The ORE BIN
Volume 27, No. 8
August, 1965

NATURAL GAS AND PETROLEUM PRODUCTS PIPELINES IN THE NORTHWEST

By Vernon C. Newton, Jr.*

Introduction

Petroleum supplies the largest portion of energy used in the United States at the present time. Fuel consumption figures for 1962 show that oil provided 43 percent of our energy, natural gas 29 percent, coal 24 percent, and electricity 4 percent (Oil and Gas Journal, 1963). Natural gas consumption is climbing rapidly and some economists predict that gas will continue to provide nearly one-third of the United States' energy through 1980.

In 1957 Oregon and Washington received supplies of natural gas upon completion of the Pacific Northwest Pipe Line Corp. system. The firm was acquired by the El Paso Natural Gas Co. in 1959. Gas is transmitted through this pipeline from the southwestern states and is imported from western Canada on the northern end of the system. Completion of the Pacific Gas Transmission Co. pipeline from Alberta to northern California in 1961 provided the Northwest with three sources: British Columbia, Alberta, and the southwestern states. Domestic and industrial consumption of natural gas in Oregon in 1964 amounted to 49.3 MMMCF (Paul, 1965). [MCF is the abbreviation for 1,000 cubic feet of gas. Each M is equal to multiplying by 1,000.]

Pipelines carrying refined petroleum have not been used as extensively in Oregon and Washington as in some of the other states because of fewer areas of dense population; however, the demand for petroleum products is increasing in these two states. The Salt Lake Pipe Line Co. has supplied the inland area of the Northwest through its 8-inch pipeline since 1950. Refineries in northern Utah supply the Salt Lake system pipeline. Industrial growth throughout the Willamette Valley prompted the building of a products pipeline from Portland to Eugene in 1962 by Southern Pacific Pipe Line Co., a subsidiary of Southern Pacific Railroad. Construction is now under way on the Olympic Pipe Line Co. system between Portland and Seattle to supply those cities with products from refineries in northern Washington. The

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Yellowstone Pipe Line transports oil from refineries near Billings, Mont., to the Spokane area of eastern Washington.

Gas Transmission Companies

El Paso Natural Gas Co.

The El Paso Northwest system provides gas for industry and households in portions of Oregon, Washington, and Idaho (see figure 1). Its executive and operating offices are in El Paso, Tex. Gas is collected into the southern end of the pipeline from fields in the San Juan Basin, N. Mex.; Paradox and Uinta Basins, Utah; Piceance Basin, Colo.; and the Green River Basin, Wyo. Gas from the Peace River fields of British Columbia and Alberta is piped to northwestern Washington, where about 300 MMCF per day is put into the north end of the El Paso system. This gas is purchased from West Coast Transmission Co., a Canadian firm, at the international border near Sumas, Wash. El Paso also purchases 151 MMCF per day from Pacific Gas Transmission Co. at Spokane, Wash. for its customers in eastern Washington and northwestern Idaho. Since El Paso is the licensed transmission company for the northwestern states, any gas taken from the PGT pipeline for use in Oregon, Washington, or Idaho must be transmitted through El Paso's facilities (Paul, 1965).

El Paso delivered an estimated 140 MMMCF of gas to distributing firms in Idaho, Oregon, and Washington in 1964. Considering the purchase price at the wellhead by El Paso, the cost to the distributing companies, and the ultimate cost to the consumer, the value of the gas used in the Northwest in 1964 amounted to approximately $160 million.

In April 1964 the United States Supreme Court ordered El Paso Natural Gas Co. to divest itself of its interests in the Northwest system. El Paso merged with Pacific Northwest Pipe Line Corp. in 1959, following acquisition in 1957 of the latter company's stock. A complete new company will be organized under a divestiture plan approved June 24, 1965, by Judge Ritter for the Federal District Court at Salt Lake City, Utah. The new company will be known as Northwest Pipeline Corp. and will be headed by Glenn W. Clark, former president of the Mississippi River Fuel Corp. The new company will start operations following the transfer of the stock and the liquidation of the El Paso holdings (Paul, 1965).

The new firm will assume control of $243 million in assets of the Northwest system, which includes 2,633 miles of pipelines, 95,220 proven acres of gas leases, and 511 producing gas wells. Reserves are estimated to be 1.7 trillion cubic feet of gas, an approximate 27-year "life index" for the system (Brumbelow, 1965).

NATURAL GAS TRANSMISSION PIPELINES

Figure 1

Pacific Gas Transmission Co.

Pacific Gas Transmission Co. is only one portion of a project sponsored by Pacific Gas & Electric Co. to import natural gas from Alberta, Canada, to its distribution systems in central and northern California. The PG&E project encompasses a 36-inch pipeline 1,400 miles long with an initial delivery capacity of 414 MMCF and an optimum delivery capacity of 800 MMCF per day at Antioch, Calif.

PGT receives its gas supply from Alberta Natural Gas Co. at the international border near Kingsgate, B.C. The gas is then transported 614 miles across the states of Idaho, Washington, and Oregon, where it is delivered toPG&E at the California-Oregon border near Klamath Falls (see figure 1). The pipeline was completed and placed in operation in December 1961. The line was constructed primarily to supply gas to the San Francisco Bay region. However, a portion of the facility's capacity is reserved for the northwestern states.

No significant changes were made in the Pacific Gas Transmission Co. pipeline in 1964. Meter taps were made by El Paso Natural Gas Co. in the 36-inch pipe at Beaver Marsh and Gilchrist to allow service to those central Oregon communities. A tap will soon be made for Chemult. Daily deliveries through the PGT system in 1964 average as follows: California, 425 MMCF per day; Washington, 116.3 MMCF per day; Montana, 30.1 MMCF per day; Oregon, 2.7 MMCF per day; and Idaho, 0.3 MMCF per day for a total of 574.4 MMCF per day (Nabors, 1965).

Hearings were scheduled to begin in July 1965 to consider the application of PGT filed January 12, 1965 with the Federal Power Commission to increase its daily deliveries to PG&E to 600 MMCF per day. If approved, the company would increase its deliveries by 50 percent, or 200 MMCF per day, by 1968 (Paul, 1965). New compressors will be installed in the system, which will increase present transmission by 52,000 horsepower. Cost of the added compressors will amount to $14 million. Oregon will receive $9.2 million of the new installations, or 34,000 of the added horsepower. Compressor stations are planned at Ione, Madras, and Bonanza in central Oregon (Nabors, 1965).

Gas Distributing Companies

Six gas distributing companies, described below, buy gas from El Paso Gas Co. and pipe it to areas in Washington and Oregon (see figure 2). Table 1 gives sales statistics on gas sold in Washington in 1963 and in Oregon in 1964. Sale and distribution of gas is regulated by the Washington Utilities and Transportation Commission and by the Oregon Public Utility Commissioner.

TABLE 1. Sales Statistics.

Sales Statistics - Washington (1963)
(Washington Utilities and Transportation Commission)

Company	Number of therms sold	Revenue	Est. cu. ft. sold (MMMCF)*
Cascade Natural Gas Corp.	301,654,377	$14,806,802	28.0
Columbia Gas Co.	2,433,236	232,455	0.2
Northwest Natural Gas Co.	108,797,901	4,555,634	10.0
Washington Natural Gas Co.	390,143,621	28,473,505	36.4
Washington Water Power Co.	124,529,983	8,431,395	11.6
Totals	927,559,118	$56,499,791	86.2

Sales Statistics - Oregon (1964)
(Oregon Public Utility Commissioner)

Company	Number of therms sold	Estimated Revenue**	Est. cu. ft. sold (MMMCF)*
California Pacific Utilities Co.	50,631,134	$ 3,310,000	4.7
Cascade Natural Gas Corp.	63,464,849	4,150,000	5.9
Northwest Natural Gas Co.	417,300,942	27,340,000	38.7
Totals	531,396,925	$34,800,000	49.3

* Estimates based on 1 cu. ft. = 1,075 Btu.

** Estimated on average 6.51 cents per therm revenue.

California-Pacific Utilities

The Cal-Pac system was organized as an independent company in 1938 with its head offices in San Francisco, Calif., for the distribution of gas and electricity in southern and eastern Oregon and northern California. The company now provides electricity, gas, water, and telephone service in Oregon, California. Nevada, Arizona, Idaho, Utah, and Wyoming. Prior to the advent of natural gas, the company served liquified petroleum-air gas in La Grande in eastern Oregon and in Ashland, Grants Pass, Klamath Falls, Medford, Phoenix, Roseburg, and Talent in southern Oregon. When natural gas became available, the systems were converted: La Grande in September, 1956, Klamath Falls on April 3, 1962, and the other southern Oregon communities in October and November, 1963.

The company has expanded service to the following additional communities: Gold Hill, Central Point, Jacksonville, Winston, Elgin, Sutherlin, Imbler, Rogue River, Canyonville, Myrtle Creek, Dillard, Island City, Yoncalla, and Beaver Marsh.

The construction budget for 1965 was set at $2.4 million. During 1964, the company sold 4.7 MMMCF (Paul, 1965, and Lyman, 1965).

Cascade Natural Gas Corp.

Cascade Natural Gas Corp. was incorporated as an independent company on January 2, 1953. On December 21, 1964, the company provided service in 64 communities, of which 49 were in Washington and 15 in Oregon.

During 1964, Cascade sold about 5.9 MMCF of gas in the following Oregon cities: Madras, Bend, Crescent, Hermiston, Pilot Rock, Athena, Baker, Nyssa, Redmond, Gilchrist, Umatilla, Pendleton, Milton-Freewater, Weston, and Ontario.

The company has three service areas in western Washington: north of Seattle to the Canadian border; west of Puget Sound to Hoquiam on the coast; and the industrialized communities between Castle Rock and Woodland. East of the Cascade Mountains the firm supplies natural gas to 12 communities in the Yakima Valley and 9 other communities in and around Pasco, Moses Lake, and Walla Walla. Construction is under way on facilities to furnish natural gas to the city of La Conner in Skagit County, Wash., late in 1965 (Camp, 1965; Paul, 1965; and Timm, 1965).

Columbia Gas Co.

The Columbia Gas Co. began selling natural gas to residents of Ritzville, Wash., in 1957. Since that time the communities of Endicott, Goldendale, Warden, and Stevenson have been added to the company's service

GENERAL DISTRIBUTION AREAS FOR NATURAL GAS IN THE NORTHWEST

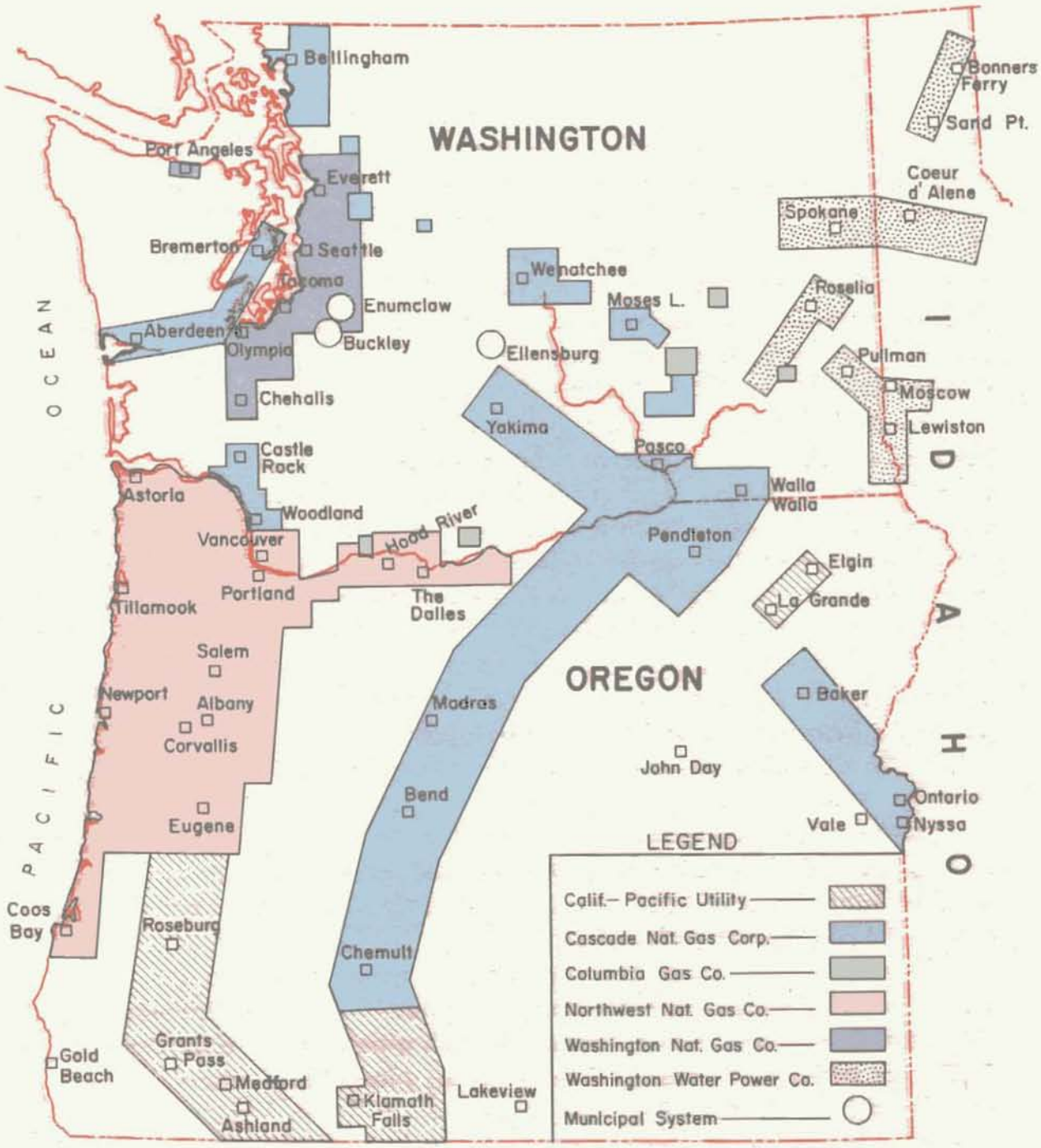

Figure 2

area. Present headquarters of Columbia Gas Co. are at Great Falls, Mont. The firm is a subsidiary of the Hardrock Oil Co. of Montana. It was formerly the Eastern Washington Natural Gas Co. of Ritzville, Wash. The company has no immediate plans for expanding its distribution system in eastern Washington (Lowry, 1965, and Timm, 1965).

Northwest Natural Gas Co.

Northwest Natural Gas Co. is the largest natural gas distributing firm in Oregon, its system encompassing in excess of 4,000 miles of main ranging from one inch to 32 inches in diameter. The firm first began operations by distributing gas made from coal, under the firm name of Leonard & Green Co. In 1913, under the then corporate name of Portland Gas & Coke Co., the company's operation was converted to the use of oil for the production of gas. From October to November 1956, the company again converted its system -- this time to natural gas. On July 1, 1958, the corporate name was changed to Northwest Natural Gas Co.

Since the advent of natural gas in 1956, the company has greatly expanded its operations. At that time it was serving the Willamette Valley from Portland to Albany and the Tualatin Valley to Forest Grove, in Oregon, and Vancouver in Washington. During the past eight years, the company has acquired the liquified petroleum distribution systems serving Camas and Washougal, in Washington, and The Dalles, Eugene, Springfield, Cottage Grove, and Coos Bay in Oregon. All these systems, with the exception of the Coos Bay system, have been converted to natural gas. It is planned to convert Coos Bay about 1967. The company now serves natural gas in 63 incorporated and about 83 unincorporated communities in Oregon. It has also extended its system to White Salmon, Ridgefield, and Battle Ground, Wash.

In March, the company announced plans to construct three transmission lines to extend its system to the Oregon coast during the next three years, at an estimated cost of $16.7 million. Construction of the transmission lines alone will require 300 miles of pipe.

Phase I of the planned program includes extension of the company's system from St. Helens to Astoria and Seaside. The project included the stringing of more than 3,800 feet of 16-inch pipe across the Columbia River near Deer Island by El Paso in March 1965. Northwest Natural Gas has completed the construction of that portion of its line to Wauna, where it is now serving the Crown-Zellerbach plant, and construction is continuing on the rest of the line. The completed line will be 16 inches in diameter to Clatskanie, 12 inches in diameter to a point west of Wauna, where it is reduced to 10 inches to Astoria. A 6-inch line will then extend the system into Seaside. (See photograph page 162.)

Phase II of the expansion involves building a pipeline from Mt. Angel to Newport and Toledo by way of Otis. The 10-inch section of the line from Mt. Angel to Perrydale was completed in 1964. The project from Perrydale to Toledo will be either 10 or 12 inches in diameter, and is scheduled for completion by November 15, 1965. At Boyer an 8-inch lateral will be laid to Hebo, where the line will be reduced to 6-inch to Tillamook and Garibaldi. The transmission line alone for this project will cost about $5 million.

Phase III includes laying a 12-inch pipeline between Cottage Grove and Reedsport, then south to Coos Bay. The south coast pipeline will cost an estimated $6 million. This transmission line is scheduled for completion some time in 1968. Termini of the three coastal laterals are strategically located with respect to offshore oil leases now being explored by several large oil companies. Should gas production be found, it would seem to be an easy matter to utilize the new resource (Paul, 1965, and Gould, 1965).

Washington Natural Gas Co.

Prior to 1956, Washington Natural Gas Co. sold manufactured gas to its customers. In the period 1956 to 1964, it increased its plant investments $3\frac{1}{2}$ times following conversion to natural gas. The company serves 45 communities along a 125-mile route reaching from Marysville in the north to Chehalis in the south. Franchises and applications are pending on the Washington towns of North Bend, Snoqualmie, Winlock, and Toledo. Delivery to these communities is expected by late 1965. Main offices of the company are located in Seattle. The Washington Natural Gas Co. is an independent company (Rockey, 1965).

Washington Water Power Co.

The company supplies natural gas to areas of eastern Washington and northwestern Idaho. The Washington Water Power Co. is an independent organization with its main offices in Spokane. Gas is obtained from the El Paso Northwest pipeline and distributed to communities in the two states in the Lewiston-Clarkston area and in the Spokane and Coeur d'Alene districts. Washington Water Power plans to add to the east end of its service area by constructing a pipeline to Wallace, Idaho; gas will reach mining towns in that area by 1966 (Cannon, 1965).

Washington Water Power Co., Washington Natural Gas Co., and El Paso Natural Gas Co. initiated an underground storage project near Chehalis in May 1963. Gas has been injected into a small structure located by the Pleasant Valley Oil & Gas Co. in 1958. A total of 13 wells has been drilled to date. Of these drillings, two are injection wells, six are

observation wells, and five are water withdrawal wells (Deacon, 1964).

Municipal gas companies

The cities of Enumclaw, Buckley, and Ellensburg, Wash., have their own departments for distributing natural gas. Consumption figures have not been included in this report.

Petroleum Products Pipelines

Olympic Pipe Line Co.

Work began on the Olympic Pipe Line Co. products system in mid-summer of 1964 and completion of the project is scheduled by late this year (see figure 3). A crossing of the Columbia River was made near Sauvie Island in October 1964. Olympic will be a common carrier of refined oils from the Shell Oil Co. and Texaco, Inc., refineries near Anacortes, Wash., and from the Socony-Mobil refinery at Ferndale, Wash. Gasoline, jet, diesel, and heating fuels will be shipped through the pipeline from the refineries to Portland. The 269-mile pipeline is designed to carry a maximum of 135,000 barrels of products daily. The line will be 16 inches as far as Renton, Wash., and 14 inches from Renton to Portland. Spurs totalling 40 miles will also deliver products to marketing facilities in Seattle, Tacoma, and Olympia. Socony-Mobile Oil Co., Shell Oil Co., and Texaco, Inc., share holdings in the pipeline company and they will be the main users of the system. However, other companies will utilize the pipeline also. Head office of the company is located at Bellevue, Wash. (McCarthy, 1965).

Salt Lake Pipe Line Co.

The Salt Lake Pipe Line Co., a wholly owned subsidiary of Standard Oil Co. of California, serves parts of eastern Oregon and Washington (see figure 3). Main offices are located in Salt Lake City, Utah.

The products pipeline between Boise, Idaho, and Pasco, Wash., was completed in 1950. Three years later the pipeline was extended to Spokane. The Boise-Pasco section is designed to carry a maximum of 32,000 barrels per day and Pasco-Spokane section to carry 14,000.

Tank storage for the pipeline fluids is located at marketing centers along the pipeline, as follows: Baker, Oreg., 35,000 barrels; Adams, Oreg., 78,300 barrels; Pasco, Wash., 1,370,260 barrels*; and Spokane, Wash.,

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* 28,000 barrels is transported by barge.

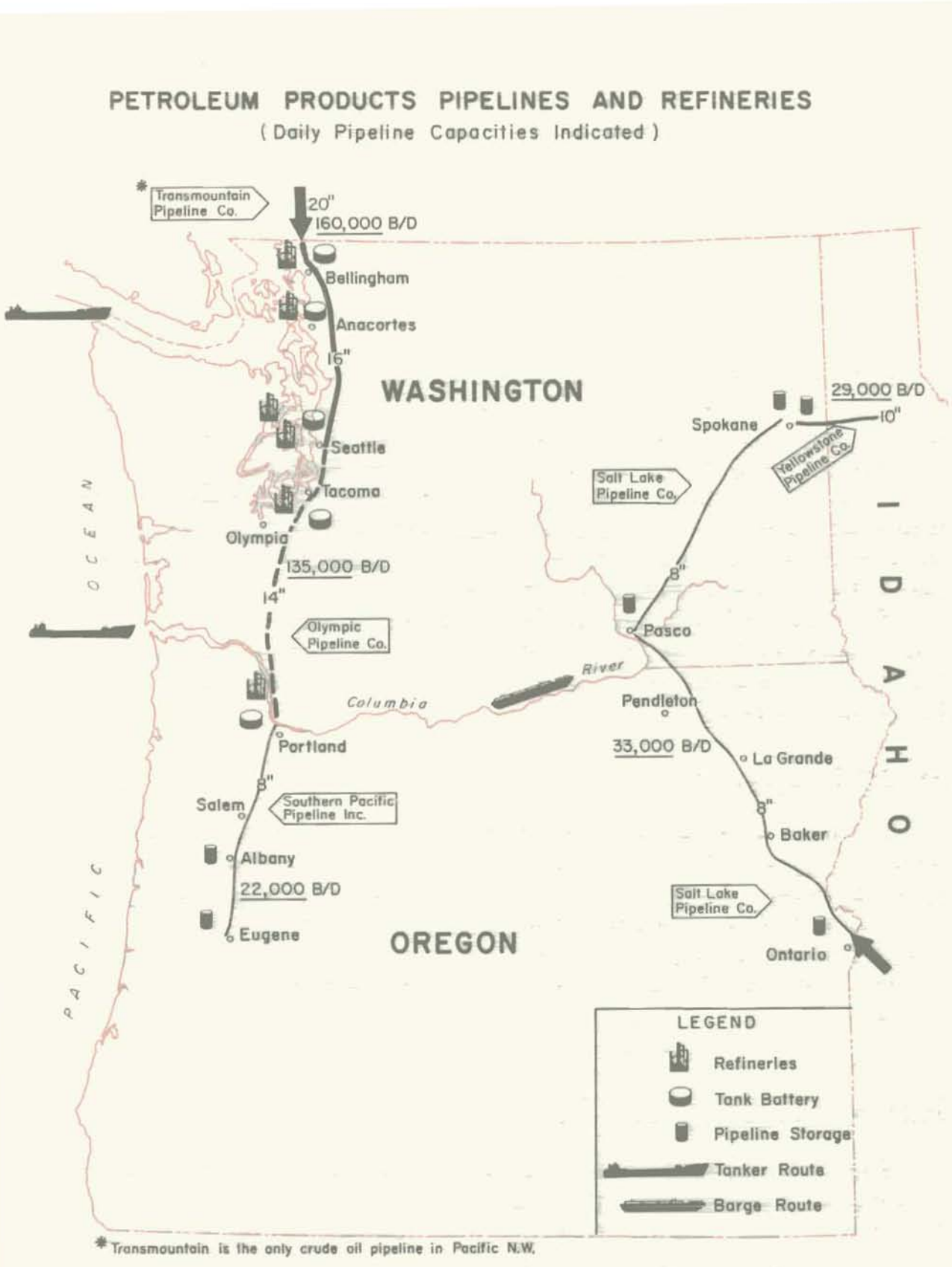
PETROLEUM PRODUCTS PIPELINES AND REFINERIES
(Daily Pipeline Capacities Indicated)
* Transmountain Pipeline Co.
20"
160,000 B/D
Bellingham
Anacortes
16"
WASHINGTON
Seattle
Tacoma
Olympia
135,000 B/D
14"
Olympic Pipeline Co.
Columbia River
Portland
8"
Salem
Southern Pacific Pipeline Inc.
Albany
22,000 B/D
Eugene
OREGON
PACIFIC OCEAN
29,000 B/D
10"
Spokane
Yellowstone Pipeline Co.
Salt Lake Pipeline Co.
8"
Pasco
Pendleton
33,000 B/D
La Grande
8"
Baker
Salt Lake Pipeline Co.
Ontario
IDAHO
LEGEND
Refineries
Tank Battery
Pipeline Storage
Tanker Route
Barge Route
* Transmountain is the only crude oil pipeline in Pacific N.W.

Figure 3

1,091,000 barrels*. Pasco is the terminus for barge traffic up the Columbia River. Because of its location on rail and water transportation, it is the central distribution point for marketing to the inland area of eastern Washington and Oregon and western Idaho (Baxter, 1965).

Southern Pacific Pipe Lines, Inc.

An 8-inch pipeline owned by Southern Pacific Pipe Lines, Inc., San Francisco, Calif., connects cities in the Willamette Valley of western Oregon with supplies of petroleum brought to Portland by ocean tankers (see figure 3). The 113-mile pipeline was constructed at a cost of $7 million. Gathering lines totalling 12 miles in length collect products from oil company storage along the Columbia River in northwest Portland.

A plant consisting of 15 tanks capable of storing 120,000 barrels of oils is located at Albany. A second and larger facility comprising 30 tanks is situated at the end of the pipeline near Eugene. Capacity of the Eugene tank battery is approximately 300,000 barrels.

The Southern Pacific pipeline is used by all the major oil companies which market in the area. Refined oils are shipped intermittently through the pipeline, depending on demand. Capacity of the pipeline is 22,000 barrels per day (Morgan, 1965).

Yellowstone Pipe Line Co.

Petroleum products gathered and refined near Billings, Mont., are shipped through a 10-inch line owned by the Yellowstone Pipe Line Co. to Spokane, Wash. (see figure 3). Yellowstone is owned and operated by the Continental Oil Co. Capacity of the system is rated at 29,000 barrels per day. Offices of the pipeline company are located at Ponca City, Okla. (Wright, 1965, and Governors' Special Study Committee, 1964).

Crude-oil Pipelines

Trans Mountain Oil Pipe Line Co.

Only one crude-oil pipeline has been constructed to the Pacific Northwest thus far (see figure 3). This is a Canadian system operated by the Trans Mountain Oil Pipe Line Co. (U.S. subsidiary named Trans Mountain Oil Pipe Line Corp.). Offices of the firm are located in Vancouver, B. C. Crude oil is transported through a 24-inch line from fields near Edmonton,

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* A portion of the storage serves the Yellowstone pipeline.

Alberta, to the company's tank farms at Burnaby, B.C., and Sumas, Wash. The capacity of the system is 250,000 barrels per day. Addition of two sections of 30-inch line and pumping stations will increase the capacity to 300,000 barrels per day.

A 20-inch extension was constructed in 1954 from the international boundary to refineries in northern Washington. Average daily deliveries of crude in 1964 were approximately as follows (Sheasby, 1965):

Vancouver, B.C.	72,324 barrels per day
Ferndale, Wash.	33,000
Anacortes, Wash.	94,115
Edmonds, Wash.	3,760
Seattle, Wash.	3,000
Tacoma, Wash.	11,740
	217,939 barrels per day

Refineries in the Pacific Northwest

The U.S. Bureau of Mines reports the following capacities for refineries in the Pacific Northwest in 1964:

Mobil Oil Co.	Ferndale, Wash.	39,000 barrels
Shell Oil Co.	Anacortes, Wash.	63,500
Texaco, Inc.	Anacortes, Wash.	50,000
Union Oil Co.	Edmonds, Wash.	4,000
U.S. Oil & Ref. Co.	Tacoma, Wash.	12,500
American Bitumels & Asphalt Co.	Portland, Oreg.	7,000

Petroleum Supply and Demand

The marketing of petroleum fuels in the Northwest has developed into a very sophisticated business involving huge pipeline facilities, ocean transport, and river barging. Each new facility has extra capacity designed in it for growth, indicating that oil companies expect the area to prosper. The major portion of the refined petroleum entering the Northwest comes by ocean freighter from California. More than two million barrels of foreign crude oil from the Persian Gulf and Venezuela were unloaded from supertankers at Anacortes in 1963.

Construction on 16-inch gas line near Rainier, Oregon, 1965 (Photo courtesy of Northwest Natural Gas Co.).

Petroleum products comprised 50 percent of the shipping at Portland docks in 1964 and approximately 55 percent at the Port of Seattle. A total of 6.5 million tons of petroleum reached the Port of Portland by ocean tanker in 1964, and 4.9 million tons were unloaded at Seattle (tonnage includes asphalts and nonclassified petroleum products). About 75 percent of the shipments received at Seattle were rerouted and 1 percent of the petroleum shipments received at Portland were reshipped. A brief review of marketing reports (table 2) gives a general idea of the petroleum supply-demand organization in Oregon and Washington.

Given below are figures for the amount of petroleum used in these two states in 1962 and net receipts of petroleum in 1963. Although data available are for different years, the total amounts are in fairly close agreement.

Amount of petroleum used*, 1962 (from "Petroleum Facts and Figures," American Petroleum Inst., 1963):

Oregon	35,348,000 barrels
Washington	56,169,000 barrels
Total	91,517,000 barrels

Total net receipts of petroleum*, 1963 (from figures supplied in this report):

Domestic crude: freighter	2,800,000 barrels
Foreign crude: pipeline	46,000,000 barrels
freighter	2,300,000 barrels
Refined products: Salt Lake Pipe Line	5,000,000 barrels
Yellowstone Pipe Line	4,000,000 barrels**
Refined products:	
Coastwise freighter	32,343,000 barrels
Foreign freighter	374,000 barrels
Total	92,817,000 barrels

* Excluding road materials

** Estimated

Approximately 8.5 percent of the petroleum received at the Portland docks is barged up the Columbia River to inland markets (table 3). Many of the river barges are constructed with oil tanks in the lower hull and grain hoppers above. Upriver hauls are made with petroleum and downriver hauls consist of grains. Pasco, Wash., is the main upriver destination of products.

TABLE 2. Ocean shipments of petroleum commodities, Washington-Oregon, 1963*.

Ocean Shipments into Puget Sound, Washington[1]
(Short Tons)

Commodity	Foreign		Domestic	
	Imports	Exports	Receipts	Shipments
Gasoline	9,633	8,466	1,148,620	1,876,368
Gas-oil, distillate fuel oil	-	140	1,310,363	765,229
Crude oil	385,659	-	220,095	-
Jet fuel	23,159	-	194,330	276,605
Kerosene	-	-	-	16,477
Residual fuel oil	44,825	17,235	878,204	231,594
Aliphatic naphtha	-	-	14,537	87,154
Lubricating oil, grease	-	737	66,988	5,029
Totals	463,276	26,578	3,833,137	3,258,456

Ocean Shipments into the Columbia River and Pacific Ports, Oregon[2]
(Short Tons)

Commodity	Foreign		Domestic	
	Imports	Exports	Receipts	Shipments
Gasoline	-	-	2,453,514	14,795
Gas-oil, distillate fuel oil	-	-	1,879,415	36,008
Crude oil	179	-	245,893	-
Jet fuel	-	-	86,742	-
Kerosene	-	-	357	-
Residual fuel oil	17,296	-	890,118	765
Aliphatic naphtha	-	-	21,236	12
Lubricating oil, grease	51	6,083	110,634	9
Totals	17,526	6,083	5,687,909	51,589

* Original data obtained from Waterborne Commerce of the U.S., 1963: U. S. Corps of Engineers, District Office, Portland, Oreg.

1 Includes ports of Seattle, Grays Harbor, Tacoma, Everett, Anacortes, Bellingham, Port Angeles, and Olympia.

2 Includes ports of Portland, Yaquina, Astoria, and Coos Bay, Oreg., and Vancouver and Longview, Wash.

TABLE 3. Barge shipments on the Columbia River for the calendar year 1964*

Commodity	Unit	Through Bonneville Dam		Through The Dalles Dam	
		Upstream	Downstream	Upstream	Downstream
Gasoline	Gals	43,746,424	1,941,559	40,417,243	1,941,559
	Bbls	1,040,000	46,400	962,000	46,400
Stove oil	Gals	11,295,833	255,000	10,765,925	255,000
	Bbls	267,500	6,014	256,000	6,014
Diesel oil	Gals	31,769,565	212,473	28,586,418	212,473
	Bbls	756,000	5,010	680,000	5,010
Misc. petroleum products	Gals	31,469,061		31,558,536	
	Bbls	748,000		753,000	
Totals	Bbls	2,811,500	57,424	2,651,000	57,424

* Waterborne Commerce of the U.S., Part 4, 1964; U.S. Army Engineers District Office, Portland, Oregon, Commercial Statistics Section. Preliminary figures, subject to revision, obtained from Lockmaster's Reports. Amounts shown in barrels were calculated from gallonage figures.

Acknowledgments: The author is very grateful to W. A. Paul, Director of Utilities, office of Oregon Public Utility Commissioner, and to R. D. Timm, Secretary of Washington Utilities and Transportation Commission for offering many helpful suggestions and for supplying much factual material for this report.

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THE RECOGNITION OF METEORITES

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After a meteorite has fallen to the surface of the earth, it becomes an object of concern to geologists, rockhounds, and even farmers and gardeners. In fact, the entire science of meteoritics is dependent on the alertness of many groups, both professional and lay, for the recovery of either old or newly fallen specimens. The writer, as well as the Oregon State Department of Geology and Mineral Industries, has received for identification from many well-meaning individuals a variety of rocks assumed to be different and meteoritic. Neither the Department nor the writer has yet found one meteorite among these rocks. However, it is hoped that, as more people become familiar with meteoritic characteristics, new meteorites of the Pacific Northwest will be made known.

The identification and subsequent recovery of meteorites is particularly difficult in this area because of the presence of so many volcanic rocks. While some meteorites resemble terrestrial volcanic rocks, they also have properties which are quite different.

In general, meteorites fall into one of three broad classes: (1) the irons, which are made up of a nickel-iron alloy; (2) the stones, which may have a gray to brown silicate groundmass through which small nickel-iron particles are distributed; and (3) the stony irons, which form an intermediate class. Of the stony irons, the Pallasites are best known, being formed of a metallic network in which the cavities are usually filled with crystals of the mineral olivine.

There is no single criterion by which all meteorites can be identified. The following points are useful in assessing an unusual specimen to determine if it is a meteorite:

1. Meteorites are heavier than ordinary rocks. The specific gravity ranges from about 3.0 for some stony varieties to about 8.0 for the iron, while most terrestrial rocks have a specific gravity well below 3.0. They are not porous or hollow, nor do they resemble cinders. The stony meteorites resemble terrestrial rocks and are often mistaken for them.

2. Meteorites are magnetic. The irons and stony irons are strongly attracted; the stony variety is only slightly attracted by a strong magnet.

3. Newly fallen meteorites usually have a black fusion coat and have shallow pits resembling thumb prints. Meteorites which have been exposed long to the weather may be brown or covered with rust, depending on the length of exposure.

4. On grinding a meteoritic specimen with an emery wheel, bright, shiny nickel-iron alloy becomes visible. The nickel-iron ranges from tiny specks in stony meteorites to the entire mass in the irons.

5. Meteorites are irregular in form and may be almost any shape. A number of known meteorites are cone shaped, but none are as round as a ball.

6. All meteorites contain the element nickel. A test for nickel is usually best done by a scientist.

7. When the polished surface of an iron meteorite is treated or etched with dilute nitric acid, characteristic patterns known as Widmanstatten figures are formed. Terrestrial alloys do not form Widmanstatten figures. Etching is usually best done by a scientist.

Meteorites, particularly those that are newly fallen, are of value as objects of scientific study and research. They are, however, of little value in the hands of an untrained individual. While there is a great similarity among all meteorites of any one class, there are also differences which are of concern to specialists. Therefore, every new meteorite is of interest to science, since it may possess properties that are somewhat unique.

If, on the basis of the above criteria, a reader feels that a known specimen is a meteorite, a small sample should be cut off without mutilating the main mass and should be sent to the State Department of Geology and Mineral Industries or to the writer for more exhaustive examination. In the case of a small meteorite, the entire specimen may be sent. The examination and evaluation of the specimen is done free of charge and the piece will be promptly returned. If the specimen proves to be meteoritic, an offer for purchase can usually be arranged.

Since it is impossible that a scientist always be present at the site of a new discovery, the addition of new meteorites for research depends largely on the ability of many lay people to recognize meteorites when they see them and on their willingness to submit specimens for scientific examination and recording in the literature.

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WATER RESOURCE PUBLICATIONS AVAILABLE

Two water-supply papers of interest, one concerned with ground water in the east Portland area and the other a non-technical report on lakes and rivers in Oregon, have been published by the U.S. Geological Survey and may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Water-Supply Paper 1793, "Ground water in the east Portland area, Oregon," by G. M. Hogenson and B. L. Foxworthy, is $1.00. Water-Supply Paper 1649, "Water in Oregon," by K. N. Phillips, R. C. Newcomb, H. A. Swenson, and L. B. Laird, is 60 cents.

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