

1. General Cargo

The tables deal first with General Cargo which is a residual category including all commodities not elsewhere classified. Despite this fact, the way in which the other categories are described means that the extremely wide variety of individual items included in this category (e.g., cars, candles, canned crab) nearly all come under the heading of fully processed or semifinished products. The General Cargo category therefore exhibits relatively high values per ton and includes container traffic as an important subcomponent.[6] This high value of General Cargo justifies the utilization of costly facilities and skilled labor in its handling and storage, making this type of traffic a prime source of gross revenue from the standpoint of each port authority.

Examining the regression results in Table A9 for Foreign and Domestic coastwise shipments of General Cargo,we observe a compound growth rate over the complete time period of almost 3%, but also note that the rate has risen in recent years to a current range of between 3.5% and 4.0% per annum. Confidence that this recent increase in the rate of growth represents a sustainable advance to higher volumes stems from independent predictions that the volume of U.S. foreign trade (both exports and imports) will grow at higher rates during the last half of the seventies.[7] This confidence is reflected in the fact that "CURRENT" projections in Table A8 are substantially higher than the "LO" figures obtained by extrapolating the linear trend.

The P.S. & A.W. study asserted that there exists a close correlation between G.N.P. and the volume of waterborne commerce and used this relationship to justify a substantial upward revision of most of the figures derived from time trends. But a very large and consistently growing portion of G.N.P. is made up of "services" which bear little or no relationship to the volume of tangible goods moving in maritime commerce. For this reason a more valid comparison is with the production or consumption of manufactured goods, rather than with total G.N.P., and since goods output is predicted to increase at rates approximately 5.0% lower than total G.N.P. as the economy becomes increasingly services-oriented, the P.S. & A.W. adjustment appears to inflate their results.[8]

It turns out that total (durable plus nondurable) goods consumption is a very good explanatory variable when used to predict General Cargo F. & D.C. tonnages, retaining its significance even when time is also included in the regression equation.[9]

Domestic Internal (D.I.) traffic in the General Cargo category has followed no discernible trend over time, fluctuating around the one-million-ton mark throughout the last twenty years. The growth of the region in terms of population and income will exert a positive influence on this volume, but will continue to be offset to some extent by improvements in the relative cost and speed of truck transport on the state's expanding network of improved roads. The "CURRENT" prediction is therefore for modest growth at a compound rate of less than 1% per annum.

2. Forest Products

Forest Products is a category for which the P.S. & A.W. projections are unambiguously too low. That this is so can be confirmed by noting that the actual tonnage in 1970 at 14.7 million is 3 million tons greater than the 11.7 million projected to be reached by the year 2000. While our regressions obtained a good "fit" with log-linear relationships implying compound growth rates in the range of 10% per annum, the absolute tonnage figures resulting from applying a rate of this magnitude over the forecast period are unreasonably high in the light of the supply constraints embodied in the forest products industry's commitment to sustained yield policies and rising pressures to dedicate additional public lands to "wilderness" uses. Since the linear relationships also exhibit good "fit," the "CURRENT" projection is derived from them. An attempt was made to use building construction statistics as an explanatory variable but its use added nothing to the explanatory power of the time variable,[10] possibly because construction is only one of the important uses of the wide range of products included in this group.

For the Domestic Internal subcategory of the Forest Products group, all time trends indicate an absolute decline in traffic over the forecast period. Inspection of the base period data series, however, reveals that the declining trend has levelled off since 1965 so the "CURRENT" projection is for a continuation of recent annual volumes of about eight million tons.

3. Dry Bulk

Since the largest single component of the Dry Bulk group consists of sand, gravel and rock, it was anticipated that construction activity would closely parallel the tonnage series for this group and that independent predictions of future construction volume could be used as a check on expected increases in traffic. That correlation was disappointingly weak,[11] but on the other hand, the time trends for this category are strong and relatively consistent, especially for F. & D.C. traffic.

4. Bulk Grain

Table A4 shows that the amount of grain shipped in bulk between Puget Sound ports in recent years has been negligible. Since there is no reason to expect a resurgence of this traffic, no Domestic Internal projections are given. The "CURRENT" projections of F. & D.C. traffic are almost identical with the "HI" estimates derived from the log-linear relationship and imply compound growth rates of about 2.5% per annum over the forecast period. This growth rate is in line with conservative projections of the growth in Asiatic demand for North American grains.[12] It also reflects the fact that both Seattle and Tacoma will be offering grain exporters competitively attractive services over most of the forecast period through their existing and projected modern, high-capacity grain terminal facilities.[13]

5. Bulk Petroleum

The Bulk Petroleum category is probably the most difficult one for which to make forecasts, especially with respect to F. & D.C. traffic which exhibits the extremely weak time trends shown in Table A9. In addition there are all the uncertainties involved in the plans to ship quantities of crude oil from the Alaskan terminus of the proposed North Slope pipeline in lieu of existing supplies presently piped overland from Alberta. Although the time element is as unpredictable as many other aspects of this project, it can be asserted with confidence that significant quantities of North Slope oil will not be reaching Puget Sound ports before 1977 at the earliest. After that date the "CURRENT" projections of F. & D.C. tonnages may begin to look somewhat low.[14]

The North Slope uncertainties have a negligible impact on the volume of Domestic Internal shipments, which also display much stronger time trends over the base period years. For this traffic, the "CURRENT" projections are larger than those made in the P. W. & A.W. report, a discrepancy arising out of the assumption in that study that growth in the regional market for petroleum products would result in the building of more intra-regional pipelines instead of (rather than as well as) causing some growth in the volume of interport traffic.

6. Liquid Bulk

The Domestic Internal component of Liquid Bulk traffic is quite small in absolute terms and it fluctuates erratically over the base years. Time trend regressions provided no useful information in forecasting this traffic so the assumption was made that the relatively new handling and storage facilities at the Port of Tacoma together with unused capacity at the Port of Seattle would provide a competitively attractive environment for shippers and result in modest growth in volume commensurate with rising market demand for the products included in this group. The "CURRENT" projections are for rates of growth consistent with the 3.7% growth rate expected for the Food and Kindred Products industry, which is a major user of commodities shipped as Liquid Bulk.[15]

B. Tonnages by Individual Ports

For each commodity group, total tonnages for each of the two major traffic classifications were obtained separately for the three major ports of Seattle, Tacoma and Everett.[16] These annual totals cover the entire period from 1952 through 1970 and were used to derive time trends for each major port in each commodity group. Summing of these projections over commodity groups then produced future total tonnage estimates which were checked by comparing them with totals arrived at by extrapolating the historical shares of each major port into the future and applying the resulting ratios to the all-ports commodity group totals arrived at in the preceding section.

1. Port of Seattle

With respect to General Cargo it should be noted that the Port of Seattle has led in the provision of extensive modern facilities for the handling of containerized cargo, making provisions to accommodate substantial volumes of this particular traffic well in advance of current requirements. In so doing the Port Authority assumed considerable financial risk but subsequent events have vindicated the policy followed since Seattle has experienced a very rapid rise in container shipments making it the leading Puget Sound port in this category and the largest port on the West Coast in tonnage of Overland Common Point cargo.[17]

Our projections of the port's share of General Cargo traffic in Table 2 show that Seattle's present domination is expected to continue throughout the forecast period. In fact, an increasing share of this traffic is anticipated during the later part of the period as proportionately more General Cargo is handled in containers, reducing still further the fraction of General Cargo shipped through those smaller ports which lack expensive container-handling facilities.

For Forest Products, while "CURRENT" projections call for a modest rise in absolute volume, Seattle's share of this cargo is expected to decline throughout the forecast period. Commodities included in this category are characterized by relatively low values per ton and present handling methods call for the use of large waterfront areas for low-yield operations such as log storage. Compared to the smaller Puget Sound ports, Seattle therefore faces a rising level of comparative disadvantage in attracting and retaining this type of traffic because of its high waterfront land values based on competition for space by more intensive uses.

Seattle's share of Dry Bulk cargo is predicted to rise moderately over the forecast period. The principal subcomponents of Dry Bulk are sand, gravel, rock, cement, alumina, dry chemicals and fertilizers; so that volume varies with activity levels in the construction, chemicals, aluminum and agricultural industries. But there is general agreement that the Pacific Northwest aluminum industry has entered a period of slow growth relative to that of chemicals and construction.[18] Since the alumina component of Dry Bulk totals is shipped through Tacoma and Everett, Seattle's proportion of future Dry Bulk traffic will tend to reflect the higher growth rates of the other industries mentioned.[19]

Seattle's export-import traffic in Bulk Petroleum is not large and all indications point to its becoming even less important than heretofore. F. & D.C. petroleum shipments are increasingly carried in extremely large tanker ships requiring specialized handling facilities justified only by

TABLE 2: TRAFFIC PROJECTIONS BY COMMODITY GROUP (SEATTLE)
(Bracketed figures are from P.S. & A.W. report)

		4 yrs 1967-1970 Inclusive		Projections to 1980			Projections to 2000	
		Average	Share	P.S. & A. W.	Current	Share	Current	Share
G. C.	F. & D.C.	1,858			2,400		4,500	
	D.I.	285			335		380	
	Total	2,143	63.0%	(4,350)	2,735	63.0%	4,880	69.7%
For.Prod.	F. & D.C.	592			900		1,400	
	D.I.	737			650		650	
	Total	1,329	10.2%	(1,250)	1,550	10.0%	2,050	9.8%
Dry Bulk	F. & D.C.	1,577			2,500		4,500	
	D.I.	4,304			8,000		15,000	
	Total	5,881	35.5%	(9,130)	10,500	40.3%	19,500	39.8%
Bulk Pet.	F. & D.C.	2,534			2,400		2,400	
	D.I.	2,480			4,200		5,600	
	Total	5,014	38.1%	(5,690)	6,600	37.7%	8,000	38.8%
Bulk Gr.	F. & D.C.	898	68.9%	(1,250)	1,350	71.0%	1,800	62.1%
Liq. Bulk	F. & D.C.	95			125		160	
	D.I.	8			15		15	
	Total	103	66.4%	(330)	140	63.2%	175	53.0%
Totals	F. & D.C.	7,554			9,675		14,760	
	D.I.	7,814			13,200		21,645	
	All Cargo	15,368	—	(22,000)	22,875	—	36,405	(32,600)
All Cargo Share:			32.3%			35.1%		36.1%

the proximity of either a major refinery or a pipeline terminus, neither of which has been suggested for Seattle. On the other hand, Domestic Internal traffic between Puget Sound ports in petroleum products is largely a function of the level of regional demand in the product market, which is expected to grow at a compound annual rate of approximately 3.5%.[20]

The traffic in Bulk Grain consists entirely of export-import shipments which were divided between Seattle and Tacoma in roughly equal shares up until the mid-sixties. Since then Seattle's share has risen to about 70% of the total, but this dominance is expected to erode over the forecast period as Tacoma's planned new grain-handling facility is completed and brought into active operation.

Liquid Bulk accounts for less than 1% of the port's total tonnage volume so even large fluctuations in this category have little effect on the overall forecast. Completion in the late sixties of substantial new facilities for the handling and storage of bulk liquids at the Port of Tacoma resulted in a sharp increase in its share of that traffic, some of the increase representing a diversion of shipments from Seattle. The "CURRENT" forecast indicates further erosion of Seattle's share to something slightly over one-half of the all-ports total by 2000.

The bottom line of Table 2 shows an increase over the entire forecast period of about 4% in Seattle's share of total tonnages of all commodities. This gain will result from the indicated increases in the port's relative share of General Cargo and of Dry Bulk which in turn are based on the expectation that the port will maintain its lead in containerized cargo handling and that the Port District will remain the population hub of the region.

2. Port of Tacoma

Tacoma's share of F. & D.C. General Cargo traffic has approximated 14% of the all-ports total over most of the last two decades, slipping lower only during the late sixties when Seattle's earlier investment in container facilities attracted an unusual share of that new and burgeoning traffic to the larger port. Since that time Tacoma's Port Authority has been actively competing for this type of cargo and has succeeded in restoring its historical share of General Cargo volume. An expectation

TABLE 3: TRAFFIC PROJECTIONS BY COMMODITY GROUP (TACOMA)
(Bracketed figures are from P.S. & A.W. report)

		4 yrs 1967-1970 Inclusive		Projections to 1980			Projections to 2000	
		Average	Share	P.S. & A.W.	Current	Share	Current	Share
G.C.	F. & D.C.	374			500		950	
	D.I.	102			130		130	
	Total	476	14.0%	(640)	630	14.5%	1,080	15.4%
For. Prod.	F. & D.C.	1,433			2,200		3,600	
	D.I.	700			600		600	
	Total	2,133	16.6%	(1,220)	2,800	18.0%	4,200	20.0%
Dry Bulk	F. & D.C.	1,748			2,400		5,000	
	D.I.	525			800		1,500	
	Total	2,273	13.7%	(3,940)	3,200	12.3%	6,500	13.2%
Bulk Pet.	F. & D.C.	736			900		1,400	
	D.I.	889			1,450		2,500	
	Total	1,625	12.3%	(1,880)	2,350	13.6%	3,900	18.9%
Bulk Gr.	F. & D.C.	354	27.2%	(950)	550	29.0%	1,100	37.9%
Liq. Bulk	F. & D.C.	37			65		110	
	D.I.	8			10		15	
	Total	45	29.0%	(40)	75	34.1%	125	37.8%
Totals	F. & D.C.	4,682			6,615		12,160	
	D.I.	2,224			2,990		4,745	
	All Cargo	6,906	—	(8,670)	9,605	—	16,905	(19,000)
All Cargo Share:			14.5%			14.7%		16.8%

that Tacoma will further increase its share of General Cargo is implied in Table 3 which forecasts a share of 15.4% by the year 2000. Since a rising share is also predicted for Seattle (see Table 2), both large ports will be gaining relative to the smaller ports which are at a severe disadvantage in the competition for container traffic. Tacoma's ability to sustain and expand this traffic is solidly founded on the supply of ample dockside acreage available for backup space as effective demand rises.

This reserve of waterfront acreage is also a factor in the prediction that Tacoma's share of Forest Products traffic will increase to approximately 20% of the all-ports total over the forecast period, in contrast to the anticipated decline in Seattle's share of such cargo. Pressure on the supply of dockside sites in Tacoma is less intense, so that wood chip and dry log storage will continue to be an economically viable user of substantial acreage.

While Tacoma's share of Dry Bulk volume is expected to remain roughly at present levels over the forecast period as a whole, some erosion in the earlier years is indicated in Table 3. This reflects the previously mentioned slow growth prospects for the Pacific Northwest aluminum industry, together with the fact that alumina accounts for a large fraction of the port's total Dry Bulk tonnage.

The prediction that Tacoma's share of Bulk Petroleum shipments will increase somewhat over the forecast period rests largely on actual tonnage figures for Domestic Internal traffic during the past half-dozen years which show volume through the port rising somewhat faster than that for all Puget Sound ports. This fact, considered in conjunction with estimates of growth in the regional market for petroleum products, helps to confirm the strong time trend regression results set out in Table A13.

The port's share of grain shipments has fluctuated widely in recent years, rendering time trend analysis unhelpful. Lately, Tacoma's share has sunk to an historical low, as Seattle's terminal facilities have entered active operation. But recovery towards parity in grain trade volume is implicit in the firm commitments now completed between the Port Authority and Continental Grain Company to erect a comparable facility on the south shore of Commencement Bay. Continental's far-flung network of forwarding and storage facilities, taken together with independent projections of growth in export demand for grain, provides reasonable assurance that the new grain terminal will progress towards capacity utilization during the forecast period.[21]

While Liquid Bulk is not an important cargo category in terms of overall tonnages, it is expected to grow along with the chemical and food processing industries for which its component commodities provide inputs. Tacoma is in an excellent position to expand its share of such traffic through the inducement offered to shippers by its modern, temperature-controlled facilities for handling and storage of these commodities.

3. Port of Everett

In the absence of an expensive and financially risky commitment to provide extensive facilities for handling and storage of container cargo, Everett's share of regional General Cargo traffic is expected to decline somewhat over the forecast period, although absolute tonnages will nevertheless rise by almost 40%. Since General Cargo accounts for only about 3% of the port's total traffic volume, this prediction by no means implies that the port's activities are headed for long-term decline. On the contrary, the outlook for future traffic in the port's traditional specialty of Forest Products is for further modest increases which will result in more than one-quarter of all regional traffic in this category being moved through Everett's public and private terminals by the end of the forecast period. This optimistic long-term outlook does not eliminate the probability of some sharp fluctuations over the next few years due to the effects of stricter pollution control standards aggravated by important instances of plant obsolescence.

Strong time trend results were obtained for the important Foreign and Domestic Coastwise component of Forest Products traffic, giving added significance to the projections made. For the Domestic Internal component the time trends are weak, but consistent in direction, yielding a clear indication that traffic volumes can be expected to level off over the forecast period. An absolute decline in this type of cargo is conceivable due to increased competition from highway transport which, if it materializes, would make the "CURRENT" figures appear somewhat high.

The time trend regression results for Dry Bulk traffic are uniformly strong and consistent, enabling us to predict steady, if unspectacular, growth in volumes handled. Since an important fraction of Everett's Dry Bulk cargo consists of alumina destined for the Montana smelter of the Anaconda Aluminum Company, total Dry Bulk volume will be affected by the anticipated slow growth in aluminum output alluded to earlier.

Bulk Petroleum accounts for less than 1% of the port's total tonnage and there is little reason to expect that volume will increase at any more rapid rate than has been forecast for regional petroleum products market demand.

4. Other Puget Sound Ports

Table 5 is largely self-explanatory. The only commodity categories in which "other ports" are predicted to make volume gains over the forecast period are Bulk Petroleum and Liquid Bulk, the latter a minor category in terms of absolute tonnage. The commodities included in these two classes require specialized handling and storage facilities which operate most efficiently at high rates of volume, making it uneconomical for most small ports to offer adequate service to shippers. At the same time, especially in the case of Bulk Petroleum, there are a number of advantages in locating such facilities adjacent to refinery installations but at a distance from any large general cargo port, since both the ships themselves and the unloading process have different characteristics from those of the typical vessel calling at a multipurpose port. For these reasons it is expected that the share of traffic in these commodities handled by special-purpose ports, such as the Cherry Point installation north of Anacortes, will increase. It is also anticipated that one or two new special-purpose port sites will be developed by the end of the forecast period, a subject on which more is said later.

For all other commodity categories a relative decline in the share of traffic is projected, based largely on the superior ability of the larger ports to cultivate new markets for their services; the expectation of continuing (albeit slower) movement of population towards larger urban centers; and the comparative advantage enjoyed by large ports in financing extensive capital improvements required by the latest cargo-handling technology.

TABLE 4: TRAFFIC PROJECTIONS BY COMMODITY GROUP (EVERETT)
(Bracketed figures are from P. S. & A. W. report)

		4 yrs 1967-1970 Inclusi		Projections to 1980			Projections to 2000	
		Average	Share	P.S. & A.W.	Current	Share	Current	Share
G.C.	F. & D.C.	118			135		150	
	D.I.	13			20		30	
	Total	131	3.9%	(270)	155	3.3%	180	2.6%
For. Prod.	F. & D.C.	897			1,400		2,400	
	D.I.	2,338			3,000		3,000	
	Total	3,235	24.9%	(2,520)	4,400	24.9%	5,400	25.7%
Dry Bulk	F. & D.C.	350			700		1,500	
	D.I.	390			600		1,200	
	Total	740	4.5%	(910)	1,300	5.0%	2,700	5.5%
Bulk Pet.	F. & D.C.	3			10		10	
	D.I.	47			50		60	
	Total	50	0.4%	(70)	60	0.4%	70	0.3%
Totals	F. & D.C.	1,368			2,245		4,060	
	D.I.	2,788			3,670		4,290	
	All Cargo	4,156		(3,770	5,915		8,350	(10,900)
All Cargo Share:			8.7%			9.1%		8.3%

TABLE 5: PERCENTAGE SHARES BY COMMODITY
(Three major ports vs. other Puget Sound ports)

	Actual Average Share 4 yrs 1967-1970		Projected Shares 1980		Projected Shares 2000	
	3 major ports	Other PS ports	3 major ports	Other PS ports	3 major ports	Other PS ports
General Cargo	80.9%	19.1%	80.8%	19.2%	87.7%	12.3%
Forest Products	51.7%	48.3%	52.9%	47.1%	55.5%	44.5%
Dry Bulk	53.7%	46.3%	57.6%	42.4%	58.5%	41.5%
Bulk Petroleum	65.7%	34.3%	51.7%	48.3%	58.0%	42.0%
Liquid Bulk	95.4%	4.6%	97.3%	2.7%	90.8%	9.2%

PART II: PORT-RELATED LAND REQUIREMENTS

A. Estimation Procedure

The value of waterfront land derives from its limited availability and its ability to lend itself to a variety of uses, one of the most important being its use as a terminal point in the movement of goods by water. The relatively low cost of this mode of transport makes it especially attractive to those industries in which transport charges account for a large fraction of total costs. The necessity of providing sufficient usable land has led many ports to locate near the mouth of a river where there is usually an extensive amount of flat land suitable for development. Functioning not only as the terminus of marine shipments but also as a transfer point for movement from one mode to another, such a location is usually well served by most if not all modes, particularly rail and truck. Thus there are advantages even to industries not necessarily associated with maritime commerce in locating within a port area. Specifically, these advantages include the availability of prime industrial land, the quality of transport linkages, and the benefits of proximity to other related industries.

Because of the basic inelasticity of supply, however, as the marginal value of waterfront land rises, those industries with greater price elasticity of demand will tend to move further away while those whose demand is relatively inelastic will come to occupy a larger proportion of the waterfront area. Industries with inelastic demand include those which are less able to substitute nonwaterfront for waterfront land and, of these industries, those which possess a low ability to substitute other inputs for land and/or for which the marginal productivity per unit of land is high will exhibit the greatest degree of inelasticity.[22]

It follows that industries found within the waterfront area might usefully be grouped into three categories. The first consists of activities exhibiting highly inelastic demand for waterfront access. Such industries which are directly dependent on water access include, in addition to terminal operations, boatbuilding, fisheries and industries with high transport costs such as cement, stone and gravel. The second group of activities is linked to those in the first category either through inputs (stevedoring, marine supplies) or outputs (fish processing, wood products), so while it is not necessary that they have direct access to the water there are substantial advantages in proximity to Group I activities. The third group consists of those industries and uses (agricultural, residential, most retail) which locate in the port area for reasons unrelated or only weakly related to deep water access. Ideally these three groups would be segregated geographically with the first category located directly on the water, the second adjacent to the first, and the third farthest away. Partly because of historical "accident," however, there are actually, at any moment of time, a number of non-water-related industries located on or next to the waterfront. Their location decisions were often made before the differentiation in value between waterfront and non-waterfront land had become significant and subsequent investment in fixed capital has helped create a reluctance to relocate. Over time, however, the location of industries tends to form a pattern of successive layers, with the third group moving further away as the demands of the first two rise and additional supply of space becomes increasingly constrained.[23]

This being the case, it should be possible to estimate the growth over time of industries located on or near the waterfront and, assuming an increase in their demand for land proportionate to this growth, to project the amount of waterfront land they will occupy. Since Group I requires a location immediately on the waterfront, supply is severely constrained as there can be little expansion inland by definition, and extension along the shoreline is confined to areas with adequate water depth and appropriate topography. In some cases additional frontage can be provided only by costly techniques such as filling, dredging, or erection of floating piers. Where these conditions prevail, the rate of growth of Group I activities will provide an indication as to when such projects may be economically feasible.

Before detailing the procedure used, it might be helpful to summarize the foregoing discussion by way of three assumptions and the hypothesis they suggest:

Assumptions: (1) The supply of waterfront land suitable for port-related uses is strictly limited.

(2) Rents for this land are rising over time because of increasing marginal productivity

(3) Economic activities directly and indirectly dependent on waterfront access (Groups I and II) extract a higher marginal value product from this land than other activities (Group III) presently located there.

Hypothesis: Group I and II industries will progressively outbid and displace those activities which are less dependent on waterfront access.

To assess the validity of these assumptions and to test the hypothesis, the major Puget Sound ports of Seattle, Tacoma and Everett were examined. The procedure used is outlined below, followed by a discussion of the results for each of the three ports. Information was obtained from a variety of sources including port authorities, city and county planning departments, state agencies, and the federal government.

B. Industrial Land

Much of the data used to arrive at projections of industrial acreage was obtained from research done by the Puget Sound Governmental Conference as part of their effort to devise a computerized land activity allocation model. For this purpose they divided the relevant four-county region into analysis zones and then allocated 1966 employment by industry to each zone using information from the Washington State Employment Security Department. These estimates were updated to 1970 and then projected ahead to 1990. The procedure by which this information was translated into land estimates utilized land-employee ratios and went as follows:

1. The analysis zones included in the port areas of the three cities were identified and 1966 employment data were tabulated by industry for each zone. Maps in the Appendix indicate the port area boundaries defined by this process.
2. Employment estimates were summed over analysis zones to derive an industry total for each port area.

3. Ratios of acres per employee for 1961 obtained from the Puget Sound Regional Transportation Study were applied to industry employment totals to arrive at acreage estimated by industry for each port area.[24]
4. These were summed over industries to yield a total industrial acreage figure for each of the three major ports.
5. The same procedure was applied using employment projections for 1990 and acres/employee ratios for 1985 to obtain total industrial acreages for 1990. The 1966 figures were then subtracted to arrive at a forecasted increase in acreage for each area over the period.
6. The P.S. & A.W. Study estimated that 25% of an industrial area was taken up with streets, highways and railroad rights-of-way.[25] Therefore, an additional one-third of the increases forecast in Step 5 above was added to account for such uses.

The estimated number of acres in industrial use for 1966 and 1990 is shown in Tables 6 and 7. It should be noted that the land/employee ratios shown represent only net land in use, not the gross holding of the industry or firm. The Washington Department of Commerce and Economic Development has estimated that net land in use varies from 50% to 100% of total land held.[26] This fact affects the forecasts in two ways. First, to the extent that employment increases come from expansion of existing firms, some of the additional acreage needed will come from land already held by the firm. But where employment increases come from the establishment of firms new to the port area, their land purchases will likely exceed the net amount used in the ratios. Thus in the first case projected increases probably overstate the amount of undeveloped land required and in the second case underestimate it. Since both kinds of development are anticipated, errors introduced by the use of net ratios will be largely offsetting.

An alternative approach would have been to use ratios of land to output. These might be more stable since with the acres/employee ratio there are at least two factors systematically working to change the ratio.

TABLE 6: ACRES IN USE 1966

Manufacturing Category	1961 Ratio	Seattle		Tacoma		Everett	
		Employmt.	Acres	Employmt.	Acres	Employmt.	Acres
Miscellaneous	0.0180	404	7.27				
Transportation Equip.	0.0078	37,270	290.71	588	4.59	46	0.36
Primary Metals	0.0753	1,603	120.71	389	29.29		
Fabricated Metals	0.0391	3,334	130.36	460	17.99	600	23.46
Machinery except Elec.	0.0069	2,409	16.62	311	2.15	60	0.41
Electric Machinery	0.0657	425	27.92				
Food	0.0282	3,443	97.09	944	26.62	88	2.48
Apparel	0.0093	581	5.40	58	0.54	9	0.08
Printing	0.0068	315	2.14			55	0.37
Chemicals	0.1439	770	110.80	1,402	201.75	6	0.86
Petroleum	0.2227	8	1.78	83	18.48		
Paper Products	0.0309	663	19.56	1,032	31.89	2,080	64.27
Lumber	0.0650	1,356	88.14	3,315	215.47	1,564	101.66
Stone, Clay & Glass	0.0796	947	75.38	183	14.57		
Furniture	0.0248	352	8.73	183	4.54		
TOTAL		53,880	1002.61	8,948	567.88	4,508	193.95

TABLE 7: ACRES IN USE 1990

Manufacturing Category	1961 Ratio	Seattle Employmt.	Seattle Acres	Tacoma Employmt.	Tacoma Acres	Everett Employmt.	Everett Acres
Miscellaneous	0.0250	1,727	43.17	1,306	32.65	215	5.37
Transportation Equip.	0.0103	32,012	329.72	1,477	15.21	46	0.47
Primary Metals	0.0992	3,828	379.74	1,006	99.79		
Fabricated Metals	0.0517	4,866	251.57	746	38.57	921	47.62
Machinery except Elec.	0.0086	6,470	55.64	871	7.49	165	1.42
Electrical Machinery	0.0757	1,284	97.20				
Food	0.0412	4,141	170.61	817	33.66	109	4.49
Apparel	0.0117	900	10.53	88	1.03	14	0.16
Printing	0.0089	541	4.81	31	0.28	112	1.00
Chemicals	0.1998	601	120.08	1,238	247.35	4	0.80
Petroleum	0.2937	21	6.17	148	43.47		
Paper Products	0.0408	2,236	91.23	1,881	76.74	2,777	113.30
Lumber	0.0857	994	85.18	2,217	190.00	1,204	103.18
Stone, Clay & Glass	0.0996	1,357	135.16	124	12.35		
Furniture	0.0363	435	15.79	157	5.70		
TOTAL		61,413	1796.60	12,107	804.29	5,567	277.81

First, the number of labor hours per unit of output falls through time as manufacturing processes become more capital intensive and labor productivity rises. Thus employment may be falling even though output is rising. Second, changing manufacturing processes have resulted in plant designs becoming more land extensive with fewer new plants occupying multistory structures. Both of these trends operate to increase the acres/employee ratio over time. However, a counteracting influence comes into play when increasing scarcity of suitable land develops pressures to combine greater quantities of capital and of labor with each unit of land. The net effect of these various influences is difficult to assess, but the consensus seems to be that the ratio will rise at an average rate of about 10% per decade.[27] The Puget Sound Regional Transportation Study used different growth rates in the ratio for each industry but they averaged about 10%.

Although utilizing a land/output ratio would minimize the effects of increasing labor productivity, it would still be necessary to allow for increases in the ratio over time resulting from the second trend mentioned. But the major drawback of this approach is the lack of reliable projections of output at the state or regional level. Employment forecasts are simply much easier to find.

C. Terminal Land

The method used to project terminal requirements is similar to that used for industrial projections except that the ratios used were derived by relating tonnages of commodities shipped to land needs rather than estimating these needs from projected employment. These "efficiency ratios" can be thought of as functions of current goods-handling techniques which in turn are influenced by technological innovations, various institutional factors such as union rules, and especially by changes in relative prices of factor inputs, including land. The procedure can be explained in the following way:

1. Efficiency ratios were estimated for each commodity group for a base year of 1966 and for the forecast years of 1980 and 2000. The estimated ratios for the base year took into consideration

data both from the ports and the P.S. & A.W. study on average handling rates. For the forecast period ratios were derived from the most efficient cargo-handling techniques now employed and it was assumed that such techniques would be in general usage by Puget Sound ports by the end of the forecast period.

2. The appropriate ratio was applied to commodity group tonnages for the given port (refer to Part I) to arrive at an acreage estimate for each commodity group.
3. These estimates were then summed over all commodity groups to arrive at an estimate of total terminal land requirements for the port.
4. Finally the results obtained from projecting industrial land were added to the projections of terminal land needs to give total land needs shown in Table 9.[28]

The column headed Tons/Acre in Table 8 shows, for each type of cargo, the ratio applied to tonnage totals to arrive at estimated land requirements. The bracketed figures appearing in this column are the ratios used in a similar manner in the Land Needs sections of the P.S. & A.W. study.[29]

In estimating the ratios for general cargo, it was realized that the two largest ports handle disproportionate amounts of containerized cargo for which the tons/acre ratio is much higher than for conventional general cargo. In an effort to adjust for this difference and to recognize that the largest ports are likely to continue to lead in applying innovative techniques for handling all general cargo, we apply a higher ratio to the traffic projected for Seattle and Tacoma than is used for the other ports.

While the newest specialized (container-only) terminals operated by the New York Port Authority at Port Elizabeth, N.J., have recorded tonnages per acre per year in the range 17,000 to 27,000, the most efficient Port of New York terminals which handle both containerized and conventional cargo operate at something in excess of 13,000 tons per acre per year.[30] While the 13,000-ton ratio used for Seattle and Tacoma in Table 8 may therefore seem low since it is not expected to be achieved until 1980, it must be kept in mind that even then the pressures for

TABLE 8: CONVERSION OF TRAFFIC PROJECTIONS TO TERMINAL LAND REQUIREMENTS
(Bracketed figures are from P.S. & A.W. report)

			Seattle		Tacoma		Everett		All PS Ports	
Type of Cargo	Year	Tons/ Acre	Projected Tonnages	Terminal Acres	Proj. Tons	Term. Acres	Proj. Tons	Term. Acres	Proj. Tons	Proj. Acres
G.C.	1966	10,000	1,975	198	343	34	111	11	3,484	348
	1980	13,000(S&T)	2,735	211	630	50				
		10,000(OTH)					155	16	4,340	359
		(12,000)							(6,800)	(565)
	2000	16,000(S&T)	4,880	305	1,080	68				
		10,000(OTH)					180	18	7,000	477
		(15,300)							(9,500)	(625)
For. Prod.	1966	19,000	1,226	65	1,749	92	2,100	111	10,101	532
	1980	22,000	1,550	71	2,800	128	4,400	200	15,500	705
		(21,200)								(454)
	2000	25,000	2,050	82	4,200	168	5,400	216	(9,600)	840
		(25,900)							21,000	(454)
Dry Bulk	1966	80,000	4,471	56	1,550	20	587	7	12,670	158
	1980	96,000	10,500	110	3,200	34	1,300	14	26,000	271
		(96,000)							(26,300)	(274)
	2000	100,000	19,500	195	6,500	65	2,700	27	49,000	490
		(100,000)							(58,600)	(583)
Bulk Gr.	1966	60,000	885	15	493	8	na	na	1,378	23
	1980	70,000	1,350					na	1,900	28
		(100,000)		20	550	9	na		(2,200)	(22)
	2000	80,000	1,800					na	2,900	37
		(100,000)		23	1,100	14	na		(2,800)	(28)
Bulk Pet.	1966	26,000	5,108	197	1,166	45	47	10*	13,885	534
	1980	32,000	6,600	207	2,350	74	60	10*	17,250	539
		(33,800)							(21,500)	(638)
	2000	35,000	8,000	229	3,900	112	70	10*	20,580	588
		(62,700)							(40,000)	(638)

*Bulk Petroleum efficiency ratio of 32,000 tons/acre not applicable at very low levels of traffic which require a minimum threshold acreage.

Type of Cargo	Year	Tons/ Acre	Seattle Projected Tonnages	Seattle Terminal Acres	Tacoma Proj. Tons	Tacoma Term. Acres	Everett Proj. Tons	Everett Term. Acres	All PS Ports Proj. Tons	All PS Ports Proj. Acres
Liq. Bulk	1966	8,000	153	19	16	2	na	na	181	23
	1980	9,000	140	16	75	9	na	na	220	25
		(9,000)							(370)	(41)
	2000	9,000	175	20	125	14	na	na	330	37
		(9,000)							(890)	(100)
TOTALS	1966			550		201		139		1,618
	1980			635	(648)	304	(308)	240	(136)	1,927
	2000			<u>854</u>		<u>441</u>		<u>271</u>		<u>2,469</u>
	Difference (1966 to 2000)			+304		+240		+132		+851
	Difference (1980 to 2000)			+219		+137		+ 31		+542

TABLE 9: TOTAL INCREASE, TERMINAL AND INDUSTRIAL LAND, IN ACRES

	Seattle	Tacoma	Everett	Major Ports Total
Industrial Land in Use, 1990	1,797	804	278	2,879
Industrial Land in Use, 1966	1,003	568	194	1,765
Industrial Land, Increase (1966-90)	794 (79%)	236 (42%)	84 (43%)	1,114 (63%)
Streets and Rail Increase (1966-90)	na	79	28	107
Terminal Land Increase (1966-90)*	195	172	118	580
Total Increase, 1966 to 1990	989	487	230	1,801

*Figures in this row obtained by halving the increase from 1980 to 2000 and adding the result to the increase from 1966 to 1980.

high-intensity land use will be lower in Puget Sound ports than at present in the New York area.[31]

In regard to Bulk Grain, it was previously assumed that grain terminals would be operating at designed levels of handling capacity by 1980, an assumption which appears unrealistic when the "CURRENT" projections of total grain traffic in Table A8 are compared with the rated capacities of Seattle's new terminal plus Tacoma's planned facility. The ratios used for Bulk Grain were therefore lowered to conform with the newer projections.

Finally, in considering terminal land needs for petroleum it is especially difficult to separate terminal land use from productive process land use. Industry spokesmen have indicated on several occasions that at least one new petroleum-handling facility will be constructed on the Sound by the end of the forecast period and the smaller ratio is based on this expectation.[32]

D. Land Requirements of Major Ports

1. Port of Seattle

Seattle's anticipated land requirements are the largest, with Table 9 calling for an increase in industrial land of close to 800 acres over the period 1966 to 1990. No allowance is included in the table for space required by new road and rail rights-of-way since the areas into which water-oriented industry must expand are not undeveloped land but consist of sites already served with an established network of transport corridors. Some revamping of access routes may be necessary to match the requirements of the changing land use pattern but the total acreage devoted to access space will probably not arise. Adding in terminal land projections raises the total additional industrial land requirements to approximately 1,000 acres by 1990.

There is insufficient unused land in the port area to accommodate this much growth. An Industrial Land Survey recently completed by the City of Seattle states that there are 477 acres of potential industrial land available in the Duwamish Industrial District, but this includes land categorized as "underutilized" and "residential." Of 509 sites located in the Duwamish Valley only 276 were listed as vacant and only 67 of these were over one acre in size. Seven vacant sites were between 10 and 20 acres in size.[33]

We conclude that land use in this area will become more intensive over the forecast period. The acres/employee ratio will rise at less than the "normal" rate or may even fall, new industries will tend to locate elsewhere, and existing industries, without strong water orientation, will be induced to relocate. Some will move to suburban industrial parks and others without specific ties to Seattle may be attracted by the relative abundance of industrial property in Tacoma. Group I and II industries with strong ties to the waterfront will increase their existing dominance of the port area. This process can be seen in the pattern of recent land acquisitions made by the Port of Seattle. Since 1962 when the Lower Duwamish Industrial District was created,[34] the Port has acquired over 280 acres of waterfront land in the area below Spokane Street.[35] More recently the old Boeing Plant No. 1 was acquired by the Port to form part of Terminal 115, the old Parr Warehouse also originally owned by Boeing was purchased, and negotiations are underway with the Shell Oil Company to buy some of their Harbor Island holdings.[36]

2. Port of Tacoma

Table 9 shows that the 568 acres of industrial land estimated for Tacoma in 1966 are expected to increase to 804 acres by 1990. This increase of 236 acres represents a 41.6% addition over 24 years. Making allowance for road and rail access to newly developed sites and adding in the expected increase in terminal land requirements raise the total additional acreage requirement to 487 acres. Since a recent study, Industrial Area Analysis,[37] indicates that almost 1,400 acres of undeveloped land are presently available in the port area, and the Port Commission estimates that over 800 acres of Port-owned industrial property are currently available within its Industrial Development District,[38] there appears to be an ample supply of suitable land on hand to meet all needs anticipated over the forecast period. In reaching this conclusion it is important to note that the requirements considered include those of a number of Group III industries with extremely weak orientation to the water. Because of the large amount of industrially zoned land in the vicinity of the port, it can be assumed that this area will absorb the major portion of industrial growth for all of Pierce County, as will be discussed in Part III.

3. Port of Everett

The increase of 112 acres in industrial land and required access space shown in Table 9 could be accommodated on existing vacant land, but needs for terminal lands are also expected to increase by about 120 acres by 1990. A great deal of this increase in terminal land requirements is based on projected growth in Forest Products traffic. Some of this increased traffic will be handled in expanded Port Commission facilities such as the planned new wood-chip loading complex, but some will flow through private terminal facilities whose land needs have already been projected under the "industrial" category. The double counting effect previously mentioned therefore applies to the Everett figures more than to those for the other ports. Nevertheless, the forecasts suggest enough expansion of port area land needs to exert pressure on existing Group III industries to relocate away from the waterfront. Furthermore, since Group III users presently occupy only a small fraction of waterfront land, it can be predicted that some expansion of usable waterfront land by way of filling, dredging and/or pier extension will become economically feasible before the end of the forecast period.

E. Relationship to P.S. & A.W. Land Use Forecasts

The P.S. & A.W. study predicts that approximately 17,130 acres of land will be needed by the year 1980 and 29,010 by the year 2000.[39] These figures represent increases of 9,630 and 21,500 acres respectively from the 7,500 acres inventoried as being in use in 1963. Why are those estimates so much higher than the figures presented herein?

The main reason for divergence in the projections of terminal lands is the difference in traffic forecasts. In the aggregate their tonnage forecasts are 2.4% higher for 1980 and 22.5% higher by the year 2000. However, the P.S. & A.W. researchers predicted only nominal growth in the volume of Forest Products traffic which they felt could be handled with no increase in terminal acreages.[40] In fact, traffic in Forest Products commodities has experienced consistent growth and presently exhibits the potential for further expansion, albeit at somewhat lower rates than in the past. Because of this, and because Forest Products has a relatively low "efficiency ratio," our total **increase in acreage** requirements for terminal lands by the year 2000 is slightly higher than the P.S. & A.W. projection even though acreage needs for most commodity categories are lower.

In forecasting needs for industrial land one of the major reasons for disparity is a divergence in the definition of a "water-oriented" industrial use. Such industries are described in the P.S. & A.W. study as those "that require or gain a significant advantage by nearness to water transport facilities" but "nearness" was defined as any distance inland "to a maximum of about five miles from a possible deep water transport terminal."[41] We felt this was too great a distance since once the industry is a sufficient distance from dockside to necessitate the use of common carrier transport to move the goods to the terminal location, it then becomes a completely arbitrary decision whether it need be 5 miles away or 6 or 10, and other locational factors will then exert a dominating influence. Thus, for example, land in Renton and Bellevue was included in acreage both in use and potential use, for water-oriented industries by following the P.S. & A.W. definition.

The second main difference lies in the growth rate applied to this base to reach the acreage figures for water-oriented industry. They begin with a set of growth rates pertaining to several loosely related economic variables calculate a mean, which turns out to be 2.5%, then apply this to their 1963 inventory figure of 5,190 acres. A pattern of straight-line growth is selected, implying decreasing percentage increments over time to reach a projected total of 61,000 acres within 100 years. The decreasing percentage over time means that a larger proportion of the land will be acquired during the first 50 years (i.e., the period being studied) than over the subsequent 50 years. This growth pattern is rationalized by saying that land costs and environmental conflicts will rise at an increasing rate over time.[42]

The projection of land requirements for industry is certainly not a refined art, being barely beyond the stage of guessing, so that a projection one hundred years in the future has doubtful validity and expecting the rate of growth in acreage over that period to average out at 2.5% may well be optimistic. Let's examine a few of the growth rates from which the P.S. & A.W. task force derived their "mean." One of them was Port of Tacoma industrial land sales based on data covering the years 1952 to 1968. When we reviewed the data, figures were available through 1971 and it is interesting to note that from a peak of 58 acres reached in 1967, sales declined in every subsequent year up to 1970 when only 2 acres were sold. In 1971 sales rose slightly to over 4 acres.[43] This may represent only a short-term dip but does illustrate the weakness of deriving long-term growth trends from data spanning an essentially expansionist period. Two other parameters employed were taken from the P.S. & A.W. study itself; namely, the projections from the Input-Output study of Appendix IV (Economic Environment) and the Navigation Appendix's previous projections of the volume of waterborne commerce. But both are too high, the latter for reasons already discussed in Part I, and the former mainly because of errors in estimates of future growth of the aerospace sector.[44] Most of the other indicators are open to objection on similar grounds of having been based on a period of relatively high growth. Nor is it clear, even granting that there is a relationship between these variables and the growth of waterborne commerce, just what that relationship is. For example, the growth of terminal land area, another parameter used, may be greatly affected by administrative decisions of the port authorities not necessarily reflected in market conditions since the ports are partly funded by public monies. Thus, substantial questions can be raised concerning the P.S. & A.W. land use forecasts, and we believe that the narrower scope and more specific basis of our forecasts produce a more realistic picture.

PART III: FUTURE PORT EXPANSION

A. Analysis of Assumptions

The three assumptions with respect to port area land use which were set out on page 21 led to the conclusion that upward shifts in the demand for land by economic activities with strong water-orientation will lead to the gradual displacement of activities with less dependence on waterfront access. What are the consequences if these assumptions are relaxed?

The first assumption is that the supply of waterfront land is limited. Instead, what if land is in fairly elastic supply, as seems to be the case in Tacoma? It is unlikely then that Group III will move away from the area since most of the needs of the first two groups can be satisfied by development of unused land. The third group might even expand its acreage within the area. The Port Industrial Area in Tacoma contains about three quarters of all industrially zoned land in the city with the undeveloped portion amounting to 1,385 acres and accounting for 80% of all undeveloped industrial land available.[45] In this case, land is not only not in limited supply, it is more plentiful in the port area than in any other area in the city. In this situation it is probable that all three groups will expand and perhaps at a faster rate than elsewhere since the availability of relatively low-cost industrial land in sufficiently large amounts gives the port area a comparative advantage.

In this case of plentiful supply our second assumption will not hold since rents need not rise, at least not as rapidly as in those areas where land is limited. Contributing to this situation is the unique treatment accorded to land under port ownership. Port districts are supported by a tax levy which includes up to one mill for general purposes, an additional one mill (for six years) upon the creation of an Industrial Development District, plus an additional amount to service outstanding general obligation bonds.[46] Thus the port district is relieved from the competitive necessity to maximize profits and can choose to sell land at less than market value. If it rents instead of selling, these same conditions apply together with the added attraction that property taxes on publicly owned land leased to private parties are often lower than those on privately held land.[47] The effect of this is to make land prices within the port area lower than elsewhere thus attracting a wider range of economic activities. The result is that relocation of non-water-oriented industry away from the port area will not automatically occur through the market mechanism, but would have to come about through a selection process imposed by the port authority.

To some extent such a selection process does occur at the Port of Tacoma in the form of favorably low sale and rental terms offered to industries the Port wishes to attract. There seems to be a set of priorities with which the Port evaluates industries interested in locating there. First priority is assigned to firms which are export-import oriented and therefore expected to utilize the port's terminal facilities. Here the port is acting in pursuit of the goal of maximizing traffic. The second priority relates to the capital/labor ratio of the industry, preference being given to those firms with relatively high labor input such as assembly plants, fabricators and manufacturers. Firms without claims to consideration on either of these two counts are quoted prices approximating full market value and, in the case of Tacoma, efforts are made to interest the prospective purchaser or lessee in Port-owned industrial sites away from the waterfront area. Despite the relative abundance of available land in the port industrial area, there is still a limited amount of actual water frontage and the present policy of the Port of Tacoma is to withhold this from sale in favor of leasing it on a short-term basis.[48] Still, as recently as 1964 the Port was leasing land formerly occupied by the Tacoma Naval Station to firms with no need for water access, though the area was potentially prime terminal acreage.[49] This suggests that at that time the Port perceived no great need for additional terminal lands. As it is now, this area, called the Port Industrial Yard, constitutes a substantial source of Port revenues, inducing some reluctance to alter the status quo.

The unique position of the ports as public corporations supported by taxes as well as operating revenues enables them to overinvest to some extent in both capital equipment and land. Thus, they can acquire waterfront land for potential terminal use even though the marginal revenue received from it is lower than that obtainable from some alternative use. This is clearly indicated in the statement made by Captain M. D. Adlum, President of the Seattle Port Commission, to the Senate Commerce Committee with respect to the possible sale of Piers 90-91 by the federal government:

> Under normal G.S.A. commercial disposal policies, it is questionable whether Piers 90-91 will remain in use as a marine terminal. Its urban location makes it an expensive piece of real estate. Undeveloped estuary land exists in rural areas which can be developed at a lower site cost than Piers 90-91 if it is sold for its highest economic use. The federal government's current disposal practices, which

> seek the highest dollar return, encourage shoreline spread and undermine coastal zone management objectives...federal programs should encourage and promote the use of surplus waterfront properties for uses most suitable in the total context of coastal zone needs.[50]

In most cases, however, even though they also possess condemnation powers, the ports do pay market value for properties acquired, but their ability to do so rests partly on their status as a subsidized enterprise.

Thus, while our assumption of increasing intensity of use leads to the conclusion that acreage actually required for terminal facilities in 1980 will be only slightly greater than that inventoried for such use in 1963, the amount of land actually acquired by port commissions will likely exceed the quantities suggested in Table 7. Some of this difference can be attributed to a prudent policy of providing a cushion or "reserve" against future land needs. Nevertheless, it should be interesting to compare the short- and long-term expansion plans of the major ports with our previous estimations of requirements.

B. Plans for Port Expansion

1. Port of Seattle

Seattle faces the basic problem of physical constraints on space suitable for expansion. Port of Seattle traffic is shifting into higher value general cargo, especially container traffic, and to handle the expected tonnages for 1975 (Port Authority estimates reach 4.5 million tons by 1975, though Table 2 figures show just over 2.7 million for all general cargo), they have been converting older piers into new additional container facilities. The old grain terminal at Pier 25 is being demolished and the turning basin filled to provide a 32-acre facility that will be completed this year. Terminal 102 was completed in 1970 and provides an additional 25 acres south of Spokane Street. The Port has been negotiating with Shell Oil Co. for the sale of its East Waterway property to the Port to provide additional acreage to Terminal 18, also devoted to containers.[51] A study issued by the Planning and Research Department of the Port of Seattle entitled "Container Terminals 1970-1975: A Development Strategy" maintains that 120-180 acres of container terminal space will be required by 1975. Most of this will come from the modernization of existing piers which the study suggests could be carried out in stages, with the first stage being the Pier 25 complex and the second being the conversion of some of the area from Piers 35 to 48 from general break bulk cargo to containerized cargo. A third stage is the pet project of the Port, but it depends on the federal government. They would like to develop Piers 90-91 with over 200 acres of land into a fully automated, second generation terminal utilizing the unit train concept, but the area which is the former Naval Supply Depot must first be declared surplus and then must be sold to the Port. Development would be expensive but this is about the last large area available for expansion.[52] Thus Seattle's Port Authority sees itself becoming essentially land-limited by about 2000 so that further expansion after that date will for the most part occur elsewhere. Already much of the increased traffic in Forest Products and certain other bulk commodities is moving through Everett and Tacoma as Seattle concentrates in the relatively high value container traffic.

One possible long-range development is the "Sea-Air-Bridge" which involves the linking of seagoing carriers with air freighters through the Boeing Field Complex. Boeing has developed a wide-bodied freighter aircraft which can load 20- or 40-foot containers to provide for rapid intermodal transfer from sea to air. This has been discussed with the Department of Transportation as a possible demonstration project but is not yet definite.[53]

2. Port of Tacoma

As part of a general expansion plan, the Port of Tacoma issued $15,750,000 worth of revenue bonds in September 1971 to finance the development of a terminal complex at the south end of Blair Waterway. The complex is designed to handle logs, bulk cargoes and heavy equipment and will cover 150 acres when completed. The bond prospectus also describes a 29-acre auto import facility and a marina for pleasure craft.[54] The new grain terminal has been described elsewhere and will occupy perhaps 10 acres. Plans therefore call for the development of almost 190 acres of additional terminal land during the next five years whereas Table 8 calls for only about 100 additional acres between 1966 and 1980.

For the long-term future there seems to be little in the way of a specific plan of development; it is more in the form of a general conceptualization. Possible developments include the use of the industrial yard for future terminal facilities when needed; the filling of the area between Piers 1, 2 and 4 and its extension westward to form long deep-water berths; the development of deep-water berths on the Southwest Shore of Commencement Bay (in addition to the grain terminal); the purchase of the Milwaukee Waterway (presently owned by the Milwaukee Railroad) for terminal use, plus further development of Blair and Hylebos Waterways. Their use by large ships is restricted by the Eleventh Street Bridge which limits the height of vessels entering, and there has been some talk of rerouting this traffic around the ends of the waterway, but the cost of such a project has made it impractical thus far.[55]

3. Port of Everett

The Port of Everett's immediate expansion plans consist of the construction of the Hewitt Avenue Terminal which includes a 17-acre landfill behind what the Port calls Piers 1, 2 and 3; demolishment of Pier 2 and construction of a 150 x 800 foot concrete dock on the south side of Pier 3. The proposed use of this terminal will be for container traffic and general cargo. This is scheduled for completion in mid-1973.[56] Subsequent to its completion the Port plans to move on to the filling and construction of a 70-acre wood chip facility located north of Norton Avenue. It would provide facilities for the storage and loading of wood chips, a storage area for logs and, at the north end, would have expanded marina facilities. It is probable that these two facilities will be completed within the next five years and represent medium-range planning.[57]

Over the longer term, Port of Everett plans become more extensive in design, after improvement of what is termed the East Waterway Docks which would apparently expand the area now owned by Western Gear to accommodate five new berths. North of the proposed Norton Avenue terminal and the 14th Street fill would be a boat launching facility and in the area which is presently mostly tidelands used for log storage would be terminals to handle expected Alaskan barge traffic and an Alaskan trainship rail grid. All the land up to Preston Point would be filled out flush to the edge of E. A. Nord and a bridge would be built to connect to Jetty Island. Here the plans become fairly large-scale and discussion of them is postponed to the next section.[58]

C. Large-scale Plans and Superports

In attempting to find means to satisfy this predicted total need of 41,500 acres by 2020, the P.S. & A.W. study concluded that all land "designated in this appendix as being favorable for terminal or water-transport-oriented industrial use" will be utilized as such by 2020. Though it begs the obvious question of what happens after that point (in the second fifty years of the hundred), this conclusion has provided support to several large-scale development plans proposed by the ports, including the Nisqually Delta proposal and the filling of Jetty Island or "Tract Q" at Everett. It might be useful to examine these proposals in light of the previous discussion.

In the past few years there has been much debate over the possible location of a "superport" within the confines of Puget Sound and over the relative merits of various alternative sites. Unfortunately, it is not really clear what is even meant by the term as was pointed out in a statement given by the Port of Seattle at a recent Legislative Council hearing:

> The term "superport" is extremely misleading. In general, it has been applied rather indiscriminately to the following different types of facilities:
>
> 1. A major contiguous land facility comprising several hundreds or even thousands of acres with water access used for a multiplicity of industrial and terminal purposes.
>
> 2. A single large terminal with deep-draft capability specializing in bulk commodities such as grain.
>
> 3. Several contiguous deep-draft facilities specializing in bulk commodities.
>
> 4. An oil refinery terminal with deep-draft capability.
>
> 5. A large complex of refineries on deep-draft tidewater with supporting water-oriented petro-chemical industries.

6. A container terminal complex sufficiently large to comprise a major load center and having deep-draft capabilities.

7. A whole body of water of deep-draft capability such as Puget Sound.

8. Any combination of the above.[59]

As this paper goes on to point out, whether a facility qualifies as a superport depends on what type of facility is being considered. For example, Seattle presently has a deep-draft grain terminal and Tacoma will construct one shortly. Under definition 2 this qualifies them as "superports." But with the completion of Tacoma's terminal any need for further expansion in bulk grain in the foreseeable future is unlikely since the two companies renting those facilities, Cargill and Continental, dominate the export movement of grain for the Northwest. In fact, the outlook is for some diversion of traffic from Columbia River ports.

For Bulk Petroleum traffic, another possible use of superports, it is not clear, according to statements made at the recent Legislative Council hearings, that new terminal facilities would be needed to augment those already at Cherry Point to handle expected oil flows. Furthermore, if and when additional unloading facilities for large tankers do become necessary, they are likely to consist of underwater ship-to-shore pipelines rather than shoreside docks.

Another possibility is the shipment of bulk ore but there is little indication of where a sufficient increase in bulk ore shipments would originate to justify development of superport facilities. This was well expressed in the statement by the Port of Seattle: "If other bulk facilities are needed for ore or coal for example, we think a clearer definition of the potential resource exploitation and movement is needed before these specialized terminals are sited or planned."[60] This may be a long-term possibility but it is hardly on the horizon. Again, if container facilities are deemed worthy of the title "superport," one already exists at Seattle, and when discussing future needs, we are dealing with relatively modest expansion and ongoing modernization. In other words, there will be no sudden jump in the traffic that necessitates building a large-scale complex of terminals all at once; rather, expansion will be incremental.

The only definition that has yet to be considered is the first, and it seems it is in this category that Nisqually Flats and Everett's Jetty Island must fall. But if industrial development is to form a large proportion of the use,we come back to the problem of projecting land requirements for industry. The Everett development plans have obviously relied on the predicted needs outlined in the P.S. & A.W. (and it is worth noting that the latter relied on Everett's plans for development to meet those needs), but if those needs are inflated both because they rely on an excessive rate of expansion and because they include industries which are in fact non-water-related (or related so indirectly they can be an indefinite distance away from the water),then Everett's plans will likewise be excessive.

The idea of filling in the Jetty tideflats area for the purpose of providing terminal and industrial sites apparently was first proposed by the Corps of Engineers in 1950, and the area was at that time labeled "Tract Q." Twelve years later the engineering firm of Tippetts, Abbett, McCarthy and Stratton came out with their first report dealing with the developmental potential of this island, a report that was later enlarged in the 1968 <u>Snohomish River Basin Planning Study</u>, done by the same firm. This study proposed three alternative plans for development, each more extensive. The Port's plan for expansion presented at the recent legislative Council's hearing in Everett modified and combined several aspects of these alternative plans. It proposes to redirect the Snohomish River "in an easterly manner at Preston Point and to press a 60-foot deep settling basin across these flat lands....The continuation of the settling basin at the new river mouth would continue easterly to a point just west of the Weyerhaeuser Kraft Mill. At this point, the channel would be allowed to rise to -30 feet to provide barge traffic..." Tract Q would be filled to provide 1880 acres of industrial sites and jointed to Preston Point by a partial fill and a bridge to enable barge traffic to move up the river. Both the west and east sides of the harbor area would be developed similarly to Plan 3 though there would be more emphasis on mixed use of the island. The only significant upstream modification would be to straighten the river at Lowell and widen it past the Ebby Slough takeoff mainly to allow for the reclamation of 2,000 acres for additional industrial land. Immediately above this would be a rail classification yard for Burlington Northern. The Port anticipates that this development will commence within the next six years.[61]

However, it appears that opposition both from private citizen groups and from the City Planning Department will have to be overcome before work begins on any of the three alternative plans. The City of Everett has sponsored a comprehensive study by Lawrence Halprin and Associates which directly contradicts the Port's proposals in that it recommends the preserving of both the jetty and the floodplain area from development. This is justified both on the grounds that development would conflict with aesthetic and recreational use of the area and that it would greatly increase costs due to flood damage. Finally, they also doubt the economic necessity of creating an additional 3,500 acres of industrial land since they project a maximum of 360 additional acres will be needed by 1990 for the Everett area.[62]

The Nisqually Delta plan was proposed by the Port of Tacoma and would have been located on the Pierce County side of the river, covering about 1,300 acres. A waterway would have been dredged to the east of the river channel providing twelve deep-draft berths with depths of up to 85 feet, and unit trains connected to the Burlington Northern and Union Pacific Railroads would have encircled the terminal area to provide transport linkages. According to the P.S. & A.W. study, the west bank of the river (the Thurston County side) would remain in its natural condition.[63] Conflicting uses which would suffer losses through such development include: agricultural uses; sports fishing and hunting since the area has good runs of salmon and trout besides being a migratory stop for waterfowl; scientific and educational; ecological and aesthetic.[64]

As it now appears, the controversy that arose over the prospect of developing this region has been temporarily resolved in favor of the conservationists. At the recent Legislative Council's hearings in Tacoma, port officials were quoted as saying, "We have no immediate need for the Delta," and Port Commissioner R. W. Copeland apparently feels that the Port has sufficient land for development available within Commencement Bay, and has no plans for using the Delta area.[65] Indeed, it was never very clear just what those unit trains and superfreighters would be hauling though there was the expectation "that bulk cargo including coal, metal ores and some general cargo would be handled."[66]

Most of the momentum behind the development seemed to come from E.L. Perry, general manager of the Port, who described his view by saying:

> When I first took command of that post six years ago, I made an inspection tour of all the rivers in my district--and when I saw the Nisqually Flats my eyes popped out. Right away I decided that here was a perfect place to build a deep-water super terminal, and as soon as I took over the management of the Port of Tacoma three years later, I began making plans to do just that. As for this study of Puget Sound waters, I have every confidence that they will recommend that this region needs all the deep-water facilities it can get, but if for any reason they should rule out the Nisqually Flats as a port site--well, we simply won't accept their decision. After three years of planning we're not about to give up now.[67]

One wonders if this same perspective isn't a large influence in the proposed development of Jetty Island at Everett when the management describes the Port as "a June bride (that) has been sitting on its river bank for 79 years waiting for something to happen."[68]

Conceivably this land could be needed at some future date as a terminal area and, if there is concern about losing it to some other use before such a need develops, perhaps it should be reserved from alternate irreversible development. In the case of Everett, however, this fear seems groundless since the Port owns most of the area in and around the jetty. However, it just doesn't appear that this land will be needed any time in the near future for terminal facilities.

SUMMARY AND CONCLUSIONS

Total traffic projections set out herein call for tonnages handled through all Puget Sound ports to increase more than one-third by 1980 and to slightly more than double by the year 2000. Looking at commodity groups, Table 1 indicates that Forest Products and Bulk Petroleum are projected to increase at rates somewhat lower than the average for all cargoes, while General Cargo is predicted to grow at about the same rate as that for total waterborne commerce, and Dry Bulk at a rate in excess of the overall average. Although Dry Bulk is the largest category in terms of tonnages handled, General Cargo is much more important from the standpoint of the value of cargo and the magnitude of the economic impact it generates. It is, therefore, interesting to note that the predicted growth of export-import traffic in this vital category is consistent with independent projections (cited in the text) of future compound growth rates in excess of 3 percent per annum for the "goods" component of G.N.P.

Turning to the relative position of the various ports on the Sound, our projections imply a gradual shift of traffic in nearly all commodity classes in favor of the three major ports. This does not necessarily mean that any smaller ports will experience an absolute decline in overall volume handled, but rather that traffic growth will occur at higher rates in the large ports. Within the trinity of major ports, Seattle will experience a relative gain in General Cargo but suffer some erosion of its present position in Bulk Grain and Forest Products traffic. Its share of the all-ports, all-cargo total is expected to rise from one-third to about 36 percent by the year 2000. Tacoma will also raise its share of total Puget Sound traffic volume from 14.5 percent to almost 17 percent by the end of the period, making relative gains in nearly every category of cargo. Everett is predicted to make a modest relative gain in the Forest Products category but to handle a slightly reduced fraction of rapidly growing General Cargo tonnage, so that its share of aggregate traffic is anticipated to change very little.

The figures reveal a strong tendency for the fastest growth in high-value cargoes to take place in the larger ports, with smaller ports taking over an increasing share of traffic in bulky commodities characterized by low values per unit of weight or volume.

Converting traffic projections into estimates of terminal land requirements, we arrive at an overall need for additional acreage by the year 2000 which is somewhat higher than that predicted in the P.S. & A.W. But this increase in the aggregate is entirely accounted for by the difference between our estimate of a substantial addition to terminal facilities for handling Forest Products and their assumption that traffic increase in this category up to the year 2000 could be handled on existing terminal sites. For all other traffic categories, except Bulk Grain, our forecasts of additional terminal land needs are lower.

When industrial land requirements are also considered, the total anticipated expansion of port area acreages becomes substantially lower than has previously been predicted. Though our figures are derived from examining only the three major ports, these ports do account for over 55 percent of total traffic on the Sound, and are located in the fastest growing centers of population.[69]

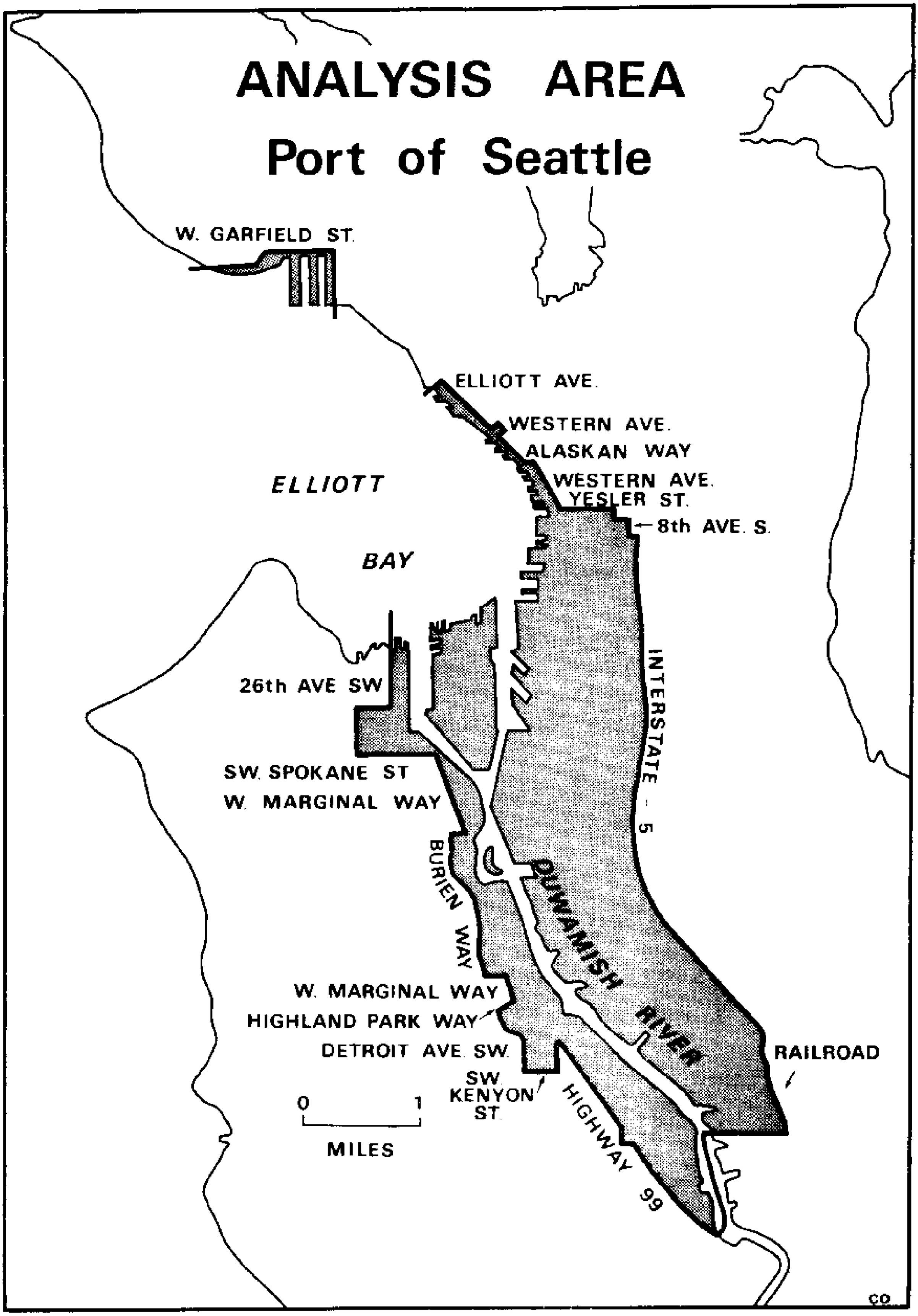
As far as the smaller ports are concerned, our projections indicate no serious difficulties in meeting their land requirements over the forecast period. This same conclusion applies with even greater force to the situation in Tacoma, where relatively abundant supplies of port area land are available. In Seattle, on the other hand, the projected land needs are of such magnitude that accommodating them will require activities with weak water orientation (or declining demand for their products) to relinquish their port area sites. By and large, this process can be expected to take place efficiently through bidding in the private market, although non-market mechanisms will have to be employed in cases where the construction of extensive new terminal complexes necessitates major revisions of the transport network.

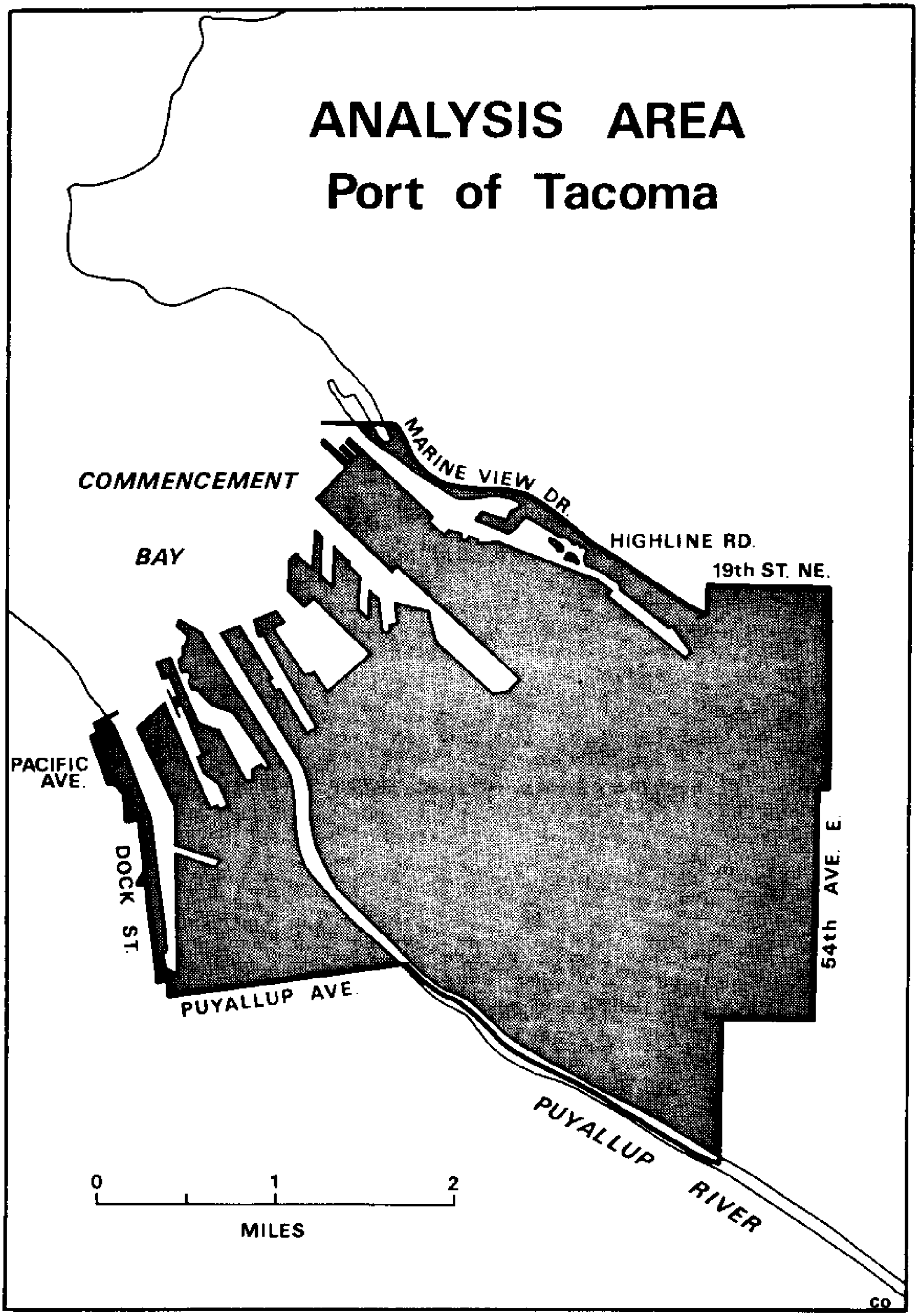
In Everett the situation seems to be one in which the quantity of waterfront land occupied by non-water-oriented activities is not great enough for anticipated port area land needs to be fully satisfied by their displacement through the market mechanism. It may then become advisable to consider the addition of new waterfront land through dredging, filling and/or pier extensions. However, developments of this type on the large scale of those presented in the Snohomish River Basin Planning Study cannot be justified on the basis of the projections made herein.

In dealing with the question of superports on Puget Sound, the conclusions reached depend on the definition employed. Seattle and Tacoma can currently claim to be superports according to some definitions of the term. Both ports already have facilities capable of handling the largest container ships and grain carriers in regular service and both ports can modify existing terminals to service more such vessels as they are built. It therefore appears that the

Nisqually Delta controversy need never have arisen in the form it took, since development of a substantial portion of the Delta for port-related activities during the forcast period cannot be justified on the basis of presently available information.

There remains the question of new facilities to handle projected increases in the flow of Bulk Petroleum, a growing proportion of which will arrive in the very largest vessels, the so-called supertankers. Even if our existing major ports could handle these giants, it would make good sense not to attempt to service them in such busy harbors. As we have pointed out, there are important advantages in unloading such ships at a specialized facility adjacent to a refinery and/or the terminus of a pipeline. Furthermore, it is not clear that conventional port facilities are necessary or desirable, since unloading by underwater pipeline has demonstrated its feasibility. Both our projections and the statements of oil industry spokesmen point to the likelihood of at least one new refinery and petroleum terminal complex on Puget Sound by the end of the forecast period. This location decision will not be reached easily or without controversy but we may take some comfort in the thought that the necessity for such decisions will arise infrequently and that the substantial expansion we predict for all other maritime cargoes will, in general, be accommodated adequately within the boundaries of existing port areas.


ANALYSIS AREA
Port of Seattle
W. GARFIELD ST.
ELLIOTT AVE.
WESTERN AVE.
ALASKAN WAY
WESTERN AVE.
YESLER ST.
8th AVE. S.
ELLIOTT
BAY
26th AVE SW
INTERSTATE 5
SW. SPOKANE ST
W. MARGINAL WAY
BURIEN WAY
DUWAMISH RIVER
W. MARGINAL WAY
HIGHLAND PARK WAY
DETROIT AVE. SW.
RAILROAD
SW. KENYON ST.
HIGHWAY 99
0 1
MILES
CO.


ANALYSIS AREA
Port of Tacoma
COMMENCEMENT
BAY
MARINE VIEW DR.
HIGHLINE RD.
19th ST. NE.
PACIFIC AVE.
DOCK ST.
54th AVE. E.
PUYALLUP AVE.
PUYALLUP RIVER
0
1
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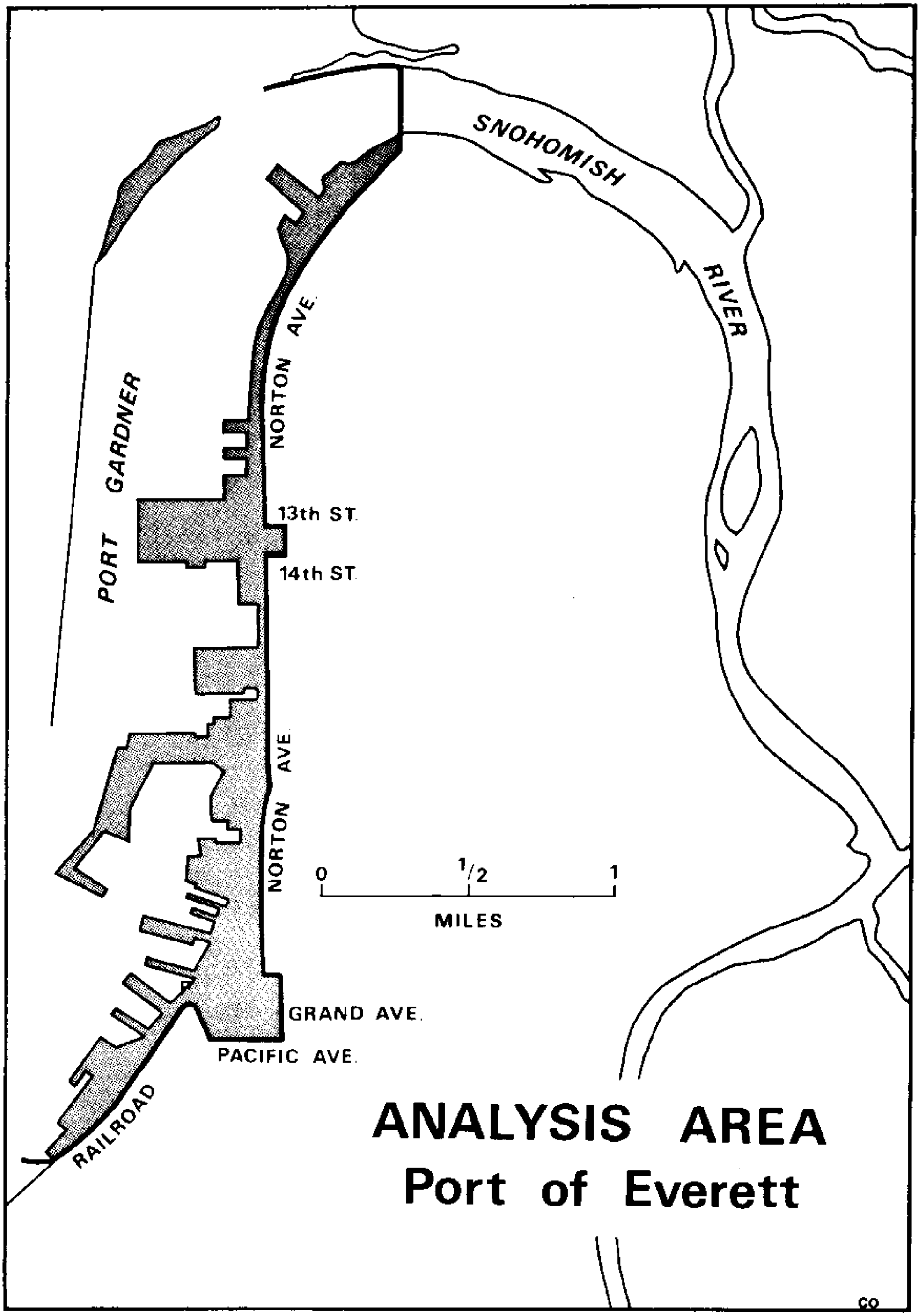
SNOHOMISH
RIVER
PORT GARDNER
NORTON AVE.
13th ST.
14th ST.
NORTON AVE.
0
1/2
1
MILES
GRAND AVE.
PACIFIC AVE.
RAILROAD
ANALYSIS AREA
Port of Everett
CO

TABLE A1: WATERBORNE COMMERCE--SHORT TONS (General Cargo)

	SEATTLE		TACOMA		EVERETT		ALL PORTS	
Year	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.
1952	1,017,336	221,818	286,938	155,594	66,071	11,352	1,578,302	741,350
1953	1,154,219	227,959	198,005	119,363	102,862	11,177	1,646,865	750,536
1954	1,180,295	244,215	229,111	166,817	130,385	11,859	1,798,232	889,591
1955	1,107,369	285,144	190,332	171,426	93,410	16,882	1,610,642	981,778
1956	1,310,089	405,406	194,684	138,086	123,393	18,759	1,824,730	1,317,847
1957	1,167,872	324,928	195,023	95,128	142,323	22,589	1,715,473	1,240,775
1958	1,126,316	187,300	225,928	122,262	135,655	57,043	1,675,942	746,653
1959	1,195,407	301,836	232,173	84,319	151,630	12,359	1,788,756	864,136
1960	1,176,702	312,635	248,351	82,707	216,477	10,228	1,805,338	807,669
1961	1,098,987	367,354	224,428	88,035	203,160	14,133	1,682,022	829,853
1962	1,054,672	361,043	242,454	99,776	163,592	21,480	1,608,577	928,192
1963	1,119,141	360,490	289,458	110,133	164,169	8,794	1,852,765	1,161,169
1964	1,316,394	337,032	252,412	80,537	96,460	10,423	1,918,662	1,145,352
1965	1,514,202	273,265	268,690	78,449	76,870	6,458	2,081,687	813,722
1966	1,709,395	265,621	262,255	80,367	103,342	9,151	2,473,884	1,010,482
1967	1,651,410	220,445	217,449	83,871	106,001	6,984	2,202,858	615,554
1968	1,842,846	259,007	289,838	94,955	102,186	7,357	2,483,223	782,215
1969	2,028,186	378,881	394,026	111,923	128,665	19,271	2,700,493	998,619
1970	1,909,239	280,021	595,452	118,700	133,155	17,911	2,984,994	824,069

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A2: WATERBORNE COMMERCE--SHORT TONS (Forest Products)

	SEATTLE		TACOMA		EVERETT		ALL PORTS	
Year	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.
1952	146,727	1,112,257	188,735	1,315,493	67,342	2,582,817	903,461	12,456,166
1953	157,865	1,146,228	216,640	1,183,204	85,610	2,468,884	1,072,749	12,168,990
1954	179,503	904,607	164,135	925,633	48,077	1,820,705	1,038,914	9,936,410
1955	212,456	945,179	181,254	1,088,628	39,674	2,746,157	880,404	11,950,457
1956	168,902	1,127,042	159,180	1,206,265	30,493	2,484,862	759,672	11,690,906
1957	265,349	854,854	103,660	700,811	54,231	2,328,994	992,321	9,803,444
1958	323,837	778,900	144,621	582,381	29,344	2,042,411	1,126,659	8,329,079
1959	454,957	973,717	144,871	885,110	19,504	2,295,095	1,196,765	10,338,425
1960	359,180	867,580	129,346	691,896	58,871	2,341,010	1,159,155	9,234,505
1961	284,371	711,756	229,824	735,881	87,726	1,528,992	1,289,218	7,430,556
1962	319,563	905,824	281,691	665,623	81,661	1,642,396	1,213,854	8,042,253
1963	364,450	656,981	414,255	576,780	329,180	696,417	1,902,562	5,928,082
1964	460,233	830,850	475,097	714,622	238,061	996,351	2,930,419	6,917,947
1965	410,478	723,564	555,674	891,032	288,278	1,537,495	2,205,993	6,387,129
1966	442,959	782,776	809,138	939,950	350,174	1,750,181	2,693,355	7,407,257
1967	482,965	851,285	1,163,028	807,825	634,021	1,614,307	3,855,562	7,097.948
1968	702,204	918,906	1,517,207	607,827	856,787	1,954,222	5,191,380	7,205,657
1969	595,883	669,053	1,339,330	743,716	780,933	2,894,667	4,997,233	8,956,816
1970	585,915	507,578	1,713,878	639,789	1,315,688	2,890,178	6,474,960	8,194,919

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A3: WATERBORNE COMMERCE--SHORT TONS (Dry Bulk)

	SEATTLE		TACOMA		EVERETT		ALL PORTS	
Year	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.
1952	580,271	1,254,525	576,031	277,716	40,388	104,343	1,678,216	4,499,107
1953	431,599	1,194,288	707,589	298,666	34,514	126,238	1,483,788	4,529,166
1954	315,933	1,377,961	783,592	276,211	37,388	142,168	1,599,813	4,596,440
1955	492,304	1,571,002	850,318	319,713	20,420	99,700	1,973,423	5,045,101
1956	135,522	1,460,365	1,014,408	262,202	31,640	114,243	2,270,870	4,636,696
1957	743,224	2,495,736	964,377	228,724	22,612	126,107	2,402,945	6,892,598
1958	666,879	1,795,300	658,868	182,048	61,723	139,094	2,092,709	5,575,541
1959	821,754	1,923,722	684,028	243,042	57,941	183,972	2,227,227	9,636,374
1960	735,562	2,121,283	748,384	322,531	72,246	137,106	2,426,681	8,464,719
1961	649,558	2,191,848	672,556	332,183	113,005	76,872	2,427,073	6,965,202
1962	671,226	3,233,701	778,430	335,833	202,803	115,001	2,414,623	8,339,167
1963	614,712	3,201,520	1,232,542	422,242	191,092	133,902	2,831,702	8,169,962
1964	769,847	2,480,333	1,157,937	412,045	149,635	149,315	2,884,344	7,100,451
1965	842,807	3,245,496	1,028,585	576,312	176,725	237,467	2,707,276	9,429,666
1966	839,484	3,631,100	1,142,044	407,832	340,705	246,627	2,853,171	9,816,498
1967	1,204,819	2,819,502	1,491,478	488,096	297,999	375,992	3,789,837	10,424,054
1968	1,684,204	4,015,480	1,724,195	487,607	324,640	364,151	4,484,824	11,254,321
1969	1,592,223	6,507,706	1,729,249	609,349	178,594	471,833	4,127,802	16,861,701
1970	1,824,790	3,875,527	2,045,939	513,535	597,420	347,037	5,080,251	10,275,613

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A4: WATERBORNE COMMERCE--SHORT TONS (Bulk Grain)

	SEATTLE		TACOMA		EVERETT		ALL PORTS	
Year	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.
1952	410,284	0	551,606	370	0	0	961,890	370
1953	337,407	0	373,662	322	0	0	711,089	370
1954	259,096	0	302,988	195	0	0	562,084	195
1955	361,695	85,056	514,544	71,530	0	0	876,239	313,187
1956	762,022	56,038	776,357	86	0	0	1,538,379	112,162
1957	1,079,653	340,926	818,636	0	0	0	1,898,289	681,852
1958	672,494	14,000	420,373	0	0	0	1,092,867	27,970
1959	653,595	49,226	341,426	0	0	0	995,036	98,452
1960	862,453	0	881,626	0	0	0	1,694,324	0
1961	824,847	0	648,932	0	0	0	1,474,922	0
1962	543,876	0	428,087	0	0	0	971,963	0
1963	689,529	0	516,448	0	0	0	1,205,977	0
1964	615,486	0	396,092	0	0	0	1,011,578	7
1965	800,767	0	495,309	0	0	0	1,296,205	0
1966	884,894	0	493,172	0	16,464	0	1,394,620	0
1967	957,068	0	443,917	0	0	0	1,401,079	0
1968	749,634	0	285,297	0	491	0	1,035,422	47
1969	810,113	0	304,590	0	0	0	1,315,991	0
1970	1,074,085	0	381,599	0	0	0	1,455,684	90

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A5: WATERBORNE COMMERCE--SHORT TONS (Bulk Petroleum)

Year	SEATTLE F.&D.C.	SEATTLE D.I.	TACOMA F.&D.C.	TACOMA D.I.	EVERETT F.&D.C.	EVERETT D.I.	ALL PORTS F.&D.C.	ALL PORTS D.I.
1952	5,243,185	1,133,652	555,514	404,151	939	97.635	5,963,662	2,317,927
1953	4,933,487	1,090,515	540,880	355,111	0	116,456	5,614,860	2,315,564
1954	4,845,256	1,185,638	497,751	380,602	0	172,086	5,546,178	2,638,282
1955	4,858,776	1,554,562	436,007	590,497	174,166	108,375	5,929.032	4,277,222
1956	4,892,024	1,744,879	413,538	569,455	171,101	75,866	6,899,262	4,658,061
1957	3,696,795	2,212,733	362,620	607,550	99,536	43,356	5,641,121	5,795,540
1958	3,117,438	2,094,100	538,634	578,682	29,728	29,708	7,227,071	6,761,054
1959	3,464,977	2,220,173	469,010	650,172	0	27,566	9,211,647	6,432,071
1960	3,321,863	2,368,339	741,162	627,204	564	32,706	10,114,641	6,967,768
1961	2,984,725	2,499,368	555,582	776,198	5,783	24,511	8,474,480	7,738,869
1962	2,898,951	2,850,554	449,767	848,831	25,078	23,361	7,511,765	8,380,959
1963	2,897,105	2,793,995	599,265	808,335	24,329	19,749	7,944,703	8,107,281
1964	2,673,553	3,479,874	603,532	874,953	165	27,592	8,050,933	9,807,107
1965	2,916,894	2,967,991	643,574	840,950	2,666	53,581	8,774,446	8,779,087
1966	2,992,529	2,115,462	547,484	618,106	0	46,991	7,565,122	6,319,683
1967	2,900,746	2,269,628	552,737	823,965	710	52,902	7,252,560	6,522,817
1968	2,615,655	2,464,430	750,609	945,138	0	54,412	7,657,924	6,449,243
1969	2,710,574	2,454,119	785,291	879,849	9,115	38,064	5,766,832	6,502,905
1970	1,909,286	2,729,999	855,420	906,661	0	44,380	5,442,582	7,018,572

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A6: WATERBORNE COMMERCE--SHORT TONS (Liquid Bulk)

	SEATTLE		TACOMA		EVERETT		ALL PORTS	
Year	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.	F.&D.C.	D.I.
1952	67,167	0	2,887	1,715	3,064	0	73,124	11,888
1953	94,417	0	4,938	0	1,310	0	100,689	737
1954	81,785	0	26,997	31	0	0	108,840	678
1955	98,456	1,200	17,394	1,266	0	0	115,920	2,873
1956	93,367	28,252	11,868	15,926	0	25	105,235	44,481
1957	96,828	51,928	15,932	21,102	0	0	118,836	75,335
1958	85,855	46,400	13,622	7,704	0	0	102,882	54,663
1959	91,585	47,843	18,546	3,151	0	0	124,131	52,829
1960	61,364	52,850	12,718	12,960	0	0	89,158	68,258
1961	97,264	48,101	12,944	13,952	0	0	125,163	72,688
1962	115,816	15,620	9,205	13,822	0	0	137,110	33,291
1963	140,321	8,663	9,348	9,574	0	0	155,625	22,202
1964	104,028	15,426	10,416	14,605	0	0	119,492	31,947
1965	117,691	23,220	11,807	21,565	0	0	132,583	47,556
1966	137,704	15,266	5,131	10,650	0	0	153,069	27,809
1967	107,246	0	12,861	0	0	0	127,027	0
1968	98,650	33,402	31,716	32,756	0	0	138,082	67,145
1969	87,165	132	37,651	0	0	0	129,902	264
1970	85,526	0	64,565	0	0	0	155,591	1,817

Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4.

TABLE A7: COMMODITY GROUPING BY STANDARD INDUSTRIAL CLASSIFICATION (SIC) AND WATERBORNE COMMERCE (WBC) CODES

SIC	COMMODITY GROUPING	WBC
	Bulk Grain	
0103	Corn	100
0105	Rice	101
0102	Barley	102
0107	Wheat	103
0104	Oats	104
2041	Wheat flour & semolina	107
0106	Grain sorghums	108
0109	Grains,nec.	108
	Forest Products	
2311	Logs	400
2412	Rafted logs	401
0871 2414	Posts, poles & piling	405
2413	Wood, unmanufactured, not elsewhere classified	408
2421	Lumber & shingles	413
2431	Wood containers & shooks; cooperage & cooperage stock except empty barrels; plywood & veneers	416
	Railroad ties	417
	Dry Bulk	
2042 0122	Animal feeds (fodders & feeds), not elsewhere classified	110
2061	Sugar	180
0111	Soybeans	231
0112	Flaxseed	232
	Copra	233
	Castor beans	234
0119	Oilseeds, not elsewhere classified, including castor beans	235
0119	Oil seeds, not elsewhere classified, except castor bean	236
	seeds, except castor beans	260
2415	Pulpwood	440
1111	Anthracite coal	501
1121	Bituminous coal & lignite	502
	Coal & coke briquets & related coal products	503
3241	Building cement	523
0129	Field crops, nec.	
1451	Clays & earths	540
1494	Gypsum or plaster rock, including gypsum cements	548
1492	Sulphur dry	550
1411	Limestone, crushed (not suitable for building or monumental purposes	551
1491	Salt	553

TABLE A7: continued

SIC	COMMODITY GROUPING	WBC
	Dry Bulk	
1442	Sand, gravel & crushed rock, except limestone	554
1449 3271 3291	Nonmetallic minerals & manufacturers not elsewhere classified	555
3312	Slag, metal refuse	556
1011	Iron ore & concentrates	600
4011	Iron & steel scrap, including tin plate scrap	602
1061	Manganese, including ferromanganese	613
1081	Chrome, including ferrochrome	614
1051	Aluminum ores, concentrates (alumina) & scrap	617
1021	Copper ore, concentrates, unrefined copper & scrap	620
	Lead ores, concentrates & scrap	640
	Nickel ore, concentrates, scrap, & semifabricated forms	652
1021	Tin ore, concentrates & scrap	660
	Tin ore, concentrates, scrap & semifabricated forms	662
	Zinc ores, concentrates & scrap	670
1091 3321 4012	Other nonferrous ores, concentrates, metals & scrap, except precious in crude & semifabricated forms	682
2810	Sodium hydroxide or caustic soda	827
2891	Other industrial chemicals, except SC	828
2861	Industrial chemicals, not elsewhere classified	829
2875	Ammonium sulphate (fertilizer material)	849
2871	Nitrogenous fertilizers & fertilizer materials, except ammonium sulphate	851
1471	Phosphate rock	852
2873	Super phosphate	854
2872	Potash fertilizer materials	855
2879 1479 2874	Fertilizer and fertilizer materials not elsewhere classified	859
2491	Wood manufacturers, nec.	
	Bulk Petroleum	
2911	Gasoline	507
2914	Gas oil & distillate fuel oil	510
1311	Petroleum, crude	511
2912	Jet fuel, all types	512
2913	Kerosene	513
2915	Residual fuel oil, including bunker oil	514
2951 2918	Petroleum asphalt & products	516
2917	Aliphatic naptha (except motor fuel or gasoline) mineral spirits, solvents, & other finished light aliphatic products not elsewhere classified	518
2916	Lubricating oils & greases	519
2991	Petroleum products, not elsewhere classified	520
	Natural gasoline	522

TABLE A7: continued

SIC	COMMODITY GROUPING	WBC
	Other Liquid Bulk	
2092	Animal oils & fats, edible	020
0161	Animal products, inedible, not elsewhere classified	095
2091	Vegetable oils & fats, edible	150
2062	Molasses, inedible	290
	Vegetable oils, fats & waxes inedible and/or crude	240
1493	Sulphur, liquid	549
2811	Crude & refined coal tar, cyclic chemical tars	801
2818	Benzol or benzene	802
	Other coal tar & cyclic chemical products	805
	Other coal tar & cyclic chemical products, except SC_1	806
2814	Sulphuric acid	825
2813	Alcohols	926

General Cargo--all items not included in one of the above categories.

TABLE A8: RANGE OF TRAFFIC PROJECTIONS BY COMMODITY GROUP (All Ports)

		Actual Data		Projections to 1980			Projections to 2000		
		Average 1967-1970	Year 1970	"LO"	"HI"	"CURRENT"	"LO"	"HI"	"CURRENT"
G.C.	F.&D.C.	2,593	2,985	3,130	3,740	3,440	4,350	7,850	6,000
	D.I.	805	824	870	950	900	900	1,150	1,000
	Total	3,398	3,809	4,000	4,690	4,340	5,250	9,000	7,000
For. Prod.	F.&D.C.	5,130	6,475	7,200	8,810	7,500	10,100	16,200	13,000
	D.I.	7,864	8,195	3,530	5,060	8,000	3,530	5,060	8,000
	Total	12,994	14,670	10,730	13,870	15,500	13,630	21,260	21,000
Dry Bulk	F.&D.C.	4,371	5,080	5,740	7,570	7,000	8,915	23,600	13,000
	D.I.	12,204	10,276	16,930	22,500	19,000	26,300	74,600	36,000
	Total	16,575	15,356	22,670	30,070	26,000	35,215	98,200	49,000
Bulk Gr.	F.&D.C.	1,302	1,456	1,610	1,850	1,900	2,030	2,820	2,900
Bulk Pet.	F.&D.C.	6,530	5,443	6,255	8,250	8,250	6,250	9,580	9,580
	D.I.	6,623	7,019	8,370	11,200	9,000	9,875	16,470	11,000
	Total	13,153	12,462	14,625	19,450	17,250	16,125	26,050	20,580
Liq. Bulk	F.&D.C.	138	156	176	190	190	233	312	300
	D.I.	17	2	-	-	30	-	-	30
	Total	155	158	176	190	220	233	312	330
Totals:	F.&D.C.	20,064	21,595	24,111	30,410	28,280	31,878	60,362	44,780
	D.I.	27,513	26,316	29,700	39,710	36,930	40,605	97,280	56,030
	All Cargo	47,577	47,911	53,811	70,120	65,210	72,483	157,642	100,810

TABLE A9: TIME TREND REGRESSION RESULTS BY COMMODITY GROUP (All Ports)
t-values in brackets for d.f. = 17 or 13)

	Dep. Variable	Data Base	Constant	Time Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	Derived Projections 2000
G.C.	F.&D.C.	1952-70	1,359,523 (12.36)	61,066 (6.33)	0.702	0.685	3,130 (L)	4,350 (L)
	"	1956-70	1,074,444 (6.34)	81,570 (6.14)	0.743	0.724	3,440	5,071
	ln F.&D.C.	1952-70		0.029 (6.73)	0.727	0.711		
	"	1956-70		0.037 (6.31)	0.754	0.735		
	D.I.	1952-70	945,665 (10.27)	- 2,727 (-0.34)	0.007	-0.052	867 (L)	812
	"	1956-70	1,150,483 (7.87)	- 17,616 (-1.54)	0.154	0.089	640	287
	ln D.I.	1952-70	Relationship not significant					
	"	1956-70	" " "					
For. Prod.	F.&D.C.	1952-70	- 433,234 (- 1.00)	263,400 (6.95)	0.740	0.725	7,205 (L)	10,103 (L)
	"	1956-70	-1,910.688 (- 3.30)	369,886 (8.16)	0.836	0.824	8,816 (H)	16,214 (H)
	ln F.&D.C.	1952-70	13.24 (102.43)	0.112 (9.87)	0.851	0.843	14,400	135,000
	"	1956-70	12.72 (96.15)	0.150 (14.44)	0.941	0.939	23,400	520,000
	D.I.	1952-70	11,755,080 (18.59)	-283,524 (-5.11)	0.606	0.583	3,532 (L)	0
	"	1956-70	10,842,480 (9.75)	-231,513 (-2.66)	0.352	0.302	4,129	0
	ln D.I.	1952-70	16.28 (222.55)	- 0.030 (-4.76)	0.571	0.546	5,000	2,720
	"	1956-70	16.21 (113.17)	- 0.027 (-2.45)	0.315	0.263	5,060 (H)	2,950
Liq. Bulk	F.&D.C.	1952-70	91,846 (13.15)	2,986 (4.07)	0.583	0.558	178	238
	"	1956-70	93,502 (8.16)	2,842 (3.16)	0.435	0.391	176 (L)	233 (L)
	ln F.&D.C.	1952-70	11.43 (182.85)	0.025 (4.70)	0.565	0.539	190 (H)	312 (H)
	"	1956-70	11.47 (121.98)	0.023 (3.12)	0.428	0.384	186	298

(Regressions of liquid bulk D.I. traffic against time yielded no significant results for either 1952-70 or 1956-70).

TABLE A9: continued

	Dep. Variable	Data Base	Constant	Time Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	Derived Projections 2000
Dry Bulk	F.&D.C.	1952-70	1,137,077 (5.56)	158,743 (8.85)	0.822	.811	5,741 (L)	8,915 (L)
	"	1956-70	835,630 (2.38)	180,483 (6.55)	0.767	0.749	6,070	9,679
	ln F.&D.C.	1952-70	14.19 (259.64)	0.057 (11.82)	0.891	0.885	7,570 (H)	23,600 (H)
	"	1956-70	14.20 (152.65)	0.056 (7.68)	0.819	0.806	7,470	22,700
	D.I.	1952-70	3,341,153 (4.15)	468,581 (6.64)	0.721	0.705	16,930 (L)	26,301 (L)
	"	1956-70	2,983,812 (2.05)	494,919 (4.33)	0.591	0.559	17,336	27,235
	ln F.&D.C.	1952-70	15.24 (191.09)	0.059 (8.52)	0.810	0.799	22,500 (H)	74,600 (H)
	"	1956-70	15.29 (106.56)	0.056 (4.97)	0.655	0.628	22,000	67,000
Bulk Gr.	F.&D.C.	1952-70	993,099 (6.38)	21,183 (1.55)	0.124	0.072	1,607 (L)	2,031 (L)
	"	1956-70	1,488,221 (7.08)	-14,116 (- .86)	0.053	-0.019	584	301
	ln F.&D.C.	1952-70	13.73 (102.73)	0.023 (1.99)	0.190	0.142	1,850 (H)	2,820 (H)
	"	1956-70	14.17 (88.89)	- 0.008 (- .65)	0.032	-0.043	1,140	968
Bulk Pet.	F.&D.C.	1952-70	6,619,636 (10.01)	56,924 (.98)	0.054	-0.002	8,270	9,408
	"	1956-70	8,496,158 (8.51)	-77,262 (- .99)	0.070	0.002	6,255 (L)	4,710
	ln F.&D.C.	1952-70	15.69 (172.44)	0.008 (1.06)	0.062	0.007	8,250 (H)	9,580 (H)
	"	1956-70	15.95 (117.61)	- 0.010 (- .98)	0.069	0.002	6,360	5,210
	D.I.	1952-70	3,566,148 (4.76)	263,333 (4.01)	0.485	0.455	11,202 (H)	16,469 (H)
	"	1956-70	6,176,961 (6.29)	75,481 (.98)	0.069	-0.003	8,366 (L)	9,875 (L)
	ln D.I.	1952-70	15.00 (103.07)	0.056 (4.39)	0.532	0.504	16,400 (H)	49,000
	"	1956-70	15.61 (113.56)	0.012 (1.16)	0.094	0.024	8,590	10,800

TABLE A10: RANGE OF TRAFFIC PROJECTIONS BY COMMODITY GROUP (Seattle)

		Actual Data		Projections to 1980			Projections to 2000		
		Average 1967-1970	Year 1970	"LO"	"HI"	"CURRENT"	"LO"	"HI"	"CURRENT"
G.C.	F.&D.C.	1,858	1,909	2,238	2,400	2,400	3,171	4,550	4,500
	D.I.	285	280	332	334	335	375	394	380
	Total	2,143	2,189	2,570	2,734	2,735	3,546	4,944	4,880
For. Prod.	F.&D.C.	592	586	860	1,440	900	1,382	6,820	1,400
	D.I.	737	508	443	516	650	207	307	650
	Total	1,329	1,094	1,303	1,956	1,550	1,589	7,127	2,050
Dry Bulk	F.&D.C.	1,577	1,825	2,034	2,830	2,500	3,383	11,300	4,500
	D.I.	4,304	3,876	6,393	10,000	8,000	10,310	44,400	15,000
	Total	5,881	5,701	8,427	12,830	10,500	13,693	55,700	19,500
Bulk Pet.	F.&D.C.	2,534	1,909	446	1,440	2,400	0	582	2,400
	D.I.	2,480	2,730	3,862	5,000	4,200	5,587	12,300	5,600
	Total	5,014	4,639	4,308	6,440	6,600	5,587	12,882	8,000
Bulk Gr.	F.&D.C.	898	1,074	1,231	1,510	1,350	1,787	4,440	1,800
Liq. Bulk	F.&D.C.	95	86	124	125	125	125	164	160
	D.I.	8	0	15	28	15	4	9	15
	Total	103	86	139	153	140	129	173	175
Totals:	F.&D.C.	7,554	7,389	6,933	9,745	9,675	9,848	27,856	14,760
	D.I.	7,814	7,394	11,045	15,878	13,200	16,483	57,410	21,645
	All Cargo	15,368	14,783	17,978	25,623	22,875	26,331	85,266	36,405

TABLE A11: TIME TREND REGRESSION RESULTS BY COMMODITY GROUP (Seattle)
(t-values in brackets for d.f. = 17)

	Dep. Variable	Constant	Time Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	Derived Projections 2000
G.C.	F.&D.C.	884,943 (9.85)	46,664 (5.92)	0.674	0.654	2,238 (L)	3,171 (L)
	ln F.&D.C.	13.77 (222.78)	0.032 (5.92)	0.673	0.654	2,400 (H)	4,550 (H)
	D.I.	275,216 (9.23)	2,028 (0.78)	0.034	0.023	334 (H)	375 (L)
	ln D.I.	12.49 (121.12)	0.008 (0.87)	0.043	0.014	332 (L)	394 (H)
	SEA/All pts.	0.517 (28.05)	0.005 (3.15)	0.368	0.331	0.672	0.762
For. Prod.	F.&D.C.	103,074 (3.28)	26,102 (9.47)	0.841	0.831	860 (L)	1,382 (L)
	ln F.&D.C.	11.92 (138.71)	0.078 (10.38)	0.864	0.856	1,440 (H)	6,820 (H)
	D.I.	1,073,955 (19.32)	-21,770 (-4.47)	0.540	0.513	443 (L)	207 (L)
	ln D.I.	13.90 (201.75)	- 0.026 (-4.33)	0.525	0.499	516 (H)	307 (H)
	SEA/All pts.	0.104 (12.67)	0.0008 (1.07)	0.063	0.008	0.086	0.102
Dry Bulk	F.&D.C.	223,912 (1.93)	62,434 (6.14)	0.689	0.671	2,034 (L)	3,383 (L)
	ln F.&D.C.	12.86 (114.69)	0.069 (7.05)	0.745	0.730	2,830 (H)	11,300 (H)
	D.I.	694,118 (2.06)	195,830 (6.63)	0.721	0.705	6,393 (L)	10,310 (L)
	ln D.I.	13.94 (162.45)	0.075 (9.96)	0.854	0.845	10,000 (H)	44,400 (H)
	SEA/All pts.	0.270 (16.65)	0.0047 (3.33)	0.394	0.359	0.406 0	0.500
Bulk Pet.	F.&D.C.	5,057,678 (25.09)	-159,037 (-9.00)	0.826	0.816	446 (L)	0 (L)
	ln F.&D.C.	15.47 (291.20)	- 0.045 (-9.66)	0.846	0.837	1,440 (H)	582 (H)
	D.I.	1,359,842 (6.43)	86,279 (4.65)	0.560	0.534	3,862 (L)	5,587 (L)
	ln D.I.	14.11 (137.08)	0.045 (5.07)	0.602	0.579	5,000 (H)	12,300 (H)
	SEA/All pts.	0.672 (13.88)	-0.0215 (-5.07)	0.602	0.578	0.049	
Bulk Gr.	F.&D.C.	424,629 (4.84)	27,795 (3.61)	0.434	0.401	1,231	8,787
	ln F.&D.C.	12.91 (89.96)	0.049 (3.89)	0.470	0.439	1,510	4,440
	SEA/All pts.	0.423 (17.22)	0.0148 (6.91)	0.737	0.422	0.852	

TABLE A11: continued

	Dep. Variable	Constant	Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	2000
Liq. Bulk.	F.&D.C.	84,160 (9.26)	1,385 (1.74)	0.151	0.101	124 (L)	153 (L)
	ln F.&D.C.	11.33 (121.64)	0.014 (1.75)	0.153	0.103	125 (H)	164 (H)
	D.I.	23,255 (2.32)	-282 (- 0.32)	0.006	-0.052	15 (L)	9 (H)
	ln D.I.	6.12 (2.74)	0.097 (0.49)	0.014	-0.044	28 (L)	4 (L)
	SEA/All pts.	0.857 (23.99)	-0.008 (- 2.67)	0.295	0.254	0.625	0.465

TABLE A12: RANGE OF TRAFFIC PROJECTIONS BY COMMODITY GROUP (Tacoma)

		Actual Data		Projections to 1980			Projections to 2000		
		Average 1967-1970	Year 1970	"LO"	"HI"	"CURRENT"	"LO"	"HI"	"CURRENT"
G.C.	F.&D.C.	374	595	457	486	500	659	940	950
	D.I.	102	119	48	66	130	0	39	130
	Total	476	714	505	552	630	659	979	1,080
For. Prod.	F.&D.C.	1,433	1,714	2,016	5,180	2,200	3,589	92,100	3,600
	D.I.	700	640	360	485	600	0	285	600
	Total	2,133	2,354	2,376	5,665	2,800	3,589	92,385	4,200
Dry Bulk	F.&D.C.	1,748	2,046	2,230	2,780	2,400	3,471	8,370	5,000
	D.I.	525	514	711	900	800	1,071	2,280	1,500
	Total	2,273	2,560	2,941	3,680	3,200	4,542	10,650	6,500
Bulk Pet.	F.&D.C.	736	855	880	912	900	1,201	1,540	1,400
	D.I.	889	907	1,245	1,590	1,450	1,830	3,980	2,500
	Total	1,625	1,762	2,125	2,502	2,350	3,031	5,520	3,900
Bulk Gr.	F.&D.C.	354	382	309	334	550	117	233	1,100
Liq. Bulk	F.&D.C.	37	65	42	44	65	68	151	110
	D.I.	8	0	17	54	10	16	24	15
		45	65	59	98	75	84	175	125
Totals	F.&D.C.	4,682	5,657	5,934	9,736	6,615	9,105	103,334	12,160
	D.I.	2,224	2,180	2,381	3,095	2,990	2,917	6,608	4,745
	All Cargo	6,906	7,837	8,315	12,831	9,605	12,022	109,942	16,905

TABLE A13: TIME TREND REGRESSION RESULTS BY COMMODITY GROUP (Tacoma)
(t-values in brackets for d.f. = 17)

	Dep. Variable	Constant	Time Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	Derived Projections 2000
G.C.	F.&D.C.	164,172 (4.52)	10,094 (3.17)	0.372	0.335	457 (L)	659 (L)
	ln F.&D.C.	12.13 (120.01)	0.033 (3.57)	0.429	0.395	486 (H)	940 (H)
	D.I.	141,738 (12.14)	-3.214 (- 3.14)	0.367	0.330	48 (L)	0 (L)
	ln D.I.	11.84 (116.17)	-0.026 (- 2.98)	0.343	0.305	66 (H)	39 (H)
	TAC/All pts.	0.137 (11.14)	-0.0007 (- 0.68)	0.026	-0.031	0.117	0.103
For. Prod.	F.&D.C.	-263,432 (- 1.92)	78,615 (6.54)	0.715	0.699	2,016 (L)	3,589 (L)
	ln F.&D.C.	11.29 (52.04)	0.144 (7.60)	0.773	0.759	5,180 (H)	92,100 (H)
	D.I.	1,088,263 (12.79)	-25,129 (- 3.37)	0.400	0.365	360 (L)	0 (L)
	ln D.I.	13.88 (139.40)	- 0.027 (- 3.12)	0.363	0.326	485 (H)	285 (H)
	TAC/All pts.	0.074 (6.64)	0.0047 (4.81)	0.576	0.551	0.210	0.304
Dry Bulk	F.&D.C.	431,907 (3.69)	62,023 (6.05)	0.683	0.664	2,230 (L)	3,471 (L)
	ln F.&D.C.	13.25 (130.22)	0.055 (6.13)	0.689	0.671	2,780 (H)	8,370 (H)
	D.I.	187,887 (5.68)	18,032 (6.21)	0.694	0.676	711 (L)	1,071 (L)
	ln D.I.	12.29 (128.22)	0.048 (5.69)	0.656	0.635	900 (H)	2,280 (H)
	TAC/All pts.	0.145 (10.32)	-0.001 (- 0.81)	0.037	-0.019	0.116	0.096
Bulk Pet.	F.&D.C.	416,017 (9.01)	16,021 (3.96)	0.479	0.449	880 (L)	1,201 (L)
	ln F.&D.C.	12.97 (161.37)	0.026 (3.81)	0.460	0.428	912 (H)	1,540 (H)
	D.I.	396,185 (9.65)	29,257 (8.12)	0.795	0.783	1,245 (L)	1,830 (L)
	ln D.I.	12.94 (180.33)	0.046 (7.41)	0.764	0.750	1,590 (H)	3,980 (H)
	TAC/All pts.	0.087 (9.20)	0.001 (1.13)	0.070	0.015	0.116	0.136

TABLE A13: continued

Bulk Gr.	F.&D.C.	586,663 (7.44)	- 9,589 (- 1.39)	0.102	0.049	390 (L)	117 (L)
	ln F.&D.C.	13.24 (87.07)	- 0.018 (- 1.39)	0.102	0.049	334 (H)	233 (H)
	TAC/All pts.	0.544 (18.85)	- 0.014 (- 5.65)	0.652	0.632	0.14	
Liq. Bulk	F.&D.C.	4,398 (0.72)	1,300 (2.41)	0.255	0.212	42 (L)	68 (L)
	ln F.&D.C.	8.88 (28.20)	0.062 (2.26)	0.232	0.186	43 (H)	151 (H)
	D.I.	5,726 (1.28)	379 (0.97)	0.052	-0.003	17 (L)	24 (H)
	ln D.I.	7.96 (4.11)	-0.103 (- 0.61)	0.021	-0.036	54 (H)	16 (L)
	TAC/All pts.	0.086 (2.26)	0.008 (- 2.50)	0.268	0.225	0.32	0.47

TABLE A14: RANGE OF TRAFFIC PROJECTIONS BY COMMODITY GROUP (Everett)

		Actual Data		Projections to 1980			Projections to 2000		
		Average 1967-1970	Year 1970	"LO"	"HI"	"CURRENT"	"LO"	"HI"	"CURRENT"
G.C.	F.&D.C.	118	133	134	137	135	141	150	150
	D.I.	13	18	8	9	20	3	6	30
	Total	131	151	142	146	155	144	156	180
For. Prod.	F.&D.C.	897	1,316	1,278	5,520	1,400	2,325	28,500	2,400
	D.I.	2,338	2,890	1,800	1,974	3,000	1,720	2,021	3,000
	Total	3,235	4,206	3,078	7,494	4,400	4,045	30,521	5,400
Dry Bulk	F.&D.C.	350	597	708	2,450	700	1,311	99,700	1,500
	D.I.	390	347	596	673	600	1,045	1,750	1,200
	Total	740	944	1,304	3,123	1,300	2,356	101,450	2,700
Bulk Pet.	F.&D.C.	3	0	-	-	10	-	-	10
	D.I.	47	44	44	47	50	50	62	60
	Total	50	44	44	47	60	50	62	70
Totals:	F.&D.C.	1,368	2,046	2,120	8,107	2,245	3,777	128,350	4,060
	D.I.	2,788	3,299	2,448	2,703	3,670	2,818	3,839	4,290
	All Cargo	4,156	5,345	4,568	10,810	5,915	6,595	132,189	8,350

TABLE A15: TIME TREND REGRESSION RESULTS BY COMMODITY GROUP (Everett)
(t-values in brackets for d.f. = 17)

	Dep. Variable	Constant	Time Coefficient	R^2	$\bar{R}^2$	Derived Projections 1980	Derived Projections 2000
G.C.	F.&D.C.	125,239 (6.47)	317 (0.19)	0.002	-0.057	134 (L)	141
	ln F.&D.C.	11.67 (77.96)	0.005 (0.35)	0.007	-0.051	137 (H)	150
	D.I.	19,264 (3.56)	- 338 (-0.80)	0.036	-0.021	9	3
	ln D.I.	9.74 (39.63)	-0.024 (-1.12)	0.069	0.014	8	6
	EV/All pts.	0.060 (6.75)	-0.001 (1.09)	0.066	0.011	0.031	0.011
For. Prod.	F.&D.C.	- 239,310 (-2.32)	52,329 (5.78)	0.663	0.643	1,278 (L)	2,325 (L)
	ln F.&D.C.	9.82 (29.95)	0.197 (6.86)	0.734	0.719	5,520 (H)	28,500 (H)
	D.I.	1,904,645 (3.82)	2,377 (0.06)	-0.001	-0.077	1,974 (H)	2,021 (H)
	ln D.I.	14.44 (47.23)	-0.002 (-0.09)	0.001	-0.076	1,800 (L)	1,720 (L)
	EV/All pts.	0.181 (10.05)	0.003 (1.65)	0.138	0.087	0.268	0.328
Dry Bulk	F.&D.C.	-167,593 (-2.46)	30,181 (5.66)	0.711	0.689	708 (L)	1,311 (L)
	ln F.&D.C.	9.82 (48.81)	0.169 (9.59)	0.844	0.835	2,450 (H)	99,700 (H)
	D.I.	- 54,619 (-1.03)	22,433 (5.39)	0.691	0.667	596 (L)	1,045 (L)
	ln D.I.	11.31 (72.73)	0.073 (5.36)	0.629	0.607	673 (H)	1,750 (H)
	EV/All pts.	0.002 (0.33)	0.002 (5.37)	0.689	0.665	0.060	0.100
Bulk Pet.	F.&D.C.	Erratic fluctuations obscure time trend (see Table A5, Col. 6)					
	D.I.	36,309 (2.99)	278 (0.29)	0.006	-0.070	44 (L)	50 (L)
	ln D.I.	10.35 (34.61)	[illegible] (0.60)	0.027	-0.048	47 (H)	62 (H)
	EV/All pts.	0.017 (6.15)	-0.0004 (-3.90)	0.472	0.441	0.006	

TABLE A16: CATEGORIZATION OF ACTIVITIES WITH RESPECT TO NEED FOR WATER-ORIENTED SITES

Group I(a):	Engage in activities for which direct accessibility to deep water is required because of the water-related nature of their product and/or process.	
	Examples:	Ship and boat builders Marine fitting and repairing Marine construction including dredging Tug and barge operators Log rafting Commercial fishing Public and private terminal facilities
Group I(b):	Direct accessibility to deep water is of significant advantage because one or more important inputs and/or outputs are transported most efficiently by water.	
	Examples:	Sand and gravel Stone, clay products Some chemical plants Some wood products producers Petroleum refineries
Group II:	Activities related to those in Group I by strong backward (suppliers) or forward (customers) linkages which make it advantageous to locate in close proximity to Group I industries.	
	Examples:	Concrete products Wood and paper products Some metal fabricators Some building materials suppliers Seafood processors Petroleum products Import-export wholesalers and distributors Service activities oriented to Group I employers, such as trucking, railways, stevedoring, marine supplies Service activities oriented to Group I employees, such as restaurants, parking areas, some retailers, some professional offices
Group III:	All others. That is, activities which currently derive little or no economic advantage from direct accessibility to deep water and which do not involve close linkages to Group I activities.	

TABLE A16: continued

Examples:	Agriculture
	Residential uses
	Most retailing and wholesaling
	Most service and financial activities
	Construction (other than marine)

REFERENCE NOTES

1. Robert L. Bish, James Crutchfield, Peter Harrison, Mitchell L. Moss, Robert Warren, and Louis Weschler, Coastal Zone Resource Use: Decision-making in the Puget Sound Region, forthcoming, University of Washington Press, Seattle, late 1973 or early 1974.

2. Comprehensive Study of Water and Related Land Resources, Puget Sound and Adjacent Waters, Puget Sound Task Force of the Pacific Northwest River Basins Commission, 1970. The complete report consists of a summary volume and 15 appendices. Material on present and future port activity is concentrated in Appendix VIII, Navigation. Data collection and research for the Navigation Appendix were contributed to and coordinated by the Army Corps of Engineers.

3. Pacific Coast Market & Business, The Bank of California, San Francisco. See p. 5, Vol. 7, January 1971, for Cross State Product in current and constant dollars.

4. Waterborne Commerce of the United States, Part 4 Pacific Coast, Alaska and Hawaii, Department of the Army, Corps of Engineers, published annually. This paper's Appendix Tables A1 to A6 are prepared from detailed data set out in the Part 4 volumes for calendar years 1952 through 1970.

5. Ibid., see "Introduction" pages in Part 4 volumes for detailed list of commodities on which separate records are maintained.

6. Seattle Maritime Commerce and Its Impact on the Economy of King County, Port of Seattle Commission, 1971. On page 22 containerized cargoes for 1969 are shown as totalling 760,000 short tons, which is 31% of total General Cargo tonnage that year. The importance of General Cargo as a source of Port revenue is indicated on page 32, which estimates a direct payroll impact of $78.30 per ton of General Cargo vs. an average of $30.10 per ton over all types of cargo.

7. M. F. Elliot Jones, Economic Growth in the Seventies, National Industrial Conference Board, New York, 1970. Pages 25 and 26 present forecasts calling for U.S. exports to increase at an average annual rate of 6.1% from 1968 to 1975 but at a significantly higher rate of 7.5% from 1975 to 1980. Imports over the same two periods are expected to rise from a rate of 7.6% to 8.5%.

8. U.S. Department of Labor, Bureau of Labor Statistics, The U.S. Economy in 1980: A Summary of B.L.S. Projections, Bulletin 1673, Washington, D.C., 1970. Refer to figures on p. 11. Difference between 4.1% growth and 4.3% is 5% of the base rate.

9. Regression results obtained using 19 annual observations of all-ports F.&D.C. General Cargo tonnages from 1952 through 1970 as the dependent variable:

Constant	Goods Consumption Coeff.	Time Coeff.	R^2	$\bar{R}^2$
319,387 (1.77)	6,643 (9.35)	n/a	0.837	0.828
-568,684 (-1.42)	12,764 (4.89)	-63,284 (2.42)	0.881	0.866

Bracketed figures are t-values for 17 and 16 d.f., respectively. Goods consumption is sum of durables and nondurables excluding services expressed in billions of constant (1958) dollars.

10. Regression results obtained using 19 annual observations of all-ports F.&D.C. Forest Products tonnages from 1952 through 1970 as the dependent variable:

Constant	Construction Coeff.	Time Coeff.	R^2	$\bar{R}^2$
-10,411,650 (-3.67)	306,127 (4.47)	n/a	0.540	0.513
2,414,298 (0.58)	-82,331 (-.69)	317,782 (3.62)	0.747	0.716

Bracketed figures are t-values for 17 and 16 d.f., respectively. Construction is sum of residential and nonresidential expressed in billions of constant (1958) dollars.

11. Regression results obtained using 19 annual observations of all-ports Dry Bulk tonnages from 1952 through 1970 as the dependent variable (first two equations based on F.&D.C. volumes; second two on D.I. volumes):

Constant	Construction Coeff.	Time Coeff.	R^2	$\bar{R}^2$
- 5,072,947 (-3.49)	189,247 (5.38)	n/a	0.630	0.609
2,038,831 (1,02)	-25,831 (-.45)	175,948 (4.21)	0.824	0.803
-16,589,400 (-3.64)	597,485 (5.42)	n/a	0.634	0.612
- 1,094,225 (-0.14)	128,210 (0.47)	383,896 (2.34)	0.727	0.693

Bracketed figures are t-values for 17 and 16 d.f., respectively. See previous note re construction variable.

12. Economic Research Service, U.S. Dept. of Agriculture. Foreign Agricultural Economic Report No. 53, Japan's Food Demand and 1985 Grain Import Prospects, Washington, D.C., June 1969; Food Grain Statistics through 1967, Washington, D.C., April 1968; Foreign Agricultural Report No. 75, World Demand Prospects for Grain in 1980, Table 25, p. 80, Washington, D.C., 1970.

13. Seattle's $5 million grain terminal was completed in 1970. It provides storage capacity for 4.2 million bushels and is capable of loading vessels with drafts up to 73 feet at the rate of 3,000 tons per hour. It is being operated by Cargill, Inc. under a long-term lease with the Port Authority. Tacoma's planned new facility is expected to cost $13 million and to compare with Seattle's terminal in all essential respects including the ability to service vessels of up to 70 feet draft. Completion is scheduled for mid-1973. Operation will be by Continental Grain Co. under a long-term lease.

14. The 1977 date is based on the following minimum time span estimates:

Overcoming remaining legal obstacles	1.5 years
Construction time	3.0 years
Break-in, testing, building up volume	0.5 years
	5.0 Years

Note also that Western Oil and Gas Association spokesmen have asserted that North Slope oil will be shipped into Puget Sound only to the extent required to accommodate growth in Washington and Oregon markets and not for transshipment to eastern or California markets.

15. National Planning Association, Center for Economic Projections, Projection Highlights, Vol. 1, No. 6, Sept. 1970. Table 2, page 3 shows projected 1970-80 growth rates for chemicals industry as 6.0%; primary metals 3.2%; food and kindred products 3.7%. The P.S. & A.W. projections anticipated that traffic in Liquid Bulk would increase at rates consistent with expected growth in the chemicals industry, but actual experience during the most recent four-year period indicates that this anticipation was overly optimistic.

16. See Appendix Tables A1 through A6.

17. Port of Seattle, Annual Report for 1971, page 25. Overland Common Point territory consists of the continental U.S. excluding the nine most westerly states. Cargoes from transpacific countries destined for this area are called OCP cargoes and are granted tariff concessions by inland carriers.

18. U.S. Dept. of the Interior, Bonneville Power Administration, Pacific Northwest Economic Base Study for Power Markets, Vol. II, Part 70 (Aluminum), 1966. See pp. 267 ff. which show the estimated growth rate in primary mill capacity falling sharply from about 9% per annum in the early seventies to 4% or 5% by 1980.

19. See reference given in Note 15 above.

20. Correspondence with Research Division of the Washington State Department of Motor Vehicles, March 1972.

21. See references given in Note 12 above.

22. It is possible, however, for an industry to have a highly inelastic demand and yet be outbid by other uses in which the land yields a higher marginal product. In this case that industry would disappear entirely or move to an alternative port where the demand on land was not as high. As will be noted later, this is the case with forest products in the Port of Seattle. The movement of most forest products, lumber in particular, is fairly land extensive, and the value per ton of product low, but because land is limited in Seattle, more productive uses such as container terminals have bid the land away from forest products and the latter instead is concentrated at other ports where more land is available.

23. The actual shape of this configuration will be influenced by the topography of the waterfront area and the incidence of major transportation corridors. Thus in Seattle, waterfront development follows the Duwamish at least to the point where it becomes too shallow for ocean-going vessels. On the other hand, development will be limited by natural barriers such as high bluffs like those which occur on the northeastern side of Commencement Bay.

24. Charles H. Graves, Forecasting the Distribution of 1985 Population and Employment to Analysis Zones for Plan A, Staff Report No. 15, Puget Sound Regional Transportation Study, (Seattle, Washington, August 1964), Table 10, p. 39.

25. P.S. & A.W., Appendix VIII, Navigation, pp. 2-19.

26. Department of Commerce and Economic Development, Land Requirements for Industry in Washington, (Olympia, State of Washington, 1966), p. 22.

27. Ibid., p. 25.

28. It should be pointed out that projecting an increase in terminal lands by a certain amount is not identical to projecting land requirements of the public port authority since a proportion of the forecast increase in traffic will be handled by private terminals operated by Group I industries. Since their total land requirements have been projected in the foregoing steps, Step 4 involves a certain amount of double counting, thus imparting some upward bias to the estimates. However, nonindustrial uses such as commercial or governmental were not estimated because though employment estimates existed for these sectors there was no real way to convert these to acreage estimates satisfactorily since land-employee ratios are not available for them. This omission would tend to make projections of total land needs somewhat low.

29. Puget Sound and Adjacent Waters Study, Navigation Appendix, pp. 2-51 through 2-56.

30. A. Lyle King, Results of Operational Practices at Elizabeth Port Authority Marine Terminal, report prepared for Port of New York Authority, 1971, pp. 10-16.

31. The inventory of Puget Sound port area land devoted to terminal uses carried out by the P.S. & A.W. study team in 1963 tallied 326 acres in use for General Cargo in the three major ports of Seattle, Tacoma and Everett (refer to bracketed figures in Table 9). Use of this much acreage implied an average of just over 8,000 tons per acre per year for the three ports. However, the corresponding ratio at the newest general cargo terminal on the Sound in the year 1967 was much higher, being approximately 12,000 tons per acre per year. It was this latter figure which was employed in the P.S. & A.W. forecasts of terminal land requirements for 1980.

32. For example, see remarks by E. A. Weymouth, Northwest representative of the Western Oil and Gas Association in the Seattle Times March 26, 1972, p. C9. Also statement presented for the Association at the public hearing held by the Washington State Legislative Council Committee on Parks and Natural Resources held in Tacoma, May 17, 1972.