The History of the Portland District
Corps of Engineers * 1871 - 1969
This history of the Portland District was researched, and edited by Henry R. Richmond III, a graduate of the University of California at Berkeley where he was a history major.
FOREWORD

Since arriving in Portland in July 1967 to become District Engineer, I have had many opportunities to acquaint myself with the long, colorful history of the Portland District.

One hundred years ago, the work of the District consisted of small, simple, almost quaint efforts to improve navigation. Pulling snags from river waterways, cutting a bar to seventeen feet with a primitive old bucket dredge, or dynamiting rocks out of the Columbia River are representative of the work done in the early days. By comparison, the massive, complex dams built by the District in modern times have made significant changes in the Columbia and Willamette river valleys.

The story of how and why the District has progressed from small dredging and snagging activities to a great multiple purpose construction program is a very interesting one.

Even more worthwhile is the story of how the work of the District has contributed to the welfare of the people of the Northwest. As this history explains, the work of the Corps helped to open up the Northwest. The prosperity of Portland and the Willamette Valley depended in large part on the early navigation projects of the Portland District. The Oregon Coast has been opened up to shipping by large jetty and dredging projects. Today's great dams are a basic part of the region's economy.

I am pleased that this history has been written during my tour of duty with the Portland District. It is a record in which Corps employees can take great pride. I commend this history to the attention of District employees, and to interested members of the public.

ROBERT L. BANGERT
Colonel, Corps of Engineers
District Engineer
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HISTORY OF THE PORTLAND DISTRICT

## FOREWORD

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PART I

BACKGROUND
1. Origins

The Corps of Engineers is not a new organization. It traces its origins to the earliest days of the Republic. On June 16, 1775, the day before the Battle of Bunker Hill, General George Washington created the first engineering unit in the Army by appointing one engineer and two assistants. Their first work was the fortified breastworks which are seen in the paintings of that famous battle. The Continental Congress approved the new organization, but on only a temporary, war-time basis. Upon the completion of the Revolutionary War, the young nation was so beset with financial and constitutional difficulties that the Continental Army Corps of Engineers was dissolved. The Army itself eventually numbered only eighty men shortly after the Battle of Yorktown.

Threatening developments from across the Atlantic and, to a lesser extent, on the Western Frontier encouraged Congress to establish the Corps of Artillerists and Engineers in 1794. The staff of the organization was composed almost completely of Frenchmen, including M. Pierre L'Enfant, the designer of Washington, D.C. The chief responsibility of the Corps of Artillerists and Engineers was to establish fortifications along the Canadian Border and the Atlantic Seaboard. For eight years the Corps of Artillerists and Engineers was basically a small, provisional military arm of the United States government.

In 1802, during the administration of Thomas Jefferson, the Congress established the present Corps of Engineers on a permanent basis, replacing the short-lived Corps of Artillerists and Engineers. A complement of five officers and ten cadets were directed to station themselves at West Point, the new U. S. Military Academy established by the same act. Jonathan Williams was appointed Chief Engineer. Since 1802, most Corps of Engineers officers have been high-standing graduates of the Academy.

President Jefferson found the country faced with mounting threats to its security. Relations with the British were becoming increasingly worse.
Captain Meriwether Lewis, left, and Captain William Clark led the famous Lewis and Clark expedition to the mouth of the Columbia River in 1804-06.
There was great concern that Napoleon had designs on the immense Louisiana Territory. But when the French government found itself in a position no longer able to expand into North America, and anxious to prevent the spread of British influence into the area, France accepted Jefferson's offer to buy the territory for fifteen million dollars. By one stroke the Louisiana Purchase more than doubled the land area of the United States and secured by treaty its claim to the territory against the major powers of the world. Of equal importance is the effect which the Purchase had upon the spirit and the imagination of the American people. The conditions of the frontier and the wilderness, the opportunities available to the adventurous, and the great wealth of the land all permanently influenced the American character. For nearly one hundred years the constant beckoning of distant mountains and rivers laid America's destiny squarely at her feet: expansion to the Pacific.

It is the Louisiana Purchase which links the history of Oregon, and the activities of the Corps of Engineers, with these very early days of the United States. Shortly after the negotiations for the Purchase had been completed, Jefferson appointed the two Army Captains, Meriwether Lewis and William Clark, to lead an expedition across the uncharted continent to the mouth of the Columbia River. Their principal aim was to find "the most direct and practicable water communication across this continent." There was reliable knowledge of the existence of the Columbia since it had been discovered in 1792 by the American sea captain, Robert Gray. He named the river for his ship. But of the rest--of the vast extent of the land spreading to the north and west of the mouth of the Missouri to the Pacific Ocean--the only sources of information were the tales of trappers who had ventured into the edges of the area, and the legends of the Indians.

Beginning in the spring of 1804, the expedition progressed up the Missouri to its headwaters, ported to waters of the Columbia, and canoed to its mouth. The winter of 1805-06 was spent at the mouth of the Columbia River where the party erected Fort Clatsop. Captains Clark and Lewis put their backgrounds in engineering and science to good use not only in successfully forging their way across the wild country, but in recording the nature of the land which they encountered. Extensive notes were made of the mountains and rivers, of the plant and animal life, of soil and climate, and of the Indians. A map was fashioned from the notes of the two men and relied upon for decades. Although the exploration foreclosed the age-old dream of a waterway across the continent, and indicated the difficulties to be faced if the land were to be settled, it also dramatically informed the people of the vast richness of the nation. This is the most important result of the expedition. More than the legal consequences of the expedition ever could have done, Lewis and Clark strengthened the claim of the United States on the "Oregon Country" by focusing the nation's attention upon it.

Until 1824, the Corps had worked mainly on military projects. Some public works were done--mainly navigation improvements such as lighthouses,
piers, jetties, a few small canals and some dredging—but the President was as likely to assign the work directly to a private concern as he was to the Corps. Occasionally the President would direct that the Corps be of assistance to a state or other organization making an internal improvement of some kind. But by law and by policy, civil construction was not a basic responsibility of the Corps. Projects were rather small and uncomplicated in those early days, and easily could be contemplated by organizations smaller than the Federal government. Moreover, the states guarded their power with considerable jealousy; it was not assumed that the Federal government had the constitutional authority to engage generally in public works.

But the developments after the War of 1812 required that this policy change. The war had largely eliminated hostile activities of foreign powers, and important segments of Indian resistance to white expansion had been defeated. For the first time the nation was able to turn to the development of the Ohio and Tennessee valleys. There was a great need to build roads and canals and to improve internal waterways so that commerce and communication could better tie the nation together. President John Quincy Adams also saw the need for further explorations of the Far West so that its economic and commercial potential might be better understood.

In addition, the improved channels of communication would tie the area closer to the United States. Thus, in 1824, the Board of Engineers Internal Improvements Act established the Corps of Engineers as the civil works construction arm of the United States Government. Under the legislation, the Corps was empowered to make surveys, plans and cost estimates for river and harbor projects. For fifteen years following the passage of the Act there was a flourish of activity which was not again equalled until after the Civil War.

1/ Though the Erie Canal, a project of the State of New York, is a notable exception. It opened in 1825.
2. Exploration

While the main aim of the Lewis and Clark Expedition had been to strengthen the claim of the nation to the territory contained within the Louisiana Purchase, further Army explorations looked to develop and settle the land. In 1832, Captain Benjamin L. E. Bonneville, an 1815 graduate of West Point and a protege of Lafayette, requested a leave of absence from the Army so that he could lead an exploration to the Oregon country. Bonneville was interested in the fur trade of the area, but his training in engineering at the military academy was put to good use. Captain Bonneville, taking a more southerly route than that of Lewis and Clark, charted extensive sections of what was later to become the Oregon Trail. He demonstrated to the doubters that wagons could be utilized in the trip west. Bonneville made extensive notes of the agricultural lands, the timber of the area and of fur-trading possibilities. He reported to Washington, D.C. that,

"As to the cultivation of the bottom of the Columbia, the lands are of the best, the timber abundant, but it is deluged at the rise of the River; but the Wallamet runs through one of the most beautiful, fertile and extensive valleys in the world,"

His journals evidence a high admiration for the Indians (save the Blackfeet), and his encounters with them produced cordial relations with several tribes for many years. Having become well-known through the publication of his journals by Washington Irving, the exploration of Bonneville served as a strong stimulus to prospective settlers of the West.

Many years later, in 1852, Bonneville was ordered to return to the Pacific Northwest to plan and construct improvements at Fort Vancouver. The treaty of 1846 with England had ceded what is now the states of Oregon and Washington to the United States. While in Vancouver, Bonneville gained the reputation of being something of a visionary. He believed that
Captain Benjamin L. E. Bonneville

Lieutenant John C. Fremont
great benefits someday might ensue from efforts to control the Columbia River. While probably not foreseeing the tremendous future of hydroelectricity, he nonetheless saw the river, under control, as the servant of man and not his master. For this Bonneville has been immortalized in the history of the Northwest by the great dam and the huge power agency which bear his name.

Lt. John C. Fremont made another important contribution to the opening of the Oregon country. Fremont, who was later to become a national hero and candidate for the presidency in 1856, was an officer in the Topographical Corps of Engineers. Founded in 1813 in the Engineering Department of the U. S. Army, the Topographical Engineers were responsible for exploration and surveying. When its functions were combined with the regular Corps of Engineers during the Civil War, the organization ceased to exist. A civil engineer by education, Fremont had made several surveying expeditions for the Army in the South and Midwest when he appeared before the United States Government in 1841 to request sponsorship of an exploration across the Rocky Mountains to the Pacific Northwest.

At this time the leading advocate of western expansion in Washington, D.C., was the Senator from Missouri, Thomas Hart Benton. Year after year he had laid before the Congress proposals to make the West a more secure part of the United States: to increase the amount of Government land for sale and lower its price; to build a string of forts from Missouri to Oregon and occupy the mouth of the Columbia; to make explorations and to build a railroad with a northerly route to the Pacific; and to establish peaceful relations with the Indians.

Fremont fully impressed upon Senator Benton that he would be able to contribute to these goals. The continued support of the Senator was assured when, in 1841, Fremont eloped with the Senator's beautiful daughter, Jessie. Thus armed with official endorsement, Lt. Fremont set off in 1842 to survey what was to become the Oregon Trail. His first trip took him as far as the Continental Divide. There, in central Wyoming, he located the breach in the Rocky Mountains, the South Pass, and accurately mapped its position on the Oregon Trail. Fremont defined the geography, botany, meteorology, and astronomy of the region, and, in addition, designated points upon which a series of forts were subsequently constructed.

On his second expedition the following year he proceeded through the South Pass, up the Snake River to the Columbia. By fall of 1843 he had visited Fort Walla Walla and The Dalles, and he had conferred at Fort Vancouver with Dr. John McLoughlin, Chief Factor of the Hudson's Bay Company and virtual ruler of the region.

While Fremont's chief contribution was the survey of the Oregon Trail, he also verified that previous reports to the Government regarding the richness of the land were indeed accurate. Even before the City of Portland had been founded, Fremont foresaw the great prosperity which would
flow from forest lands and agriculture. He lamented the firm control over the area held by the Hudson's Bay Company, and urged that this situation be altered. Together with his powerful backing in the Congress, Fremont's ability to write eloquently and vividly of his exploits succeeded in firing the imagination of many Americans about the future of the Northwest. It is not entirely a coincidence that in 1846, only a few years after Fremont's visit, an agreement between the British and American governments made the long disputed Oregon country a part of the United States.
3. Civil War Days and the Army in Oregon

For roughly twenty years after Fremont's expedition, the nation's attention was directed away from the Northwest. In this same period levels of Corps of Engineers activity dropped considerably throughout the nation. Initially this was caused by the war with Mexico, which lasted from 1846-48, and the gold rush to California starting in 1849. But the main development was the resumption of conflict between the North and the South.

Previously the political strength of the North and South had been somewhat equal, and conflicts had been resolved by compromises. With the nation expanding westward and an opportunity existing for one section or the other to gain advantage by securing the support of the West, the conflicts between the two regions became more heated and intractable. For many years the West had provided a balance between the two regions. In the 1840's the West was developing an importance and political power of its own. The West was to decide its own fate, and in the process, by aligning its interests with either the North or the South, it was to determine whether the North or the South would prevail throughout the nation.

When it became apparent in the 1850's that the interests of the West were to be more closely parallel to the North than to the South, and that Western lands would not be admitted to the Union as slave states and territories, the South realized that its position in the nation as a political minority was assured. Because this was unacceptable to the South, and because they were unsuccessful in securing a policy by which acts of the Federal government could be nullified by an individual state, the South chose to secede and risk war with the rest of the country.

The heightening struggle between the North and the South tended to monopolize the energies and attention of the nation. Normal political activities became somewhat paralyzed. One victim of this development was
the civil construction work of the Army Engineers. Neither section, North or South, was willing to support work done in the other, east or west of the Mississippi River. The resulting decline in the activities of the Corps had adverse effects in Oregon as well as the rest of the nation. It was not until after the Civil War that construction and improvement of civil projects in Oregon had the sanction of official policy.

Yet while civil improvements were impeded in Oregon, there was a good deal of military work done. The role which the Corps played in this work helped to counter—at least in Oregon—the adverse effects of the declining trend elsewhere in the nation. In 1848 Oregon had gained territorial status in the United States, and there was the normal need for the War Department to secure and defend the area. 1848 also marked the beginning of almost three decades of Indian difficulties. The massacre of Marcus Whitman and his party in that year dramatized the need for a significant military representation to settle the growing hostility between white settlers and the Indians. In response to these developments the Army embarked upon an extensive fort and road construction program. While there were some strictly non-military benefits resulting from this work, until 1866 the activities of the Army in Oregon were primarily military in nature.

Previous to the Cayuse War of 1848, of which Whitman was a victim, there had been no major problems between whites and Indians which could not be solved. A general accommodation, enforced by Dr. McLoughlin, was accepted by all. But with the rush for gold in Southern Oregon at the outset of the fifties, and the aggressive land grabbing by the settlers streaming into the area, relations were bound to become severely strained.

In 1849 five hundred dragoons and infantrymen arrived at Fort Vancouver to secure the area. While Fort Vancouver was always the most important fort in the Northwest, three other forts constructed in 1850 helped form the military backbone of the region. The Columbia River and the Puget Sound were guarded by fortifications at Astoria and Steilacoom. Fort Dalles served notably against uprisings of the Umatilla's and the Yakima's for nearly twenty years. Forts constructed later were in response to other Indian difficulties.

The Rogue River War of 1855-56 was the most significant Indian uprising in Oregon. The most important of the several forts constructed to deal with it was Fort Lane, named for the first governor of the Territory. It was of considerable size and contained several buildings, but the fact that it was abandoned only a few years after being completed gives an indication of the substance of this type of fort.

Most of the forts in Oregon were not the spacious, high-walled structures containing immaculate parade grounds and numerous buildings which have been popularized through moving pictures or television. To an Oregon settler, the word "fort" meant a small earthmound and log breastwork surrounding a single crude blockhouse about twenty or thirty
feet square. When there was a threat of hostilities, settlers would "fort up"—bring provisions and weapons and gather in the fort—and stay there until the trouble had passed.

If the forts were not temporary in design, the enterprising habits of these early Oregonians produced the same result. The logs and timber of these forts invariably became the cabins and barns of nearby settlers. Other forts were abandoned for other reasons. It seems that in 1862 a high-ranking officer travelled to Fort Umpqua for an inspection. Upon his arrival he discovered that all the officers and men had vacated the fort and were off on a hunting expedition. The Army took this as an indication of the importance of the fort to the security of the area. Shortly thereafter it was decided that Fort Umpqua would be abandoned. Today there are few traces whatsoever of the existence of most of these old forts.

The role of the Corps of Engineers in this fort construction program was to build roads to connect the otherwise isolated outposts. The Army Engineers did do some fort construction: Captain George H. Elliot directed construction of Forts Stevens and Canby at the mouth of the Columbia in 1864; and various Corpsmen aided in the expansion of Fort Vancouver. For the most part, however, the large forts were built by regular army and cavalry officers, and the smaller ones by groups of local Mounted Volunteers or other citizens. The Corps' responsibility was to build roads.

The first Corps of Engineers office on the West Coast was the Pacific Wagon Road office in San Francisco. It was established in 1855. Equipment and advice came from this office to Oregon, but the main line of authority was still directly from Washington, D.C. Joseph Lane, who was elected to serve as Territorial Delegate to the Congress after serving as Governor, worked with effectiveness in the nation's capital to help his region. After much difficulty, in 1853 he succeeded in obtaining authorization and an appropriation of funds for the construction of four military roads. One went from the Rogue River Valley to Myrtle Creek. When completed in 1858, it served as part of the main stage line (and eventually highway) from Oregon to California. Another road in southern Oregon was northwesterly from Myrtle Creek to Scottsburg at the head of tidewater on the Umpqua River. The other two roads terminated at Fort Vancouver: one coming from Fort Steilacoom, the other from Fort Dalles.

The initial work on a road survey from Steilacoom to Fort Walla Walla was performed by Army Engineer Captain George B. McClellan in 1853. A number two ranking graduate of West Point, McClellan later became Commander in Chief of Union forces in the early years of the Civil War.

Congressional delegate Lane was able to get authorization for a road from Astoria to Oregon City in 1854. Portland, less than ten years old at the time, was deemed to be of secondary importance. But because the Congress was so reluctant to appropriate funds for this project and
because the work was so difficult, this sixteen foot wide road required fifteen years to complete. During the Civil War military roads were extended northward from Steilacoom to Bellingham and south from The Dalles to Eugene by way of Lake Harney.

Officially, when appealing to Congress, the roads were spoken of in terms of military uses. This was the only possible way of securing the approval of Congress. But the designs clearly provided for utilization in ways not required by the military. Every settler who had livestock to drive, or who shipped personal or commercial goods by wagon, stood to benefit by the opening of the roads. And, of course, the ability of Army personnel to communicate and move forces rapidly from one part of the territory to another was in itself a great boon to commerce. Until the 1880's a man who desired to build a sawmill or a farm had to consider whether or not the Army would be able to give him timely assistance in the event of Indian hostilities.

To understand how significant the road-building program was, one can compare the cost to build the roads with figures for improvements after the Civil War. The period during which the roads were built was generally a time of drastic contraction of Corps activities. When the Civil War was over, there was a great expansion. Yet the $280,000 spent on roads alone ten years before the Civil War in Oregon is only slightly less than the total amount spent ten years after the Civil War for all river and harbor improvements in the entire Pacific Northwest.

Another important activity was surveying for railroad routes. The most significant of these surveys was conducted by Isaac Ingalls Stevens, a Topographical Engineer who graduated at the top of his class at West Point in 1839 and who was to become the first Governor of Washington Territory. Stevens, while Governor, led a survey party in 1853 from St. Paul, Minnesota to the Puget Sound in a successful attempt to find a route through the Cascade Mountains. His route is today followed by the Great Northern Railroad. Stevens was killed in the Civil War serving as a Brigadier General. Lt. James H. Wilson, another Army Engineer, surveyed a route from the Puget Sound to the Columbia River. His route is today followed by the Northern Pacific Railroad.

The Civil War broke out in 1861. Before its conclusion in 1865, work on virtually all civil construction and on most military projects not contributing directly to the war effort was halted. Manpower requirements left only a skeleton Army force in Oregon. The records which Army officers established while serving in the Civil War, who had previously served in Oregon, indicates how important the War Department regarded the territory to be. Some of the finest officers of that generation served in the Northwest. Army Engineer Generals McClellan, Wilson and Stevens have been previously mentioned. In addition were Ulysses S. Grant, the most famous Union General of the War, and Philip Sheridan, one of its boldest. Both men were stationed at Fort Vancouver. Other officers who distinguished themselves were Generals Wool, Harney and Canby.
4. The Corps of Engineers in the Northwest

The close of the war in 1865 freed the energies of the nation and ushered in an age of tremendous growth in the United States. The vast expanse of the American West was finally settled. At the same time the combination of rich natural resources, rapid growth in population, encouraging governmental policies and an innovative business community dramatically shifted the economic base of the nation from agriculture to manufacturing and industry. At the dawn of the 20th century the United States emerged as a world power.

These national trends were reflected in the west. With the establishment in 1866 of the authority, "Rivers and Harbors of the Pacific Coast", Army Engineer activity in the Far West was on an equal footing with the rest of the nation. San Francisco was the location of this office, and its authority included all of the Pacific Northwest. Major (Brevet Lieutenant Colonel) R. S. Williamson was the first District Engineer. Major Williamson, having served in California since 1859, had done extensive surveys of the mountains of northern California and southern Oregon. His first two duties in Oregon under the new authority were to improve navigation on the Willamette and Upper Columbia Rivers.

In 1864 the City of Portland paid $42,000 in gold coin for dredging equipment. Two river bars--one at Swan Island and another at the mouth of the Willamette--presented dangerous obstacles to ocean vessels going from Portland to the sea. Many ships with deeper drafts could not negotiate at these shoals when fully loaded. Indeed, ships were grounded on these bars almost daily. This meant that goods from Portland would have to be hauled by lighters or wagons to points above the mouth of the Willamette where ocean-going ships could safely take the cargo aboard. But since this was not usually a profitable alternative, much of the capacity of many ocean vessels contained the products of towns downriver from Portland. With 15-foot ocean-going ships arriving in Portland each month, these bars constituted threats to Portland's growth and prosperity.
Dredging work on the bars, however, did not progress satisfactorily. To complete the work, city officials petitioned their representatives in the Congress to secure the assistance of the Corps of Engineers. An appropriation was obtained and, in 1866, Major Williamson was ordered to complete the work. Having no dredging equipment of his own, Major Williamson advertised for bids. But all the bids, including that of the City of Portland, exceeded the amount of the appropriation. To solve the problem, the City of Portland in 1867 proposed to loan its dredging equipment, free of charge, to the Corps under the condition that the Corps complete the work and be responsible for damages to the equipment beyond normal wear and tear. Major Williamson accepted the offer and commenced to complete the work with hired help the following year.

Major Williamson's assistant in Oregon, Lt. W. H. Heuer of the Engineers, supervised the dredging on the Willamette. The work also necessitated the first snagging activities on rivers in the Northwest by the Corps.

These huge logs, once firmly embedded in the mud and silt of the bank or bottom of a river, posed a treacherous threat to navigation. Only a pilot who knew the river well could safely negotiate his craft past these menaces. With the water level seasonally varying from high to low, snags often were just below the waterline. The unsuspecting craft which collided with one of these hefty monsters--some were forty feet long and four feet in diameter--were assured of quick destruction. After his own dredging craft had been disabled several times by snags, Lt. Heuer decided it was necessary to remove them. By the time a 17-foot channel had been cut out of the two bars a year later, in 1869, some 33 snags had been removed as well. Major Williamson reported that,

"The amount of commerce to be benefited by completion of this work is very great. Ocean steamers measuring 2,000 tons leave San Francisco weekly for Portland, and a large number of sailing vessels ply regularly between the two cities. The improvements already made have been very beneficial, for the reason that not a single vessel has grounded on the bar during the last year, previous to which time, during low-water seasons, grounding was an almost every-day occurrence."

This was the first river and harbor work of the Corps in Oregon.

Major Williamson was also charged with the responsibility of surveying the upper Columbia River from Portland to the mouth of the Snake. J. C. Ainsworth, powerful owner of the Oregon Steam and Navigation Company, had suggested the survey of the river so that the several dangerous rapids of the Upper Columbia could be eliminated. The same factors upon which his boats thrived--wheat export, mining "rushes", supply import and passengers--also justified work done by the Corps of Engineers.
Like the Mississippi, the Columbia River had its great steamboat era. The Hudson's Bay Company sent the first steam-powered vessel to the Columbia River in 1836. But stern old John McLoughlin had nothing but disdain for the modern contraption, and ordered it to British Columbia. It served there dutifully for fifty years. The first steamboat to be constructed on the Columbia was appropriately christened COLUMBIA by the two Astorians who built her in 1850. A ninety-foot side wheeler, the COLUMBIA provided freight and passenger service from Astoria to Vancouver and Oregon City for about ten years.

Another side-wheeler, the 160-foot, 600 ton LOT WHITCOMB, was christened in a gay celebration on Christmas Day at Oregon City. Governor Gaines of Oregon was the featured speaker, and the ladies were treated to the army band and blue uniforms from Fort Vancouver. The band played "in most excellent taste", but one of the cannons brought by the soldiers blew up, killing a celebrant. The elegant lines and finely finished work of the LOT WHITCOMB compared most favorably with the entirely functional design of the COLUMBIA. The COLUMBIA soon reduced its rates from $25 to $15 for fare from Astoria to Oregon City. On the run to Astoria the LOT WHITCOMB made stops at Fort Vancouver, Milton, St. Helens, Cowlitz and Cathlamet. One of her first Captains was J. C. Ainsworth, a man with experience on the Mississippi.

The mother of the famous poet, Edwin Markham, saw the LOT WHITCOMB try to make its first ascent of the Clackamas Rapids. She was sufficiently moved by the event to write the following verse:

Lot Whitcomb is coming!
Her banners are flying--
She walks up the rapids with speed;
She ploughs through the water,
Her steps never falter--
Oh! that's independence indeed.
Old and young rush to meet her,
Male and female to greet her,
And waves lash the shore as they pass.

Oh! she's welcome, thrice welcome
To Oregon City
Lot Whitcomb is with us at last.
Success to the Steamer,
Her Captain and crew,
She has our best wishes attained.
Oh! that she may never
While running this river
Fall back on the sandbar again.

The poem was published in the Oregon Spectator, the state's first newspaper.
The JENNIE CLARK, the first sternwheeler on the Columbia, was launched midway in the 1850's and played a crucial role in supplying the fort at The Dalles during Indian difficulties. The gold discoveries in the Walla Walla Valley and in Idaho in the 1850's, plus the growth of wheat farming in the area, served to stimulate expansion of steamboat shipping after this date. It was in response to these developments that the Oregon Steam and Navigation Company came into existence in 1860. Until the end of the century, its twenty or so freight steamers completely dominated the commercial traffic on the river.

The sight of one of these grand old steamers, usually preceded by the muffled blast of its whistles, was for over fifty years an integral part of the river. Most of the people, goods, mail and news which went up or down the river came by way of steamboat. In 1877, the Oregon Steam and Navigation Company brought to Portland a magnificent passenger ship, the WIDE WEST to join its fleet of freighters. 218 feet long and luxuriously appointed, the WIDE WEST was regarded as the finest and most comfortable passenger steamer on any river of the nation. The masted feather beds of the WIDE WEST were a much appreciated contrast to the accommodations for earlier passengers on the river. Ticket holders on the overnight cruise from Astoria to Portland for many years had brought their own blankets and slept on the deck.

The coming of the railroads in the 1880's slowed traffic on the river. Faster service, and often times cheaper rates on rail, left only bulk transport to the steamers. But it was the huge barges and diesel-powered tugboats which finally made the steamboat a part of the history of the river. Like many of the forts which Oregonians built in the same period, few traces of these charming old river queens remain today.

In 1867, J. C. Ainsworth was concerned about three rapids in the Upper Columbia River. These were Umatilla, Homely, and John Day. Umatilla Rapids were located where today stands McNary Dam. Homely Rapids are now covered by the slackwater of the upper end of the McNary Dam pool. John Day Rapids, just below the huge John Day Dam, are now covered by the upper end of The Dalles Dam pool. Many boats were lost at these rapids. In low water only the most experienced pilot could negotiate them, even then at considerable risk. Boats were guided slowly through the rapids by lines extending to the shore. Even with these precautions, during low water periods, only the very shallow draft riverboats could pass up or down stream. These small riverboats were wholly inadequate to ship the quantities of grain then available.

Ainsworth, writing to Lt. W. H. Heuer in Portland to support the work, commented upon the great importance of the proposed improvement to navigation on the Upper Columbia River.

"Walla Walla Valley alone, with boundaries and resources sufficient for a State, to say nothing of Eastern Oregon, Northern Idaho, and Western Montana, is wholly dependent on
the Columbia River for the transportation of the large surplus of grain (increasing so rapidly every year as to assume even now huge proportions) to the markets of the world. At present, wheat is worth 60 cents per bushel in Walla Walla Valley. In Portland it is worth from $1.25 to $1.50 per bushel. The expense of freight from Wallula to Portland is 17½ cents per bushel, but the amount that is transported during the season of low water is so small as to make the great difference in prices above stated. If one rock in "John Day's Rapids" were removed, a few loose bowlders in 'Devil's Bend', and one patch on 'Umatilla Rapids', above the 'Gravel Bar', we could then run our large-sized steamers, and, by the assurance of transportation, and consequently good markets, this large, important, and rapidly improving country would have free communication with, and access to, the commerce of the world. Every available house in Wallula is now filled with wheat that will have to remain there till next May."

Major Williamson assigned Lt. Heuer to survey these rapids. His task was to determine which of the rapids were obstructions to navigation, how much of the rock had to be removed, and at what cost, so that the six-foot draft boats which then used the river could navigate at all stages.

The survey was begun in September 1867 at low water, but bad weather and boat damages resulted in the completion of only half the work. The following autumn in 1868 the survey was completed with Major Williamson in the party. A blasting experiment on John Day Rock, the chief impediment of the rapids, constitutes the first permanent improvement on the Columbia.

The difficulties which the parties encountered indicate the conditions prevailing in that period. The Indians and "laborers" which the two engineers hired for the work drilled powder holes in the rock with a three-man drill which could progress only 12 inches per day. Much delay was incurred when the drill itself broke. It seems that the nearest blacksmith who could properly "dress" the instrument was 35 miles away at The Dalles. In those days the Columbia River was not the even, lake-like body of present times. Rather, it was a swift and powerfully flowing river which, when combined with the rapids which the party was required to approach, was extremely dangerous. Lt. Heuer, in his report to Major Williamson, described the water as being "fearfully rapid", and stated that he "dared not attempt sounding" in some areas.

Nevertheless, the survey was completed, and a report furnishing the desired information was submitted to the Office of the Chief of Engineers in Washington, D.C. By 1873 the entire rapid at John Day was blasted out of the river, and the work which had begun in 1867 was complete. The free navigational water formed thereby constituted the first permanent improvement completed by the Corps of Engineers on the Columbia River.
Also completed under Major Williamson's supervision were surveys at the mouth of the Willamette River and at Willamette Slough, and a survey of the Upper Willamette above the falls at Oregon City to Corvallis. The up-river limits of the survey were limited to Corvallis because the obstacles at low water above that town were so numerous and difficult to remove that improvement was not thought practical. Lt. Heuer, who performed the survey, reported that

"Steamboats navigate the river between Oregon City and Salem (sixty-five miles) during the entire year, and as far as Corvallis, forty-two miles above Salem, during nine months of the year. During a high water stage of the river, they run up as far as Eugene City, about eighty miles above Salem."

At the time of the survey, the People's Transportation Company monopolized the shipping trade on the river, running seven steamships above the falls at Oregon City and two below. Lt. Heuer, besides measuring depth, width, and current, made careful observation of the bars on the river which obstructed navigation. He noted five, and proposed that $16,000 be appropriated to construct wing dams to eliminate the bars. Eventually this was done.

Wing dams, commonly used for several decades on the rivers of the Northwest, deserve brief mention. In Lt. Heuer's words, they were

"of the simplest construction, consisting of logs 2 feet in diameter and long as possible, to be thrown diagonally across the current and held in position by four piles, two at each end of the log; willow brush to be lodged against the upper side, and held in place by gravel."

The result is that the current is concentrated into the middle of the stream and the material forming the bar is washed downstream to areas of greater depth. The dams were generally satisfactory devices. But unless carefully constructed, they succeeded merely in moving the bar downstream, or, if the current was deflected too sharply, in washing out the opposite bank. The pile dikes built later on the Columbia River are essentially larger, sturdier wing dams.

Other work done by Major Williamson was an extensive examination of the possibility of improving navigation on the Rogue River in southern Oregon. Persons in that region wished to develop a trade route from the interior to the coast so the long haul overland and up the Willamette could be avoided. Major Williamson wanted to take a small skiff down the Rogue River to the ocean to see for himself what difficulties might be encountered in improving it. But when no pilot could be found who was willing to take the Major down the rock-strewn, rapidly-falling stream, his enthusiasm for the project declined somewhat, and plans for the improvement were set aside.
One additional responsibility was assigned to Major Williamson. Since 1831 Army Engineer officers had assisted the Treasury Department in the construction of lighthouses. The functions of the officers were somewhat informal organizationally, and consisted of disbursement of funds and design and supervisory duties. In 1832 the Lighthouse Board was created to have entire charge, under the Secretary of the Treasury, of the construction, maintenance, superintendence, and operation of lighthouses. Serving on the board as co-equals with the Army Engineer officers were two naval officers and two civilians. Until 1910, when the military personnel of each branch were replaced with civilians, the Corps of Engineers contributed to the federal lighthouse construction program.

Thus, when Major Williamson took up his duties as District Engineer on the West Coast, he was also assigned to the 13th Lighthouse District. Until 1910, one District Engineer from the Pacific Northwest would have the same assignment.
PART II

THE FIRST FIFTY YEARS:

NAVIGATION IMPROVEMENTS
5. Early Work

A.

The growing importance of the Columbia and Willamette Rivers as navigational waterways led to the establishment of the Portland District in 1871. Without improvements on these rivers, the development of commerce in the region would be halted. In their nearly natural conditions, the Willamette and Columbia Rivers could not efficiently meet foreseeable demand for safe, extensive movement of goods and people. Orders from the War Department on March 28 divided Corps of Engineer responsibilities for the West Coast at roughly the Oregon-California border. Major Henry M. Robert, the first Portland District Engineer, was directed to establish an Engineer office in Portland and resume work under the authorization, "Improvement of Rivers in Oregon." The office was located at S.W. 3rd Avenue between Alder and Morrison Streets. Major Robert was later to become well known by the publication of his Robert's Rules of Order, the leading authority on parliamentary procedure. By 1901 he was a Brigadier General and Chief of Engineers.

The flow of waterborne commerce on the Columbia had been given its first sharp boost by the gold rush to California in 1849. Great quantities of wheat and finished lumber were shipped to San Francisco. In 1853, the first cargo of foreign export lumber from the Pacific Northwest left Portland for Australia. J. C. Ainsworth informed Major Williamson in 1867 that Oregon Steam and Navigation freight and passenger activity in the first half of the decade had more than quadrupled. The year 1868 marked the beginning of direct wheat exports from Portland, the first shipment going to Liverpool, England. After arriving in April, 1871, Major Robert reported the growth of river traffic at Portland. Writing in September, he said,
Major Henry M. Robert was the first District Engineer of the Portland District, established on March 28, 1871. Major Robert, later to become Chief of Engineers, is famous for his definitive study on parliamentary procedure, *Robert's Rules of Order*. (U.S. Signal Corps photo)
"Since October last, the coin collections at this port alone amounted to more than $210,000, and more than twenty vessels with full cargos have arrived in this river from distant foreign ports, taking out from hence full cargoes of local produce... during the past nine months 106 vessels, of an aggregate tonnage of 73,714 tons, have arrived at this port. Of these 70 were steamers, 5 ships, 23 barks, 8 brigs and schooners, and many were heavily laden with railroad iron, and took out, on their departure, full cargoes of wheat to Liverpool and China."

Within three years, eighty-five ships would be operating in the wheat business alone.

A cycle had set in which reinforced and strengthened river activity and, indeed, the commerce of the entire area. The more that could be profitably shipped, the more people were attracted to settle and develop the area. The more people came in, the greater was the need to transport and supply them. And the more they were supplied and equipped, so much more was their ability to produce increased. Yet while the wheat and the lumber were what made this great process valuable, it was the river which made it all possible. Without means of cheap transportation, profitable development of the resources of the area would have been much delayed. Railroads and highways may have partly solved the problem in later times. But to early Oregonians, river navigation was a vital necessity. Elimination of the immediate obstacles to navigation and obtaining precise knowledge of the region were the chief goals of the Portland District in its first five years.

Major Robert's first recommendation as Portland District Engineer was for the removal of the bar at St. Helens, located twenty miles downriver from the mouth of the Willamette. In 1871 he cited the bar, which had formed in the previous two years, as a "serious obstacle to the trade of this port." Vessels of 17 and 18-foot drafts were frequently delayed here for considerable periods of time. In most of these cases it was necessary to transfer cargo from the stranded vessels to lighters, thereby adding a significant expense. In this year Major Robert ordered a survey of the bar.

Previous to this time no work had been done on the Lower Columbia. Authorized work had been confined to "Improvement of the Willamette River at Portland, Oregon, to the mouth of the river." Major Robert stated, in 1872, that since "the object of these appropriations has been and is to enable large sea-going vessels to reach the City of Portland, Oregon", and since "One bar in the Columbia last year was a more serious hindrance than anything in the Willamette", the wise course would be to change the wording of the appropriation to "Improvement of the Willamette and Columbia Rivers from Portland to the Sea." This would allow work to be done on the Lower Columbia.
After another survey was made in 1872, the following year an appropriation was passed which contained the desired wording. It recognized that, for navigational purposes, the Lower Willamette and the Lower Columbia were a single unit. Improvements on the one without improvements on the other could produce no real benefits to either. Work on the bar was begun in 1873, but could not be completed until the following year because of unusually high water. The completed improvements at Swan Island on the Willamette and St. Helens on the Lower Columbia were the first work on the Portland-to-the-sea waterway. The 17 feet of safe water provided by these two projects supported over 175,000 tons of freight traffic in 1875. To Portlanders who had watched traffic on the river rise year after year, this represented a great deal of activity. Few would have imagined then that 100 years later the same waterway would be improved to 40 feet and over 25 million tons of freight traffic per year would pass up and down the Lower Columbia River.

Major Robert was also successful in securing for the Portland District its first dredger. When he arrived in Portland, the Corps was still using the equipment owned by the city. But this craft was in such a deteriorating condition, it was decided that the money would be put to better use by constructing a brand new outfit. In 1872 Robert secured an appropriation of $35,000 for this purpose, built the dredge, and continued dredging operations already begun. Though a depth of seventeen feet had been obtained at both the mouth of the Willamette and at Swan Island, the 2 feet of sand and silt deposited by the annual freshet had to be removed to maintain that depth. In addition to the steam dredge, a snagger and a scraper were also constructed and used on the Willamette. In its first year, the snag boat removed over 200 snags.

Other work by Major Robert were surveys on the Upper Columbia and at Port Orford in Southern Oregon. The survey on the Columbia furthered the work of Major Williamson and Lt. Heuer at Umatilla and Homely Rapids, plus the actual removal of John Day rock. The survey at Port Orford resulted from Robert's belief that it was a suitable location for a harbor of refuge. However, reviewing boards ruled that the cost of constructing a breakwater necessary for the project was excessive.

From 1873-76 Major N. Michler was Portland District Engineer. Accomplishments of the Corps during his tenure basically were to continue projects already underway or authorized, and to undertake projects of the same kind in new areas.

Thus Major Michler carried on with the dredging on the Lower Willamette and completed the work already begun at St. Helens. Snagging, rock removal and bank protection were continued on the Willamette, above and
below the falls at Oregon City. Several thousand feet of wing dams were
built, following the suggestions of Lt. Heuer. Rapids on the Columbia
previously surveyed by Major Robert were blasted and removed.

Major Michler also surveyed and eliminated the obstructions at Post
Office Bar on the Willamette River 2 miles from its mouth. Commencement
of the removal of rapids, as far as the mouth of the Snake River was begun,
and obstructions beyond that point--both up the Columbia and into the
Snake--were surveyed. The eventual chief benefit of this work was the
connection of navigable waters with the railheads of Northern Pacific
and Union Pacific near Wallula and the Snake River. Large areas deep in
the interior were connected with Portland almost overnight.

Numerous surveys were performed at or near the mouth of the Columbia-
Point Adams, Cape Disappointment, Astoria Sand Flats, Sand Island, and
the bar at the mouth of the river. Surveys of rivers in Washington Terri-
tory--Puyallup, Skagit, Snohomish, and Chehalis--and the Yamhill southwest
of Portland were made. Surveys of the mouths of the Alsea, Coquille and
Nehalem Rivers were the first of many improvements at these locations on
the Oregon coast. A map was made of the Puyallup River as far upstream
as the fork of the river (21 miles). Beyond that Michler ordered no
further work because "None but flat boats and canoes can make an ascent
above that point". At this time only 400 persons inhabited the entire
valley. The main settlement was Tacoma.

The Upper Willamette was charted from Eugene City to Portland. All
of the trees, rocks, bars, banks, snags, sloughs, falls and other impedi-
ments were measured and located on maps. A reconnaissance of the Snake
River was also made which indicated the great difficulties involved in
improvements.

In addition, Major Michler performed the first thorough survey of
the Columbia River for the Cascades and Dalles-Celilo Canals. The work
on the Cascades is one of the most significant early projects undertaken
by the Portland District. Begun three years after Major Michler's survey
was completed, work on the Cascades canal relied on his preliminary
findings.

Another of Major Michler's projects, however, did not enjoy such
good fortune. Water from Percy's Slough entered the Willamette River
near its mouth. The force of the water coming from the slough tended to
back up or slow down the current in the Willamette with the result that
sand and silt accumulated, forming an obstruction. To prevent slough
water from interfering with river water, Major Michler attempted to con-
struct a small dam at the mouth of the slough. A few months after the
dam was completed, the high water flow succeeded in washing it out.
Indicating perhaps that even the "good old days" had its share of fast
operators, Major Michler's report stated that "the contractor had sadly
abused the confidence of this office." Apparently while Major Michler
was necessarily out of town and unable to supervise the progress of the work, the contractor had seen fit to construct the foundation with insufficient amounts of inferior materials. When the force of high water hit this essentially foundation-less dam, its bulk was washed into the Willamette and formed a bar. Thus, Major Michler's dam became the very thing which it had originally been designed to remove.
6. Permanent Projects

The end of Major Michler's service in Portland on December 28, 1875 marks the completion of the first decade of Corps of Engineers work in the Northwest under authority primarily for civilian projects. Roughly halfway through this period, the Portland District itself was established. On the Columbia and Willamette Rivers, several bars and rapids had been surveyed and eliminated. Great numbers of dangerous snags and rocks had been removed. Banks had been improved, and fast current provided by wing-dam construction kept shoaling in check. Many important surveys were made which would serve as guides for future projects as well as information for current use. Even at low water, navigation was reasonably safe and dependable for ocean-going vessels sailing from Portland to the sea, and for riverboats going from Portland to the mouth of the Snake and from Oregon City to Corvallis.

There were still numerous delays, and even a few disasters. The refilling of a bar before a United States dredger could get to it would sometimes strand a ship for a day or two, or require the use of lighters. Or one of the remaining snags or rocks on the Upper Willamette would fatally pierce a careless steamer. This was the fate of the Oregon Steam and Navigation Company's heroic SHOSHONE in 1874. After making an unprecedented run from the hitherto unpassed rapids of the Upper Snake downstream to Lewiston, she was unceremoniously sunk by a rock in the Willamette River near Salem in 1874.

Basically, however, the improvements made by the Corps were thorough and yielded great benefits. The nearly ten-fold growth of river traffic from 1866 to 1876 would not have been possible without the work of the Corps of Engineers. The great burst of activity in Oregon after the Civil War would have been throttled and frustrated without open rivers. The contribution of the Corps was fundamental.
Nonetheless, the work of this period—however effective and beneficial it may have been—was basically provisional and designed to meet the immediate needs of the area. Large, permanent projects which could not have yielded quick results were not attempted. Until the waterways were made to be basically useful and free of hazard, these types of projects could not be started. By 1876 this had been accomplished.

Thus, when Major John M. Wilson arrived in Portland in January, 1876 to take up his responsibilities as new District Engineer, a new and different period of Corps activities began. For nearly fifty years the most significant activities of the Corps would be the construction of several large, substantial projects which would permanently improve coastal and river waterways for navigation. Until the late 1920's—when projects began to be planned for multiple purposes to work in coordination with similar projects in entire river basins—jetties, canals and locks, and deep-water channels were to be the principle works of the Portland District. Major Wilson was promoted to Brigadier General in 1897 to serve as Chief of Engineers.

Major Wilson’s first recommendation was for permanent projects whose purpose would be to prevent the annual refilling of bar areas on the Lower Willamette and Columbia Rivers, and which would maintain navigable water at a depth of 20 feet from Portland to the sea. This would eliminate the need for much of the costly dredging which each year consumed over half the budget appropriation, and it would better serve the increasing trade and larger ships on the river. In his report of 1876, Major Wilson stated that:

"The more I see of this section of the country and its growing foreign commerce, the more satisfied I am of the absolute necessity of keeping open a channel with a depth of 20 feet at low-water from Portland to the sea."

In the following year, Portland demonstrated its trading strength: imports valued at $388,476 and exports valued at $2,509,159 went in and out of the harbor. Nearly all the export goods were grain products from the Upper Columbia area. The attached maps made by civilian engineer Robert A. Habersham show where four of the five proposed projects were to be located.

The first of the projects, the bar at Swan Island, is not shown on the map. Major Wilson states the problem quite well in his annual report to the Chief of Engineers in 1876:

"At this place there are 2 channels, the one north of the island, the present ship channel, being about 600 feet wide and quite deep, and the other, 1,800 feet wide, is very shoal, presenting a depth of not more than 7 feet at low water; about three quarters of a mile above the Island the bar commences to appear, and through this a channel about 100 feet wide and
eighteen feet deep at low water has been cut, and dredging has
continued annually since it was opened, each year's freshet
partially filling the cut.

"As long as the water continues to run through both channels,
just so long annual dredging will be required; confine it to one,
and let the entire volume pass through it, and the natural result
will be a deep and commodious river.

"The question arises, Which one should be closed?

"I cannot but believe that it should be the narrower of the
two, and that if a dike should be built from the upper end of
Swan Island to the north shore, closing the north channel, as
indicated on the chart transmitted in May, 1876, and a new
channel should be opened south of the island, when it was once
dredged it would give but little trouble thereafter."
Small dams at the heads of three sloughs near the mouth of the Willamette River are among the first four permanent structural improvements undertaken by the Portland District.
The next three projects, all of which can be located on the map of
the Lower Willamette River, were for the permanent improvements at Post
Office Bar near Willamette Slough and Coon Island Slough, and at Nigger
Tom Slough. By constructing dams at the heads of these sloughs, and
reventing the banks, the velocity of the current in the Willamette would
be increased and the bars permanently eliminated. The heavy dotted lines
on the map indicate the intended positions of these dams.

The other project was at St. Helens bar on the Columbia. Major
Wilson's project map for work here also is presented. As shown on the
map, the bar was over 2 miles long. The widening of the river plus the
conflicting currents of the Willamette Slough, Vancouver Slough, and the
Lewis River served to decrease the velocity of the river, consequently
forming the bar. Warrior Rock, jutting boldly from the Oregon shore,
acted as a wing dam deflecting the current to the far shore. The result-
ing bank erosion on the Washington Territory side caused the bar to
shift and expand. This made the old navigation channel also on the
Washington side of the Columbia constantly in need of dredging and almost
as constantly undependable.

To remedy this, Major Wilson proposed to remove roughly 100 feet of
Warrior Rock, and

"...to run out a dike from the shore below to receive the
water, and gently lead it through the new channel."

River pilots had recently begun to use this new channel as the
Washington side became less navigable. The new channel referred to runs
close to the Oregon shore along Basalt Cliff, St. Helens and across the
point in the bar marked "Upper Ship Channel".

In 1876, the Board of Engineers for the Pacific Coast was founded.
For ten years it was to review major projects of Army Engineer work in
the Far West. Appointed by the Chief of Engineers, review boards such
as this existed elsewhere in the nation. They served to relieve the
Office of the Chief of Engineers of the burden of acquainting itself
intimately with each and every major project throughout the country. The
conclusions of these boards were usually accepted by the Chief of Engi-
neers and, in turn, the Congress. Composed of senior Corps of Engineer
officers, the Review Board of the Pacific Coast was headed by Lieutenant
Colonel B. S. Alexander. Also serving was R. S. Williamson, recently
promoted to Lieutenant Colonel. The proposals of Major Wilson were sub-
mitted to the Board for approval, and its decisions were reported in
April 1877.

The Board did not accept Major Wilson's view that the north channel
at Swan Island should be closed. They cited the disruptive effect on
commerce which would inescapably result from shifting the channels, and
excessive cost as their reasons. $51,000 was allowed for closing the
south channel, a sum half that required to close the north channel.
Two dikes were built in 1882 to eliminate shoaling at St. Helens Bar. This project, plus three others at the mouth of the Willamette River, provided 20 feet of safe water in the navigation channel from Portland to the sea.
Major Wilson reported to the Chief of Engineers that he would resurvey the Willamette at Swan Island. If the same findings were had, he would resubmit his original conclusions for appeal.

However, before this could be done, the commercial interest acknowledged by the Review Board brought pressure to bear in Washington, D. C. Plans for any improvement at all were simply dropped. For ten years there is no mention of Swan Island in the Annual Reports of the Chief of Engineers, except for continued dredging. It was not until 1927 that the work at Swan Island was finally done. Major Wilson would have been gratified to know that his original plan eventually was used.

Work on the Willamette at Post Office Bar and at the Mouth were approved by the Board of Engineers as submitted. The only exception was that the dam at the head of Nigger Tom Slough was to be built only if the desired depth was not obtained by the dam at the head of Coon Island Slough. Work at the head of Willamette and Coon Island Sloughs was completed in 1881, and on Nigger Tom Slough several years later. The two sloughs at the Mouth of the Willamette gradually were filled. Today, perhaps fortunately, there is no trace of them on the map.

For work at St. Helens, the Board recommended two dikes to be built

"...across the bar on each side of the present ship channel, about one-half mile below the lower end of Sauvies Island; the dikes to be each about 950 feet long, flaring at the upper end to a width of 800 feet; and narrowing to 300 feet at the lower."

Major Wilson concurred with the report, and work was completed at St. Helens by 1882, though repairs had to be made shortly thereafter.

An appropriation of $298,974 was granted by the Congress for these projects. Funds for Swan Island were applied to dredging operations. Together with this dredging, the four permanent projects provided an all-year, 20-foot navigable channel from Portland to the sea. All other points on the channel then used were normally deeper than 20 feet. When completed, these four projects were the first permanent structural improvements for navigation in the Northwest.
A woodcut by R. Swain Gifford shows how the Cascades appeared in the late 1860's. The structure on the north shore of the Columbia River is part of the portage railroad. Another line was operated on the Oregon side. The Cascades Canal, completed in 1896, was a tremendous improvement over the portage railroads.
7. Cascades Canal

A.

The most important project undertaken during Major Wilson's brief two and one-half year tenure, however, was the beginning of work on the canal around the Cascades on the Columbia River. The Cascades were located a few miles upstream from where now stands Bonneville Dam. Major Wilson reported in 1876 that,

"It is well known that navigation of the Columbia is interrupted by the falls at the Dalles and the Cascades. It is evident that the interests of this great and rapidly-developing portion of our country will demand the construction of canals around these obstacles, now passed by railway portage;...it is scarcely necessary for me to say more (about) the absolute necessity for such improvements other than that the route via the Columbia and Snake Rivers is the only one by which the products, not only of Eastern Oregon but also of a large portion of the Territories of Washington and Idaho, can be brought into market."

From the days when traffic on the river first appeared, means had to be devised to transport people and goods past the barrier presented by Cascade Rapids. The first was a one-mule, one-car outfit built in 1851 and placed in operation on the Washington Territory side of the river. For seventy-five cents one hundred pounds of "emigrants effects" could be ported safely around the rapids. Additional mules and cars added by subsequent owners improved the service somewhat. Eventually a competitor was active on the Oregon side.

In 1862, the Oregon Steam and Navigation Company gained control of the portage roads, mules and cars. By adding ownership of portage
Progress of the excavation and foundation work at Cascades Canal
facilities to their existing domination of boat traffic, Oregon Steam and Navigation obtained a secure monopoly of activity on the river. The mules and cars were removed, and a steam locomotive—the first in Oregon—and several cars were installed. Running on five miles of steel rail, river travellers enjoyed an efficient and quick portage. A similar operation, over twice as long, was located by Oregon Steam and Navigation at Celilo Falls.2/

The Reviewing Board on the Pacific Coast was not unaware of the monopoly conditions enjoyed by Oregon Steam and Navigation on the Columbia. Reporting in 1878 they stated:

"The whole of the navigation of the Upper Columbia and Snake is now in the hands of a single company. It owns and operates all the steamers on the waters just mentioned, and has railroad portages around the Cascades and between The Dalles and Celilo. All freight has to be handled twice at each of these places."

The improvement was made with the knowledge that not merely navigation per se would enjoy benefit, but competitive navigation as well.

In 1877, Major Wilson presented in his annual report a plan for the construction of a canal around the Cascades. The cost was set at $1,188,680. As modified by the Board of Engineers for the Pacific Coast, the canal was to be 8 feet by 50 feet by 7200 feet at low water, with two locks 8 by 50 by 7200 feet at low water, and two locks 8 by 50 by 300 feet. The following year the width was increased further to 70 feet.

Work on Cascades Canal and Lock began in December 1878. The contract for the initial excavation was awarded to a New York firm, Ball and Platt, after bids had been received from throughout the nation. Shortly after work had commenced, Mr. Ball, senior partner and managing contractor, died from exposure while supervising the work. For several months nothing whatsoever was done for lack of competent supervisory personnel within the company. Real progress did not begin until one year later. Partly as a result of this debacle, most of the rest of major work on the canal and locks was done under the direct supervision of civilian assistant engineers or by officers of the Corps. Contracts were let only for specific tasks such as wharf construction or rock removal. General responsibility stayed with the Corps of Engineers.

In 1880, the initial plans were reviewed again. Instead of two locks with a total lift of 16 feet, there was to be one lock, 90 feet wide and 462 feet long with a lift of 24 feet. The width of the entire canal was to be at least 90 feet at all points, but with the lower and upper entrances eventually tapering to 140 and 250 feet, respectively. The depth was later increased to 30, and just before completion, to 34. Walls built on the banks, plus the enlargement of the gates of the locks, 2/

Author has relied upon Stewart H. Holbrook's The Columbia and Randall V. Mills' Stern-Wheelers up Columbia for information regarding Oregon Steam and Navigation Company.
Progress of brick and rock work on wall of Cascades Canal. Rail cars which ran on track on bottom of canal were powered by horses.
Workmen putting finishing touches on gates of the Cascade Canal Lock
gave the canal the ultimate capacity to handle traffic at any stage of the river, however low. It was decided to build the gates with steel instead of wood. The final addition was a wall-gate device above the lock to serve, in effect, as a second lock. It served as insurance against failure of the main lock, and was rarely used.

Work was stopped at the canal lock site in 1881 to improve the river approaches below the canal. Plans for the depth of the canal were now actually deeper than the river at several points. Without the removal of great quantities of rock below the canal, ships would be unable to take full advantage of the canal's depth. For five years this was the primary activity at the Cascades. When full work resumed in 1886 at the canal site proper, ten years were required to complete the project. In the process, the original cost estimate was eventually tripled to over $3.8 million.

The amount of time necessary to finish Cascades Canal and Lock has been held up to some undue criticism. Even before the canal was completed, it was said half-jokingly that only the early settlers of the area could remember when work had begun. There are, however, quite reasonable explanations. Apart from the great difficulty of the work, until 1886 much time was consumed in unavoidable delays or on work not originally planned. Revisions of the project—planned to improve benefits to navigation—greatly increased the amount of work to be done. Several of the contractors did not perform their agreements satisfactorily. Of great importance was the difficulty in obtaining the necessarily large amounts of funds. This was because (1) the seventies and early eighties were periods of depression and retrenchment as a result of the "Panic of '73"; and (2) of the other very costly projects being installed elsewhere in Oregon at the same time.

But whatever time was required for construction of the canal, completion day was greeted with great excitement and celebration. On November 5, 1896, several hundred excursionists passed through the locks on steamboats to view the great work at close quarters. The steamer SARAH DIXON had a small cannon bolted to its deck. At appropriate intervals she would let go with a booming salute to the new free water.

And well she might. After moving 25,000 tons of freight by railway portage at very high rates in 1896, the canal was eventually to carry five times that amount at no charge to any shipper, commercial or otherwise. The value of freight over the canal in one year alone was equal to the entire cost of constructing the project. In addition, the canal helped to resist the power of monopoly: no longer the Oregon Steam and Navigation Company, but the Union Pacific Railroad, which controlled the rails along the Columbia from Walla Walla to Portland. By making the shipment of bulk materials on water economical, railroad rates were encouraged to be honest. The wheat ranchers of the Walla Walla Valley, and all shippers on the river, had won a big battle.
B.

In addition to the canal and lock at Cascades Rapids and the 20-foot channel, Major Wilson's report of 1876 contained several other proposals.

Among them was an extensive survey of the Puyallup River which flows into the southeastern corner of the Puget Sound. Significant deposits of coal were thought to lay twenty-five miles above the mouth of the river. Development of the resource would be greatly aided by making the river navigable. Assistant Engineer Habershon performed the survey. From the findings, Major Wilson recommended the construction of small dams to improve the flow of the river, and that snagging and scraping operations be undertaken. However, the proposal was not favorably reviewed. The entire area drained by the river contained only 400 persons, a goodly number of whom lived in a village then becoming known as Tacoma. The work proposed by Major Wilson for the Puyallup was eventually done. But, it was not until two years after the Seattle District was founded in 1896.

Major Wilson reported in 1876 that navigation on the Upper Columbia River was still menaced by rapids, though considerable improvement had been made. "In order to safely pass them", he wrote, "the steady hand, keen eye and cool hand of an experienced pilot" are required. Delay of work begun by Major Michler was caused by a disastrous accident. Major Wilson reported that,

"On March 1, while engaged on Rock 17 (at Upper Umatilla), the holes having been drilled and cartridges inserted, just as the capstan was being manned, a terrific explosion of giant-powder took place on board the scow, whereby 13 men were killed, one dangerously wounded, and the whole plant destroyed."

Replacement of men and equipment delayed work on the Upper Umatilla rapid until late in the following year, 1877.

Even without a delay such as this, removal of rapids was a necessarily slow process. Surveys were difficult to make and the few men qualified to perform them were much needed elsewhere. Getting and maintaining good equipment was time consuming. Finding men to hire and keeping them on the job was not without problems. The work itself was dangerous and quite difficult to execute. Of great significance was the fact that the only time the work could be done was at low water periods—and this coincided with the most severe weather conditions. These factors may help to explain why it was not until ten years after Major Wilson had left the Portland District that the rapids as far up the Snake as Lewiston, and as far up the Columbia as Priest Rapids, had been removed. Though this was a long time, the work was done first where it
was needed most. As a result, the great bulk of traffic on the Columbia could steam up and down the river with little fear of rapids long before all of them were finally removed.

Throughout Major Wilson's tenure, considerable progress was made on Upper Willamette River. Wing dams were constructed at several locations, and repairs were made on those built previously. Snagging and scraping continued. Major Wilson repeated the requests of his predecessor for another snag boat, and eventually one was obtained, though after he had left Portland. Over 20 detailed maps and charts were made of the principle bars on the Willamette and were made available to the public. Later, these maps were the basis for improvements. Major Wilson also proposed that small dams be constructed at the heads of the numerous sloughs on the Willamette. This, too, was done after he left the District.

River traffic and commerce on the Willamette was able to develop largely because of these improvements made to date. In 1878, three companies operating steam freight and passenger boats on the river had sprung up to compete with the still dominant Oregon Steam and Navigation Company. 50,000 tons of freight and over 15,000 passengers passed through the newly constructed locks at Oregon City in that same year. The locks, completed in 1873, were privately constructed and operated. The United States Government purchased the locks several decades later, and their present role in the Corps is discussed below. Together with the improvements of the Corps, the locks made the Willamette an important navigational waterway for shallow-draft steamers, riverboats and log rafts.

One other project of important proportions was directed by Major Wilson. The omnibus River and Harbor Act of Congress in June 1878 provided for an examination of the Clearwater River, Idaho and the preparation of estimates for "improvements proper to be made." Upon the suggestion of S. S. Fenn, Congressional Delegate from Idaho Territory, plans were made for an examination of the 65 miles from the South Fork to its mouth on the Snake near Lewiston.

The survey was performed by Assistant Engineer, Mr. Phillip G. Eastwick, who,

"proceeded to Wallula, Washington, by steamer, 240 miles; thence to Walla Walla by rail, 30 miles; thence to Lewiston by stage, 90 miles; thence to Mount Idaho by stage, 70 miles; a total distance of 430 miles. At Lewiston, he organized his party, being fortunate in obtaining the services of a gentleman who had rafted on the river for several years."

The survey showed that the principle obstruction to light-draft river steamers was formed of the gravel, cobblestone and boulders in the river. Major Wilson recommended $34,000 for the removal of these obstructions for 40 miles up the river. This would obtain a depth of
four and one-half feet, adequate for existing and foreseeable activity on the river. Funds were forthcoming from the Congress, and work on the Clearwater was completed in three years.

Finally, three surveys were made at locations on the Oregon coast where substantial improvements were to be made within a few years. The first was a survey at the Mouth of the Columbia River. $5,000 had been appropriated in 1878 for "a thorough survey of the mouth of the river in preparation for permanent improvement." Forest fires and violent, stormy weather delayed the work, but it was finally concluded in October, having been performed by Lt. A. H. Payson, Corps of Engineers. The information obtained was soon to be incorporated in the most important early project which the Portland District undertook, the jetty at the mouth of the Columbia. The other two surveys were at the mouth of the Coquille and at Coos Bay.

Major Wilson's last assignment in Portland posed something of a dilemma for him. The omnibus bill authorizing work on the Clearwater River in Idaho also provided for a survey "of the Rogue River, Oregon, from Scottsburg to its mouth." But as Major Wilson stated in his report,

"Scottsburg is on the Umpqua River, about 100 miles north of the Rogue River, and I was consequently in doubt what action to take; the facts were submitted to the Chief of Engineers and by him to the honourable Secretary of War, who directed that no survey should be made, but that a report should be prepared from such facts as might be at hand or could be easily obtained . . .

"The mouth of the Rogue River is about 270 miles below the mouth of the Columbia; it can only be reached by going to Roseburg by railroad and thence by stage and horseback for three or four days across the mountains down the coast. I made diligent inquiry in Portland, without success, among merchants, bankers and shippers, to find some one interested in the river from whom I might learn its character. I then wrote to the member of the State Legislator from that county; to the Collector of Customs at the mouth of the Rogue, and to the firm of Hume and Duncan, who have a salmon-cannery on the river . . . These letters were written on October 5, but up to this date (October 22) no reply has been received.

"I have, therefore, transferred the subject of a report on Rogue River to my successor, Maj. G. L. Gillespie, Corps of Engineers."

This episode is hardly in keeping with the significant developments which began during Major Wilson's service.
8. Initial Work on the Oregon Coast

For almost three years, from October 1878 until July 1881, Major G. L. Gillespie served as District Engineer in Portland. Under his direction important projects were commenced on the Oregon coast. Major Gillespie served as Chief of Engineers from May 1901 to January 1904 with a rank of Major General.

As would four of his successors, Major Gillespie was responsible for progress at the important canal being constructed at the Cascades. Alterations to the original plans, as noted above, were made. After delays, excavation work began, additional surveys were made and, near the end of his term of service, work was shifted to improve the bed of the river below the site of the canal. First Lieutenant Charles F. Powell was assigned to supervise the work at the canal.

Work and improvements on the Willamette were continued. Major Gillespie stated his view that the Willamette River Valley was:

"of exceeding richness and fertility, and has a thriving and industrious population, which is increasing in numbers and wealth all the time. The encouragement given to emigration to the State by the introduction of Eastern Capital in building and extending railroads and increasing the number and tonnage of steam propellers and sailing vessels plying between the mouth of the Columbia and foreign and domestic ports, is having a direct influence in enhancing the values of all kinds of property, and will contribute most materially in increasing the agricultural interests which center along the main arteries of commerce."

He further reported,
"The present plans for keeping open the navigation of the river as high up as Eugene City contemplate the constant employment of the snagboat in removing snags at all stages of water, the scraping of the bars at low water, and the construction of an occasional inexpensive dam to close a slough or to sluice a narrow bar."

Authority was obtained in 1878 to clear all obstructions in the Willamette to Eugene, and for annual operations thereafter to keep it clear. A few dams were built, hundreds of snags, rocks, and other obstructions were removed, and authority to extend this work to the lower Yamhill River was obtained in 1880. This was the main type of work done on the Willamette throughout the 1880's.

The most important work performed during Major Gillespie's tenure, however, was on the Oregon coast.

The survey made under Major Wilson at Coos Bay in 1878 showed that obstructions to navigation were caused by shifting sands and by unpredictable tides. A detailed chart was made of the entrance, and Major Wilson submitted plans calling for 2 training walls 8,000 and 5,000 feet long to cost $972,000. The Board of Engineers accepted his findings, but ruled that only 1 wall would be built, and the cost would not exceed $600,000.

When work actually got underway during Major Gillespie's tenure late in 1879, an additional need for modification of Major Wilson's original plan at Coos Bay was quickly perceived. Lt. A. H. Payson, Corps of Engineers, the supervisor of the work, found that the floor of the entrance was too rocky to permit pile driving. Another method was required to secure the jetty stones and keep them in their place. Almost as an experiment, it was decided to build large timber cribs, fill them with heavy stone, and lower them into place in the water. This became known as the "crib" method. The cribs were quite large--fifty feet long, ten feet high and twenty-six feet wide. The obvious difficulty in placing these huge structures in the water with the crude means then at hand, together with the small amounts ($40,000 for the first year) appropriated, resulted in very slow progress. Only 700 feet of cribbing had been set in place after two years.

In his 1881 request for additional funds for work at Coos Bay, Major Gillespie stated the desirability of completing the project,

"... if better water in the lower harbor and more direct channel over the bar can be maintained all the lumber interests bordering the bay will be increased in value, the mills will be kept running throughout the year ... the improvement will be of benefit to all of southern Oregon, for at the present time this is the only port south of the Columbia River from which there is a regular steamer line south, and from which lumber is shipped in noteworthy quantities."
"It is possible to build up here a very important trade, not only with San Francisco, but with the islands of the Pacific which give a demand for lumber, and the various kinds of excellent timber."

Work on the project continued throughout the 1880's, and was completed by 1889. Small appropriations and great damage to the jetty and tramway caused by rough seas made progress slow. But despite these difficulties, substantial benefits were realized by the stabilization of the channel as early as 1883. Trade and commerce grew rapidly at Coos Bay even from the $468,000 valuation of shipped goods it enjoyed in 1877. At the time of these earliest improvements, Coos Bay was the most important port on the Oregon coast. Later works would help it to become the greatest lumber product exporter in all the world.

The difficulty at the mouth of the Coquille was shifting sand and rock obstruction. The survey completed in the summer of 1878 was performed by Assistant Engineer Channing M. Bolton. He learned from the pilot at the Coquille, a certain Captain Parker, that

"the sands shift so rapidly that (I) cannot rely on information from one day to the next, but have to make a thorough examination of the channel before each trip."

Major Wilson, in transmitting Bolton's report, stated that:

"The Coquille River drains a section of country of about 900 square miles, consisting of valleys and low rolling mountains, which are covered with magnificent timber, including maple, ash, live-oak, fir, and etc.; the mountains are said to be rich in coal, gold, and other minerals, while the valleys are well suited to agriculture, all kinds of cereals growing luxuriantly, and fruits and vegetables in abundance."

Major Wilson requested $164,000 with which to build two training walls, two and three thousand feet long, to run parallel to each other along the deepest section of the existing channel to deep water in the ocean. He stated that:

"the increased velocity due to the contraction of the channel will give sufficient scouring force to keep open a channel with a depth of 12 feet . . . It is thought that if the mouth of this river was once properly improved a large amount of capital and a number of vessels could be immediately employed in securing and carrying to market production of this rich valley."

Work at the mouth of the Coquille proceeded under Major Gillespie in 1880 after the original plan drawn up by Major Wilson had been revised. Instead of two large jetties, it was thought that only one smaller jetty would be adequate to cut the bar and the spit at the
entrance, and provide 15 feet of safe water at high tide. Work under Assistant Engineer R. S. Littlefield proceeded quickly because the cribs placed in the water for the foundation were reduced in size to 4 feet tall, 6 feet wide, and 30 feet long. Within two years 850 feet of jetty had been laid which was 5 feet wide at the top and 15 at the bottom, and which protruded 2 feet out of the water at low tide. By 1886 the jetty had been strengthened and extended to nearly 2,000 feet. Two years later, work on the small, $215,000 jetty was complete.

A third project on the coast gotten underway during Major Gillespie's term of service was at Yaquina Bay. Surveys were made in 1879, and again in the spring of 1880. Plans were drawn up by Assistant Engineer J. S. Polhemus calling for a 2,500 foot jetty. Midway between Astoria and Coos Bay, the entrance to the large bay at the mouth of the Yaquina River was limited to 7 feet by a sand spit which extended from the south. Another hazard was the reefs which ran parallel to the coast only a few thousand feet offshore. It was believed by Major Gillespie that,

"if a depth of 17 feet on the bar at high tide can be maintained by improvement, the harbor will become a shipping port of great importance, not only for the products raised in the immediate vicinity, but for a great part of the Upper Willamette Valley, with which it is said that there will soon be a railroad connection."

The plan was approved in July 1880 and in the same year an initial appropriation of $40,000 was given to start work in the fall.

The difficulties encountered by the work party--and the resulting slow progress--was reported by Major Gillespie.

"The village of Newport, in the harbor, is very small . . . and at the time the assistant engineer took charge of the improvement, the single sawmill which the bay possessed was out of order, and had no logs on hand suitable for the construction.

"In consequence considerable time was spent collecting logs before any lumber for the scows or timber for the cribs could be obtained, and all the various materials and implements of construction--iron, anchors, picks, chains, crowbars, oakum and etc.,--had to be purchased either at Portland or San Francisco, and sent to the harbor by special boat.

"These considerations not only made the initial preparation very expensive, but delayed--much beyond my patience--the time of beginning the jetty."

The entrance to the harbor was considered so dangerous that no tugboat captain was willing to hire out and assist in the work. A tug had
to be purchased in San Francisco. The "exceedingly strong and variable" currents at Yaquina Bay presented the party with "the greatest imaginable difficulties." Work in the boats became quite impractical, and Assistant Engineer Polhemus decided to build the jetty from the shore outward. He reported that,

"... the stone for the purpose to be delivered by a tramway 2500 feet long, starting from a wharf erected in a sheltered spot on the inside of the harbor. This plan necessitates the handling of the stone four times before it reaches its final place in the jetty, but I see no other way of accomplishing the desired end."

This method was used by Assistant Engineer Polhemus for the next seven years until 1888 when the project was modified.

While Major Gillespie was District Engineer, the first work on the important project at the mouth of the Columbia River was undertaken. The River and Harbor Act of June 1878 had authorized an examination at the mouth of the Columbia to determine the nature and cost of permanent improvements. In 1879, Major Gillespie reported that

"It is impossible to give an estimate of the extent to which commerce will be benefitted by this improvement. Should an improvement be adopted for the harbor which will give an increased depth of water over the bar and enable vessels drawing 22 to 23 feet of water to cross without danger at all stages of the tide, the commerce of the whole of the Northwest will be increased beyond the capabilities of anyone to estimate at the present time."

In the period 1876-78, the value of exports crossing over the Columbia River bar totaled $19,214,099. But Major Gillespie reported that

"Even these large values are increasing rapidly with the increase in wealth and population of the State of Oregon and Washington Territory."

In addition,

"The citizens of Astoria are anxious that some extensive improvement should be undertaken in hand to increase the depth of water over the bar."

With the mouth of the river in its natural state, the tides and currents from the ocean, plus the natural current of the Columbia itself, could alter almost overnight the entrance to the mouth of the river. Charts dating back several decades showed that two channels existed at the mouth of the river. The difficulty lay in the fact that of these two channels, neither was deep enough or dependable enough to satisfy
the volume of commerce and the size of ships which now were passing up and
down the Columbia. Only desperate or foolish ships attempted the entrance
without the aid of a pilot or tug. Even if the channel were quickly
found, the depth which could be relied upon, 17-21 feet, left precious
little to spare. For the largest ships, entrance was impossible. In
1879 three large vessels were sunk at the mouth, and the cargo lost.

From the date of the initial authorization for an examination for
permanent improvement at the mouth in 1878, numerous surveys were made,
and sets of plans were drawn up and submitted. In 1880 Major Gillespie
submitted a plan for an 8,000 foot jetty on the south side of the mouth
to cost $4,750,000. Its function was to obtain a secure, deep channel by
concentrating the current of the river and the tidal action of the sea.
The jetty would have prevented sand from drifting into the channel from
the south, would have minimized the effect of stormy weather on the water,
and would have allowed vessels to enter the Columbia with little delay or
cost.

The Review Board of the Pacific Coast, however, was not convinced
that such a substantial improvement was necessary at that time, and Major
Gillespie's plan was not accepted. It was the opinion of the Board that
the natural effects of tides and currents would open a channel adequate
for present needs. This decision was hardly acceptable to citizens of
the area whom for many years had observed no beneficial effect of the
tides or currents. Within two years, the Board of Review was assembled
by an order of Congress and considering another, even larger, plan for a
jetty at the mouth of the Columbia. While this plan was not adopted
until after Major Gillespie had departed from Portland, during his tenure
the need for substantial improvement became recognized, the public became
actively interested, and much valuable information was accumulated. When
work on the jetty finally was begun, it proved to be the greatest project
undertaken by the Portland District until the 1930's.
9. River Improvement

Within ten years after the establishment of the Portland District in 1871, improvements were being made to rivers throughout the Pacific Northwest. The main types of work for several decades were surveys, snagging, rock removal, dredging and wing-dam construction.

A.

Much of the work was done in Washington Territory. Washington became a state in 1889.

The most important of the rivers improved in Washington was the Cowlitz, the largest river to flow into the Columbia below the mouth of the Willamette. Major Gillespie reported in 1881 that

"The Cowlitz is quite an important little river, and the country it drains is rapidly filling up with a thrifty and industrious population. The two river steamers which do the carrying trade for the river have brought out this year a larger amount of produce than ever before, and it is expected that the yield next year will be still larger."

An appropriation of $50,000 was given the same year to provide for snagging operations. In 1881, Major Gillespie reported that in the fall of the previous year

"... the snagboat drew out from the channel at various points from the mouth to Cowlitz Landing, a distance of forty miles, three hundred and twenty-five snags, cut from the bank one hundred and twenty-two overhanging trees, and raised two sunken scows."
Similar operations in the next several years were carried on which made the Cowlitz safe for navigation at high water. The construction of wing dams together with dredging operations in the last half of the decade improved its depth, thereby making it navigable at low water by the steamers then serving the area. Before the improvements, a section of the river only half as long, during only a part of the year, could be navigated—and even then at considerable risk.

Similar work on other rivers in Washington Territory was completed but on a smaller scale. Four rivers which flow into the Puget Sound—the Nooksack (or Lummi), the Skagit, the Stillaguamish, and the Snohomish—were either surveyed or improved, or both, during Major Gillespie’s tenure in Portland.

Almost at the Canadian border, the Nooksack flows southwesterly into Bellingham Bay. The report of R. A. Habersham described the area as "generally rich and populated with about 650 settlers." In transmitting Habersham’s report to the Chief of Engineers, Major Gillespie observed that,

"There are no railroads in this part of our country, and as it is not probable that any will soon be built, the settlers in the Northwest must depend upon their small rivers for getting their produce to market."

The main improvement recommended here was for snagging.

An examination of the Skagit showed that great numbers of snags and trees, and even log jams, made the river completely unnavigable. It was proposed to remove these obstructions and improve the banks 45 miles up from the mouth of the river to Dyer's Camp. Work was commenced here when a "competent foreman" was hired and sent to the river to remove snags and jams.

"He went to Dyer's Camp . . . built a timber raft or improvised snag-boat, rigged it with a derrick and capstan, and then floated down to the small jam at Little Mountain, the worst obstruction in the river."

The small jam referred to was over 150 yards long.

Examinations were made of both the Stillaguamish and Snohomish rivers. Major Gillespie reported that,

"Both valleys are fertile, and possess an abundance of the finest timber, which is brought out in large quantities to the mills on the sound. The finest body of cedar anywhere on Puget Sound is said to exist near the mouth of Ebey's Slough. There are several thriving towns in these valleys, and the last census shows a total population of 1,120 . . . It is evident that the
many sources of wealth in this valley will soon attract a large immigration of farmers and millers, and it is important that the few existing obstructions to navigation of the river should be removed."

To eliminate the problem posed by the great quantities of snags on these rivers, Major Gillespie requested $25,000 to construct a snag boat. It would have been impossible to do this work with the existing snagging boat at Portland. An appropriation for this purpose was given the following year. By 1883 the boat was completed, and in its first two years of work nearly 1,000 snags were removed from the four rivers. This work in addition to the removal of boulders, drift, sunken boats, and "leaners" kept these rivers navigable for the next fifteen years.

After July 1881, District Engineer Lieutenant Charles F. Powell examined and improved the Chehalis River in Washington. Surveys were also made on the Lewis River, at Willapa Bay, Grays Harbor and Olympia Harbor.

No important work was done on the Lewis River until 1899. In its original condition, the Lewis was obstructed by snags, overhanging trees, and shoals and was navigable for small, light draft boats only. La Center, on the East fork, 6-3/4 miles and Woodland, on the North fork, 7-1/4 miles, were the heads of navigation. Under the 1899 River and Harbor Act, snagging, bank clearance and scraping were performed, 5 wing dams were constructed, and much rock removed. This type of work was continued until 1913 and cost $30,000.

In 1913, work was authorized giving water 6 feet deep and 50 feet wide to the forks from the mouth, 4 feet deep and 50 feet wide from the fork to La Center, and 4 feet deep and 50 feet wide to Woodland. Also provided were funds for annual clearing of the Lewis River 12.5 miles above Woodland. This project was completed in 1927 at a cost of $35,880 and is the existing project.

The River and Harbor Act of 1912 provided for a channel 4 feet deep and 50 feet wide from the mouth to Ostrander (9 miles), 2½ feet deep and 50 feet wide from Ostrander to Castle Rock (10 miles), and 2½ feet deep by 40 feet wide from Castle Rock to Toledo (18 miles). This was completed in 1913 at a cost of $32,908 and is basically the existing project. Annual dredging plus snagging and regulation works maintain those depths. In the first fifteen years after the improvement an average of about six million dollars worth of freight and rafted timber passed up and down the river each year. In 1965, the depth of the first 4.75 miles from the mouth was improved to eight feet and the width to 100 feet.
A very interesting survey, under the supervision of the Office of the Chief of Engineers, was performed in Washington on the Upper Columbia River by Lieutenant Thomas W. Symons, a Corpsman and number-one ranking graduate of West Point. His journey, in the fall of 1881, took him from the mouth of the Spokane River to the Snake River. The expedition was made through largely unsettled country in a small skiff with two corpsmen and several Indians serving as pilots. A map was made of the river from the Canadian Border to the Snake River, and of the land in the immediate vicinity. Rapids and other obstructions were described and charted.

A very thorough and lengthy report on the geologic and historic development of the river and its tributaries was submitted to the War Department. Lieutenant Symons states that he sought to

"... show the economical relations of the Columbia to the surrounding country," ... and to address himself to "any questions which may arise in connection with the improvement of the river, to all persons who take interest in the development and the prosperity of the Northwest."

Included in his report was the observation that the dry, almost desert country in central and southeastern Washington Territory possessed good, rich soil. All that was required was irrigation water. This accurate prophecy, plus the successful completion of one of the last of the old-time surveying expeditions, give Lieutenant Symons a page in the history of the Pacific Northwest.

Work on the Upper Columbia and Snake Rivers continued after 1888 for twenty years about as it had for the previous ten: removal of rock, reefs, boulders, ledges and snags. In 1892 the construction of dikes at Wild Goose and Log Cabin rapids to provide deeper water was authorized. These were completed by the Fall of 1896. They were small but fairly substantial contracting structures made of rubblestone. Cribbs were used at Log Cabin Rapids. Both these rapids are on the Lower Snake.

The turn of the century found the Corps of Engineers attending to the gravel shoals of the two rivers. The contract dredge NORMA and the newly-constructed U. S. dipper dredge WALLOWA (1904) each worked on gravel shoals. The WALLOWA had a rake-like attachment which reached down and scraped the obstructing gravel to deeper areas of the river.

In 1907 the continuation of the several types of work described immediately above was authorized by Congress. This remained the controlling project until the 1930's. From 1907 to 1912, a total of $300,000
was spent on the 124 mile stretch of water extending upriver from Celilo Falls into the Lower Snake. But from 1912 until 1928 a mere $100,000 was spent. This reflected the drastic decline of commercial shipping on the river during this period. All through this period virtually no tonnage passed upriver from Celilo Falls. Most of the $100,000 was spent on the Lower Snake since traffic there averaged about 25,000 tons a year. Most of the traffic on the Snake was designed to make railroad connections for the trip to Portland. Not until the late 1930's did navigation on the Upper Columbia and Lower Snake show signs of strength.

C.

Clearing, snagging, scraping, damming and blasting operations during the 1880's kept the Upper Willamette open for navigation for flat bottom pole boats all year as far as Salem, and nine months of the year to Eugene. Steamboats could navigate safely only at high water. Bank revetment work on the Willamette was first done during this period. Revetting consists of the covering of a riverbank with stone or masonry to prevent the bank from washing out. In 1892, heavy log traffic on the Yamhill justified the authorization for this type of improvement as far as McMinnville.

The River and Harbor Act of 1896 provided for the maintenance of minimum channel depths in the Willamette and Yamhill Rivers. Controlling works such as dams and dikes plus dredging operations were to maintain 4 feet of water from Portland to Clackamas Rapids (11 miles), 3 1/2 feet of water from Clackamas Rapids to Corvallis (107 miles), and 2 1/2 feet of water from Corvallis to Eugene (53 miles). The result was that light-draft steamboat traffic could navigate all during the year as far as Corvallis on the Willamette, and as far as Dayton on the Yamhill. For nine months of the year, steamboats could get to Harrisburg and McMinnville on the same two rivers, respectively. The dams which were built to aid in obtaining these depths were not storage dams with the ability to release water when needed. Rather, they merely kept what water was on hand at a given time in a smaller channel. That is, a dam would be constructed to connect the bank with an island, thereby diverting all the water in one channel. Or, a dam would be built to seal off a slough or other low area. These dams were built of logs, rocks and brush, and required repairs every year or two.

Dredging activities were mainly responsible for the improved depths in these rivers, however. The snagboat MATHLOMA was equipped with a shovel bucket dredge in 1904. It was constantly employed thereafter (until 1917) removing the gravel shoals and hardpan which wing dams could not wash out. In 1909 the dipper dredge CHAMPOEG joined the MATHLOMA on the Willamette and served for nearly 15 years.
An old woodcut by Gifford shows how the "Falls of the Willamette" appeared before a series of four locks were installed by the People's Transportation Company in 1873.
In 1904, the 20 mile section of the Willamette from Harrisburg to Eugene was chopped from the project. There was insufficient traffic to justify the expense. What traffic there was consisted mainly of logs which did not require improved depths. In 1912, a 6 foot by 150-200 foot channel from Portland to Willamette Falls was authorized. In 1930, this same stretch of the river was improved to 8 feet. In the intervening years, the same dredging, snagging, diking, revetting and repair work was continued on a regular annual basis.

Plans for a small lock and dam on the Yamhill River were drawn up in 1896. Located near Lafayette, the dam was to provide 3 feet of water during the entire year to McMinnville. The dam held and released water to regulate flow, and the lock lifted water craft over the dam. In 1898 the contract for the work was let to Normilie, Fastebend and McGregor of Astoria, and this firm completed the contract by October 1900. The lock was 175 feet long by 38 feet wide with a lift of 16 feet. Total cost for the project was a little over $72,000.

The lock and dam served a useful purpose for about twenty-five years supporting log traffic. By the 1930's, however, the river above Dayton was rarely used even for logs, and the locks were basically inactive. In 1956, the lock and dam were turned over to Yamhill County and the area is now a park.

One of the important reasons why the Willamette has been valuable for so long as a navigational waterway was because a series of locks were built at the 40-foot Willamette Falls in 1873. The locks were built by the People's Transportation Company at a cost of $600,000 -- including aid from the State of Oregon. In 1876 the locks were sold to Willamette Transportation and Lock Company. This company eventually became controlled by the Oregon Railway and Navigation Co., which sold the locks in 1892 to Portland General Electric. During much of this period, there was considerable political activity aimed at getting the State of Oregon to purchase the locks. It was widely believed that levying tolls for use of the locks impeded the development of the Willamette Valley. These efforts failed, however, and the people of Oregon turned to the Federal court. A survey was made, and in 1899 a report by the Board of Engineers stating the desirability of federal government ownership was drawn up. But the Portland General Electric Company, apparently overestimating that desire, set the price on the locks (which would require substantial repairs) at $1,200,000. The Corps declined to purchase at this price and stated the opinion that the locks were worth about one-third that amount. Ownership of the locks changed hands one more time and finally, after much negotiation, the Corps of Engineers purchased the locks from the Portland Railway Light and Power Company for $375,000 in 1915.

Included in the authorization for purchase was a provision for rehabilitation of the locks. This work included renewing the gates, timber-work and fenders, and the construction of a division wall to separate the canal from the powerhouse intake of an adjacent private
Willamette Falls Locks

Barge passing through one of the four 10-1/4 foot locks at Willamette Falls.
power generation facility. This was to be done at a cost of about $600,000, of which the State of Oregon would provide half.

The reason the locks exist is because the Willamette River at Oregon City spills over a rocky, basaltic, horseshoe-shaped reef about 41 feet high. The lock system is comprised of four locks, each having a lift of about 10-1/4 feet, a canal basin and a guard lock. The total length of the project is about 3,500 feet.

The Flood Control Act of 1938, and the Rivers and Harbors Act of 1945, provide for reconstruction of the Willamette Falls Locks and converting the existing flight of four locks into a single lock of 47.5 feet lift with a length of 440 feet and a width of 56 feet, and a guard lock. To date funds have not been appropriated to carry out reconstruction.

Meanwhile, Willamette Falls Locks continues to carry the load. In recent years, an average of 1,129,260 tons of commerce pass through the locks. There are roughly 8,580 lockages per year, two-thirds of which are for vessels traveling downstream. Most of the traffic is rafted logs towed by tugboats.

D.

The improved depth provided at the mouth of the Columbia by the south jetty, plus plans to extend and enlarge it, plus the growing trade on the river, made it possible for the Corps of Engineers in 1902 to secure an appropriation from Congress to improve the channel from Portland to the sea to 25 feet.

District Engineer Langfitt reported to the Chief of Engineers that,

"The value and the availability of this waterway for purposes of trade and commerce is proved by the quantities of grain and produce which through it find their way to the markets of the world from Oregon, Washington and Idaho. Its improvement to navigation for deep-water craft is of the utmost importance for the entire Northwest, whose inhabitants find the natural outlet for their produce through the valley of the Columbia."

In addition, he stated that

"The river is not now available for vessels of larger ocean draft to Portland, and on this account it is widely claimed that considerable transport and other business has been lost to this community."

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Clamshell dredge COOS, Dipper Dredge CHAMPOEG, and Tender WOODLAND used for early District maintenance of Columbia River and tributaries.
On the basis of a survey in 1899, the River and Harbor Act of 1902 provided for a 25-foot channel from Portland to the sea. $225,000 was appropriated the first year, all of which was applied to dredging. The work was performed by the U. S. Dredge WILLIAM S. LADD. By the end of the following year tonnage on the Lower Columbia River had grown to nearly 3 million tons. This was nearly double the average of the previous ten years.

The Port of Portland was established in 1891 by the Oregon Legislature with a general mandate to foster to economic development of the area. A plan for a 25-foot channel was advocated by Major T. H. Handbury, District Engineer responsible for improvement of the Willamette River and Lower Columbia River and its tributaries, in 1891, but no appropriations were forthcoming from the Congress. Until the Portland District took up the project in 1902, the Port of Portland attempted to maintain satisfactory depths as outlined by Major Handbury in 1891. The Port was only partly successful in this effort, however, since depths at most locations on the Lower Columbia River were only 20-23 feet. Major Handbury was allowed by the Chief of Engineers to serve as a special consultant to the Port, and the first Chief Engineer of the Port of Portland was hired from Major Handbury's staff.

When the Corps began to work on the 25-foot channel in 1902, the Port of Portland contributed the services of a 30-inch pipeline suction dredge to the effort. From this date until 1920 the Port dredged about 4 million cubic yards of material each year on Lower Willamette and Columbia River navigation projects.

Low appropriations left the river somewhat below project depth for a few years. But after 1907, 25 feet of safe water was maintained until 1912 when plans were made for further improvement.

All through the 1890's, there was a rising level of dredging activities on the rivers and harbors of the Pacific Northwest. The plans for extensive dredging to form and maintain a 25-foot channel from Portland to the sea were made in 1902. Both these developments posed the need for mooring facilities which could adequately service the growing Corps of Engineers floating plant.

The old Government Moorings, prior to 1903, were located in the area occupied by the old Oceanic Terminals on the west side of the Willamette River just north of the Broadway bridge. This location had been the home of the Corps of Engineers' mainstay, the WILLIAM S LADD, which served from 1897 to 1909. Many of the older boats --dredges, snaggers, and scrapers alike -- had no name but merely were known as the "U.S. dredge" or the "U.S. snag boat". These craft, plus all other boats owned or rented by the Corps, were housed and serviced at the old location.
The first of three parcels of land for the new Moorings was acquired in 1903. The location is on the St. Helen's Road on the west bank of the Willamette River just past the old Portland Gas and Coke Company plant. The new moorings immediately had its hands full. In 1903 the hydraulic dredge CHINOOK was put in service. Four boats were commissioned in 1904; the sluice boat WALLA WALLA; the snag boat MATHLOMA; the surveyboat ARAGO, and the shovel dredge WALLOWA. The 18-inch pipeline dredge OREGON was commissioned in 1907, the hopper dredge CLATSOOP in 1909, and the dipper dredge TITAN in 1911. In 1913 the 260-foot long, 24-inch pipeline dredges WAHKIAKUM and the MULTNOMAH were put into service. These dredges are in operation as of this writing, and are the oldest boats in service. Eventually the Portland District Moorings were to be, in size, second only to the Memphis District.
The Dalles-Celilo Canal has often been referred to as the skeleton in the closet of the Portland District. For many years after completion it was virtually unused, and when it finally did bear a substantial level of traffic, it was permanently flooded over. But there are good explanations for the anomalies of The Dalles-Celilo Canal and, on balance, the time and money spent on the project were worth it.

Major James Post, District Engineer from 1894 to 1895 stated the conditions which he felt would justify the project.

"The demand for the open navigation of the Columbia River comes from the wheat-growing districts east of the Cascade range. Those portions which would now be affected by the improvements at the Dalles lie chiefly south and east of the Columbia, 115 miles to Wallula, and on both sides of it to Priest Rapids, 83 miles above, with a portion of the rich Wallawalla district. The improvement of the lower section of the Snake will open to the sea 200 miles of navigation through the heart of the wheat lands of the "inland empire". Other large tracts, tributary to it but now considered barren will doubtless be made productive in the not distant future when water for irrigation is supplied.

"The wheat crop of eastern Oregon and Washington probably exceeds 400,000 tons. In 1890 the railways were not able to transport the crop to market within a reasonable time, presumably for want of rolling stock. The acreage of 1891 exceeded that of 1890, and it was feared that the railways would not be able to move the crop before the next one would be harvested. (See "Memorial of the Columbia and Snake Rivers Auxiliary Waterway Association," Wallawalla, February, 1891).
Woodcut by Gittord showing early Indian fishing scene at Celilo Falls
"The quantity of wheat and other cereals received at Portland from the country east of these obstructions in 1891, was nearly 8,000,000 bushels. The total receipts of agricultural products from eastern Oregon and Washington were 271,000 tons. From the information the Board has been able to obtain, it is probable that in 1891 about 15,000,000 bushels of wheat were shipped to the Pacific coast from the country which would be, to a greater or less extent, affected by the removal of these obstructions at the Dalles. Statistics for 1892 have not been available.

"The report on the internal commerce of the United States for 1890 estimates that the lands tributary to Tacoma and Portland were capable of producing 2,000,000 tons (more than 65,000,000 bushels) of wheat per year.

"These figures merely show the recent production of the country, which is rapidly increasing both in population and in production.

"Along the Columbia River the lands now productive are not immediately upon the borders of the stream, and the area which can reach the river is at present limited by the distance it will 'pay' to haul the grain in wagons. It is not so upon the Snake; the Wallawalla district on the south and the Palouse country on the north extend almost, if not quite, to the river's bank. There is in the minds of the members of the Board no doubt that the improvement of the lower Snake will follow the removal of the obstruction of the Dalles and the reestablishment of navigation on the upper Columbia.

"A number of short railways have been built from the wheat centers to points on the main lines of transportation, and others will doubtless be constructed to the river if the navigation should assume sufficient proportions.

"The effect of water competition upon the cost of transportation between Dalles City, the present head of navigation, and Portland, which has been rendered possible within the last two years by the construction of the State portage railway at the Cascades, has been to reduce the rates by rail on general merchandise from 67 cents per 100 pounds to 37 cents, and by water to still lower rates. For instance, wheat, of which 1,500,000 bushels are shipped, pays 11 cents per cental by water against 17 cents by rail; wool, which reaches 6,000,000 pounds, costs 20 to 25 cents per cental by water and 50 cents by rail. The water rates include 40 cents per ton paid to the State of Oregon for the portage at Cascades."
Much of the excavation at The Dalles-Celilo Canal was done by hand. The equipment was simple and makeshift.

An unlined section of The Dalles-Celilo Canal.
Unwatered section of the Dalles-Celilo Canal is shown here with Washington shore of Columbia River at right. Canal was placed in operation in 1915.

View looking downstream along the Dalles-Celilo Canal on Oregon shore after completion. Swing bridge across 8-1/2 mile canal opened to permit water traffic through canal.
"In considering these projects with a view to selecting the one 'best adapted to the necessities of commerce', the Board is embarrassed by the difficulty of forecasting future commerce on the river.

"At present there is no commerce on the Columbia above Celilo. It can not be doubted that when the obstructions to navigation near the Dalles shall be removed there will be commerce, although the extent of its development can not now be foreseen.

"There is no fuel supply in the wheat districts. Boats on the Snake are now supplied with wood cut 100 miles to the westward and transported to the river by rail. This circumstance, together with the distance of the wheat lands from the river, and the number of rapids in the Columbia, is not favorable to a cheap transportation on the upper river. But whatever may be the extent of the navigation in the future, it may be said that when the great obstructions at the Dalles shall have been overcome, the fact of an unobstructed waterway to the sea will act as a corrective of excessive rates of transportation by rail."

It was upon this basis that the canal was constructed.

A plan was submitted to the Secretary of War in 1904 calling for improvement of the Columbia over the 12½ mile length of river from Celilo to The Dalles. 8½ miles were part of the canal proper. It was to be 65 feet wide and 8 feet deep. The canal was to run upstream from the foot of The Dalles Rapids to the head of Celilo falls. It was to have 5 locks of 8 feet lift each, 3 at the lower end, 1 just past the middle, and the 5th at the head of Celilo falls. Open river improvements were to be made from the foot of Dalles Falls for three and one half miles past Threemile Rapids. The project was approved, funds appropriated, and work authorized for 1905.

With the exception of the deepening of the river at the Cascades, the work at The Dalles-Celilo was basically the same as the earlier project. Apparently some lessons had been learned. The length of the project at The Dalles was over twice that of the Cascades. But The Dalles project required about half the time. Excavation, blasting, and concrete work preceded the construction of the locks. The last work on the project was completed by 1915.

Major Post's optimistic forecast of traffic above Celilo, however, was not to materialize for 25 years. There certainly always was the great quantity of wheat grown which Major Post described -- much more, in fact. But until the era of huge locks and slackwater pools provided by the run-of-the-river multi-purpose dams on the middle Columbia, and until huge barges plied the Columbia, most of the wheat continued to go by rail. If the railroad rates didn't decrease, at least there was never a chronic shortage of rolling stock as in Major Post's time. All through the
The old steam-powered sternwheeler J. N. TEAL of Portland makes her way downstream through The Dalles-Celilo canal. Note wool bags and old vintage automobile on deck.
twenties virtually no commercial traffic passed through the canal. Except for a spurt in 1933 and 1934 of about twenty thousand tons, traffic was very light. In 1938 shipping picked up, rose to 139,542 tons in 1939. This was in response to the completion of the lock at Bonneville Dam in January 1938. Traffic increased steadily through the 1940's until in 1951 over one million tons passed through the canal. The bulk (2/3) of this traffic, however, was not wheat, but petroleum products. About one million tons passed through the canal up until and including 1956. After this river traffic passed through the 86-foot lock of The Dalles Dam. The pool of the dam inundated the Dalles-Celilo canal, ending its forty-year history.
11. The Mouth of the Columbia

A.

In July 1881, Lieutenant Charles F. Powell was promoted to the rank of Captain, transferred from the Cascades, and directed to take up responsibilities in Portland as District Engineer. His period of service remains one of the most noteworthy in the history of the District. Captain Powell served for nearly seven years, longer than any District Engineer before or since.

Operations were now progressing on a significant scale in an area roughly 400 miles north to south and east to west—from the Canadian border to Coos Bay, and from the mouth of the Columbia to the Upper Snake. Rapids were being removed at Lewiston; large jetties were being constructed on the Oregon coast; numerous rivers in Washington Territory were being surveyed and improved; important works on the Willamette had been completed; and on the Columbia an important canal was being built. Appropriations had reached an all time high shortly before his appointment, and before he was to leave, they would have doubled. When Captain Powell arrived in Portland, the job of construction of the jetty at the mouth of the Columbia was added to already existing responsibilities. This was the most important project undertaken by the Portland District in its first fifty years.

For three years, the task of supervising these far-flung projects was skillfully performed by Captain Powell. The scope of this responsibility is seen in the fact that by 1884 work in the Northwest was divided among two or three officers of the Corps. Even when the Seattle District was founded in 1896—and the size of the Portland District was cut down almost by half—this responsibility did not rest on one man alone.
In the three-year period required to get work on the jetty underway much had been done elsewhere. The first large pier and wharf installation in Portland had been approved by Captain Powell in 1882. The first permanent and continuous river-gauging operation had been installed by Captain Powell at Astoria. Data obtained from the self-registering instrument was made part of public record. Additional gauges were placed on the Columbia and Willamette Rivers over the next fifteen years, and coordinated information was distributed daily to interested parties.

Captain Powell had a thorough survey performed of the site for the canal past Celilo Falls at The Dalles. This was accompanied by a rough plan and a cost estimate. Another survey was made of Nehalem Bay. Dredging operations continued along the Willamette and Columbia where necessary, and several thousand trees were removed from the banks of the Upper Willamette. At the Cascades, work progressed under resident engineer Corpsman, Lieutenant P. M. Price.

One reason why the Congress had ordered the Board of Engineers to reconvene and draw up a plan to permanently improve the mouth of the Columbia River was the hue and cry let loose by Oregonians living along the Columbia. Captain Powell reported the situation to the Chief of Engineers.

"The north channel had remained the ship channel during the year. It has shoaled from 20 to 19 feet at mean low-water. This is causing much uneasiness in the shipping interests of the Columbia River."

One example of this "uneasiness" is the following letter from the Astoria Chamber of Commerce sent to Captain Powell in 1882:

"If a vessel should not be able to take on her full cargo at Astoria, or anywhere inside the bar, she must proceed to her destination without it, as it is not possible, on account of the roughness of the ocean at this latitude, to take on additional cargo from lighters after getting across the bar, as is possible at many southern ports. The German ship, Fritz, now lying in the harbor awaiting a favorable opportunity to go to sea, draws, when fully loaded, 26 feet. It is not possible for her to cross the bar in safety drawing more than 22 feet. She must therefore proceed to Great Britain with a cargo 800 tons less than her capacity.

"These facts, we hold, should give the improvement of the Columbia bar the preference over any other work in the Northwest. In the winter months, when the greatest amount of shipping is done, vessels . . . have to wait frequently a long while for a high tide and a smooth sea . . .
"This delay is due solely to want of proper depth of water on the bar... A sufficient depth of water is wanted on the bar to allow vessels drawing 26 feet of water to cross the bar without delay, in order to meet the requirements of the commerce of this country."

The letter went on to add,

"The present state of the bar prevents patronage being given to American ships. The British vessels are nearly all built of iron as generally as the large American ship is built of wood. The grain of this coast must be carried in large vessels to its market in Great Britian. But little would be left the farmer and producer should we be obliged to ship the grain exclusively on such a long voyage in small vessels. Yet the large American vessel drawing 23 to 26 feet, carries no more than the British iron vessel drawing 20 to 22 feet.

"We are obliged, therefore, to employ British vessels to carry our produce to Great Britian and Europe, in much larger proportions than is done from San Francisco or deeper ports."

The board handed down a plan for the mouth of the Columbia during the same month it met, September 1882. Extensive land and hydrographic surveys were made to determine the feasibility and cost of the project. An examination was made of the area to locate a source of heavy stone. The proposal was approved by the Chief of Engineers, and in July 1884, Congress provided the authorization together with an initial appropriation of $100,000. The improvement was to be

"A low-tide jetty, about 4 1/2 miles long, extending from near Fort Stevens, on the south cape, and by a slightly convex curve on the north to a point about 3 miles south of Cape Disappointment. A certain construction of stone and beton rocks resting on a foundation course is provided for at an estimate of cost, without contingencies, of $3,710,000..."

Before work actually had commenced on the jetty at the mouth of the Columbia River, it had been seen by the Office of the Chief of Engineers that responsibility for work in the Pacific Northwest would have to be divided between two men. In August 1884, Major W. A. Jones was assigned to supervise work at

"Improvement of the Willamette River above Portland, Oregon--Construction of Cascades Canal, Columbia River--Improvement of Upper Columbia, Snake and Cowlitz Rivers, Oregon and Washington Territory, and of Lower Clearwater River, Idaho"

This left Captain Powell with,
"Improvement of Willamette and Columbia Rivers below Portland, Oregon, and of the mouth of the Columbia River; of the entrance to Coos and Yaquina Bays and mouth of Coquille River, and of certain rivers emptying into Puget Sound, Washington Territory--Water gauges on the Columbia River."

By this arrangement, each man would have responsibility for one of the two major projects in the Northwest, the Cascades Canal and the jetty at the mouth of the Columbia. Offices for each man were located in Portland, and the division was put into effect as work was getting underway on the jetty.

In 1884-85, men were hired, materials were ordered and delivered, offices and shops and a wharf and a dock were constructed, and work on an approach trestle from the beach was completed. Quarry sites for stone were selected, housing and mess facilities were erected, and final surveys were made. The appropriation for 1886 was $170,000. Two years later it was $500,000.

The completion of the south jetty at the mouth of the Columbia River required ten years time and over $4,000,000. Construction throughout this period followed essentially a three-step pattern. First, a double track tramway was built from the approach trestle on the beach to the starting point of the jetty. A steam locomotive and about 30 gondolas or flat-bed dump cars operated on the tramway which was built above and ahead of the projected crest of the jetty. The second step was to place the foundation of the jetty into the water. After iron pilings had been driven, brush fascines one foot in diameter and eighteen feet long were bound together by galvanized wire to form forty foot wide "mattresses". These were laid on the floor of the sea, and were secured by piling and small stone. Their function was to minimize erosion of the ocean bottom on which the jetty rested.

When the foundation had been laid, the large jetty stones were hauled to the end of the jetty and dumped. Later techniques placed stones more in their desired position. The tramway method resulted not only in the breakage of many jetty stones, but in a somewhat haphazard assembly as well. Broken stone made the jetty weaker than specifications. With some rocks falling so that their long axes were perpendicular to the structure instead of parallel to it, the force of the ocean water could more easily pick the structure apart. Each year a good deal of time and money was spent making repairs to sections of the jetty already completed. In 1892, more repair work was done than anything else.

When the jetty was completed in 1895, it measured 30 feet at its crest and variously 80 to 90 feet along its base. It maintained a height of from 12 to 10 feet above the mean level of lower low water except at the outer end where the height sloped sharply to 4 feet. Measurements in the channel over the bar showed that a minimum of 30 feet had been obtained by the improvement. In many places 31 feet of safe water could
be relied upon. Benefits to navigation were substantial and quick to come. Within two years after completion of the south jetty in 1895, the value of tonnage passing over the bar was more than double the average for the previous decade.

B.

Despite the benefits provided by the completion of the south jetty, substantial new work was necessary by 1902 in order to support navigation on the Lower Columbia River. Surveys made at the mouth annually since 1897 showed that "marked shoaling" each year diminished the project depth. Nor was the channel stabilized as was necessary for the ever larger ships desiring entrance into the Columbia.

Thus, in 1902, the Board of Engineers submitted a project for approval of the Secretary of War which was designed to eliminate the shoaling and re-establish a deep and dependable channel. The plan called for major repairs to the existing 4-mile jetty, and for a 3-mile extension. Project depth was to be 40 feet. It was to cost $2,510,000 including $250,000 to re-outfit an old Army transport, GRANT, to serve as a dredger. The new hopper dredge was named CHINOOK. It was required so that the shoaling at the mouth could be eliminated before completion of the jetty extension. Also included in the authorization for work on the south jetty was the provision that a jetty on the north side of the mouth of the Columbia would be constructed if that were necessary to obtain project depth.

Except for damage caused by rough seas, the work on the south jetty progressed satisfactorily. Despite much effort and expense to protect the wooden structures, thousands of feet of trestle were washed away each spring. In winter of 1905-06, over five miles of trestle were destroyed by stormy seas. Even the wharves and approach tramway required annual repair. But by 1913, new work on the south jetty was complete. Its total cost was raised upward to nearly $4 million. The same construction method used for the original jetty was used again here.

The result of work on the south jetty was 36-37 feet of safe water over the entrance. The decision was therefore made to go ahead with construction of the north jetty so that the project depth of 40 feet would be obtained. The cost of the 2½ mile jetty was to be roughly $6 million. Actual construction began in the spring of 1914 and was completed by the fall of 1917. Surveys made the following spring showed that depth across the entrance at all places was at least 40 feet. When completed, the jetties at the mouth of the Columbia River were the largest in the world.
The District Engineer, Lieutenant Colonel C. H. McKinstry, reported that

"The improvement has made it possible for the largest vessels operating on the Pacific coast to enter and leave at all normal stages of tide and in any weather except during the most severe storms. Bar-bound vessels, once so common, are now, on account of improved conditions, rarely to be seen."

No improvement of the project was required here for almost 40 years.

It is well to note that the name, "R.E. Hickson", appears on several of the survey charts of the mouth of the Columbia. The north jetty was built in reliance of the information contained in these charts. At this time Mr. Hickson was a junior engineer, chiefly engaged in surveying. Over forty years later he would retire as Chief of Construction and Operations for the North Pacific Division. Mr. Hickson, who had previously served many years as Chief of the Engineering Division in the Portland District, was an internationally recognized authority on jetty construction.

C.

While big, oceangoing ships could cross the bar at the mouth of the Columbia, unless the channel to Portland were deepened, many ships would have to unload at Astoria. The increased freight rates resulting from transshipment to smaller-draft boats or transfer to railroad cars adversely affected commerce in Portland. Thus, in 1912, a plan was approved for the establishment of a navigation channel from Portland to the sea, 300 feet wide and 30 feet deep. In 1913, two 24-inch pipeline dredges, MULTNOMAH and WAHKIAKUM, were obtained to do the bulk of the dredging. These two dredges are still in service as of this writing. The federal cost of the channel was $3,770,000 for new work, and no more than $300,000 per year for maintenance. Most work under maintenance consisted of the removal of the deposit of the annual freshet.

Part of the project was to be the responsibility of the Port of Portland. It was to maintain 30 feet in all project sections of the Willamette River (Broadway Bridge to mouth) and, in addition, meet all annual costs of the Corps over $300,000 for the project. This usually amounted to about $50,000 per year.

The channel was completed to project depth in 1918, just one year after completion of the north jetty. Writing in the early twenties, Major R. Park assessed the benefit of the work:

"The improvement has greatly increased the draft of vessels that can ascend to Portland and Vancouver, and has enabled
steamship lines to operate on regular schedules. Vessels now arrive and depart from Portland at all hours and seldom have to wait for tides.

"There is a large saving in freight on the commerce handled in oceangoing vessels on the lower Columbia and Willamette Rivers between Portland and Astoria, and vice versa. The saving last calendar year on a total of 4,163,554 tons is estimated to have been $9,867,622.98. On receipts of oil and gasoline alone (1,129,282 tons during 1922) there was an estimated saving of $3.32 per ton, or a total of $3,749,216.24."

No other improvement on the Portland to the sea navigation channel was needed until 1930.
12. Organization

The organizational changes began in 1886. An indication of the confidence which Captain Powell's superiors placed in him was expressed when the Office of the Chief of Engineers returned the responsibility for the construction of the Cascade Canal and Locks to Captain Powell. This had been shifted to another officer in 1884 in anticipation of the large responsibility of supervising work on the jetty at the mouth of the Columbia which Captain Powell already had. Until Captain Powell left in April 1888, he had full responsibility for the two most important projects in the Portland District in its first 50 years.

Since 1884, there had been two District offices in Portland. Each was separately commanded by Engineer officers. In 1887, another change was made by order of the Chief of Engineers. An additional District office was formed and headed by Captain Willard Young. Responsibilities for works in the Pacific Northwest were divided as follows: Captain Powell retained the works at the mouth of the Columbia and at the Cascades, and on rivers in Washington Territory; Captain Young was assigned to projects on the Oregon Coast; and Major W. A. Jones, who had been in Portland since 1884, retained responsibility for improvements on the Clearwater, Snake, Columbia and Willamette Rivers.

The following year, 1888, Captain Powell was transferred out of the District and Major T. H. Handbury, another outstanding District Engineer, succeeded him. Major Handbury was assigned the same responsibilities which Captain Powell oversaw. The other two officers retained their same assignments, except that Tillamook Bay was added to work on the coast under Captain Young.

In 1889, two offices again operated in Portland. Major Jones and Captain Young were transferred out of the area, and their assignments were absorbed by Major Handbury and by Captain Thomas W. Symons, the successor to Captain Young. Major Handbury again retained the responsibility...
Area responsibilities of the Portland District were cut down by a little over one-third when the Seattle District was established in 1896. The next major change in the territory of the Portland District occurred in 1948 when the Walla Walla District was created.
for the mouth of the Columbia and the Cascades --assignments he held until he left the District in November 1893-- as well as work on the Lower Willamette and the Cowlitz Rivers. In anticipation of the benefits which the completed south jetty at the mouth of the Columbia would provide, Major Handbury had recommended improvement of the channel from Portland to the sea to twenty-five feet. However, the merits of this proposal were not recognized by the Board of Engineers until 1902. Under the assignment, "Improvement of Certain Rivers and Harbors in Oregon and Washington", Captain Symons was put in charge of all other projects in the Northwest. It was Captain Symons who had performed the notable survey of the Upper Columbia several years previous, discussed above.

With minor variations, these two men held these responsibilities until November 1893 when Major J. C. Post replaced Major Handbury. In 1895, two new Engineers came to Portland. In November, Captain W. L. Fisk replaced Captain Symons. In December, Captain Harry Moore replaced Major Post.

The following spring, on April 30, 1896, the Seattle District was organized and Captain Taylor was assigned to Seattle as the first District Engineer. The formation of the Seattle District cut the territory of the old Portland District almost in half. The outlines of the new Portland District are shown on the accompanying map.

Captain Fisk immediately assumed the former responsibilities of Captain Taylor in the Portland District. In November 1897, he was promoted to Major. At the same time a second Portland District was again established. From this date until 1926, two districts operated continuously in Portland. The assignments between them varied.

After 1907 the system of numbering districts was put into effect nationally. The two districts in Portland were officially listed as "First Portland, Oregon", and "Second Portland, Oregon" Districts. In 1926 the two districts were consolidated into the Portland, Oregon District. Previous to 1907, districts had been listed according to the type of work authorized, such as "Improvement of the Lower Willamette and Columbia Rivers, from Portland, Oregon to the sea", and the like.
13. Oregon Coast Projects

From the late 1880's to the 1920's great progress was made in developing the bays and harbors of the Oregon coast. Work begun previous to this period -- at Coos and Yaquina Bay, and at the mouth of the Coquille River -- soon had to be revised. This was because the structures installed were either not substantial enough to withstand the exceptionally rough waters of the Oregon coast, or they did not produce the desired results.

New work was begun on the Umpqua River on the southern Oregon coast in 1885 by Captain Powell. For the following fourteen years, until 1899, work proceeded somewhat intermittently on this small project to remove rocks, rapids, and, outside the entrance, reefs. Only $20,000 was spent on the Umpqua in this entire period, but the improvements were adequate for the needs of the valley. The chief beneficiary of the work was the mail boat. Once every three weeks it made its way up the Umpqua River with its small but greatly appreciated cargo of mail, "express" freight and occasional passengers. No other work was done on the Umpqua until 1922.

In 1888 Captain Young presented a plan to the Board of Engineers for a substantial improvement at Yaquina Bay. The south jetty, on which work had begun in 1880, had resulted in the formation of two 13-foot channels at the entrance. This was an improvement over the original 7-foot depth. The difficulty was that the two new channels were constantly shifting. Even when the channels could be located, there was no assurance that sand obstructions had not formed.

The Board approved Captain Young's plan, and work was begun in December 1888 on the construction of a 2,300 mid-tide jetty from the north head. The existing south jetty was to be strengthened and raised to full high-tide level. Its original height was mid-tide. In addition, the south jetty was extended from 2,500 to 3,700 feet. The north jetty was designed so that the channel would avoid the reefs just outside the
entrance. When the work was completed in 1896, at a total cost of $715,000, the channel had been stabilized and the depth improved to nearly seventeen feet.

In 1900 the Board of Engineers held a meeting in the opera house of Newport, Oregon, the principal town on Yaquina Bay. Newport, claiming only about 500 citizens at this time, had grown hardly at all since the Corps had first begun work at Yaquina Bay 20 years previous. The townspeople were informed by the three Engineer officers who comprised the Board that the commerce of the area would be adequately served by the existing jetties for the foreseeable future. At this time the "total industries of any importance whatsoever in the whole region", according to the Board, consisted of,

"...(a) railroad repair shop, small salmon cannery, and sawmill at Toledo, a small salmon cannery at Newport, and a small sandstone quarry on the Yaquina River ..."

The prediction of the Board, though not enthusiastically received by the citizens of the area, proved to be accurate. No other work was needed at Yaquina Bay until 1919.

Work completed at Coos Bay up until 1889 had succeeded in stabilizing the channel at the entrance. Its depth of 13 feet, however, had not been improved upon. The tremendous potential of the lumber trade in Coos Bay soon required that the depth at the entrance be improved to 20 feet. Captain Symons reported in 1889 that,

"It is extremely desirable that the government should undertake at the earliest possible date and with the most liberal appropriations the construction of the work necessary to make of Coos Bay the best harbor possible.

"There is tributary to Coos Bay an enormous forest area, the lumber from which, to reach the markets of the country and the world, should have an outlet to the sea for vessels drawing at least 20 feet. A harbor of this character would, it is estimated, give an additional value to this lumber of about $1 per thousand feet. The county surveyor of Coos County estimates that in that county alone there are 7,500,000,000 feet of merchantable timber; this consists of fir, cedar, spruce, hemlock, myrtle, maple, ash, and alder.

"... If the harbor could be made to permit vessels drawing 20 feet to engage in this trade the cost of freight would probably be diminished to about half ... But aside from the lumber and the agricultural, dairying and other interests about Coos Bay, the improvement of this harbor will have a far-reaching effect on the whole of southern Oregon, especially of the portion west of the Cascade Mountains."
Improvement of entrance to Coos Bay and Harbor, Oregon, June 1900. This photo looking along channel or south side of north jetty shoreward from tramway bent No. 615. Coos Head, on south side of harbor throat, is shown to the extreme right.
In response to this recommendation, the Board of Engineers in the same year, 1889, came up with a plan which provided 20 feet of safe water at the entrance to Coos Bay. Two slightly converging jetties, 1,500 feet apart at the outer end, were to be constructed to high-water level. The north jetty was to be built to 9,600 feet, and the south jetty, already largely in existence, extended to 4,200. The method of construction at Coos Bay was nearly identical to that used on the initial south jetty at the mouth of the Columbia. That is, a tramway was constructed, fascine support mattresses lowered and secured with ballast, and rubblestone dumped from the railroad tram cars into the sea.

Work proceeded satisfactorily, and by 1899, after an expenditure of over $900,000, both jetties were completed. Two problems had developed during construction, however. One was the result of rough seas. Over 1,000 feet of tramway was destroyed, and nearly half the length of the north jetty at the outer end had been leveled. Though the jetties were completed to specification by 1899, substantial repair and reinforcement work lasted until 1901.

The other difficulty was the accumulation of sand at the entrance. The strong winds at Coos Bay blew great amounts of sand from the North Spit into the channel. This problem had been recognized as early as 1891. The solution proposed at that date -- and carried on for fifteen years -- was to hold the sand down by planting grass on it. The Park Commissioner of Golden Gate Park in San Francisco had successfully dealt with a similar problem by planting Holland grass root (Arundo arenaria), a very hardy weed, over large areas of the park. Seeds and roots were shipped to Coos Bay. Each year an additional section of the North Spit was reclaimed by planting. By 1907, nearly 1,000 acres were thriving, and most of the sand was prevented from blowing into the channel.

In 1907, a $350,000 appropriation was obtained to construct the hydraulic dredge OREGON. It was assigned to work on harbors on the Oregon and Washington coast, principally including Coos Bay. The jetties at Coos Bay successfully kept the ebb and flow tides moving quickly enough so that sand obstructions did not form as a result of tidal movements. But deposits of sand from the annual freshet from the Coos and Millicoma Rivers were unavoidable. In 1899 it was seen that the effect of the jetties alone would not maintain the entrance to project depths. From 1908 for almost 20 years thereafter, this was accomplished by dredging.

The waterway at Coos Bay is shaped roughly like an upside-down letter "U". Above the entrance of the ocean at one end is an entrance channel of some eight miles, a two-mile, east-west turn around North Bend, and then a seven mile section going north to south down to the head of navigation in the bay. Considerable dredging work had to be performed over this entire distance to make it navigable. Before any improvements, the entrance channel contained only eleven feet of safe water, and the channel in the bay itself had only six.
Dredging operations commenced at Coos Bay in earnest in 1908 immediately after completion of the fifteen-inch, hydraulic pipeline dredge OREGON. A small dipper dredge had done some work previously on a contract basis, but records on this are contradictory. Since the working capacity of the OREGON was ten times that of the dipper dredge, the earlier work is comparatively unimportant anyway. Four main shoals were removed, and depths in most sections of the channel in Coos Bay were at least sixteen feet by 1910.

In 1910 Congress authorized a project to improve the entrance channel and bay to eighteen feet depths. The Act also provided for a three hundred foot square turning basin. This was accomplished by 1912. After that date annual dredging operations maintained the channel and the bay to project depths. In 1919 Congressional authorization improved the depth of the 1910 project to twenty-two feet. This work was accomplished six years later, in 1925, and maintained afterwards by annual dredging.

The River and Harbor Act of 1896 had authorized improvements on the Coos and Millicoma Rivers. Snagging, the removal of "bowlders" and debris, and some occasional minor dredging were performed on the 5½-mile length of the main stem of the Coos up to the confluence of the Millicoma and the South Fork of the Coos. A small dam was built on the South Fork Coos to eliminate Carpenter Shoal. The same types of improvements were made for about 8 miles up each one of these streams. This was basically the type of work which was done on these rivers until 1948, when the project was modified. The benefits of these simple improvements, however, were important to the area. District Engineer J. B. Cavanaugh pointed out in 1922 that,

"There is no railroad serving the locality. The river furnishes the only means of transportation for the farmers to reach the timber markets, to whom the improvement has been of great benefit, enabling them to materially increase shipments of products. Navigation has been made much safer and easier."

The destructive waters of the Pacific had, by 1920, beaten down almost to water level nearly all of the original south jetty, and nearly half of the north jetty. The tramways and receiving wharves had long since been washed away. The entrance between the two jetties was still navigable, but this was increasingly due to dredging. In 1922, therefore, Congress provided that the south jetty be reconstructed and extended to 3,900 feet, and the north jetty be restored and reinforced wherever necessary. $4,085,000 was appropriated for the project. The same method of construction used previously at Coos Bay was employed in this work. The south jetty was completed in 1928, and the north jetty the following year.

Improvements at the Siuslaw River began in 1891. In the spring of that year, Captain Symons described the problem at the mouth of the Siuslaw.
"The unconfined channel has a range of about 1 mile, over which it wanders in making connection with the ocean. In consequence of this wandering and spreading out of the outgoing and incoming waters, the bar at times shoals very badly, while at other times it has a depth equal to the controlling depth inside the entrance. The depth on the bar varies from 5 to 12 feet at low water, and the bar channel changes very much in position and direction."

Captain Symons also reported the extent of commerce in the area.

"Of the 900 square miles drained by the river it is estimated by persons familiar with the country that 380 square miles are covered with merchantable timber that can be floated to tide water.

"Some of the tributaries to the Siuslaw have been settled, notably the South and North Forks, Sweet, Hadsell, Knowles, Lake, Deadwood, Wild Cat, and Wolf Creeks, and the land cleared and cultivated is said to yield abundantly... A good hay is produced. Hops have done well, ... All fruits and vegetables are grown, are of good quality and require little care and no irrigation. There are 700 cattle in the valley, 900 sheep, and a few hogs."

In July 1891, the Board of Engineers approved a project consisting of two converging jetties of rubblestone with brush-mattress foundation. They were to be high-tide structures, the north being 7,500 feet in length and the south 5,700. The cost was estimated at $751,000.

Assistant Engineer G. A. Lyell performed a preliminary survey in the fall and work was gotten underway the following year, 1892. It was the opinion of the Board of Engineers that,

"...when once work is commenced on the north jetty it should be pushed to completion as rapidly as possible. If this is not done, great additional expense is liable to be rendered necessary by the currents scouring out the sand in advance of the jetty, compelling its construction in deeper water, as well as by endangering the unfinished work."

But funds from the Congress for this project were not in amounts sufficient to quickly complete the work. By 1900 only $162,000 had been expended on the jetty construction, barely one-fifth the estimated cost. At that date the north jetty had been constructed to 3,900 feet, but the work was inferior to original specifications.

The work had also been hindered by the stormy winter seas. At one point Captain W. W. Harts, District Engineer for the Upper Columbia River and Tributaries from 1898-1901, reported that rough waters carried away the sea end of the tramway as fast as the contractor made extensions to it. But if adequate funds originally had been applied, the structure would
not have been exposed in its half-finished condition for such long periods of time; much of the damage could have been avoided. By 1901 work on the project was halted altogether. Though the depth at the entrance had been improved hardly at all, the spreading of the channel was held in check on the north side.

In 1910, Major J. F. McIndoe cited the importance of completing the project.

"The river and ocean form the only means of transportation, and any increase in depths and permanency in location in the bar channel would be of great benefit in lessening the cost of marketing the products. There are tributary to the port extensive logging interests, besides salmon canning and dairy products, the sawmills having a combined daily capacity of 150,000 feet of lumber."

Without improvements at the entrance, the commercial potential of the area could not be competitively developed. The depth at the entrance kept even medium size ocean vessels out of the Siuslaw. Those small craft which could get in safely were able to take on half a load. These factors resulted in the Siuslaw-San Francisco freight rate being significantly higher than other Oregon ports which were only slightly closer to San Francisco.

The River and Harbor Act of 1910 provided for the completion of the original 1890 project. The cost estimate was $426,000. By 1917 the work was completed. Depth at the entrance to the Siuslaw was improved to 17 feet, more than double the original depth of safe water.

The River and Harbor Act of 1925 extended the project depth 5 miles up the Siuslaw River to the town of Florence, the locale of the principal commerce in the area. This work -- consisting of snagging, boulder and debris removal, dredging, sluicing and revetment -- was completed by 1930. This project was maintained and was adequate for the needs of the area until 1958.

The work done at the mouth of the Coquille River had, by 1888, resulted in a 2,000-foot jetty extending from the south side of the mouth. Depth at the entrance was 10 feet at low tide; originally it had been 4 feet. Freight rates to San Francisco had been reduced from $10 per ton to rates ranging from $2.50 to $4.00.

In 1891, Captain Symons, citing the "steady and rapid" growth of the commerce carried on through the mouth of the Coquille, proposed that further improvements be made at the mouth. At this time, he reported,

"The principal industries of the valley are lumbering and farming. The timber is a good quality of fir, white cedar, spruce, ash, and myrtle. ... The dairy and grazing region

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halfway south to Port Orford finds an outlet at the mouth of
the Coquille."

The following year, 1892, the river and harbor act provided for ex-
tension of the south jetty to 2,700 feet, and the construction of a 1,575
foot north jetty, the heights of each to be 3 feet above high water.
Construction of plant and equipment, and of receiving wharves and approach
tramway proceeded until fall 1894. In 1895, using the mattress foundation-
tramway-rubblestone method, construction of the jetties proper was begun.
Work proceeded somewhat slowly until 1908 when it was completed. Small
appropriations and considerable sea damage again delayed work. On three
occasions, the responsible District Engineers reported that if a single,
large appropriation could be obtained, work at the Coquille could be com-
pleted within one year.

Except for dredging the channel to 13 feet between the jetties to a
point upstream less than 1.5 miles distant, no further work was done by
the Corps of Engineers until 1942. At that time the north jetty was re-
constructed. The channel work had been completed since 1933. Previous
to this work, minor dredging, snagging and clearing had maintained a depth
of about 5 feet in the same stretch of water.

No substantial, permanent project was authorized by the Congress at
Tillamook Bay until 1912. But as early as 1886, Captain Powell had sur-
veyed the bar and made plans for at least temporary improvements. The
first effort was to build a pile dike to contract the flow of water over
the bar at the entrance and thereby improve its depth. $5,000 was spent
on this in 1888. Unfortunately, the first freshet washed the pile dike
into the sea. By 1893 similar dikes, functioning like wing dams, had been
constructed and were successful. The controlling safe depth at the en-
trance at low water was 14 feet. A project commenced in 1892 to improve
the channel in the bay itself. At least 9 feet of water prevailed at all
times from the entrance to the city of Tillamook itself, 12 miles deep
in the bay. This was produced mainly by the annual efforts of a dredger,
but several small dikes and wing dams were installed to regulate the
water. Snagging operations also benefited the waterway. Until 1912,
about $250,000 was spent on this type of work at Tillamook Bay.

The Rivers and Harbors Act of 1912 authorized the construction of a
5,700 foot jetty on the north side of the entrance. It was to provide a
channel 18 feet deep, "and of such width as can be practically and
economically obtained". A channel from the entrance to Miami Cove and
Hobsonville 18 feet deep and 200 feet wide was also provided. The cost
was to be $800,000. The north jetty and the dredging of the channel to
Miami Cove and Hobsonville were completed by 1917. Repairs to the north
jetty and the addition of a groin dike were finished by 1933, and the
project was completed. The cost had risen to $1,026,000. The Rivers and
Harbors Acts of 1919 and 1925 had restricted the channel work to points
north of Hobsonville.
In 1889, Captain Willard Young performed a survey at Nehalem. This followed a very rough examination fourteen years earlier by Major Michler. Captain Young recommended the construction of two converging high-tide jetties at a cost of $615,000, but the Board of Engineers ruled the work was not justified. Until 1912, only $633, representing the cost of the survey, had been spent. In that year, the River and Harbor Act authorized basically what Captain Young had recommended over twenty years previous.

The difficulty at Nehalem was that the entrance to the bay was so wide that the navigation channel itself was shallow, and was constantly changing. A mere 6 foot depth prevailed at the bar, permitting entrance to only small, coastwise vessels. The Port of Nehalem had already constructed a 2,400 foot south jetty. Thus the Act of 1912 provided for a 2,500 foot extension to the existing south jetty and a north jetty to be 3,850 feet long. Each jetty was high-tide and rubblestone. Each was 10 feet wide and 30 feet high on the inside half section, and 15 feet wide and 32 feet high on the outside. The cost of the work was to be $632,000 of which the Port of Nehalem contributed $220,000. The work was completed on both jetties by 1918. The depth was increased and the channel stabilized. As of this writing, the work authorized in 1912 continues to be the existing project.
PART III

THE SECOND FIFTY YEARS
The completion of the jetty at the mouth of the Columbia and of the 30-foot navigation channel from Portland to the sea brought nearly to a close the first half century of the Portland District. The highlights of the period were the large, single purpose projects undertaken to aid navigation: the Cascades Canal and Lock, channel improvement and maintenance, the Dalles-Celilo Canal, the improvements on the Oregon coast, and the great jetties at the Mouth of the Columbia. These works were prerequisite to the commercial development of Oregon and Southern Washington.

The 1920's, however, ushered in the period in which the mighty Columbia River began to be tamed by huge multi-purpose dam projects. The role played by the Portland District in this effort is the most important achievement in its one hundred year history. Other work by the District which dwarfed the projects of earlier years was the great flood control system constructed in the Willamette River Valley.

The background to the basin-wide development of the Columbia River lies partly in the national conservation movement.

The greedy and wasteful use of the nation's natural resources in the nineteenth century -- soil, water, trees, wildlife and minerals -- needs no documentation here. It was matched only by the apathy and lack of vision of political leadership in regard to that question during the same period.

One of the early bright lights of the conservation movement was John Wesley Powell, a former Union Army Engineer officer. Well known for his daring three month boat trip down the Colorado and for his work in ornithology and Indian languages, Powell spent many years exploring and writing about the American West. His numerous books include the first prominent expressions that the natural resources of the United States
President Theodore Roosevelt is a key figure in the history of American natural resource conservation. He is shown here with naturalist John Muir at Yosemite Park. Roosevelt strongly defended the general public interest in natural resources, and argued for a policy of comprehensive development.
were not limitless, but required conservation planning. He discussed the interrelation between land and water and advocated control projects which would serve several purposes; for example, irrigation coupled with prevention of floods and soil erosion. The national conservation plan he published in 1878 contributed to his influence which was important until World War I. Powell died in 1902, the same year the Bureau of Reclamation was established.

Questions of natural resource conservation attained public prominence for the first time during the administration of President Theodore Roosevelt. The despoilment of the previous century prompted Roosevelt to adopt the policy that public ownership of the nation's natural resources must be affirmed, and that close and continuous regulation of private development of resources would be essential to prevent their destruction and monopolization.

At the behest of Gifford Pinchot, national forest holdings were increased five-fold to nearly two hundred million acres. Reclamation projects were begun in the West. New laws regulated grazing and mining on public lands. The first inventory of the nation's resources was taken. Numerous conferences were sponsored by the President to explain and publicize the problems involved. Newspapers and journals picked up the theme, and the Congress of 1907 became known as the Conservation Congress.

Roosevelt's speeches and messages urged development of the nation's rivers. Such development was to be consistent with "comprehensive plans designed to benefit the whole country", plans which would "consider and include all the uses to which streams may be put and coordinates the points of view of all users of water." He reported to the Congress that,

"Every stream should be used to the utmost. No stream can be so used unless such use is planned in advance. When such plans are made, we shall find that, instead of interfering, one use can often be made to assist another. Each river system, from its headwaters in the forest to its mouth on the coast, is a single unit, and should be treated as such."

In characteristically forceful language, Roosevelt's veto of Congressional private power dam bills in 1908 and 1909 affirmed the public interest in American rivers.

"The present policy in making these grants is unwise in giving away the property of the people in the flowing waters to individuals or organizations practically unknown, and granting in perpetuity these valuable privileges in advance of the formulation of definite plans to their use."

In his James River veto, Theodore Roosevelt stated that,
"When the public welfare is involved, Congress should resolve any reasonable doubt as to its legislative power in favor of the public and against the seekers of special privilege . . . The people of the country are threatened by monopoly far more powerful because in closer touch with their domestic life than anything known to experience. . . . The great corporations are acting with foresight, singleness of purpose and vigor to control the water powers of the country. They pay no attention to State boundaries and are not interested in constitutional law affecting navigable streams except as it affords what has been aptly described as 'a Twilight Zone' where they may find a convenient refuge from any regulation whatever by the public, whether through the national or state governments.

"I esteem it my duty to use every endeavor to prevent the growing monopoly, the most threatening that has ever appeared, from being fastened upon the people of this nation."

The failure of the Bull Moose party, the indifference of the Taft administration, and the threat and eventual outbreak of World War I during Wilson's administration brought work in conservation and resources planning to a halt. Ironically enough, it was not until the 1920's -- a period generally loyal to the doctrines of laissez-faire -- that Corps of Engineer work on the Columbia River was to begin its most important tasks.

Previous to federal involvement on the Columbia, however, numerous state or local organizations had generated interest or initiated programs for development of the river. Citizens groups offered competing proposals. The State of Washington sponsored surveys and even attempted a project in the Grand Coulee. Interstate compacts were formed. Newspapers, notably the Wenatchee Daily World, campaigned for action. The issue was prominent in state and Congressional elections. All of these efforts utilized the information produced by the many surveys of the river made by the Corps of Engineers, including the Symons expedition of the 1880's.

In March 1925, the River and Harbor Act directed the Corps of Engineers and the Federal Power Commission (established in 1920 to, among other things, issue licenses for projects on navigable rivers) jointly to prepare and submit to Congress estimates of costs for making surveys of those navigable streams

"whereon power development appears feasible and practicable, with a view to the formulation of general plans for the most effective improvement of such streams for the purposes of navigation and the prosecution of such improvement in combination with the most efficient development of the potential water power, the control of floods and the needs of irrigation."

In April 1926, the Corps submitted to Congress a list of rivers across the nation which it felt worthy of detailed investigation. This
became the now famous House of Representatives Document 308. Prominently included in the report of ten river basins was the Columbia River and its principle tributaries.

The Rivers and Harbors Act of 1927 directed the Corps of Engineers to make the surveys recommended in House Document 308. This was done from 1928 to 1931. After the investigations made by the Bureau of Reclamation were coordinated into the report, it was submitted to Congress in 1932. The 1932 "308" report (contained in House Document 103, 72d Congress) recommended a ten dam comprehensive plan for the Columbia River with Grand Coulee as the key upriver project, and a dam near Bonneville as the lowermost in the chain. The document remains the basic plan of the river.

It should be recalled that while Engineers were making plans to harness the great energy of the Columbia River, the United States was deeply sunk in the Depression. Thirteen million men were out of work, commerce was nearly paralyzed, bankruptcies and mortgage foreclosures were rife, the agricultural scene was chaotic, the stock market had long since crashed, savings were wiped out, a march on Washington, D.C. by the "Bonus Army" had to be routed by troopers, and there was considerable hardship throughout the nation. Public discussion of this bizarre tragedy -- the collapse of an economic system presenting the spectacle of great need amidst plenty -- centered in the Presidential campaign of 1932. Franklin Delano Roosevelt was promising a "New Deal" for the American people.

In September 1932, candidate Roosevelt spoke in Portland, Oregon. He stated his interest in the "vast possibilities of power development on the Columbia River". He promised that if elected, "The next hydroelectric development to be undertaken by the federal government must be on that Columbia River". Though in the midst of a crowded campaign schedule, Roosevelt insisted upon being driven east along the Columbia so he could see for himself the site of the future Bonneville Dam.

The great benefits to be obtained by government investment in the Columbia River, the need for efforts to overcome the Depression, and the election of F.D.R. combined to initiate construction of Bonneville Dam in 1933. Roosevelt's first one hundred days included the National Industrial Recovery Act, Title II of which continued the Federal Emergency Administration of Public Works. This agency advanced funds for building Bonneville Dam as public works project number 28. The dam was to be built by the Corps of Engineers in accordance with the plan presented in the House Document 103 of 1932.

Bonneville was the first federal dam on the Columbia River. Its power was to be no longer allowed to rush out to the Pacific without serving the people by turning a turbine blade, or dependably supporting an ocean vessel. The Columbia's potential is emphasized by the fact that the Columbia River is the greatest hydroelectric power stream in North America. About 40 percent of the nation's potential hydropower -- the cheapest and
Bonneville Dam under construction. Looking downstream from Oregon side, this photo was taken in January 1936. Powerhouse and navigation lock are at left, spillway structure at right.
Bonneville Dam during construction. View looking north from the Oregon side. This photo shows progression of construction as of November 1935. Note how low the river is at that time of year.
cleanest energy known to man -- lay in the Columbia River system alone.

This fact is accounted for by the river's great volume, and by its rapid rate of fall -- two to five feet per mile of flow. Only the Mississippi has more run-off volume. Though the 280,000 square mile area drained by the Columbia is less than half the area drained by the Missouri River, the Columbia's flow is five times greater. It is equal to ten Colorado Rivers. Rising high in the towering Canadian Rockies, the Columbia is fed by tributaries which are themselves important rivers. Among them: the Kootenai, Pend Oreille, Kettle, Spokane, Wenatchee, Yakima, the mighty Snake, John Day, Deschutes, Willamette, Lewis, and the Cowlitz. The mighty Columbia River was soon to share its great power and provide the economic base of the Pacific Northwest.

Organizational changes were made in the Portland District to accommodate construction of the Bonneville Dam. A Resident Engineer's Office was immediately set up at the dam site. Mr. Ben Torpen supervised this office for the first three years of the project. In May 1935, the Portland District itself was split into two units: the First Portland District remained in the Custom House; the Second Portland District, with primary responsibility for construction of the dam, moved into the Pittock Block. In July 1937, the Second District moved out to Bonneville, and the First District moved from the Custom House into the Pittock Block where it remained until 1968. The switch in 1937 changed the names of the units to the Portland, Oregon District, and the Bonneville, Oregon District. In 1941 the Bonneville District was consolidated with the Portland District.

The purpose of building a dam at Bonneville was to create a head of water so that:

1) water could fall and turn generators

2) navigation locks in the dam would lead to a slack water pool -- a pool which would cover Cascade Rapids and reach upstream 48 miles to The Dalles.

Drilling and construction of the cofferdam began in October 1933 at Boat Rock, several hundred yards upstream from the present site. A flood in December 1933 stopped work. Drilling done during the work stoppage demonstrated that the foundation of the existing site was superior to that of Boat Rock. Work began anew in February, 1934 at the present location. The initial appropriation was $20,240,700.

The plans drawn up by the Corps of Engineers for the huge project called for two separate structures. The spillway section, on the north side of the river, was to be 1,450 feet long and 197 feet above the lowest point of bedrock excavation. Bonneville Dam is technically described as a concrete gravity, ogee crest, gate-controlled structure. Eighteen 50-foot wide spillway gates were installed to regulate a pool which had a
Washington shore fish ladders under construction at Bonneville Dam.
maximum elevation of 82.5 feet above mean sea level. Columbia Construction Company, and later Guy F. Atkinson, Inc., were awarded contracts for construction of the spillway dam. Excavation work began in June 1934.

Between Bradford Island and the Oregon shore was the powerhouse site. It was to be 1,027 feet long and 190 feet in width and height. It had a capacity of ten generating units, eight of which were rated at 54,000 kilowatts and two at 43,200 kw -- a total of 518,400 kw. In non-technical terms this is enough power to satisfy the electricity needs of a city three times as large as Portland in 1935. Each of these generators was to be equipped with the adjustable-blade Kaplan turbine. Wicket gate opening and turbine blade slope are automatically controlled by a governor in the generating unit. This allows the most efficient use of water passing through the powerhouse. A 4,000-kw, station-service unit was also to be installed. General Construction Company and J. F. Shea Co. were awarded the contract for the powerhouse. Excavation began in February 1934, and construction in July 1934.

The single-lift navigation lock to be installed on the south shore was 500 feet long, 76 feet wide and 27 feet in depth over the sills. It had a lift capability of 70 feet, and was able to handle ships weighing up to 8,000 tons. Work on the navigation lock was begun in July 1934 by the same contractors working on the adjacent powerhouse.

The fish-passage facilities at Bonneville Dam are discussed at length in chapter 21, "Fish Conservation". This has been an important part of the work of the Portland District. It is sufficient to remark at this point that construction of the $7,000,000 fish facilities at Bonneville Dam was started in conjunction with navigation and powerhouse works, and was completed in May 1938.

From the beginning of the Bonneville Dam project, Lieutenant Colonel Charles F. Williams was District Engineer of the Second Portland District (later Bonneville District). Colonel Williams was succeeded by Major Theron D. Weaver. The man who had direct responsibility for the project was C. I. Grimm, Chief of the District Engineering Branch. Mr. Grimm later was transferred to the Division to head its Engineering Branch. Among the many Corps of Engineers officers who were assigned to the important Pacific Northwest project were Lieutenant William F. Cassidy and Lieutenant Charles H. Bonestelee, III. Each of these two men later became Lieutenant Generals: Cassidy as Chief of the Corps of Engineers; Bonestelee as United States Commander in Korea in the mid-1960's.

Work on Bonneville Dam was begun by means of emergency funds from the Public Works Administration. Apart from resource development, this was part of the New Deal effort to put men to work. The Bonneville Project Act of August 1937 gave formal Congressional authorization to the project and put Bonneville Dam on a more expeditious financial basis. From this date, money for the project was obtained from regular Congressional
Looking northwest, this photograph shows the upstream side of Bonneville Dam powerhouse in November 1935.

View of the Bonneville Dam spillway section under construction, looking northeast.
appropriation procedures rather than Presidentially designated emergency funds.

The location of the dam and the size of the pool behind it required a good deal of relocation work. Union Pacific track on the Oregon side, and Spokane, Portland and Seattle Railway track on the Washington side, plus sections of old Washington State highway 8 had to be moved back away from the river to higher ground.

The closure of the spillway dam was accomplished in September 1937. From that date until January 1940, the pool behind the dam was allowed to rise to its mean level of 71.5 feet. The navigation lock was completed in January 1938.

The first two generators (43,200 kw each) were operative by March 1938, and power was on the line from these units within three months. The original plan called for the powerhouse to contain six generating units with expansion capacity to ten units total as energy requirements dictated. Even before the first two main generating units were completed, the need for additional generating capacity was apparent. At that time contracts were let and work began to expand the powerhouse superstructure to full size.

When World War II broke out, the demand for electric power increased so rapidly for aluminum, aircraft and shipbuilding industries that quick installation of the four remaining generating units was essential. This was done in record time by December 1943. The use of Bonneville Dam electric power during World War II is discussed in Chapter 16, "Military Work".

The construction of Bonneville Dam by the Corps of Engineers and the huge irrigation and storage project at Grand Coulee by the Bureau of Reclamation made available vast amounts of hydroelectric energy. Title to this resource lay in the federal government. Long before Bonneville and Grand Coulee had been completed, a question of much discussion was according to what policy this electric power was to be distributed.

The eventual result was the Bonneville Project Act, passed by Congress and signed by President Roosevelt in August 1937. The Act rejected proposals to simply sell the power at the dam site to those able to come and get it. Rather, a federal marketing agency, the Bonneville Power Administration, was established to sell power in accord with the policy of "widest possible use of available electric energy" and with preference given to publicly and cooperatively owned distribution systems. The terms and conditions of the sale of hydroelectricity by the Bonneville Power Administration were designed to prevent monopolization of this vital resource by limited groups. The performance of the Bonneville Power Administration would provide a "yardstick" by which the activities of other electric utility systems in the Pacific Northwest could be measured.
Looking downstream, this view shows Bonneville Dam in the final stages of work.
Bonneville Power Administration was organized as a bureau of the Interior Department. The Administrator was empowered to construct and operate the necessary transmission and substation facilities, and to enter into power contracts of 20-year duration. The Administrator was also authorized to set rates consistent with the policy of the Act and with repayment obligations to the United States Treasury. At Bonneville Dam, as eventually at other federal dams to be built in the Northwest, the Corps delivered electricity to the Bonneville Power Administration at the converting facilities on the powerhouse. Electric energy requirements during World War II resulted in the rapid growth of the Bonneville Power Administration.

At the same time Bonneville Dam was being constructed, the Portland District Hydraulic Laboratory at Bonneville, Oregon was also built. Completed in 1938, the laboratory first constructed models of Mud Mountain Dam for the Seattle District, and the tailrace at Bonneville Dam and the Willamette Falls Locks for the Portland District.

In connection with the design and construction of multiple purpose dams and navigation channel improvement plans, many problems arise which cannot be solved by theoretical analysis or past experience. These problems are solved in the Laboratory by means of hydraulic models. The structures and topography in each model, and all the hydraulic quantities (flow directions and velocities, discharges, and pressures) are to scale. Model scales range from 1 to 100 in the general models to 1 to 4 in tests of detailed structures.

Comprehensive model studies are conducted on general layouts of projects; sectional models are used for tests on navigation locks, spillways, fishways, conduits and valves. The most economical plan is determined, designs are checked, improvements made, and new and better plans are developed in the models before the project itself is actually constructed. Results of these tests and investigations have enabled the Corps to save many millions of dollars.

Studies have been made on approximately 100 models of such projects as Bonneville, Mud Mountain, Lookout Point, Howard Hansen, Dorena, Chief Joseph, The Dalles, John Day and Ice Harbor. Studies of fish passage facilities are prominent in the program.

Major expansions of the laboratory have occurred in 1947-49 and in 1963. At the latter date, the operation of the Laboratory was shifted from the Portland District to the North Pacific Division.

Excitement and formal ceremony marked the official opening of Bonneville Dam on July 9, 1938. The Chief of the Corps of Engineers, Major General Julian L. Schley was in attendance accompanied by North Pacific Division Engineer, Colonel John C. H. Lee and District Engineer, Major
A tow of logs passes through the locks at Bonneville Dam.
Theron D. Weaver. Colonel Lee had succeeded Colonel Thomas M. Robins in May 1938. Colonel Robins had served as Division Engineer since August 1931. Secretary of the Interior Harold L. Ickes threw the switch for the first delivery of electric power for commercial and municipal use to the City of Cascade Locks. A microphone connected with the public address system was placed deep in the powerhouse structure to pick up the sound of the turbines as they whirled around and around.

The S. S. Charles L. Wheeler, Jr. was the first ship to pass through the navigation locks. When the water was raised up to its full height, a flag ceremony was performed on the deck of the ship. As the ship passed through the locks, the master of ceremonies grandly announced to the crowd that, "Ships are now passing through the heart of the Cascades Mountains and entering into the Inland Empire."

Formal dedication of Bonneville Dam had occurred several months previous in September 1937. Before a large crowd and assembled dignitaries, President Roosevelt dedicated the dam to "a policy of the widest possible use of electricity", and to "more wealth, better living and greater happiness for our children." The President pushed a button to electrify a string of lightbulbs which adorned the speaker's stand.

The total cost of the Bonneville project, when completed, was $83,585,600. Of this total, the funds were applied as follows (in millions)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>power facilities</td>
<td>$37.3</td>
</tr>
<tr>
<td>spillway dam</td>
<td>21.2</td>
</tr>
<tr>
<td>fish facilities</td>
<td>7.6</td>
</tr>
<tr>
<td>relocation</td>
<td>7.2</td>
</tr>
<tr>
<td>navigation</td>
<td>6.0</td>
</tr>
<tr>
<td>miscellaneous</td>
<td>4.3</td>
</tr>
<tr>
<td>total</td>
<td>$83.6</td>
</tr>
</tbody>
</table>

There had been some who felt that such an investment would be a waste of money. "Dam of Doubt", an article which appeared in the June 1937 issue of Collier's (now out of business) was typical of this minority view. The article claimed that there is no "real need for Bonneville", and that "there is no market remotely in sight for the power" from Bonneville Dam. The article spoke of the "fine concrete monuments scattered up and down the wilderness of the Columbia Gorge, still being paid for by the taxpayers." The Grand Coulee project was the object of similar abuse by others.

Not too many years were required to demonstrate that such views were incorrect. First of all, power requirements during World War II left not a single kilowatt of capacity unused. Occasionally the generators were worked above their nameplate capacity. Since the war, both the Corps of Engineers and the Bonneville Power Administration have had to scramble to construct generation facilities and to distribute electric energy to meet the ever-growing demand for power in the Pacific Northwest. In
Bonneville Dam, the first federal multiple purpose project on the Columbia River, is one of the most famous dams in the world.
addition, revenues from power sales are more than paying for the cost of the projects -- including non-power facilities, interest payments, irrigation subsidies, and operation and maintenance costs. Unlike nearly all other government programs, Columbia River dams are self-financing.

Navigation at Bonneville Lock improved greatly. From 1922-33, cargo shipped upriver from Bonneville, Oregon averaged less than 5,000 tons per year. In successive years after the completion of the dam and lock in 1938, tonnage was 161,000, 416,000, 707,000, 923,000. For five years thereafter until 1947 tonnage averaged about 750,000 tons. The ability of larger ships to go upstream made shipping on the river economically possible. Unit costs of smaller vessels were uncompetitive with railroads. The dollar value of the cargo passing through Bonneville Lock in a single month would have more than paid for the cost of navigation facilities. Navigation improvements further upstream in the decades after World War II would increase the utility of the work at Bonneville Dam. Such improvements would also extend the multi-purpose development of the Columbia River which was begun at Bonneville in 1933.
The Flood Control Act of June 22, 1936 is a milestone in federal
government water resources policy. It is also the legislative source of
the most important work of the Corps of Engineers throughout the nation,
and of the Portland District in the Willamette River Basin. In addition
to navigation (1824) and reclamation (1902), the national water responsi-
bilities of the federal government now included flood control.

The Corps had been involved in federal flood control programs previous
to 1936. Acts of Congress in 1917 and 1923 provided for improvements on
the main stem of the Mississippi River. In 1928 Congress adopted a plan
submitted by the Chief of Engineers which called for comprehensive work on
the Mississippi. The plan included levees, floodwalls, floodways, reser-
voirs, bank stabilization and channel improvements on the Mississippi and
its tributaries to the extent the latter were affected by the Mississippi
backwater.

In 1917 Congress provided for a less extensive project on the Sacra-
mento River in California. State and local interests cooperated with the
Corps of Engineers to enlarge river channels; make cut-offs; build levees,
weirs, pumping plants and outfall gates; construct bank protection works
and levee setbacks; erect and operate gauging stations; clear obstruction
from flood channels; raise bridges to provide proper vertical clearance
for the passage of flood flows, and providing for the necessary altera-
tion of highways; and building drainage and irrigation structures.

Like many tragedies, floods evoke a half-conscious "it-will-never-
happen-to-me" reaction in many people. But when Congress passed the
Flood Control Act of 1936, it was well aware of the terrible destruction
caused by flood waters in every section of the United States.
In 1828 thousands were left homeless and several hundred killed by a major flood on the Mississippi. Exact statistics are unavailable. 700 deaths resulted from flooding in the sparsely settled Sacramento Valley in 1861. Between 1865 and 1936, no less than 23 major floods ravaged Mississippi Valley residents and their property. Uncontrollable waters killed 2,209 persons and destroyed over $10 million in property in Johnstown, Pennsylvania in 1889, one of the most famous floods in United States history. Galveston, Texas was rocked by floods and hurricanes in 1900 and 6,000 persons lost their lives and 3,000 buildings were destroyed there. In 1903, 3,000 persons were killed in Heppner, Oregon by the devastating waters of a record cloudburst. 1913 saw 730 persons killed in Ohio and Indiana by flood waters. Even the small coastal rivers of the New England states caused the destruction of thousands of buildings and the loss of nearly 100 lives in 1927. 15,000 persons lost their homes and 250 died in the San Francisquito Canyon flood of 1928 near Los Angeles. $30 million in property was lost. 2,000 were killed in Florida in 1928 by flood waters whipped up by a hurricane. In 1936, flood losses in Pennsylvania and New England amounted to 250 killed, $150,000,000 in property destroyed, and 500,000 persons without homes.

This sobering history, plus knowledge of the fact that greatly increased social and economic utilization of flood plain areas was inevitable, prompted passage of the 1936 Flood Control Act.

At the dawn of the 20th Century, the United States had become an industrialized nation. Many types of manufacturing or processing plants required locations on riverbanks for water supply or navigation. Most of the large cities of the United States are situated on rivers. With population and commerce continually growing, it became clear that rivers could not be allowed to spill destructive flood waters simply because haphazard weather conditions might so arrange. Man was not helpless to face this occasional threat to life and well-being, and his need to live near rivers was substantial.

Section 1 of the 1936 Flood Control Act indicates the Congressional response to the flood problem:

It is recognized that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including the erosion of lands, and impairing and obstructing navigation, highways, railroads, and other channels of commerce between the States, constitute a menace to national welfare; that it is the sense of Congress that flood control on navigable waters or their tributaries is an proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof; that investigations and improvements of rivers and other waterways, including watersheds thereof, for flood control purposes are in the interest of the general welfare; that the Federal Government should improve or participate in the improvement of
navigable waters or their tributaries, including watersheds thereof, for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.

Under the Act, the Corps of Engineers was assigned direct responsibility for construction of flood control projects. Flood prevention work in watershed areas became a job of the Department of Agriculture.

The last two clauses in Section 1 of the Act contain the basis for a ratio test which is applied to all Corps of Engineer flood control projects. Its object is to ensure that each dollar of investment results in at least one dollar of return. In that ratio, it is the reasonably assured average benefits which are measured, not the maximum potential benefits which might occur. Accordingly, the benefit-cost ratio is a somewhat conservative financial technique.

It works like this: Streamflows for the Willamette River are expressed in cubic feet per second. Studies determine in a given year (1969 for example) a streamflow of 230,000 c.f.s. has a 1% probability, 150,000 c.f.s. has a 10% probability, 105,000 c.f.s. has a 35% probability, 100,000 c.f.s. has a 50% probability, etc., until streamflow probabilities totaling 100% are included. Gauging instruments and records over 75 years old provide data for these estimates. For each streamflow, a dollar-amount damage level can be estimated. For the Willamette, flooding in 1969 commences at 100,000 c.f.s. with $40,000 damages. Damage figures are obtained by extensive residential, agricultural, commercial and industrial surveys and interviews, and real estate and land use statistics. The next step is to multiply the damage figure corresponding to a particular streamflow by the probability percentage figure corresponding to the same streamflow figure. When each set of figures for the various streamflow levels have been so multiplied, all the products are added. This figure is termed the reasonably assured average annual loss. The sum is the "even-odds" figure representing the amount of damage which is likely to occur in a given year. This is termed the reasonably assured average annual loss. The extent to which a project can reduce these losses is termed its immediate flood damage reduction benefits. If the annual benefits (plus a yearly-increasing amount representing benefit growth, and less a yearly-increasing amount representing the capital cost of the project) multiplied by the number of years of the life of the project is an amount more than its total cost, the requirements of the benefit-cost ratio test have been satisfied. As such, it is a project which legally may be authorized by Congress under the Act.

The Willamette River flows 294 miles from its source in the Middle Fork north to the Columbia River at Portland, Oregon. Fed by tributaries from the Coast Range on the west (Long Tom, Luckiamute, Yamhill, and
Tualatin) and the towering Cascades on the east (Coast Fork, McKenzie, Calapooya, Santiam, Molalla and Clackamas), the Willamette every year pours an average of about 22,000,000 acre-feet into the Columbia River. The Willamette drains an area of over 11,200 square miles. It waters one of the lushest agricultural areas in the entire United States.

Between the latter part of November and the early part of February the Willamette River is at its high stages. Floods have occurred when southwest rains fall on deep snow in the higher elevations, accompanied by a rise in temperature and heavy precipitation in the valley. Frozen ground in the mountains greatly increases flood run-offs.

The greatest recorded flood on the Willamette occurred in December 1861. 635,000 c.f.s. was measured at Portland. The river was 19 feet over its banks at Albany (mile 120), and over 353,000 acres were flooded. In January 1881 and February 1890, flood waters at Portland measured 544,000 c.f.s. and 570,000 c.f.s. respectively. In 1927 uncontrollable water rose to ten feet over the river bank and covered 273,000 acres. In all of these floods, roughly half of the acreage flooded was between Eugene and Albany.

Previous to the comprehensive plans for flood protection undertaken by the federal government in 1938, flood control works chiefly sought to keep high water in the river channel. No efforts were made to store flood run-off in upstream reservoirs. The City of Portland built a retaining wall in 1928 at a cost of $2.9 million. Interception sewers and a pumping plant were a part of the project. The retaining wall was designed to protect the business area on the west bank of the Willamette from flood waters as high as 29.3 feet. This would equal the 1861 flood of record on the Willamette River.

Local interests in the Willamette Valley spent $250,000 on spur dikes, revetments and channel improvements and to protect highways, bridges, and to prevent soil erosion. The Federal Emergency Relief Appropriation Act of 1935 included $300,000 for bank protection work near Independence, and between Harrisburg and Eugene. This was partly a Depression-combatting effort. Navigation projects carried on by the Portland District over the past fifty years which protected banks and improved channels also alleviated flood threats in a minor way.

Law passed by the Oregon Legislature in 1937 authorized the formation of flood control districts. The legislation was designed to facilitate the cooperation of local interests in connection with provisions of the 1936 Flood Control Act. Under the Act, local interests were required to supply land and necessary easements, to assume responsibility for damages for which the federal government might become liable, and to maintain the work upon its completion. A flood control district could be formed by a majority vote of the landowning citizens in a given area. Existing as a corporate firm, flood control districts had the power to issue bonds, levy and collect assessments, and enter into contracts with the United
States. Affirmative acts by a flood control district required a two-thirds vote of the membership. Nearly all of the activities of the flood control districts were carried out in conjunction with the Corps of Engineers.

Formation of these districts increased rapidly with the passage of the Flood Control Act of 1950, to be discussed in chapter 19. The 1936 Flood Control Act had authorized $2,430,000 for extensive bank protection work along nearly the entire length of the Willamette River above Oregon City to Albany and on several of its tributaries. The time required for local interests to organize and decide on plans, plus World War II, delayed any significant appropriation for the authorization for over ten years.

The 1932 House Document 308, in addition to the famous survey of the Columbia, also authorized a Corps of Engineers study of water resource development for the Willamette River Basin. That survey focused on improvements for navigation, but included only secondary flood control, power and irrigation. On that basis, no basin-wide project was recommended by the Portland District.

The 1936 Flood Control Act, however, elevated flood control to a primary purpose. Section 6 of that Act authorized the Secretary of War (by means of the Corps of Engineers) to undertake a preliminary examination and survey for flood control on the Willamette River. Since costs of government projects could now be matched against flood control benefits, such projects in the Willamette Valley might be feasible.

Information compiled by the Portland District was forwarded to Congress by the North Pacific Division with the approval of the Board of Engineers, the Chief of Engineers, and the Secretary of War. The report was printed as House Document 544, 75th Congress, 3rd Session.

The report stated that recurrence of a great flood such as 1861 or 1890 "with the present development of the valley would be something of a catastrophe." Such a flood would cause major damage to the $100,000,000 worth of property in the 1861 flood plain area. About two-thirds of the damage would be to agricultural assets. It was stated that a flood of the 1927 level -- 80% as large as the 1861 flood of record -- could be expected once every five years. The occurrence of such a flood would partially or completely cover 7,000 farms and 18 cities or towns. 3,000 homes would be lost. Cottage Grove, Junction City, Harrisburg and West Salem would be under 8-13 feet of water. Disease, hardship and disruption of commerce are undoubted after effects of such a flood.

The report called for the construction of 7 storage reservoirs to control runoff from 3,456 square miles of Willamette River drainage area, and create usable multiple purpose storage capacity of 1,345,000 acre-feet. The emphasis in flood control changed from keeping flood waters in river channels by means of dikes and levees to a system of storage reservoir projects which were to hold and contain flood water until it was safe to
release it. This not only offered better control over high run-off, it also made water available for other purposes. The cost was to be $51,512,000. Average annual flood losses would be decreased by these storage reservoirs by roughly 80%, from about $1.7 million to about $349,000. Flood plain property values would increase by $182,000.

While flood control was a principal benefit of the plan, navigation, irrigation and power generation would also be included as primary purposes. Pollution abatement, recreation and fish life preservation would be incidental project effects. Such multiple use was the key to meeting basin needs and making the project economically feasible.

Navigation would be improved by releases from upstream storage reservoirs. When the river is high in the winter months, water levels are satisfactory for navigation. At that time reservoirs would be collecting water for flood prevention. In the summer, when the Willamette runs very low, stored water would be released. This is consistent with the need for reservoirs to be low as winter approaches for flood storage capacity. Supplemented by dredging, bank improvements and contraction works, these releases would increase channel depths to 6 feet between Willamette Falls and the mouth of the Santiam River and thence 5 feet to Albany (river mile 120). For ten years previous to 1938, commerce on the Willamette River above Portland had averaged 610,000 tons of vessel traffic and 824,000 tons of rafted logs. Average annual benefits accruing to these activities from navigational improvements were estimated to be $834,000.

"Stream purification" was one of the needs considered in the plan for development of the Willamette River. The following excerpt from a report, dated 17 April 1937, forwarded by Division Engineer, Colonel T. M. Robins, indicates the early concern which the Corps of Engineers has demonstrated on questions of the environment:

Stream pollution, with a resultant harmful effect on fish life, recreational pursuits, and public health, is fast becoming a serious problem in the Willamette Valley, especially on the lower reaches of the main Willamette River where sanitary sewage discharge into the stream is augmented by sulphite waste liquors from pulp and paper mills and other industrial wastes . . .

On the upper section of the Willamette River, above the mouth of the Santiam, pollution is local in character and is due to domestic sewage discharge, principally along the communities along the river. The only significant industrial waste entering the stream above Salem is the effluent from the pulp mill at Lebanon on the Santiam River. At Salem, in addition to domestic sewage, wastes enter the stream from a pulp and paper mill, a woolen mill, meat-packing plant, tannery, a flax-retting plant, and seven canneries. As the lower section of the river is approached, the pollution is augmented by domestic sewage, sulphite liquors from the paper mills at Newberg, Oregon City and West Linn, and by other industrial wastes. Due to the biological oxygen demand of these wastes, the dissolved oxygen
content of the stream gradually decreases during the summer months when streamflow is low from about 8 parts per million at Salem to only a trace in the section below Portland. The dissolved oxygen in the stream in the vicinity of and in the stretch below Portland is insufficient in the interest of public health, inadequate for the requirements of most fish life, and unsatisfactory for the purpose of preventing a nuisance.

In 1930 the engineering experiment station of the Oregon State Agricultural College completed a sanitary survey of the main stream. Pursuant to the results of this survey, the Governor in 1933 appointed a board of consulting engineers to determine the extent of present pollution and to devise means of alleviating such conditions. The board has prepared preliminary estimates as to the cost of primary and complete treatment works for the valley communities and has caused studies to be made as to the extent of industrial wastes and possible means of alleviating them . . .

If this quotation expresses the early concern of the Corps of Engineers with the ruination of Oregon waterways, it also indicates that remedies such as appointing consulting engineers and studies are utterly lacking to meet the task of restoration. It indicates that until genuine political awareness and anger exists on a sufficiently broad scale, nothing substantial will be done to alleviate this national disgrace.

The report stated that minimum low-flow in the summer months could be doubled at most locations on the river from Eugene to Portland. The annual dollar benefits -- which cannot embrace the questions or benefits of aesthetics -- amounted to $90,000 per year.

The report was careful to state that installation of primary and, eventually, final treatment plants by municipalities would still be necessary. Thirty years later the need for such installations -- plus solutions for agricultural and industrial pollutants -- is still great. Public institutional leverage must be brought to bear on the sources of pollution. Augmentation of river flow simply cannot deal with the quantity of pollutants which currently are being poured into American rivers.

Irrigation and power benefits were also included in the plan.

It was estimated that of the roughly 5,000,000 agricultural acres in the Willamette Valley, 1,373,000 were susceptible of feasible, useful irrigation. Of these, only 12,000 were irrigated in 1937. The storage projects in the report would have made available 566,000 acre-feet of water for irrigation thereby facilitating irrigation of an area larger than 659,000 acres. Farmers would be charged $8.00 per acre for the water. The actual irrigation would be carried out by irrigation and drainage districts set up under Oregon law similarly to the flood control districts described above. Like flood control district work, significant irrigation efforts were delayed until after World War II.
Fern Ridge Reservoir, authorized by the 1938 Flood Control Act, was completed in 1951. Its 116,200 acre-feet of usable flood control storage also offers excellent sailing and other water recreation.
Cottage Grove Dam on the Coast Fork of the Willamette River was completed in 1951 at a cost of $3.1 million. It has a storage capacity of 30,000 acre-feet.
Provision was made for electric power facility installation on a future basis. Increased stream flow would allow greater generating capacity (about 14,500 kw), at municipally operated plants on the McKenzie River outside of Eugene. In addition, there were plans for installation of generation at the Lookout Point (Middle Fork) and Detroit (North Santiam) sites as energy was needed in this area. It was not until after World War II that Congress provided that power from federally constructed dams in the Pacific Northwest would automatically become part of the Bonneville Power Administration Power Pool. Thus, in 1937, though power may have been foreseeably needed elsewhere in the region, since there was no immediate demand in the area south of Oregon City, generating capacity was not recommended for Willamette River Basin dam sites. The downstream benefits from increased flow, and the future at-dam power benefits from storage could, however, be calculated. These totaled $4 million.

On June 28, 1938, the projects recommended in House Document 544 for the multiple-purpose development of the Willamette River were authorized by Congress in the Flood Control Act of 1938. Though important modifications and additions were to be made at later dates, the House Document 544 plan remains the basic plan for multiple-purpose water resource development of the Willamette River Basin.

As stated, the 1938 Flood Control Act provided for seven storage reservoirs. Of these, three were begun in 1940 and 1941, and two were started after World War II. The other two, Sweet Home and Quartz Creek, were not built.

Sweet Home was to have been built on the South Santiam River. It was subsequently determined that an alternative 3-dam plan would be better suited to meet changing conditions and needs in the South Santiam basin.

The tentative site of the Quartz Creek project was the McKenzie River. Three projects, on tributaries of the McKenzie, were substituted in 1950 and 1962 for Quartz Creek because of fishlife and scenic considerations.

Construction on Fern Ridge and Cottage Grove reservoirs began in 1940. Fern Ridge is located about 15 miles northwest of Eugene on the Long Tom River. It has a usable storage capacity of 116,200 acre-feet and cost about $6.5 million. Cottage Grove is located 30 miles south of Eugene on the Coast Fork of the Willamette. Its storage capacity is 33,000 acre-feet and it cost $3.1 million. Fern Ridge was placed in operation in 1941. Since that time it has been one of the chief recreational attractions in that part of the State of Oregon. Cottage Grove was placed in operation in 1942.

Dorena Reservoir is the third Willamette Valley project begun before World War II which was authorized by the Flood Control Act of 1938. Started in 1941, it was placed in operation in 1949. It cost $14.6 million.
Dorena Reservoir is on the Row River southeast of Eugene, Oregon. It holds 77,000 acre feet of usable flood control storage.
and it provides about 77,000 acre-feet in usable storage. It is located 25 miles southeast of Eugene on the Row River.

The two additional projects of the 1938 Act, and the projects authorized in the 1950 and 1962 Flood Control Acts, will be discussed in chapter 19.
16. Military Work

The Corps of Engineers is an organization which combines military organization with a public works construction program. The first several chapters of this history have very briefly sketched this relationship as it existed up to Civil War times. The role played by the Corps of Engineers in wars of the 20th Century has confirmed the wisdom of one of the nation's oldest policies.

The Portland District's involvement in World War I was very small. The Quartermaster Corps retained construction responsibilities for the military at this time. Airplanes played a relatively insignificant role in World War I. The need for airbases at home was almost non-existent, except for a few training bases. Unlike World War II, World War I enemies posed no threat to the West Coast of the United States. Consequently there was no need for coastal defense activities. The extent of the Portland District's contribution was trained personnel and officers, and general cooperation with the military. The American involvement in World War I was so brief, and the fighting so immobile, sunk as it was in the trenches of France, that even the contribution of trained engineer officers and men was relatively unimportant.

A.

World War II, however, produced a tremendous change in the activities of the Portland District. Huge training camps and air bases, defense installations, and logistics facilities had to be quickly constructed in the Northwest. Work on civil projects except hydro-power works and navigation maintenance were slowed or put aside. Civilian engineer specialists were commissioned into the army as officers either to train enlistees or other prospective military engineer personnel, or to serve overseas.
Others directed the work at the new assignments. Work often proceeded on a 12-hour-per-day, seven-day-per-week basis. Fantastic sums of money were spent to insure that the work was done as rapidly and as well as necessary. Cost data for military work is not readily available or even separately compiled. But an indication of the amount of money spent is reflected by the fact that of the many bases constructed by the District, the three largest required nearly one hundred million dollars. By 1943, $4 billion in war contracts had been awarded in Oregon and Washington alone.

Immediate responsibilities assumed by the District included efforts to facilitate war-use water cargo. The frenzy of activity in the Pacific right after Pearl Harbor to strengthen the U. S. Navy and to secure at least the western reaches of that vast ocean put great demands on ports up and down the West Coast. The construction of great shipbuilding plants in the Portland-Vancouver area, and the supply and aid materials from the Northwest going to Allied forces also contributed to the burden on shipping facilities. The Portland District took over supervision of loading and scheduling of military shipments. Dock facilities in Portland were requisitioned and stevedore laborers were hired. Great quantities of coal and weapons went from Portland to Australia. A giant derrick from the newly-completed Fort Peck Dam in Montana was sent to South Asia.

Another early wartime task of the District was to protect military aircraft arriving in the Northwest. This was accomplished by revetments. A revetment was a mound-shaped, three-sided rectangular wall which surrounded an aircraft. It was built of pilings, timber, earth and surfaced with asphalt. There was no roof, but netting and camouflage completed the protection. These were first built at Portland air cantonment, and later at other bases servicing military aircraft.

These revetments, together with other strictly defensive installations, indicate the reasonable concern widely held in the nation over the threat of an armed attack on the American West Coast. In 1942, America found herself suddenly fighting a two ocean war with a one ocean navy. This little appreciated fact is why it was so important for the United States to be of assistance to the British.

Until the tide of war was turned in early 1943 in the Pacific, the prospect of hostile military activity on the North American continent was an important factor in the plans and operations of the Portland District. The significant American victories in the Coral Sea and at Midway in Spring 1942, the Japanese difficulty in replacing sunk or disabled vessels, and the successes at Rabaul and, after several strenuous months, Guadalcanal in early 1943 are the factors which represent seizure of control of the Pacific by United States Naval forces. After this point, the war in the Pacific consisted chiefly in dislodging the Japanese from positions gained early in the war and moving closer -- island by island -- to Japan and the conclusion of the war.
The most important work done by the Portland District during World War II was the construction of training camps and air bases, providing electric generating capacity, and coastal defense activities.

Until 1940, the airport for the City of Portland had been located on Swan Island. The increasing size of aircraft and volume of traffic required that it be moved to its present location northeast of the city. Funds provided by the New Deal's Work Projects Administration allowed the Corps of Engineers to fill old Lake Whittaker which until then had covered much of the site. Building runways, however, was a project not previously encountered by the Portland District. Textbooks on road-building and an occasional inspector loaned from the Bureau of Public Roads proved helpful in the experiment. Specifications were drawn, contracts let, and the filled area was graded and paved with a crushed rock and oil surfacing.

This part of the work had been performed under Civil Aeronautics Authority authorization. No sooner was it completed than the war in the Pacific had broken out and the Portland District thrust into the effort. Orders from the War Department in Washington instructed the District to construct a group-sized military aviation base at the location of the new Portland Airport. To accommodate the military air traffic, the runways had to be enlarged and strengthened. Barracks, offices, dispensaries, post exchange, hospital, fire station, mess halls, utilities, roads, laundries, a chapel and other buildings had to be constructed. Even an organ was purchased and installed by the Portland District.

About a year before the war, the Corps of Engineers had been assigned a new mission: peacetime construction for the Air Corps. Directly after Pearl Harbor, this military construction responsibility was increased by transfer of the planning, design and construction functions of the Quartermaster Corps of the Regular Army to the Corps of Engineers. This was a permanent shift entailing all military construction for the U. S. Army. The Quartermaster Corps was left with the huge task of supply.

The strong arm of military work during World War II in the Portland District was the Operation and Construction Division. During the actual war period, the name was changed to Military Works Division owing to the preponderance of military work to which the unit was assigned. After the war, the title reverted to Operations and Construction. Mr. Theron W. Ragsdale, who retired in 1963, directed the activities of the Division throughout the war. In 1951, it was split into two divisions.

Military construction of airports and training bases proceeded at locations throughout the area. Airport work was either started or consisted of expansion of already existing municipally-built or CAA-built facilities. The most important training camp work was the construction of Camp White at Medford, Oregon; Camp Abbott near Bend, Oregon and Camp Adair near Corvallis, Oregon. Important air facilities were constructed at Walla Walla, Washington; Boise, Mountain Home and Pocatello, Idaho and Pendleton, Oregon -- as well as the work already described at Portland.
Airport. In addition to these was a Naval Air Station at Klamath Falls, and smaller airstrips at Baker, Lakeview, Prineville, Port Orford, Newport, Eugene, Burns, Beaverton, Corvallis, Madras, McMinnville and Redmond (all in Oregon), and in Burleigh and Idaho Falls, Idaho. An airstrip was started near Raymond, Washington but never completed.

The Flood Control Act of 1936 had authorized extensive levee construction along the Columbia River at more than forty locations from the mouth of the Sandy northeast of Portland to the mouth of the Columbia. When the work on the airport construction began after Pearl Harbor, the manpower which had been built up to handle the levee work was switched over to the military work. Some of the force was also obtained from the Engineering Division.

Camp White, near Medford, Oregon, was the largest military installation built during the war by the Portland District. Work began less than two months after the strike at Pearl Harbor. When completed, Camp White housed 25,000 to 30,000 men for the duration of the war. Its principal purpose was infantry and artillery training. To provide living quarters, training facilities, warehouse space, water supply, sewage disposal, range areas, infirmaries, roads and communication for such a large group of men was equivalent to building a medium-sized city.

Much of the basic structure design had been done in advance by architect engineers, or the Quartermaster of the Regular Army. Thus, the task of the District was to site-adapt those plans to the terrain and conditions of particular locations. The actual construction was by contract. Road plans, water supply, drainage and sewage disposal, however, were less amenable to centralized designing than structures. Hence the on-location design work necessary was one of the main tasks of the District.

The substantial improvements made by the Army near Medford have not lain dormant. The sewage treatment facility built for Camp White was one of the first complete treatment sewage units in the State of Oregon. The District was very much concerned to protect the beautiful Rogue River from pollution. The unit performed so well that the City of Medford took over operation after the war, and it has served the area for the more than twenty years since the war. Roads put in during the war are still giving useful service. The former site of Camp White is now a large industrial area. The hospital is one of the better Veterans Administration Hospital facilities in the West and is fully utilized.

Camp Adair near Corvallis was an installation similar to Camp White. At each of these two bases there was a triangular division. The triangular division was the result of a re-examination in 1935 of the Office of the Chief of Staff to improve mobility by decreasing the number of men in a division. This was to take advantage of improvements in tanks, transport vehicles, aircraft and rail facilities. The decrease was feasible.
because of improvements in weapons firepower since World War I. Hence a triangular division consisted of three regiments, not four as previously.

At Camp Adair, as at Camp White, an artillery practice range was set up by the District. While this was located apart from the Camp, and far outside Corvallis, there were some precautions which had to be taken in regard to stray shells. Farmers were instructed to place red flags beside any shell which they might find in their orchards or strawberry patches. Employees of the District were instructed in the defusing of these dangerous objects, and many trips were made to the Corvallis area to aid an alarmed farmer or picnicker. One Corvallis farmer tried to improve upon this procedure. In response to a call from this man, a Corps of Engineer employee was dispatched only to discover that the man had hauled the live shell over snowy fields on a sled and placed it in his barn— together with his livestock— for "safe keeping". The shell was successfully defused, but it was suggested to the well-intentioned farmer that in the future a red flag might be a more prudent approach.

In addition to the artillery range, a special area was maintained at both Adair and White where men could be instructed in infiltrating enemy-held camps, towns or battle zones. A demolition practice area and numerous rifle ranges were constructed.

Camp Abbott, built on the Deschutes River 10-12 miles south of Bend, Oregon was another major accomplishment of the Portland District during World War II. Camp Abbott was completed late in the war in May 1943 to serve as an Engineer Replacement Training Center. Until the end of the war, the 15,000 men who were housed there were instructed in construction and engineering functions for the War Zone. Corps of Engineers officers were responsible for the training of the men at these camps. The other two camps in the nation of similar purposes were Fort Belvoir in Virginia and Fort Leonard Wood in Missouri. The design and construction activities described above for Camps White and Adair were repeated by the District at Abbott, though at a smaller scale. Upon taking command of the Camp, Colonel (later Brigadier General) Frank S. Besson, Jr., declared Abbott to be the "best camp in the entire country." He had previously served at Fort Leonard Wood.

There was a staggering amount of information to be learned. Men were trained in heavy equipment operation, fire-fighting, carpentry, demolition, tank operation and maintenance, bridge construction, infiltration, map-making, pipeline construction, depot storage, communications, design, surveying, railroad and port construction, specialized mechanics, aerial photography, water and sewage work systems, camouflage, mine detection and bomb disarmament. Training periods ranged from five to seventeen weeks.

The airbase built at Walla Walla, Washington was similar to the work done at Portland. Runways installed under previous CAA authority had to be torn up and extended for the fighter aircraft to be stationed there. Before the war, Walla Walla airport was a peaceful place, with only the
old Zimmerman line providing service to the city of some 20,000. It is said that the air traffic was not sufficient to disturb the wild Morning Glory which grew up through the original runway. With the war came bustling traffic, new barracks, McCaw hospital, offices, hangars, roads, a control tower and five new runways.

At Mountain Home two 10,000 foot runways were constructed to accommodate bomber training activities. Facilities similar to those at Portland also were installed at Mountain Home. Another major installation was the bomber air base located near Boise. A practice bombing range was measured off in the Crater of the Moon country outside of Boise, and bomber aircraft from each of these bases used it. A corps-built anti-tank destruction range was also maintained near Boise Barracks. A training base of similar size was built at Pocatello. Installations there included a hospital.

A fighter base was constructed at Pendleton, Oregon. Old runways were extended and strengthened. New ones were designed and laid out. Like Portland, the base at Pendleton served fighter-training and defense reserve functions.

While Bonneville Dam is primarily a civil, not a military, project the electric power generated at this Corps of Engineer facility was of tremendous value to the war effort.

Modern warfare is fought in the factory as much as in the air or trenches. While some would today refer to American economic productive capacity as the "military industrial complex", when the nation was threatened during World War II it constituted the Arsenal of Democracy. The aircraft carrier in the Pacific and air power in Europe were decisive factors in the locating V-J Day and V-E Day in New York rather than Tokyo and Berlin.

The detailed planning, the immense size, and the great quantities of materials and manpower required for these weapons introduced into warfare radically new measures of time, money, organization, resources and technology. Tanks, other ships and aircraft, weapons development, communication, and supply provisions all demanded the same process. As the nation was to learn, over a year was spent simply amassing the wherewithal of combat -- a year after the war had been underway. The productivity of nearly every factory and plant and working man and woman was involved in the grim effort to overcome unpreparedness.

The metals, aircraft and shipbuilding industries in the Northwest exemplify this massive and direct involvement of the nation's economic and productive power in World War II. Each of these required large amounts of electric energy. Federal dams on the Columbia River provided this electricity. The Portland District constructed and operated Bonneville Dam. Its full generation capacity of 514,000 kilowatts was made available in record time by December 1943.
Power from federal dams on the Columbia River was marketed during World War II by the newly-created Bonneville Power Administration. At that time Bonneville and Grand Coulee, a Bureau of Reclamation project, were the only federal dams on the Columbia. The need for electricity during the war is reflected in the growth of the war-time Bonneville Power Administration. From 1939 to 1944, high-tension, 230 kilovolt transmission lines increased from zero miles to 2,500 miles; installed generating capacity increased from less than 100,000 kw to 1,350,000 kw; and revenues advanced from about $367,000 to $20 million.

The availability of this electric power was essential to the metals industry which established itself in the Northwest during the war. Over one-third of the light metals required by the National Air and War Program was supplied by plants in the Pacific Northwest. Great quantities of aluminum were required by the urgent airplane construction effort. Boeing was a large consumer. Electrolytic zinc to be used in brassmaking for munitions brass, magnesium for aircraft, calcium carbide to be used in acetylene welding for ship construction, and in addition, manganese, chlorates, ferro alloys, and electrolytic manganese for non-ferrous metal alloys were all produced. All told, 16 new metal and chemical plants located in the Northwest. 14 of these were large, direct users of federal power.

Shipbuilding also needed electric energy. The Oregon Shipbuilding Corporation of Portland and the Kaiser Corporation of Vancouver each established national records for speed and quantity of output. One-third of the tankers built during World War II were built in Swan Island Shipyards. 16% of the nation's total shipbuilding program was assigned to the Northwest in 1943.

Large amounts of power went to the Hanford Project. Scientists there participated in the race with Germany to develop an atomic weapon.

In addition to camps and airbases, and electric generating capacity, a variety of lesser work was done by the District during the War. Near Clatskanie, Oregon on the Columbia River in Northwest Oregon, a large ammunition storage depot was built. Railroad trackage was laid through the camp, and from main lines and to the river. Barracks, testing pits, mess halls, offices, etc. were constructed. A pier was built out into the river to facilitate shipping and receiving. It was designed to accommodate the landing ship tanks used widely in the Pacific during the war. The ammunition itself (which was of all varieties) was stored in small structures called "Frog Houses". These were about 25 by 40 feet and 10-12 feet high. They were stoutly constructed of timbers and corrugated metal, and covered with sand. The doors were of steel and protective concrete block of equal height was set several feet in front of the doorway. The depot was run by officers of the Coast Artillery of the regular Army.
Hermiston, Oregon was the site of a similar, though smaller, ammunition storage depot. In the same general area was an airplane bombing practice range. The Corps was responsible for setting up targets, surveying, and constructing markers to guide pilots and keep them on range. The latter chore was apparently done effectively since none of the bomb practice flights destroyed any of the bomb storage facilities. This work was started by the Quartermaster Corps of the Regular Army, but the District took over the project before its completion.

During the war, Lend-Lease shipping to the Russians left through the Port of Portland. Many of the locomotives shipped to the Russians were manufactured in Portland. While in port to take aboard a locomotive, the Russian ship ILLICH sank in the harbor, blocking traffic. It was the responsibility of the Corps to maintain navigability of the Willamette River. To remove the sunken hulk, a former flagship of the Russian Czar, the Corps hired divers who cut the ship into sections with underwater blowtorch equipment. Another vessel equipped with a large derrick pulled the sections, which were later sold for scrap, out of the river.

The 29th Engineer Topographical Battalion was stationed in Portland during World War II. The 29th served the important function of transforming aerial photographs into composite maps for intelligence and bombing uses. The Portland District was responsible for providing the 29th with its working facilities located on 82nd street (including the necessary air conditioning equipment), and for its housing and mess facilities which were located in the school yards of three elementary schools in the area.

The procedure of the 29th was very efficient: photographs would be flown in from the war zone at the end of the day; members of the battalion would work through the night to make the maps; in the morning the completed maps would be flown back to intelligence officers in the Pacific. The 29th also trained men in photogrammetry who were transferred overseas. Late in the war the group was transferred -- in a lightning, overnight shift -- to the Phillipine Islands where it served for the duration of the war.

The vast amount of goods and men required for the war effort in the Pacific resulted in the clogging of railroad terminals and transfer areas. To alleviate this problem, the Corps laid several thousands of yards of parallel track in the switching yards located east of Reed College and in north Portland. Besides the track, switches were installed, transformers built and warehouses constructed.

The District had a direct interest itself in keeping railroads open because it had the responsibility for lumber procurement for the great amount of military construction in progress in the Northwest, and in the Pacific Theatre as well. The West Coast Lumber Office and, later, the Army-Navy Lumber Agency handled this huge job for the District.
At Vancouver Barracks, the Portland District took over the responsibility of the Quartermaster Corps in improving and expanding the facilities. Electric lines, living quarters, a motor pool, roads and water systems were built, and Barnes Hospital was enlarged.

B.

Wartime work of the Portland District also focused on coastal defense. The principal effort was located at the mouth of the Columbia River. Fort Stevens in Oregon was the main installation there, with Forts Canby and Columbia in Washington state serving with it.

The guns installed beginning early in 1942 were 6-inch Navy Barbett's, radar guided with a 360 degree traverse control and steel shields. This type gun was installed, fired and tested at both Canby and at Stevens. The gun had a range of 17 miles. The war had shifted far to the western Pacific before the guns were completed at Fort Columbia, and the decision was made not to complete the installation.

Before these guns were installed and completed by the Coast Artillery of the Regular Army at either Canby or at Stevens, a Japanese submarine had surfaced several miles off shore. This was early in 1942. The Japanese fired several shots at Fort Stevens doing no damage but engendering considerable alarm. It is said that there had been a party at the Fort the previous evening, and the officer of the day was not in an entirely sober condition at the time of the attack. His men were anxious to return fire, but the commanding officer, not in a crisply decisive frame of mind, was unable to arrive at a course of action until the submarine was safely out of range.

Another type of artillery at the forts at the Mouth of the Columbia were several high-arcing, 12-inch mortars. These were installed at Fort Stevens and Fort Canby in 1898. The mortars were designed to lob a deck-piercing shell high into the air so that it would come down almost vertically onto the deck of the enemy craft, then pierce the deck, pass into the hold, and there midst the vital organs of the vessel, release its explosive charge. The difficulty with the weapons was that the range was short (less than 8 miles) and the relatively narrow deck of a submarine offered a very small target. Another submarine surfaced just off North Head at the Mouth of the Columbia. This one did not fire at the shore installations, and, though it was the middle of the afternoon, a search by planes and ships could not find the vessel. Depth charges were used to no avail.

In addition to the 6-inch guns and the mortars described above were the 10-inch guns installed in Battery Russell at Fort Stevens. The batteries in which the guns were housed included plotting rooms, shell and
powder storage compartments, and rude sleeping quarters. During the first
eyear's half of the war they were manned twenty-four hours per day. The
guns were camouflaged. Authority to fire had to be passed from a joint
command consisting of both Naval and Army officers.

As in World War I, the mouth of the Columbia River was mined by the
Coast Artillery to protect against the entrance of hostile vessels. These
mines were large -- four feet in diameter -- and were anchored at the
bottom of the river by steel cable and weights. They could be detonated
either by contact or by electric charge. In most circumstances, these
would be set for electric charge detonation. If an enemy ship were to
pass into the mouth, its exact location would be plotted. With this in-
formation, the mine closest to the ship would then be detonated. Head-
quartes for mine operation was at Fort Columbia during World War II (it
had been at Stevens during World War I) but the actual blast control
machinery was still at Stevens, closer to the mouth and with better visual
contact. The electric blasting gave the Army a very selective and accu-
rate firing capability.

Mines were set for contact when visibility was very bad. American or
friendly vessels were informed of the safe channels. The electric firing
circuits were simply opened, and the mine switched for contact detonation.
This was for protection against submarine entrance.

Submarine nets were strung elsewhere on the Pacific coast--notably at
San Francisco -- but none were required at the mouth of the Columbia.

At war's end, the mines were pulled out of the river by the Coast
Artillery of the Regular Army and by the Corps of Engineers. Some were
simply detonated because of their inaccessibility owing to shifting silt
and sand. Most were physically removed and disposed of elsewhere. Some
mines are still on the bottom of the river. They are deeply covered by
sand and silt, and well out of the channel zone. It is believed that
seepage has eliminated any possibility of explosion, even if means of
electric detonation still existed.

The Portland District also was involved in radar facilities construc-
tion. Tower design and installation of control and calculating equipment
were performed either by branches of the regular army or by private con-
tract. The Corps, however, did construct the housing for the equipment
itself. These were of heavy concrete. Camps for the groups of men who
operated these radar installations provided water, living quarters, roads
and utilities for one hundred men. These were also built by the District.

Most of the early installations were for surface craft or submarine
detection purposes. Radar put in after 1942 was designed to protect
against intruding aircraft. Towers were usually one hundred feet in
height, but a few ranged down to fifty feet. Radar installations were
located at Shore Acres (south of Coos Bay), Gold Beach, Oceanside, Yachats,
Neskowin, Tillamook Head, Fort Stevens, two at Fort Canby, and one at Bear
Twelve-inch mortars were installed at Fort Stevens, at the Mouth of the Columbia River, in 1898.

Fort Stevens and Fort Canby were originally constructed in 1864 by Captain George H. Elliot, Corps of Engineers.
Horsepower had a more literal meaning at the turn of the century.

"Barnhart's Steam Shovel -- Style A", hard at work.
Sand was brought by steam railroad.

... to a cement plant.
In vest and hat, this cheerful worker waited for the cement plant to perform.

That having happened, he then led the cart to the construction site.
Mountain between South Bend, Washington and the beach. The radar housing and living quarters at the mouth of the Columbia and at Bear Mountain were strengthened with heavy timber and covered with camouflage. Air and naval craft detection radar was installed at the mouth of the Columbia. Many of the camps were utilized for training of personnel to be stationed elsewhere in the country or overseas.

In addition to radar, large searchlights -- similar to those in nightly use in England throughout the war -- were installed at the mouth of the Columbia to aid the artillery batteries in the event of the appearance of enemy naval vessels or aircraft.

Watch towers were also built at several locations on the Oregon coast. These were manned by civilian volunteers and designed to give warnings to American fighter bases further inland. The volunteer civilian observer had a list of all aircraft with clearance to be in the sky. If an unidentified aircraft was observed, fighter craft at Portland were alerted to intercept.

One startling but eventually humorous incident occurred when a wing of Canadian fighters flew up the Columbia River. The Canadians had been out over the Pacific on exercises. Upon return they mistook the mouth of the Columbia for the Mouth of the Fraser. Civilian observers quite alarmedly telephoned to authorities that a wing of unidentified fighters was approaching the mainland. The entire group at Portland was scrambled, and air units throughout the Northwest alerted. One supposes that the surprise of one group of pilots equaled the relief of the other at the eventual climax of the event.

During the war, the Japanese demonstrated a good deal of imagination in regard to methods of inflicting damage on the U. S. mainland. One of these, in Oregon, was the attempt to start forest fires. A Japanese submarine was equipped with a small collapsible-wing, radio-controlled aircraft on its deck. Close to the United States coast, but out of range of radar, the submarine would surface, prepare the plane for flight, load it with incendiary bombs and direct it to the Oregon forests. Either because of weather conditions or mechanical failure, this effort met with no success in Oregon. One small fire was started, however, in Northern California.

Another ingenious, almost quaint, technique was the use of the armed balloon. These were made of paper and filled with a lighter-than-air gas. A rectangular electronic control device of about two square feet automatically released sandbags as the balloon lost gas in its flight over the ocean -- thereby controlling altitude. The payload of one of these balloons was a bomb. Used late in the war effort, there are very few press reports of the effectiveness of this weapon -- the military releasing no information on them. One indication, however, is the fact that among the standing assignments of the fighters stationed at McChord Air Base near Tacoma was to respond to reports of these balloons and to shoot
them down before they reached shore. Many, however, escaped detection. Some were reported to have reached as far as the mountains of Idaho. Another lodged itself in a tree in southern Oregon. A Sunday school group on a picnic outing climbed to investigate the strange object with the result that several in the party were killed and injured. One of the objects of those who manned the watch towers constructed by the Corps of Engineers was to detect and report the approach of these balloons.

In addition to the lookout towers, the Portland District built camps for the men who patrolled the beaches. These camps housed 100-125 men. Much of the actual patrolling was done by the Coast Guard. Camps for this branch of the military required stable facilities for the horses which the men rode while on patrol. Others -- volunteers, regular army -- worked on foot. Camps were located at Long Beach, Washington; Nehalem, Oregon and just north of Coos Bay.

All work done by the Corps at the mouth of the Columbia was done by direct hiring. The design and supervision was performed directly by the employees of the District. One of the results of this was to keep costs at a minimum. An inspector from the Office of the Chief of Engineers informed officials of the District that the cost of the installations at the mouth of the Columbia were the lowest anywhere in the nation for comparable type work.

Late in the war, 90 millimeter anti-aircraft artillery was installed at the mouth of the Columbia. One battery was placed at Fort Canby and another at Fort Stevens out on the spit. Each battery contained two guns. Camps were constructed at both of these locations by the Corps to house the soldiers stationed there. These were of heavy timber construction and completely buried in sand. To keep the sand in this artificial location, the same type Holland grass which had been planted fifty years earlier at Coos Bay Spit was planted on the tops of these living quarters. The men who manned the guns lived in these underground homes full time.

Work was also performed to facilitate wartime shipping and navigation. Throughout the war a ferry operated directly between Fort Canby and Fort Stevens. This was for military use only. The Portland District designed and constructed the ferry slips at each side of the river. A ferry slip is the wooden receiving structure to which the ferry ties up at the end of each crossing. It must be so constructed as to adjust with the tides.

In addition to the ferry slips, the Corps built a 400-foot dock at Fort Stevens and dredged out a turning basin.

A nation's wartime military power depends on three factors: productive capacity, combat effectiveness, and construction. An element which, in turn, is central to each of these is rapid and dependable mobility. The construction responsibility of the Army Engineers in World War II was to keep United States Armed Forces on the move.
General Kenney, Air Commander in the Pacific, stated:

"Down here operations require one third Air Corps, one third Engineers, and one third everything else."

There were few existing facilities which could be converted to military use in the underdeveloped Pacific islands. Nevertheless, great airfields were carved from jungles, the Ledo Road was built, the Burma Road was improved, huge ports were constructed in uncharted coves, and large bases were set up where nothing had existed but wilderness. The island-hopping campaign in the last years of the war was premised on the rapid and expert construction capabilities of the Engineers.

In Europe, the Engineers were the first to land on the beaches of Normandy. Many of the Engineer troops and officers who landed there had been trained for that purpose at Camp Abbott in Oregon. The quick clearing of mines and other obstacles was essential to the success of the initial stages of the invasion.

French ports lay in ruins, assumed by the German staff to be beyond repair. Yet shortly after their fall, the Engineers had the ports operating again. Cherbourg was most notable in this respect.

The Allied advance across France was made possible only by the work of the Engineers. Oil is the blood plasma of a mechanized army. The Engineers laid 4,000 miles of pipeline in France alone, working at or near the line of battle. Occasionally pipe would be laid so fast -- at the rate of 50 miles per day, twice as fast as the average man can walk -- that Engineers would be ahead of their own advancing lines.

In this connection, the now classic story is told of General Manton S. Eddy, Commander of the XII Corps in France and Captain F. J. Thompson of the 359th General Services Regiment. During one of the General's inspections at the front he saw an Engineer officer and his assistant bent over their transit 500 yards or so in front of the advancing troops. Alarmed, the General sent a messenger hurrying out to the captain.

"The General sees you, sir -- said you had better get the hell back", the messenger reported.

"I know", the captain replied, "but the men are laying pipe on our tails and we can't stop for Germans."

General Patton's Third Army was the chief beneficiary of one of the Engineer's most spectacular feats. The dash to St. Lo became slowed by the destruction of a 75 mile rail line leading to Laval. The Germans had left behind them a shambles of rails and smashed bridges, blocked tunnels, and wrecked marshalling yards. German experts assured their commanders that five weeks would be required to restore the vital rail link. On August 13, 1944 the Engineers arrived on the scene, made their plans and
started to work. On August 15 -- 48 hours later -- the line had been restored. General Patton got his supplies and ammunition on time, and the historic advance roared eastward to the Rhine.

The achievements of the United States Army Corps of Engineers in World War II have been hailed as an "American miracle." But of course it was no miracle at all. Rather, these accomplishments -- about which entire books have been written -- were the planned results of the sound policy which anticipated the need for a highly competent and immediately available engineering construction organization in the event the United States should become engaged in war. The ability of civilian and military employees of the Corps of Engineers to perform with confidence, effectiveness, and imagination overseas stemmed from the practical experience gained from working with the sophisticated and greatly varying civil projects in the United States.

There was minimal difficulty in the switch from civilian to military activities -- and back again after the war -- because the Corps had historically been a blend of each. There was no dangerous delay necessary to build an organization, to become familiar with personnel abilities, or to establish efficient relations with the American construction industry. Urgent activities similar to those in the Portland District described above were carried on in other Districts throughout the nation.

In the Korean War the Portland District was involved in dredging activities in the waters of South Korea. Rapid movement of men and supplies depended upon deep, safe navigation waters.

Also noteworthy during the Korean War were the activities of the Lumber Branch, Supply Division of the Portland District. Only two of these offices exist in the United States, the other being in the Atlanta, Georgia District. National authority during the Korean conflict was in St. Louis at the Lumber Control Office of the Chief of Engineers.

The Lumber Branch purchased over $100 million worth of lumber in 1951. At auctions presided over by Ruel G. O'Neel, Chief of the Branch, 100 million board feet of lumber were commonly sold. Some of the lumber was used stateside: boxes and containers; construction and maintenance of training facilities; and dunnage in the holds of ships. Most went overseas to be used in wharf and dock construction, offices, camps, warehouses, rail ties, communications poles, and the military assistance aid program. Employment in the Lumber Branch grew from about 20 to over 125 during the Korean War.

In 1962, by order of the Secretary of Defense, the Lumber Branch was transferred out of the Corps of Engineers to the Defense Supply Agency. This national agency does purchasing for all branches of the military. The local unit receives administrative support in the offices of the Portland District, and is now entitled the Portland Regional Procurement Suboffice.
The security and the interests of the United States are enhanced by the Corps of Engineers, an organization which in peacetime is the nation's chief civil improvement construction agent. It is a certainty that any future war will require more, not less, support construction, mobility and technical expertise. A current example: The Engineer-constructed helicopter bases in Vietnam have improved not only American firepower, but also the ability to care for troops in the field. The fact that American forces in Vietnam are the best-housed, best-fed, and best-supplied troops in history results partly from the extensive dredging activities in South Vietnam. The seagoing hopper dredge DAVISON of the Portland District has served in Vietnam since February 1966, mainly at Cam Ranh Bay. The cook of the Dredge DAVISON, who had previously been decorated with the Purple Heart, was killed when the launch on which he was returning to the DAVISON struck a Viet Cong mine. In a different vein, it is likely that the Corps of Engineers will be involved in the water resource development aid program in the Mekong River Basin once hostilities have ceased.

Another military-related activity of the Portland District is civil defense. This work is done through the Civil Defense Support Section of the Engineering Division. The territory for this office extends through Oregon, Idaho and Montana.

Civil Defense performs fallout shelter planning and inspection services. In conjunction with state and local authorities, population units are allocated to shelters, maps and brochures are distributed to the public, and existing structures are checked to see that structural and supply requirements are met. The Civil Defense office is also responsible for sign-posting which designates the shelter areas.

Sixteen radio stations have been "hardened" to a protection factor of 100 to provide communications in the event of a military attack. Emergency generation, living quarters, and food and fuel supplies for 14 days have been provided these stations.

Civil Defense maintains an inventory of all equipment and machinery in the region which could be used in a military or natural emergency. Information pertaining to the availability of large pumps, caterpillars, heavy drills, scrapers, generators, shelter, special trucks and boats, fuel and food supplies, warehouses, communications equipment and other similar items is maintained by the Civil Defense office of the Portland District.
From its establishment in 1871, the work of the Portland District in its first fifty years was to improve Northwest waterways for navigation. Projects on the Oregon Coast, the Columbia and Willamette rivers, and streams in Washington State have been described above. While multiple-purpose projects were gotten underway on the Columbia and Willamette rivers in the 1930's, important work on the navigation channel from Portland to the sea was also carried out. Three projects -- in 1930, 1954 and 1962 -- were the heart of this work. Improvements were also made on the Oregon Coast. The background, justification and benefits of these projects all show the direct relationship between the work of the Portland District and the economy of the region which it serves.

Before 1930, the last major channel project of the District was in 1912. This is discussed in chapter 12 above. It provided for a navigation channel from Portland Harbor to the sea, 30 feet deep and 300 feet wide. The main exports at Portland before the 30-foot channel were wheat, flour, lumber and barley. Cement, coal and rice were the principal imports. From 1875 to 1918 total tonnage had increased from 175,000 to about 2,000,000. Petroleum product imports became increasingly important after the completion of the 30-foot channel in 1918.

A.

Four significant projects were undertaken by the District between the time the 30-foot channel was authorized in 1912 and when it was further improved in 1930.

The first was a result of World War I. The construction and training activities at Vancouver Barracks conducted by the Regular Army required additional shipping to the Vancouver, Washington area.
The original project for improvement of the 4 mile stretch of the Columbia River between Vancouver and the Mouth of the Willamette was in the River and Harbor Act of 1892. This amounted to a 3,000 foot dike from the Oregon shore to the head of Hayden Island, and revetment work also at its head. The dike increased flow in the main channel on the north side of Hayden Island. The object was to obtain 20-foot depths during all but low water periods from the Mouth of the Willamette to Vancouver. This proved to be inadequate, and in 1905 the Portland District began annual dredging maintenance to 20 feet.

In 1916, the River and Harbor Act provided that the Columbia River between Vancouver and the mouth of the Willamette River be included in the Portland-to-the-sea project. As a result, 20-foot depths and a 200 foot width were to be maintained by dredging from Vancouver to the Willamette throughout the year. The formal project was to be designated Columbia and Lower Willamette Rivers from Vancouver, Washington and Portland, Oregon to the Sea. By 1920, $150,000 had been expended on the first three years of dredging operations. In 1925, the depth was increased to 25 feet and the width to 300 feet. The population of Vancouver at this time was about 15,000. The principal use of the channel was lumber exporting. The Vancouver Port Commission was established in 1912.

The second project, authorized by Congress in 1917, was for improvements at Cathlamet Channel. This channel is on the Washington side of Puget Sound Island about 40 miles from the mouth of the Columbia River.

District Engineer Major J. F. McIndoe stated that,

"The town of Cathlamet is the only shipping point on the channel. This is a town of about 400 inhabitants. It has 3 general stores, one creamery, a salmon cannery, two hotels, a newspaper, public school, two churches, a bank, and several other smaller business houses."

He noted further that, "the largest industries in the vicinity, and practically the only ones, are logging, fishing and dairying". He reported that timber reserves in the area were "4 to 5 billion board feet in extent, lying mostly in the drainage basin of the Elochoman River".

The channel was greatly obstructed by snags and an 8-foot shoal at the downstream entrance. Depths were undependable and hazardous even for riverboats (deep-draft vessels operated on the south side of Puget Island in the Columbia River) particularly in fog or stormy weather. The Portland District was authorized to remove snags, and to maintain safe water in Cathlamet Channel 10 feet deep and 300 feet wide. At this time there was no railroad on the Washington side of the river. Navigable water was a spur to the development of Cathlamet.

In 1923, a 1½ mile channel was cut from St. Helens, Oregon to the 30-foot channel in the Columbia River. St. Helens is located at mile 86
on the Columbia River at the head of Willamette Slough. A 19-foot bar separated St. Helens from the deep water in the Columbia. The authorized connection channel was 25 feet deep and 300 feet wide, and costs were about $4,000 a year to maintain the project. At this time St. Helens had a population of about 2,200 and its principal industries were four lumber mills and a creosote plant. Waterborne commerce in the area in the previous five years averaged about 150,000 tons.

The fourth project was undertaken in 1927. This was a plan first advocated by Major Wilson in 1876 to close the northeast channel of Swan Island. A description of the Willamette River at that location and a statement of the object of the work is found in chapter six. Basically, the southwest channel is much wider than the northeast channel. Since the Port of Portland at this time was maintaining the Willamette River portion of the Portland-to-the-sea project, the Port did the work to close off the northeast channel at Swan Island. The work was completed within 2 years of authorization at no cost to the Federal government. Swan Island has since become the principal civilian ship repair facility in the Pacific Northwest.

In 1930 work was begun to improve the navigation channel from Portland to the sea. The project called for a depth of 35 feet and a width of 500 feet.

Oceangoing cargo on this waterway had more than tripled to 6,297,000 tons in 1926 from the time the 30-foot channel had been completed in 1918. Total value of the cargo in 1926 was roughly $315,000,000, double the amount of five years earlier.

As impressive as that growth may have been, the existing 30-foot depth and 300-foot width greatly restricted further improvements in import shipping. Almost 90 percent of the higher valued package freight was carried at this time in Trans-Pacific liners having full-load drafts of about 30 feet to 32 feet-9 inches. Since the Columbia River had only 30-foot depths, these ships could not enter the river fully loaded. Imports of this type ultimately destined for Portland had to come on coastwise vessels from Puget Sound or San Francisco, or lighter to smaller craft at Astoria. The additional costs involved in this method amounted in 1925 to about $448,000. This, of course, was passed on to the ultimate consumer. Shipments by land from Puget Sound or San Francisco cost $335,000 in 1924.

Shipping on smaller vessels, or on larger ships only partly loaded, resulted in higher costs as well. In each case the fixed costs of a vessel would have to be matched against a smaller payload -- with the result that each unit of cargo would have to bear a higher freight rate than it would have in a larger ship fully loaded.

The limitation to smaller, slower freighters greatly hindered the development of foreign trade at Portland. Deep-water ports up and down
The Portland District's 24-inch pipeline dredge WAHKA KUM. The 261 foot long vessel has been in the District since 1913, when it was built.
the Pacific Coast recorded rapid increases in visits by vessels of 30 to 33-foot depths.

Another indication of the need for greater depth was the fact that the number of vessels requiring the maximum depth of the channel tripled from 1924 to 1926. Since ships require 2 to 3 feet in addition to their draft for safe steerage and for squat (the settling of a ship's stern when underway at high speeds), these vessels had drafts of only 27 to 28 feet. About 40 large ships used the river each day.

An example of the difficulties facing shippers -- and the higher prices facing Oregonians -- is in petroleum products. Standard Oil Company shipped 848,000 tons in 1924-25. Most of its ships had drafts of 31 feet. Since the Columbia River was not deep enough to handle these ships, older, smaller ships of 26½ feet were used instead. Result: a 10 percent higher cost of petroleum products for Oregon users. Even though Seattle required 250 additional sailing miles, ample depths there allowed petroleum products to sell for the same price as at Portland.

Another problem on the Columbia was grounding. During 1925, 37 ships went aground. This was caused not so much by shallow depths as by the narrow channel. Increased traffic on the river sometimes would crowd a ship out of the channel. Longer ships would have difficulty passing other ships and turning. Many owners would not allow their ships to navigate at night on the Columbia for fear of damage and delay resulting from a grounding. But to anchor in a narrow channel at night was equally risky. The effects of grounding a ship were reflected in insurance rates as well as shipping costs.

These conditions being persuasive, District Engineer, Major R. T. Coiner recommended to the Board of Engineers for Rivers and Harbors and to the Chief of Engineers that a 35-foot channel be dredged and maintained from Portland to the sea. The initial cost of the project was $1,366,000 with annual maintenance set at $685,000.

The Port of Portland, as in the previous project, was responsible for obtaining and maintaining project depths in the Willamette River from its mouth to the Broadway Bridge, and to dredge the shoal just outside the mouth. The Port of Portland was also required to provide the Portland District six dredge months annually (including a full crew) during the critical period following spring freshets in the Columbia River. This was to be provided to the Corps at no charge except operating costs. Two hydraulic pipeline dredges belonging to the Port of Portland were made available for this work. The channel was completed in 1933, with U. S. dredges MULTNOMAH, WAHKIAKUM and CLATSOP doing the Portland District work.

Several smaller but noteworthy projects were performed between the time the 35-foot channel was completed in 1933 and the entrance at the mouth of the Columbia was improved in 1954.
Provisions in the River and Harbor Acts of 1933, 1935 and 1937 established navigation improvements to Vancouver, Washington. The result was a channel 30 feet deep and 300 feet wide from Vancouver to the mouth of the Willamette River. Two turning basins, 30 feet deep, 300 feet wide, and 2,000 and 3,000 feet long for the upper and lower basins, respectively were also dredged at Vancouver. The latter were conditioned upon the construction of new terminal facilities by local interests in Vancouver.

Navigation upstream from Vancouver was improved by the River and Harbor Act of 1937, with modifications by the River and Harbor Acts of 1945 and 1946. These provided for a channel 27 feet deep and 300 feet wide between Vancouver, Washington and The Dalles, Oregon (about 85 miles). Incorporated in this project was a channel 10 feet deep and 300 feet wide at the upstream entrance of the Oregon Slough; a suitable turning basin in the vicinity of Camas and Washougal, Washington; a boat basin at Hood River, Oregon 10 feet deep, 200 feet to 450 feet wide and 1300 feet long, with a connecting channel 10 feet deep, and a breakwater on the easterly side; a barge channel to Bingen, Washington, 10 feet deep, 150 to 300 feet wide and about 1800 feet long; a harbor at The Dalles, including a breakwater and a basin 8 feet deep, 400 feet wide and 800 feet long. A 15-foot deep barge channel under the Interstate bridge was also authorized.

The legislation was prompted by the desire to take advantage of the lock at Bonneville Dam and the slackwater pool behind it. Work was completed on the project at a cost of nearly $6,000,000. The channel depth, however, was allowed to fill to 15-foot depths after 1959 because of the predominance of shallow-draft barges using the river which did not require the project depth.

Two projects were begun near the Mouth of the Columbia River on the Washington side in 1933 and 1938. Their object was to benefit the important fishing trade at this location.

At the northwest end of Baker Bay is the fishing town of Ilwaco, Washington. The River and Harbor Act of 1933 provided for a channel 10 feet deep and 200 feet wide from Ilwaco through the easterly passage at Sand Island to deep water in the Columbia River five miles away. A 20-acre, 12-foot deep mooring basin with a breakwater was also constructed. Another channel 10 feet deep, 200 feet wide and 3 miles long went from Ilwaco through the westerly passage of Sand Island to the Columbia. The large east channel was completed in one year. The remaining work, as modified by River and Harbor Acts of 1945 and 1950, was not completed until 1957. Part was financed by military funds. The total cost was about $950,000.

Chinook is a small fishing town in the east end of Baker Bay about ten miles from Ilwaco. Civic pride in this area centers on the fact that Captain Robert Gray, the man who first sailed into the Columbia River, landed here in 1792. The River and Harbor Act of 1938 authorized a channel 10 feet deep and 150 feet wide from the head of Sand Island to Chinook;
a small turning basin; and reconstruction of about 100 yards and extension of a breakwater built previously by private interests. The breakwater connects with land at Portland Street, downtown Chinook, Washington. The original project was completed in 1940. Modifications in 1958 were completed in 1962. Total cost of the work was roughly $220,000.

An Act of Congress on August 30, 1935 assigned primary responsibility to the Portland District for maintaining 35-foot project depths in the Willamette River from its mouth to the Broadway Bridge. The original project in 1930 required that the Port of Portland perform this job. Depression-time financial pressures, however, prevented the work from being done on a regular basis. Also, it was the opinion of the Board of Engineers that assumption of the responsibility by the Portland District was "warranted in the interests of general commerce and navigation."

The Port was still obliged to provide 6 months of hydraulic dredge time, and to assist on work in the Willamette and Columbia Rivers, "when required". Reimbursement to the Port was limited to operating costs on a basis approved by the Chief of Engineers. The Portland District maintained the channel in the Willamette to a width of 500 feet but never closer than 50 feet to pierhead lines. Pierhead lines establish boundaries for extension of dock, wharf and other shore installations. Initial costs were estimated to be about $500,000, and annual maintenance costs thereafter about $105,000.

The same Act of 1935 provided for two auxiliary channels at St. Helens, Oregon. These two channels -- 30 feet by 300 feet and 30 feet by 500 feet -- improved the depth of the earlier 25-foot project and provided a new connection with upstream deep water to serve traffic coming from Portland. The first channel was designed to receive vessels arriving from the coast. Two channels made shipping quicker and safer. The cost was estimated to be $50,000 for initial work and $6,000 annually. Benefits to the St. Helens area would be $11,000 per year.

The 1937 Act also provided for a 24-foot by 200-foot auxiliary channel at Rainier, Oregon. Rainier is on the Columbia River at mile 68 opposite Longview, Washington and the mouth of the Cowlitz River. At this time the main industries in Rainier were a sawmill, shingle mill, creamery, rock quarry and a cannery. Its population was 1,353.

The purpose of the auxiliary channel was to deepen the frontage of the shipping area in Rainier. Depths at either end of the new channel would be sufficient to allow ships to get from Rainier to the main channel in the Columbia River, about 1,200 feet away. The main channel and the auxiliary were parallel to each other. Completion of the channel eliminated the need for expensive lightering to Longview across the Columbia, where greater depths prevailed. Initial cost was $11,200.
The work at Rainier was the last new navigation project undertaken by the Portland District before World War II. At the end of the war, three small projects were begun.

Two of these projects were located at Longview, Washington. At this time Longview had a population of 14,000 and Kelso, Washington, on the other side of the Cowlitz River, had a population of 7,000. The principal industry here consisted of wood products. Long-Bell, Weyerhaeuser, Longview Fibre and M & M Plywood all operated large plants. Good highways and three railroads served the area. Average annual log movement on water in the early 1940's was over 310,000,000 board feet. Five to six large rafts were towed in daily.

The Old Mouth of the Cowlitz River was the site of the first of these two projects. Earlier levee construction had forced the river about one half mile east of its original mouth. An upper section of the Old Mouth formed a large pond which connected to the distributing basin of the principal lumber interests in Longview. The desired improvement was an 8-foot deep, 150-foot wide and 3,000-foot long channel to connect the pond with the Columbia River at the lower section of the Old Mouth of the Cowlitz. This would greatly facilitate delivery of logs to the area. The project was authorized in March 1945 and completed five years later. The cost was $12,000.

The second project at Longview was a long auxiliary channel along the town's commercial frontage. The channel went downstream along the pier-head line from the Longview Port Dock, past the Weyerhaeuser plant, to a connection with the main ship channel on the Columbia below Mount Coffin. The first 2,400 feet were to be 30 feet deep and 300 feet wide; the remaining 10,800 to be 28 feet deep and 250 feet wide. The work was authorized in March 1945 and completed in four years. Local interests were required to provide disposal areas for dredged material, hold the United States free from claims resulting from the improvements, and assist in the dredging.

The third small project undertaken after World War II was a small boat mooring basin at Astoria, authorized in July 1946. The then existing small boat harbor at Astoria offered protection for 400 fishing boats, pleasure craft and other small vessels. The Astoria Yacht Club could provide service for only several dozen pleasure craft. Residents and organizations in Clatsop County pressed for construction of a mooring basin which would at least double the existing capacity.

At this time Astoria was the most important fishing port in the Pacific Northwest. 68,000,000 pounds of fish were received in 1944 in Astoria -- more than any other Northwest port. Today Oregon and Washington together pack an amount of fish more than 2/3 as great as all the Atlantic, Gulf and Great Lakes canneries combined. Astoria was also the Pacific Coast's biggest source of frozen and processed bottom fish. Resident and transient fishermen participating in this catch, as well as
Small boat basin at Astoria was authorized in July 1946.
This is an aerial view from 1,000 feet.
This photograph, at the mouth of the Columbia River, was taken in July 1939 after rehabilitation work had been completed. Mount St. Helens and Mt. Adams are visible in the distant background.
These three photographs were taken of the South Jetty at the Mouth of the Columbia River shortly after a severe storm in the winter of 1936-37. The crane in photo No. 2 weighed over 25 tons.
over 1,500 annually visiting pleasure craft, would greatly benefit from construction of an improved small boat mooring basin.

The project adopted called for a steel pile, sand-filled breakwater about 2,400 feet long with a 20-foot maintenance roadway running along its entire length, and two steel pile shore wings totaling 1,460 feet in length. The basin was to secure 1,000 boats. The cost was $1,044,000. The basin was to be located between 33rd and 39th streets in Astoria. Local interests were responsible for building roadways and docks extending from the shore. The basin was completed in September 1949.

B.

On March 10, 1949 the District Engineer, Colonel O. E. Walsh, conducted a hearing in Astoria, Oregon to determine the merits of improving the entrance at the mouth of the Columbia River to a depth of 48 feet. Bar pilots, shipping operators, port commissioners, manufacturers, fishery and agricultural interests, governmental agencies, chambers of commerce, and river pilot representatives were unanimous in stating the need for improving the mouth of the Columbia.

The previous project had provided at least 40 feet in the channel across the entrance bar -- in many places up to 48 feet. This was authorized in 1905 and completed in 1918. The outer two miles of the north jetty had been subject to heavy wave action and undercutting. Much of this portion had been flattened. This was rehabilitated in 1938-1939, and a concrete terminal block placed in the structure. Annual maintenance included strengthening and repairing existing structures, repairs to sand fences (to prevent erosion), repairs to pile dikes (to influence river and tidal flow), dredging the northwest shore off Clatsop Spit, and maintaining Sand Island to protect the inner reach of the entrance. Maintenance costs averaged about $225,000 per year for the five years previous to 1954.

The difficulties facing navigation at the mouth in the Columbia in the early 1950's lay in the fact that the entrance was gradually deteriorating and the ships were quickly becoming larger.

From 1926 to 1941, the channel across the outer bar had a least depth of 46 feet or more. By 1944 the bar had shoaled to 44 feet. In 1951 the least depth in the channel was 42 to 43 feet. In addition to the shoaling, the westerly sector of the outer bar was eroding with the result that rougher seas were allowed access to the entrance. Another problem was the constant accretion to the northwest portion of the Clatsop Spit. This contributed to shoaling in the inner channel which in 1952 was only 41 feet deep. It also made the turning angle in the channel sharper and therefore more dangerous.
South jetty at the mouth of the Columbia River, with a portion of Clatsop Spit at right.
In rough seas a ship will develop a tremendous pitch. This is known as "sounding". The weight of a large vessel diving into a low trough in the sea presents a different question of drafts and safe channels than does a smaller ship on calm river water. When storm waves are running, vessels may strike bottom in depths exceeding their draft by fifteen feet or more. Oregon seas are notoriously rough. During the later 1940's and early 1950's many larger vessels reported striking bottom when sounding. In stormy weather, ships of 28 to 33-foot drafts would be unwise to attempt entrance into the 41-foot deep Columbia River. 15 extra feet is considered a minimal safety margin in bad conditions. Maritime underwriters would be very likely to restrict travel by large ships through the entrance if it were to remain in a dangerous condition.

In 1925, 4 ships of 30-foot drafts or deeper had crossed the bar. In 1940 there were 7, and in 1950 there were 398. Ships crossing the bar at the mouth of the Columbia in the early 1950's carried about twice as much cargo (2,818 tons on the average) as did ships in 1925. Most of the larger ships were tankers.

The DREXEL VICTORY attempted an entrance in stormy conditions in 1947, cracked amidship, broke into two parts shortly after grounding, drifted to sea and sank. No lives were lost but the ship and cargo, valued at $2,250,000, were total losses. Other losses were less spectacular. Yet in the early 1950's annual losses due to grounding averaged about $200,000, excluding operating costs.

Oil companies operating large tankers loaded their vessels for less than full draft for Columbia River delivery in order to provide a greater margin of safety. Of 112 voyages made in 1952, 100 were loaded to 9 inches less than full draft and 12 loaded to 7 inches less than full draft. Each inch on these ships represented 67-70 tons of cargo, amounting to 66,000 tons less than full capacity. On oil imports alone, this ultimately cost Oregon consumers an additional $118,000 in petroleum product price.

Less-than-capacity loads were not the only costly result of an unsafe entrance at the mouth of the Columbia River. Delays were also wasteful. When a deep-draft vessel encountered stormy conditions, it was usually advised by the bar pilot to wait for better weather and a safer crossing. The cost for lay time for general cargo carriers ranged at this time from $50 to $125 per hour. The same cost to a tankship averaged about $101 per hour. Delays at the Columbia River were a common occurrence. This, too, drove up rates and prices.

From 1940 to 1950 the population of the Pacific Northwest had increased rapidly. Oregon had grown 39.6%, Washington 37%, while the rate for the rest of the nation was 14%. In 1905, total oceanborne commerce over the lower Columbia River was about 940,000 tons. By 1950 oceanborne commerce had increased nearly tenfold to 9,214,000 tons per year. All tonnage above The Dalles was 1 million per year, and above Willamette Falls Locks 2 million in rafted logs and barge traffic. Nearly all of
The 352-foot long sea going hopper dredge BIDDLE is the largest vessel in the Portland District floating plant at Government Moorings. It has a crew of 83 men.
the increase on the Columbia was domestic. Better conditions at the mouth would have greatly improved foreign oceanborne trade, too.

In 1952, 40 ship lines served the Lower Columbia River offering service to and from the major ports of the world. Ten lines provided regular inter-coastal and Gulf of Mexico service. Several lines were specialists in lumber or cement carrying. Eight major oil companies brought petroleum products in T-2 class tankers. There were six port associations on the Lower Columbia. Portland, the oldest, Astoria and St. Helens in Oregon, and Vancouver, Kalama, and Longview in Washington. Over $60,000,000 had been invested in terminal and dock facilities.

The promise of greater difficulties than those then being experienced, plus the solid prospects of increased trade, prompted the Portland District to propose an $8,555,000 project to improve and maintain the mouth of the Columbia River to 48 feet deep and one half mile wide. The project was adopted in the River and Harbor Act of September 1954. $2,898,000 of this sum was for initial dredging, and $5,657,000 for construction of a one-mile spur jetty. The spur jetty was to be extended from Cape Disappointment on the inside of the north jetty and running roughly parallel to it.

Dredging of the 48-foot bar channel started in April 1956 and was completed in September 1957. A total of 17,446,341 cubic yards of material were removed to complete that part of the project.

The entrance project is about 5 miles long. It curves running northwest at the outside to almost due west at the inside reach. The project is divided into parallel quarters, each five miles long. As one approaches the entrance from the outside, these quarter sections are labelled left outside, left inside, right inside and right outside. The first three average depths slightly greater than the project depth -- about 49 feet. The right outside quarter is considerably less than the project depth because of the severe shoaling from the Clatsop Spit. Pilots at the bar and the Portland District are in agreement that a somewhat narrower channel with better depths is as desirable as the authorized project. Maintenance dredging is performed on this basis.

The spur jetty was never built. Its purpose was to have been improvement of tidal and river flow over the bar for scouring action. Initial dredging operations showed that the material could be removed more cheaply by annual dredging than by the effect of the jetty. Annual dredge cost would be less than the annual amortization rate of the spur jetty.

Adequate depths would be provided by dredging, by the original north and south jetties, and less importantly, by pile dikes at Sand Island. The south jetty was rehabilitated from 1962 to 1964, the north jetty from January to April in 1965, and the pile dikes were repaired in 1966. About 2,220,000 cubic yards of material were removed by the United States government hopper dredge BIDDLE in 1966.
C.

In March and April 1957, the Committees on Public Works of the United States Senate and the House of Representatives adopted resolutions which required the Chief of Engineers to determine the advisability of modifying the navigation project on the Lower Columbia River to provide larger dimensions. Responsibility for making this report to the Congress lay with the Portland District. After several years of study and research, projecting and planning, and consultation with the States of Oregon and Washington and various government agencies, a report was published as House Document 452, 87th Congress, 2d Session. The report called for a 40-foot deep, 600-foot wide navigation channel from Portland to the sea. The cost was to be over $23,000,000. This would be the most costly navigation project ever undertaken by the Portland District. The two huge jetties built from 1905-1918 at the mouth of the Columbia cost less than half this amount.

Good transportation resources are vital to the economy of the Pacific Northwest. Located in a distant corner of the United States, the Northwest is far from the largest markets and producing areas of the rest of the nation. The result is that the cost of transportation can make Northwest-produced goods uncompetitive with goods in other regions, and it raises the price of goods coming into the region. The great mountains which ring the Pacific Northwest make inter-regional highway and railroad construction more costly than in other parts of the United States. Railroads have served the Northwest since the 1880's. Work on the important Interstate Highway 5 has recently provided 24-hour truck service between Portland and Seattle and the huge Southern California market. The rapid growth of air freight shipping has also benefited the region. High-value, low-weight, Northwest-produced electronic devices, for instance, can be competitive throughout the nation. Navigation, however, has been and remains the transportation backbone of the region. In terms both of the value of cargo and of the type of cargo, waterborne commerce capacity is an essential asset of the Pacific Northwest.

Immediately after World War II total shipping on the Lower Columbia River was about 15 million tons per year. This includes rafted logs and "through" (cargo originating outside the project which passes through and is destined for points beyond the project) traffic. Total rafted traffic usually amounts to 20-25 percent of all traffic, and through traffic less than 10 percent. By the time the 40-foot channel was being seriously discussed ten years later, total tonnage had passed the 20 million ton per year level. Growth in tonnage for the 1960's added to that figure by about 30 percent.

Of the roughly 20.6 million cargo tons in 1959, nearly 33 percent were coastwise imports of petroleum products, almost 20 percent represented foreign exports of grain (principally wheat), about 22 percent were internal log shipments, 10 percent were finished forest products, and about
8 percent consisted of sand, gravel and crushed rock. Total value of the cargo was about $510 million.

The chief factor which justified the undertaking of the costly 40-foot project was the increase in vessel size after World War II.

Commercial ships are generally classified as being either tankers, dry-bulk carriers, or general cargo vessels.

After World War II, the world's tanker fleet had grown both in number of ships and in size of ships in response to increased demand for petroleum throughout the world. An additional factor was discovery of oil fields in the Middle East which were farther than other sources (existing Middle East, Venezuelan) from the principal markets in America and Europe. From 1925 to 1959 total fleet tonnage increased from 8.5 to 62.7 million tons, an average growth rate of about 6.2 percent per year. Since World War II, world tanker fleet dead weight tonnage (d.w.t., i.e., empty) has increased at an even higher rate: 7.7 percent per year. During the same period world petroleum demand was growing at a rate of 7.8 percent per year.

In 1959, a 25,000 d.w.t. tanker was the rough dividing line between one of the new, larger vessels and the older, less efficient ones. From 1953 to 1959, tankers in the 25,000 to 30,000 d.w.t. class increased 100 percent to 197. In 1959, there were 241 tankers in the 30,000 to 35,000 d.w.t. class, 60 in the 40,000 to 45,000 d.w.t. class, 5 each in the 50,000-55,000 d.w.t. and 60,000-65,000 d.w.t. class, 7 in the 85,000 to 90,000 d.w.t. class, and 1 ship over 100,000 d.w.t.

"Supertanker" class was set at 27,000 d.w.t. and up. These first appeared in 1948-49. From 1953 to 1959, world fleet tonnage in supertankers went from 10 percent to 37 percent; from 119 ships to 666.

Generally, seagoing tankers have an economic life of about 20 to 25 years. This was a prime factor in determining needs of channel improvement in the Columbia River. Most of the tankers operating after World War II were classified as T-2. During the war, the United States tanker fleet had more than doubled to 775. Portland's Swan Island Shipyard constructed about one-third of the new T-2's. This ship had 16,700 d.w.t., 75-foot beam, 573-foot length and 30-foot draft measurements. Because of economies enjoyed by larger vessels, and because of the 20 to 25 year life of this ship, many tankers of much larger size began to be built in the late 1950's to replace the old T-2. Many more new, larger ships would be built in the 1960's.

These were the supertankers which were twice as heavy, up to 25 feet wider, 100 feet longer, and with drafts 3-6.5 feet greater. Tankers of this size simply could not navigate in the 35-foot deep, 500-foot wide channel then existing in the Lower Columbia River. Studies showed that tankers would increasingly tend to larger sizes. Unless the Columbia
River channel were improved, the older, smaller, less economic ships would have to serve the area. Columbia River basin users would be forced into paying prices on many petroleum products which would be higher than in most locations in the United States. An indication of the possible impact of this problem is afforded by the fact that petroleum products are the most important cargo on the Lower Columbia, and that the Lower Columbia River is the second largest seaport on the Pacific Coast.

Economies and demand-growth factors similar to those which stimulated tanker development after World War II also encouraged expansion of dry-bulk carriers. Specifically important was the depletion of high-quality domestic mineral reserves -- principally iron ore -- which ultimately are the cargoes these vessels carry. This spurred the location of sources far from manufacturing and consuming centers. This was true of the aluminum industry. Bauxite and aluminum supplies were developed in the West Indies, Surinam and Japan. Huge dry-bulk carriers linked the source with the consuming center.

Dry-bulk carriers are smaller than tankers. The United States fleet had 49 dry-bulk carriers in 1959. Average d.w.t. was 13,980 (19,700 d.w.t. for United States tankers the same year). Dry-bulk carriers are also smaller in draft, average being less than 30 feet and the greatest ranging up to 34 feet. The largest vessels operated in the iron and coal trade on the east coast, thus construction trends in dry-bulk carriers did not place immediate pressure on the Portland District to deepen the channel in the Columbia River.

In 1955, however, the United States Maritime Administration prepared a prototype design of a typical bulk carrier for future American fleets. The proposed vessel would be 24,000 c.w.t. with a design draft of 33 feet. This vessel was specifically designed to accommodate lighter weight conditions such as grains, alumina and bauxite. The Maritime Administration design was similar to many dry-bulk carriers then being constructed in European shipyards. Such a ship would be unable to navigate the 35-foot channel in the Columbia River.

Dry-bulk carriers haul about 25 percent of the grain from Oregon and Washington ranches. Grain shipments are second only to petroleum on the Columbia River. In terms of total product value, agriculture is still the second largest business in each of these two states. About half of the Columbia River grain trade was in Liberty, Victory, C-3 and similar cargo vessels of the 10,000 to 13,000 d.w.t. size. However, ranchers and exporters were finding it increasingly profitable to utilize large tankers for grain shipments. In the late 1950's there was a trend away from the smaller cargo vessels to the larger-load tankers and, to a lesser degree, dry-bulk carriers. This development would be strengthened by the fact that construction plans for general-cargo vessels in this period involved only small increases in size.
Several factors beyond a ship's design draft and beam determine safe navigable water.

A 16,000 d.w.t. ship underway at 10 knots will sink 2-5 inches at the bow and about 2 feet at the stern. This is called squat. The greater the size and speed of the vessel, the greater the squat.

"Drag" results from loading a ship heavier at the stern to obtain better handling. Inbound tankers will average 1 foot 3 inches, and outbound wheat vessels average about 1 foot 8 inches drag.

"Sinkage" is the effect upon a ship when entering fresh water from salt water. In the Columbia River this amounts to 1/4-inch per foot of draft, or a range of about 6 to 9 inches.

Finally, 2 to 3 feet of clearance is absolutely essential for safe steerage. This varies with the weather, the size of the ship, and the pilot.

The sum of these factors results in the need for a channel 5 to 6 feet deeper than the draft of the largest ships on the Columbia River. A 40-foot channel would provide safe passage for ships of 30,000 to 33,000 d.w.t. and 34-foot to 35-foot drafts. Ships of this size are basically similar to the trends in tanker and dry-bulk construction. Larger vessels could operate in good weather with modified load and speed factors.

Adequate channel width is also a problem for ship operators and river pilots. Ships require greater width when passing another vessel in restricted river channels than is required in open water. This is because of bank suction. The propeller action of a large vessel close to the side of the channel will suck water out of the space between the ship and the side of the channel. The ship will naturally move to the area of least water resistance. Cross currents, anchoring requirements, and weather conditions (observations at Portland International Airport indicate that between 1 September and 31 March restricted visibility poses a hazard to navigation 10 percent of the time) also help determine the safe width for the channel. A vessel changes course 106 times in the 8-hour transit from Astoria to Portland.

Experience has provided a formula to determine safe widths. When one vessel passes another, the river has six areas: clearance between the banks; clearance between the two vessels; and the maneuvering lanes. Bank-clearance is equal to the sum of the two ship's beams. Ship clearance is equal to the beam of the larger ship. Maneuvering lanes are not less than 180 percent of a ship's beam.

A 600-foot wide channel would provide more than adequate passage for old Liberty, Victory, C-3, C-4 and T-2 vessels. All of the newer ships could pass safely in such a channel using care. The additional 100 feet width in a new channel would eliminate the threat of hazard or delay posed by the older channel.
The large aluminum industry in the Pacific Northwest would benefit from the improved navigation on the Columbia River.

World War II required great quantities of aluminum. The first Pacific Northwest plant was opened in 1940 at Vancouver, Washington by the Aluminum Company of America. The Northwest industry expanded rapidly after 1948 because large amounts of low-cost hydroelectric power were available from federal projects on the Columbia River. 10 to 12 kilowatt hours of electricity are required for one pound of finished aluminum. The monthly power bill of an average size Northwest plant is about $100,000. Industrial rates from the Bonneville Power Administration are half those in the Tennessee Valley, the next lowest rate region in the nation.

Four tons of bauxite combine with two tons of alumina ore (plus smaller quantities of carbon and electrolyte) to yield one ton finished aluminum. Traditionally, Northwest aluminum plants had purchased alumina from bauxite reduction plants located on the Gulf of Mexico. Rising internal transportation costs in the 1950's, however, made this practice increasingly unattractive. Greater depths in the Columbia River would make it economically feasible for aluminum companies located on the Columbia River (or those affiliated with plants on the Lower Columbia River, e.g. the Alcoa Plant at Wenatchee, Washington) to ship alumina in dry-bulk carriers directly from Jamaica, Surinam and Japan, and bauxite from Panama and Surinam. New and future Pacific basin sources of alumina ore and bauxite favored Pacific Northwest plants.

The Harvey plant, located at The Dalles, Oregon and the Reynolds plant located at Troutdale, Oregon experimented with this procedure in 1958 and 1961. By 1968 all plants on the Lower Columbia were utilizing navigation.

Since overhead, wages and materials costs are relatively uniform throughout the country for the aluminum industry, transportation and power costs are crucial in determining where a plant will locate, and what its profits will be once it becomes established. Cheap electric power and, to a lesser extent, navigation capacity have resulted in 35 percent of the nation's aluminum being produced in the Pacific Northwest. The metals industry has provided a much-needed diversity and finished-product capability to the basically immature, extractive economy of the region. In addition, the industry provided over 11,200 jobs and directly contributed about $334 millions in 1968 to the northwest in wages, salaries, purchases, taxes and other expenditures.

The increasing size of ships, the promise of greater use of the river, and the benefit to industrial expansion prompted adoption of the project. In the River and Harbor Act of October 1962, Congress called for a channel 40 feet deep and 600 feet wide from Vancouver, Washington to the mouth of the Columbia River, and from Broadway Bridge in Portland to the mouth of the Willamette River. Widths in the Willamette ranged from 600 feet to 1900 feet to accommodate movements in Portland harbor.
Aerial view of Portland Harbor and Willamette River with Steel Bridge in lower section and St. Johns Bridge in downstream section. Swan Island is in upper center, the major ship repair yard in the Northwest. (Photo by Ackroyd Photography, Inc.)
These two pile dikes are typical of those on the Columbia River. Their function is to protect the shore, and to concentrate the current in the middle of the channel—thereby minimizing dredging expense. Upper is at Wauna Bar and lower is at Westport Bar.
The Act called for the channel from the mouth of the Willamette to the Interstate Bridge at Vancouver to be improved to 35 feet deep and 500 feet wide. Turning basins 40 feet deep, 800 feet wide and 5,000 feet long, and 40 feet deep, 1,200 feet wide and 6,000 feet long were provided for Vancouver and Longview, Washington. The Willamette River from Broadway Bridge upstream to Ross Island Bridge (3 miles) is being maintained to 30 feet deep and 300 feet wide by the Port of Portland.

Authorization for pile dike construction was also included in the 1962 River and Harbor Act.

Pile dikes are permeable groins extending into the river, and consist of two rows of untreated timber piling driven on 2½-foot centers alternatively placed on each side of horizontal spreader piles. The piling are driven to refusal, or to a specified penetration depending on location, and securely bolted to the spreader piles. Stone is placed along the pile dike and around the outer end for protection from scour.

A pile dike works in several ways to maintain a navigation channel: (1) concentrates the flow of the river in the channel, thereby producing a natural scouring effect; (2) provides alongshore areas where disposal material may be retained without loss due to annual freshets; (3) protects the bank.

Pile dike construction in the lower Columbia River was initiated in 1885 at St. Helens Bar where natural depths of 15 feet were increased to 25 feet. Other early dikes were constructed at Martin Island Bar and Walker Island Bar in 1892-93. The bulk of the present day dike system was built in the period 1917-23 and 1933-39. In 1961 there were 159 dikes totaling 14,400 linear feet. Much of the old dike system was sand-bagged in or buried under material dredged from the river.

Twenty-nine new dikes were to be built and 14 existing dikes extended amounting to 19,600 feet. The dikes were located at various locations where additional dike construction is necessary to insure that maintenance of the channel will provide project dimensions on a year-around basis. Pile dikes eliminate the need for several millions of dollars of dredge work each year.

Shipping facilities in Portland are very good. There are 20 terminals to handle general cargo, bulk grain, lumber; 10 fuel oil and gasoline wharves and piers; mechanized handling devices and heavy lift equipment. Portland, Vancouver, Kalama, Longview and Astoria have large grain storage facilities.

The Port of Portland operates an important ship repair yard. Dry-dock #3 is the largest (27,000 d.w.t. capacity) and fastest (30 to 60 minute lift) operating floating drydock on the Pacific Coast. The two other drydocks located at Swan Island have 18,000 and 14,000 ton lift capacity.
The Commission of Public Docks installed a Hitachi crane in 1967 to handle important containerized cargoes. Note ready-to-ship containers on dock and on board vessel.

(Photoby AckroydPhotography, Inc.)
A floating drydock works like this: side compartments are filled with water. When the ship is over the sunken drydock, the water is pumped out of the side compartments. Air in the compartments lifts the ship out of the water so that its bottom can be worked on. The high value of ships requires that drydocks be operated on a 24-hour basis.

The Commission of Public Docks, created by the City of Portland in 1910, installed a huge Hitachi crane in 1967 to handle the fast-developing container cargo shipments. Container shipping offers minimal handling, more efficient loading and better security. The crane can lift 33-ton loads from a horizontal extension of 104 feet. It is located at the St. John's terminal. Another Hitachi, with a 40,000 ton lift capability, is planned to be located at Terminal #2.

In April 1965 America's largest commercial vessel, the 940-foot, 108,590 d.w.t. SS MANHATTAN, visited Portland harbor and took on 58,000 tons of wheat. This was the largest shipment of grain ever to leave the Pacific Northwest. The MANHATTAN has a top speed of 18 knots and can cruise 25,000 miles without refueling. Its two propellers weigh 62,500 pounds each and are 22 feet in diameter.

Local cooperation required by the River and Harbor Act of 1962 was extensive. Local interests (the six Port Districts on the Lower Columbia) would have to provide land and right of way for the project, including spoil-disposal areas from the dredging, and all the necessary retaining dikes, bulkheads and embankments. The United States would be held free from damages. All alterations to sewage works, cables, water supply, drainage and other utility facilities would be accomplished by local interests as necessary. Adequate public terminal and transfer facilities must be provided and maintained open to all on equal terms. Adequate depths in berthing areas and access channels were to be maintained. A lump-sum payment of $386,000 was to be paid as a contribution to project costs. About $190,000 was paid by the Port of Portland for land value enhancement owned by that organization.

An important element of local cooperation was actual assistance in the dredging. A suitable pipeline dredge in good operating condition, with full crew and equipment, was to be made available to the Portland District, without charge except operating costs, on a basis approved by the Chief of Engineers. This last requirement is fulfilled by the Port of Portland's huge pipeline dredge OREGON. Built in 1965, the $4 million OREGON works on the 40-foot project about six months each year.

Progress on the 40-foot channel has been delayed due to inadequate Congressional appropriations. In 1969, the project was about 55 percent complete. From 1960 to 1965, commerce on the Lower Columbia River had increased from about 21.9 million tons to 27.6 million tons. Columbia River shipping interests, the Port of Portland, and the Portland Army Engineer District have stated to Congress the benefits which will result
The seagoing hopper Dredge DAVISON has seen action in Vietnam.

The Colonel P. S. MICHEL was retired from seagoing hopper dredge duties in the Portland District in 1950, just before acquisition of the BIDDLE.
from the rapid completion of the 40-foot project. Total cost was estimated in 1966 to be $22.6 million. Value of trade on the Lower Columbia River amounted to $779 million in 1967. A total of over 15,000 jobs, earning about $103 million in wages and salaries, are directly dependent upon shipping activities in the Port of Portland.

D.

Dredging has always been one of the most important works of the Portland District. Dredging activities have been mentioned throughout the pages of this history. The first Corps of Engineers civil work in the Pacific Northwest was dredging a 17-foot channel through the bar at Swan Island in 1867. Extensive dredging was required on each improvement in the Portland-to-the-sea waterway -- from the 20-foot channel in 1878 to the huge 40-foot project in 1962. Each year after the late spring freshet, it has been necessary to remove great quantities of material from the navigation channel. If the amount of dredged material which has been taken from the Columbia and Willamette rivers were placed in downtown Portland, it would cover 400 city blocks 30 stories high, and the streets and sidewalks in between. It may be said, of course, that such a project is not presently being considered by the Portland District.

In 1968, the Portland District had about 1,250 employees. Over 450 were employed in dredging operations. Value of the floating plant is about $7,575,000. In the mid-1960's the cost of dredging activities averaged about $7,074,000 annually. Repairs to the floating plant each year have been about $2,500,000 in the same period. The Portland District Moorings are second in size only to the Memphis District Moorings in Tennessee. The Memphis District is responsible for dredge operations on the Mississippi River.

A purchase of land in 1940 brought the St. John's Road site Moorings to 13.13 acres of land and 4.36 acres of water. This is the size of the Moorings in 1969. There are 12 buildings at the Moorings, including a welding shop, machine shop, garage, and a building which contains a radio room and a carpenter shop. The radio room has over $500,000 worth of communications and radar equipment. There is a pattern storage building with patterns for all dredges, a materials storage warehouse with miscellaneous items for the dredges, 3 open front storage areas, a dock derrick house and a lumber and steel storage warehouse. The Plant Branch office houses administrative personnel. The Moorings is operated under the general supervision of the Navigation Division and under the direct supervision of the Plant Branch.

The Portland U.S. Army Engineer District has four seagoing hopper dredges and three non-self-propelled hydraulic pipeline dredges which work on ports and ship channels to accommodate waterborne traffic, as authorized by Congress.
The four seagoing hopper dredges are the BIDDLE, the largest at 352 feet long with a crew of 83 men; the HARDING at 308 feet; the DAVISON at 215 feet; and the PACIFIC at 180 feet, with a crew of 44 men.

These seagoing ships work from Seattle, Washington to San Diego, California on the west coast, and the BIDDLE and DAVISON have been to the Hawaiian Islands. The DAVISON has also dredged in the Panama Canal, the Texas coast, and the Mississippi River. During the Vietnam war the dredge DAVISON deepened the rivers and harbors of South Vietnam, notably at Cua Viet and Qui Nhon, to help insure rapid shipment of goods.

All of the Portland District hopper dredges suck material into their hoppers from both the port and starboard sides. Capacity ranges from 3,060 cubic yards in the BIDDLE to 500 cubic yards in the PACIFIC. When the hoppers are full, the dredge sails to deep water, usually at sea, and dumps the material.

A hopper dredge has certain advantages over pipeline dredges. It can work in water exposed to open seas. It can be quickly transferred, having its own power. It can be used in locations where no bank disposal areas exist. Since it requires no extensive disposal pipeline, it does not interfere with navigation.

The three hydraulic pipeline dredges are the MULTNOMAH, WAHKIAKUM and the LUCKIAMUTE. The MULTNOMAH and the WAHKIAKUM are the largest and the oldest. Constructed in 1913, these two 24-inch hydraulic pipeline dredges are 261 feet long, have about 7 foot drafts, can remove 800 to 1500 cubic yards per hour, and can dredge in depths up to 62 feet. The 18-inch pipeline dredge LUCKIAMUTE, built in 1944, has measurements about half those just given. The MULTNOMAH and the WAHKIAKUM work in the Lower Willamette and Columbia rivers. The LUCKIAMUTE operates in the Upper Willamette and the Cowlitz rivers. The WAHKIAKUM has traveled aboard a floating drydock to Alaska where she performed harbor dredging for the Alaska Engineer District.

The cutterhead on a pipeline dredge is the part of the ship which makes actual contact with the river bottom. These are about 7 feet in diameter, mounted at the end of long steel pipes at the bow of the vessel. A cutterhead looks like a large cluster of curved chisels, all facing in one direction perpendicularly to the line of the ship. The cutterhead is powered by a 500-horsepower engine. Two tall, iron spuds at the vessel's stern function like giant stilts to hold the vessel in place, and to shift it forward. The ship's leverman operates the spuds, and also controls the depth of the cut and the pressure of the pumping action.

A pipeline dredge sucks material off the river bottom and then, by means of a pontoon-supported pipeline, pumps the material to disposal areas. A pipeline dredge avoids the time-consuming emptying runs which amount to well over half the work time of a seagoing hopper dredge.
The 12-inch pipeline dredge LUCKIAMUTE was built in 1944. It works mainly in the Willamette and Cowlitz rivers.

The HARDING is one of the four Portland District seagoing hopper dredges.
The HICKSON, a $200,000 survey boat, was named to honor R. E. Hickson, former Chief of the Portland District Engineering Division. It began operations in 1968.

Booster Barge BAXTER used on Columbia River to assist District pipeline dredges MULTNOMAH and WAHKIAKUM.
The dredged material has been put to considerable good use. The huge Rivergate Industrial Park developed by the Port of Portland at the mouth of the Willamette River is composed largely of dredge fill. Numerous industrial sites on the Columbia River have been formed by dredge fill. Alcoa Aluminum in Vancouver, and the huge grain elevators at Kalama, are two examples. Most of the shore side facilities of the Port of Vancouver are built on fill. Disposal areas on Sauvie Island and at many locations on the Washington side of Columbia River are good recreation areas. The dredged material is almost invariably a fine sand.

In addition to the four seagoing hopper dredges and the three pipeline dredges, the Moorings serve as home base to many smaller craft.

Two tugs were obtained from the Beaver Ammunition Depot in 1946 after World War II. These serve the three non-propelled pipeline dredges. Two large surveyboats and 4 survey launches are part of the Portland District fleet. The $200,000 surveyboat HICKSON was christened in 1968 in honor of the late R. E. Hickson, former Chief of the Portland District Engineering Division. Each pipeline dredge had a 45-foot tender. These serve as workboats and personnel launches. There are about 22 barges for pipeline support and anchoring, and nine utility power scows.

Rock and, to a lesser extent, clay deposits will pose problems to any future improvement of the lower Columbia River. Warrior Rock on the south shore of the Columbia at river mile 88 has been a problem for the Portland District since the late 1870's. Slaughter's Bar, Eureka Bar, and Port Harbor are a few of the several locations with rock problems. Wauna Rock has recently been improved by blasting. Henrici Bar, Martin Island Bar and Stella Fisher Bar have clay deposits which are very difficult to dredge. The mouth of the Columbia River also has clay deposits. Such problems will figure importantly in the cost-benefit calculation of any new channel project.

Projects on the Oregon Coast up to the 1920's and early 1930's have been discussed in Part II. Improvements to navigation were made on the Oregon Coast after this period at existing projects and at new locations. Over $100 million has been spent on jetty work. Commercial shippers, fishermen and pleasure craft have all benefited from quicker, safer and larger waterways at the rivers and bays on the Oregon Coast. From the mouth of the Columbia 300 miles south to the Chetco River, there are ten significant projects.

The entrance to the Nehalem River, about 40 miles south of the mouth of the Columbia River, was completed in 1918. The combination of private work and Corps of Engineers efforts produced 2 jetties 4,950 and 3,850 feet
Depoe Bay, 100 miles south of the mouth of the Columbia River, provides an excellent small boat basin for recreationists and commercial fishermen.
A dike built in 1956 closed a break in the Bayocean Peninsula.

View of the north jetty at Tillamook Bay entrance. Work was started on a south jetty at this location in 1969.
long at a total cost of about $640,000. A survey in 1963 showed 5-foot controlling depths -- adequate for fishing boats, pleasure craft and logs. Population of Nehalem, Oregon in 1930 was 245. In 1968 it was 228.

Tillamook Bay is 50 miles south of the mouth of the Columbia. Previous work, principally a 5,700 foot jetty on the north side of the entrance, had been completed in 1933. In 1948 a 12-foot deep small boat basin was authorized at Garibaldi, at the north end of Tillamook Bay. This was completed in 1956.

Running north to south and separating the ocean from the bay is the Bayocean Peninsula. In 1954 a 1.4-mile sand and rockfill dike was authorized to close the breach in the peninsula. This was completed in two years.

In 1965 the River and Harbor Act provided for an 8,000 foot jetty on the south side of the mouth to produce a channel at the entrance 18 feet deep, 200 feet wide, to extend 3 miles from the entrance east to Miami Cove. Plans were completed and work was begun in July 1969. Congressman Wendall Wyatt drove the truck which dumped the first jetty stone into the water. Total cost of the new work is estimated to be about $11 million.

Depoe Bay is 100 miles south of the mouth of the Columbia River. Work here has provided a very good small boat harbor. Initial work was authorized in 1937 and modified in 1945 after World War II. This provided for a breakwater north of the entrance, an entrance channel 8 feet deep and 30 feet wide, and an inner basin 350 by 750 feet and 8 feet deep. A 13-foot retaining wall was built on the east side of the basin. This work was completed in 1952. A second breakwater was built in 1966. Revetment, a spending beach and a check dam at the mouth of Depoe Creek at the south end of Depoe Bay have also been built.

The earliest Portland District work at Yaquina Bay was performed in 1880, consisting of 2 jetties. Citizens of the area were informed in 1900 at a Board of Engineers hearing held in the Newport Opera House that no further improvement would be justified at that time. An Act of Congress in 1919 authorized restoration of the jetties, removal of the rock at the entrance, and dredging in the bay 4-1/2 miles to the railroad terminus at Yaquina.

Authorizations in 1937, 1945 and 1946 further improved the work. The 1937 River and Harbor Act extended the north jetty 1,100 feet. The 1945 River and Harbor Act was the most important of the three. It extended the north jetty to 4,700 feet and the south jetty to 5,800 feet. An 800-foot spur jetty was to be built off the south jetty near its land end. Five groins channelward were also built from the south jetty, west of the spur jetty. A channel of "suitable" width and 26 feet deep was provided across the entrance bar, as well as a channel from the entrance 2 miles to McLean Point, 20 feet deep and 300 feet wide. A turning basin over 1,000 feet square was to be dredged near McLean Point.
This photo taken in 1929 shows the mouth of the Siuslaw River emptying into the Pacific Ocean between the nearly completed jetties. Rehabilitation of the two jetties was in 1958 and 1962. Florence, Oregon is famous for its beautiful sand dunes.
Repair work on the north jetty at Yaquina Bay in June 1966.

Vessel leaving Yaquina Bay through calm, deep waters between the jetties. Newport, Oregon is in the left background.
The 4-1/2 mile channel from Newport Docks to Yaquina was to be improved to 18 feet deep and 200 feet wide.

The 1946 River and Harbor Act authorized a small boat basin to be formed behind a 2,650 foot breakwater at the north end of Yaquina Bay at the town of Newport. All of this work provided in the three Acts was completed in 1952.

Newport, founded in 1882, had grown from its population of 500 in 1900 to about 6,000 in 1968. A large lumber industry is located here, as well as prosperous fishing activities. In order to provide necessary navigation facilities for the area, the 1958 River and Harbor Act authorized extending the north jetty to 6,500 feet and the south jetty to 7,600 feet. This would produce 40 feet of safe water at the entrance over the bar, and 30 feet in the channel leading into Yaquina Bay. The width of the project would be 400 feet at the entrance, and 300 feet from the entrance to McLean Point. The turning basin under the previous project was to be lengthened 400 feet.

Surveys were completed in 1963. Repair and extension of the north jetty was completed in 1966. Dredging of the channel and the turning basin was completed in October 1968. The south jetty was 60 percent complete in July 1969. A 9 to 10-foot channel roughly 10 miles up the Yaquina River has been maintained by annual dredging since 1914. Since the Corps of Engineers first started work at Yaquina Bay, over $13,612,000 has been spent on improvements.

The Siuslaw River empties into the Pacific Ocean 154 miles south of the mouth of the Columbia. The early projects which provided safe water at the entrance and a channel upriver 2 miles above Florence was completed in 1930. Rehabilitation of the outer 1,700 feet of the north jetty was performed in 1957-58. The south jetty was rehabilitated in 1962.

In 1958 the River and Harbor Act authorized depths of 18 feet over the bar and 16 feet in the river channel. Width at the bar would be 300 feet, and 200 feet throughout the channel for 7 miles upstream. Construction of a turning basin was authorized opposite Siuslaw Dock in Florence.

Principal users of the improved waterway would be the lumber and plywood shippers, commercial fishermen and pleasure craft. These improvements were to be provided by a 700-foot extension to the north jetty and by increased dredging. This work commenced in August 1968. Plans have been made to plant Holland grass in the spoil deposit areas along the river. The project as modified was about 20 percent complete in July 1969.

The Umpqua River is the biggest river between the Columbia and San Francisco, California. The mouth of the Umpqua is 180 miles south of the mouth of the Columbia near the town of Reedsport, Oregon. The first lighthouse on the Oregon coast was built at the mouth of the Umpqua River in 1857. Navigation on the Umpqua was important in the 1850's because
This photo shows the three principle works constructed by the Portland District at the mouth of the Umpqua River. Winchester Bay is in the middle of the picture.
of the gold rush in southern Oregon. The supplies demanded by the miners could best be brought from California by sea and river.

The Portland District had often considered doing work on the Umpqua River. Major Henry M. Robert, the first Portland District Engineer, was interested in making a trial run up the Umpqua himself. In 1871, the President of the Merchants and Farmers Navigation Company tendered the use of a small skiff to Major Robert to go up the river. The stockholders of the organization, however, protested the offer and the trip was abandoned.

For approximately 50 years after Major Robert's interest, rock removal and surveys were the main activities of the Portland District on the Umpqua River. Successor's to Major Robert proposed several projects. None were approved by the Board of Engineers. About $40,000 was spent during that period.

The first structural improvement on the Umpqua was a 7,500 foot jetty on the north side of the mouth. This was authorized in the River and Harbor Act of 1922. After project dimensions were extended 500 feet, the north jetty was completed in 1930. Acts of Congress in 1930 and 1935 authorized a 4,200 foot south jetty which was to extend to a point 1,800 feet south of the north jetty. The south jetty was completed in 1933. The 1935 Act also provided for dredging to 25 feet over the bar. The River and Harbor Act of 1938 authorized a 22-foot deep and 200-foot wide channel from the entrance 11 miles up the Umpqua River to Reedsport.

In 1942 the north jetty was rehabilitated. The outer 800 feet had been beaten down by the seas to such an extent that it was submerged at high tide.

In 1945 a channel about 1 mile long, 22 feet deep and 200 feet wide, was built from the main channel to Gardiner. A turning basin was built opposite Gardiner.

In 1948 a 12-foot deep, 100-foot wide channel was dredged from the main channel to Winchester Bay just inside the mouth on the south side of the Umpqua. The turning basin and mooring area which were also built here helped to make Winchester Bay a very fine small boat basin.

By the late 1940's, the rough seas had partially destroyed the south jetty. To replace it a 4,000-foot long training jetty was built about 2,000 feet upstream in the mouth of the Umpqua between the original 2 jetties. The south side of the mouth narrows at a rate of about 45 degrees. This was completed in 1951. The south jetty was rehabilitated in 1963. These completed works form the present project. Nearly $11 million has been expended by the Portland District to improve navigation on the Umpqua River.
Coos Bay after completion of the 1929 project.
(Photo by Brubaker Aerial Surveys, Portland)
Repair work on the south jetty at Coos Bay in 1963.

Entrance to Coos Bay, with North Bend in the background. Coos Bay is the largest wood product exporting port in the world.
Coos Bay is the most important seaport on the Oregon coast. Located 200 miles south of the mouth of the Columbia River, it is also the biggest forest-product exporting seaport in the entire world. This is because tremendous stands of timber and many of Oregon's largest forest products plants are located in the southwestern part of the state. Because bulk is the most economical cargo, wood chips account for the greatest tonnage of the forest products leaving Coos Bay. The value of exports in 1965 was $44 million.

Previous work on two large jetties was completed in 1929. Acts of Congress in 1930 and 1935 provided for a navigation channel 24 feet deep and 300 feet wide from Pigeon Point just inside the entrance 15 miles inland to Smith's Mill at Coos Bay. Also provided was a 30-foot deep, 600-foot wide and 1,000-foot long turning basin at the mouth of Coalbank Slough near Smith's Mill. A project in 1922 had previously authorized a channel 2 miles further inland to Millington on Isthmus Slough. This channel work was completed by 1937. In 1940 and 1942 the north and south jetties were reconstructed.

The important River and Harbor Act of 1946 increased all project dimensions at Coos Bay. The depth over the bar at the entrance was to be dredged to 40 feet, decreasing to 30 feet at Guano Rock at about mile 1. This was completed in 1952. The navigation channel from Guano Rock at the entrance to the mouth of Isthmus Slough about 15 miles away was improved to 30 feet deep and generally 300 feet wide. A large turning basin at North Bend (mile 12) and improvement of the basin at Coalbank Slough were also provided by the 1946 Act.

In addition, the 1946 Act provided two 30-feet deep, 600-feet wide and 2,000-feet long anchoring basins at mile 3.5 and mile 7. Work on the channel and the basins was completed in 1951. A 10-foot deep, 150-foot wide channel from the main channel to Charleston was built in 1956, together with a small boat basin. Charleston is at the mouth of South Slough southwest of the entrance to Coos Bay. Rehabilitation of the south jetty was completed in 1963. In the more than ninety years since Corps of Engineers work began at Coos Bay, the Portland District has spent over $27 million on improvements.

The existing south jetty at Coos Bay has a concrete-reinforced core about 35 feet wide. It is about 80 feet wide at the land end base, and tapers to about 140 feet wide at the seaward base. From mean lower low water, the south jetty ranges from 16 to 24 feet high, the higher elevations being at the seaward end. The north jetty is narrower but somewhat higher than the south jetty. The north jetty has a stone, rather than a concrete core. All stones in the jetty are carefully placed according to shape and weight so as to best withstand the action of the sea. Portland District hopper dredges remove material which the scouring effect of the jetties is unable to remove.
1928 photograph of mouth of Rogue River at Gold Beach, Oregon before work done by the Portland District. The river is almost completely obstructed by sand.
(Photo by Brubaker Aerial Surveys, Portland).
Until 1948, the Coos and Millicoma Rivers had been maintained to 3-foot depths about 13 miles upstream from Coos Bay. The River and Harbor Act of 1948 authorized improvement of the depth of about 2/3 of the project to 5 feet. This was eventually performed by 1966. Over $350,000 has been spent on these rivers since work began in 1896.

The Coquille River flows into the Pacific Ocean at Bandon, Oregon 225 miles south of the mouth of the Columbia River. A small project here has improved the mouth of the Coquille for over seventy years. Previous projects had provided a safe entrance channel by means of 2 rubble-mound high tide jetties 600 feet apart, and by dredging.

The River and Harbor Act of March, 1945 provided for snagging up the Coquille River to the town of Coquille, about 24 miles from the mouth. In 1951 a 750-foot extension to the easterly end of the north jetty was constructed. Repairs were completed on the south jetty in 1954 and on the north jetty in 1956. In 1967 controlling depths at the project were 9 feet over the bar and 13 feet in the inner channel. About $2.5 million has been spent for improvements to the Coquille River since the first work in 1878.

Port Orford is about 250 miles south of the mouth of the Columbia River. The River and Harbor Act of 1965 authorized the Corps of Engineers to do the necessary work to extend the existing privately constructed breakwater by 550 feet. The purpose of the breakwater was to protect shore installations and craft from winter storms. Piers and wharves constructed in 1934 had to be reconstructed five times following nearly complete destruction by winter storms from the southwest. Many boats were damaged or lost. Design plans for the breakwater were completed in 1967. The extension was completed in October 1968 at a cost of $758,692.

Portland District Engineers had early recognized Port Orford as a possible site for a harbor of refuge. Major Robert investigated Port Orford in 1873. Major Wilson recommended the project in 1878, and Captain Fisk did likewise in 1898. There is a natural deep-water entrance into Port Orford, and it enjoys a fairly central location between Northwest ports and California. The harbor is an open roadstead protected from the north and west by a bold headland 300 feet high which extends seaward for about 1 mile. Lumber and plywood, and salmon and crab fishing are the main commercial activities of Port Orford, a town of about 2,000.

The Rogue River rises in the Cascade Range in southwestern Oregon, flows westerly through the Coast Range and empties into the Pacific Ocean 264 miles south of the mouth of the Columbia River. Work had been considered for the Rogue River by Major Williamson even before the Portland District had been founded in 1871. Cost of improvement and lack of significant benefits to the Valley ruled out any substantial work by the Portland District for over 80 years.
Jetties completed by the Portland District at the mouth of the Rogue River in 1960 make passage to and from the sea safe and quick.
The River and Harbor Act of 1954 provided for the improvement of the Rogue River at Gold Beach, Oregon by construction of 2 jetties at the entrance. Also provided was a channel 13 feet deep and 300 feet wide leading from the ocean to a turning basin 13 feet deep, 500 feet wide and 650 feet long. The turning basin was to be just below the highway 101 bridge.

Construction of the south jetty was completed in October 1959, and the north jetty was completed in September 1960. About 680,000 tons of stone was placed in the jetties. Dredging of the channel, the turning basin and the entrance bar was completed in October 1961. The north jetty was considerably damaged by the flood of 1964. Repair work on the north jetty was completed in 1966. By 1969, about $5.4 million had been spent for work on the Rogue River, begun in 1954.

The tenth project undertaken by the Portland District on the Oregon coast is at the mouth of the Chetco River at Brookings, Oregon. The Chetco River is 300 miles below the mouth of the Columbia, and about 10 miles north of the California border.

The River and Harbor Act of 1945 authorized construction of two small jetties at the mouth of the Chetco River. These were completed by 1957 at a cost of roughly $490,000. Removal of rock pinnacles and an abandoned bridge structure was accomplished in 1959. Repairs were made to the south jetty in 1962.

The 1965 River and Harbor Act modified the project by authorizing a 450-foot extension to the north jetty, and increasing its existing elevation to 18 feet. This would help produce project depths of 14 feet and a width of 120 feet. Also provided was construction of a barge turning basin 14 feet deep, 750 feet wide and 650 feet long to be enclosed by a protective dike 18 feet high and 1,800 feet long. A small boat basin, barge slip and spoil deposit areas were provided by local interests.

By June 1969, work on the north jetty and dredging the entrance channel was completed. Plans for the turning basin, small boat access channel, and the protective dike have all been completed. Contracts for this work will be awarded in 1970. About $1.8 million has been spent at the Chetco River.

Two small projects are on the Salmon and Smith rivers.

The mouth of the Salmon River is located at Cascade Head, south of Nesowdin, Oregon. The River and Harbor Act of 1945 provided for the removal of dangerous rocks just inside the mouth of the river. The precise location of this $2,145 project is "3 Rox, Oregon" at the Tillamook and Lincoln County lines.
Work on the Smith River provides a navigation channel. The River and Harbor Act of 1948 authorized a channel 6 feet deep and 100 feet wide from the mouth to the mouth of North Fork, then 4 feet deep and 75 feet wide to Sulphur Springs Landing. A passing place 125 feet wide and 800 feet long was provided at North Fork, mile 16 upstream. Overall length of the project is 20 miles. It was completed in February 1957 after about 6 months work and an expenditure of $143,720. The Smith River empties into the Umpqua near its mouth at Reedsport, Oregon. Since its completion, much of the project has not been maintained.
The 25 years which have elapsed since the conclusion of World War II have been a period of great progress in the development of the Columbia River Basin. Tremendous benefits in power, flood control, navigation, and irrigation have resulted from federal dam construction on the Columbia, Snake and Willamette Rivers. Portland District projects on the Willamette River are discussed in chapter 19. The multiple-purpose dams on the Lower Snake which were started by the Portland District, plus the huge dams on the Columbia will be discussed here.

A.

The efforts devoted to taming the waters of the Columbia River have been one of the most dramatic and successful chapters in American natural resource policy.

Public discussion of this question occasionally flounders on the controversy of public versus private ownership. This is not the most important issue. The fundamental goal of federal water resource policy in the Pacific Northwest has been the development of the economy of a large region of the United States. The potential to achieve that goal lay in the fact that the Columbia River is the chief economic asset of the Pacific Northwest. Thus, the primary question was how to most wisely and efficiently use the Columbia River so as to benefit the Northwest.

The federal Columbia River program amounts to a national investment by the United States in the Pacific Northwest. This investment creates public capital goods which fully pay back the government both directly and indirectly. The direct payments are in the form of power revenues. These cover the cost of the dams, the construction and marketing
activities of the Bonneville Power Administration, and a portion of irri-
gation costs. The indirect repayments to the United States consist of a
region better able to contribute to the nation in terms of taxes, goods
and services, and economic aggregate demand. The nation and the region
are each strengthened.

Why was the federal government the entity which undertook this
investment? The primary reason is because the federal government was
better suited to develop the Columbia River in a comprehensive and
multiple-purpose manner than any other organization or agency.

Irrigation, for instance, would be one of the great benefits of
Columbia River development. Yet the reclamation of several millions of
acres in southern Idaho and eastern Oregon and Washington is simply not
a feasible business undertaking. While farmers are charged a reasonable
rate for irrigation water, Northwest reclamation projects depend in large
part -- about 80 percent -- on federal power revenues to finance project
costs. A tremendous irrigation effort like the Columbia Basin project in
eastern Washington would not produce a return to a business organization
in the form of profits. But it would produce a substantial and tangible
return to the nation generally and to the federal government by transform-
ing an arid wasteland into a rich agricultural area. Such natural
resource activities are among the basic functions of government.

Another example of the unique capability of the federal government
to develop the Columbia River is electric power marketing policy. Energy
costs are basic factors in industrial and economic decision-making. A
national policy of diversifying, decentralizing, strengthening and sta-
bilizing the economy of the Pacific Northwest would be directly served by
making available to electro-process and other industries low-cost,
interruptible power. The establishment of many large metal and chemical
concerns in the Pacific Northwest has been the result of this policy.

The regional asset of cheap power tends to counteract the regional
liability of an adverse freight and transportation position. Electric
power and aluminum are basic components of national security. Electric
power from federal dams would provide Northwesterners with the lowest
household rates in the nation. A regional transmission grid would offer
the most reliable service. In these and other ways, the accumulation of
electric power in a federal agency would provide the national government
with a very effective tool by which broad policy objectives could be
achieved.

In addition to the nature of the "return" or benefits resulting from
the most comprehensive development of "the River" are several other
factors which required federal responsibility. One of these was the large
cost involved. Over $4 billion has been spent to develop the Columbia
River. No state or other organization in the Northwest was capable of
such a large financial undertaking.
WATER RESOURCE DEVELOPMENT
NORTH PACIFIC DIVISION

LEGEND
- PROJECT EXISTING OR UNDER CONSTRUCTION
- AUTHORIZED OR LICENSED PROJECT
- RECOMMENDED PROJECT
- PROJECT UNDER STUDY
- NATURAL LAKE WITH STORAGE CONTROL
  - ARMY
  - BUREAU
  - NON-FEDERAL
Another factor was the need for integrated operation. Flood control capacity, irrigation systems, hydroelectric energy, navigation and fish facilities all depend upon exactly the same sources of water for their successful operation. This involves complex calculations and evaluations at not merely one dam, but for all the dams on the Columbia and Snake River system working in concert. The storage or release of water at one dam is geared to all uses of the water, plus the capabilities of projects downstream. Unified management and control optimizes the benefits available from the Columbia River.

Finally, navigable rivers have traditionally been considered part of the public domain. No individual can own a river in the United States. This is the result of policies developed early in the Nineteenth century. Rivers are held in trust for the public by the national government. Practices relating to the use and development of navigable waterways must be consistent with the policy which requires wide use and maximum public benefit.

B.

The Walla Walla District, U. S. Army Corps of Engineers was established November 1, 1948 by General Order of the Chief of Engineers. The first District Engineer of the Walla Walla District was Colonel William Whipple. Until the establishment of the Walla Walla District, the Portland District had responsibility for improvements on the Snake River, and on the Columbia River as far upstream as the mouth of the Snake.

Section 6 of the River and Harbor Act of 1935 authorized the Chief of Engineers to supplement the surveys made pursuant to House Document 308 by such additional studies as might be necessary, in light of changing conditions.

A resolution by the Commerce Committee of the United States Senate the following year requested a review of the previously submitted report on the Snake River to determine if any projects were advisable upstream as far as Lewiston, Idaho.

These studies were completed by June 1937 by the North Pacific Division and the Portland District. The war effort precluded any further action until the River and Harbor Act of 1945. This legislation authorized the construction of "such dams as are necessary" consistent with the plan submitted in 1937 by the Corps of Engineers.

Four dams were authorized for the Lower Snake:
Estimated Cost (millions)

<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th>Cost (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice Harbor</td>
<td>mile 10</td>
<td>$87.7</td>
</tr>
<tr>
<td>Lower Monumental</td>
<td>mile 42</td>
<td>$79.9</td>
</tr>
<tr>
<td>Little Goose</td>
<td>mile 70</td>
<td>$81.6</td>
</tr>
<tr>
<td>Lower Granite</td>
<td>mile 108</td>
<td>$82.2</td>
</tr>
</tbody>
</table>

Each would have navigation locks 675 feet long, 86 feet wide and 15 feet over the sill. Hydroelectric power generated at these facilities would total 1,485,000 kilowatts from initial construction, with expansion up to 3,033,000 kilowatts. Irrigation would be helped in several ways. Besides increased availability of water, low-cost electricity would power the pumping systems. With water in the slackwater pools at higher elevation than previously, irrigation pumping would be easier.

The necessary surveys and studies for selection of these four dam sites were made by the Portland District. At Ice Harbor, the District conducted over 85 percent of the field exploration. This consisted of core and churn drilling, to test foundations, and also test pit digging. About 30 percent of the planning and design specifications for Ice Harbor Dam was performed by the Portland District. A model of the project was made at the District Hydraulic Laboratory at Bonneville Dam.

At Lower Monumental Dam a topographic survey of the site was completed and a hydrographic survey was conducted during the 1948 spring freshet. Project reports on real estate purchase requirements, railroad and highway relocation, and water flow were prepared by the Portland District for Ice Harbor and Lower Monumental dams. $356,000 was spent for actual work at Ice Harbor and Lower Monumental, and $500,000 for land and damages (eminent domain) at all four projects.

The previous channel project would be eliminated by the navigation pools provided by the four dams, except that portion reaching to Johnson's Bar above Lewiston. This would be maintained to 5 foot depths. Up to 1948, the Portland District had spent about $281,000 for open rivers improvements on the Lower Snake. This figure excludes $85,000 allotted to the Corps by the Washington State Legislature in 1907 for the same purpose.

The Walla Walla District completed construction of Ice Harbor Dam in 1962. Lower Monumental and Little Goose are scheduled for completion in 1970, and Lower Granite in 1974. "Slippages" in these completion schedules have been caused by inadequate federal appropriations. Fish passage facilities will be installed at each project. Total construction costs have doubled from the original estimates, made 25 years ago.

Umatilla Dam was also authorized by the March 1945 River and Harbor Act. The name of this project was changed to McNary Dam by Congress to honor U. S. Senator Charles L. McNary of Oregon.
This was the third federal dam constructed on the Columbia River. McNary Dam was planned to sit at the upstream end of The Dalles Dam reservoir -- the latter a project to be started by the Portland District in 1952. Located 292 miles from the mouth of the Columbia River, the foundation of McNary Dam rests on a massive basalt flow that reaches a thickness of up to 130 feet.

Considerable work was performed by the Portland District during the 18-month period before the Walla Walla District was established. Construction of McNary Dam started in May 1947. Temporary dormitory facilities, 162 temporary family quarters on the Oregon side, and 53 temporary family quarters on the Washington side were constructed. A warehouse, motor and machine repair shops, and field office buildings were built for the initial phase work. Access roads on each side of the river were finished, and a ferry transportation system began hauling loads back and forth across the Columbia.

The north shore section of the cofferdam, consisting of 26 steel, sheet-pile circular cells filled with gravel, was completed in May 1948. That part of the cofferdam was designed to keep Columbia River water out of the navigation lock and fishway construction areas, and away from about two-thirds of the spillway dam work.

The great flood of June 1948 caused severe overtopping at the cofferdam. The cofferdam floodgate was opened on the morning of May 26. By the evening of the next day the structure was overtopped. The McNary flood crest of 980,000 c.f.s. was reached on May 30. Until June 14, flood waters remained above 900,000 c.f.s. By November 1948 excavation for the navigation lock and about one-half of the approach channel was finished.

Surveys for the 42 miles of Spokane, Portland and Seattle railroad track relocation were nearly completed. Contracts were awarded for clearing and construction of part of the new tracks. Surveys for the relocation of Union Pacific Railroad and for Oregon and Washington highways were also made.

Bids for the first four turbines and generators were opened in June 1948, and contracts awarded. Design specification for the four generators were completed. Powerhouse designs were nearly 50 percent complete.

Included in plans for the McNary project was a navigation lock 675 feet long, 86 feet wide, with a maximum lift of 92 feet. The slackwater navigation pool behind McNary would extend 64 miles to the foot of Ice Harbor Dam, providing inland navigation to the ports of Walla Walla, Pasco, Kennewick and Richland in Washington State. The pool would eliminate part of the old 7-foot deep, 180-foot wide navigation channel between Celilo Falls and Wallula. The old project had also removed obstructions from Wallula to Kennewick, immediately upstream from the mouth of the Snake.
Fish facilities similar to those existing at Bonneville Dam were planned for McNary.

The McNary Dam powerhouse, containing 14 units of 70,000 kilowatts each, has a generating capacity of 980,000 kilowatts -- nearly twice that of Bonneville Dam.

The Walla Walla District completed McNary Dam in 1953, when the navigation lock was put in service, and the first power went on the line. President Eisenhower dedicated the huge structure. The last generating unit was installed in 1957. Revenue from sales of McNary Dam power up to 1968 by the Bonneville Power Administration have returned $130,000,000 to the United States Treasury. Irrigation -- chiefly because of diminished pump lift load -- and recreation are direct, additional benefits at McNary Dam. Total cost of the project was $295 million.

C.

Preparations for post-war construction on the Columbia River were quickened by the flood of June 1948.

The greatest flood of record on the Columbia River was in 1894. It was caused by a quick-melting heavy snowpack augmented by heavy rains. This is the basic cause of flood stage runoff in the Columbia River, occurring in May or June. Peak discharge measured at The Dalles was 1,240,000 cfs (cubic feet per second). In 1876 flood waters reached 1,020,000 cfs. By comparison, the maximum flood of record on the Missouri River is less than 700,000 cfs.

Usually the amount of water which passes down the Columbia River during a calendar year does not vary a great deal -- about 180 million acre feet minus about 10 million acre feet consumed by irrigation use. A flood occurs when weather conditions concentrate the runoff in a short period of time.

The 1948 flood fits this pattern. Unusually heavy snows lay on the Rocky Mountains after the winter of 1947-48. Weather conditions in April, May and the first half of June combined with heavy snowpack to cause the flood. Temperatures in the first half of that period were below normal. In the second half, temperatures were considerably above normal. In the critical period of the last half of May and the first half of June, precipitation was quite heavy.

The result was a tremendous volume of water pouring off the mountains into the streams and rivers which feed the Columbia. The Kootenai, Clark Fork, Clearwater and the Snake were the worst offenders. By the
This view shows damage caused by the 1948 flood looking northeast from the Oregon shore. Interstate Bridge is in upper left. Note water level on roller coaster at Jantzen Beach Park, and on the sternwheel steamboat approaching the Interstate Bridge. Extreme upper left shows damage at Vancouver shipyards and Pearson airport. Foreground shows damage on Oregon shore.
time highest flood waters reached the gaging stations at The Dalles, over one million cfs were roaring downstream to the lower Columbia area. For nearly three weeks the water flow was not less than 900,000 cfs. Average annual peak or maximum discharge on the Columbia River is usually about 650,000 cfs.

Flood protection works on the Columbia River below the mouth of the Yakima were inadequate to control the flood. 3,500 feet of levees existed at Umatilla, Oregon, constructed by local interests. A similar but smaller project existed at Bingen, Washington. The Corps had built two miles of levee and had installed pumping apparatus at The Dalles. 1,600 feet of levee, 500 feet of concrete flood wall, 800 feet of bank protection, and four pumps were built by the Portland District at Hood River, Oregon.

Between the mouth of the Sandy River and the Pacific Ocean were 61 projects, over two-thirds of which were on the Oregon side. Most of these were built cooperatively by the Corps and local drainage and diking districts. The work included levees, flood walls, revetments, bulkheads, drainage canals and ditches, pumping plants and tide gates. These were designed to protect 72,000 persons and about 97,000 acres of land. A substantial concrete harbor wall, about one mile long on the west side of the Willamette River protected the Portland commercial area from Columbia River backwater. Flood stages from rivers on the Cascade and Coast ranges leading to the Willamette occur in December or January.

The main flood plain area on the Columbia River lies below Bonneville Dam. It consists of a series of low, flat areas generally three to four miles wide and five to ten miles long, separated by sloughs or minor tributaries entering the main channel.

The flow of the Columbia River progressed in normal fashion until May 19 when an unusually large daily rise occurred. This continued until May 23 when runoff assumed proportions of a major flood. The next day the Portland District Engineer notified the Chief of Engineers that The Dalles-Celilo Canal was inundated. Three days later the McNary cofferdam was overtopped.

By May 27 a lower levee at Clatskanie had been overtopped, railroad travel was hampered, and drainage and diking districts notified the District that they were faced with seeping, clogged drains and sand boils. The District Engineer issued instructions for patrolling and maintaining levees. Sandbagging and evacuation operations commenced. District employees were dispatched to over 25 locations to act as supervisors. The resident engineer at Big Eddy helped direct the flood fight for the city of The Dalles.

By May 28 the upstream face of the powerhouse at Bonneville Dam was clogged with drift and debris. The Camas city dock was in danger of washing away. Evacuation activities by the State police, Red Cross and
Damage caused by flood waters in Portland is shown in this photo looking north to Union Station.
municipal organizations was stepped up. The Portland District Government Moorings were evacuated. River stage, on the Vancouver gage, was 25.4 feet. Highway 30 was blocked off near The Dalles. Troops arrived at Vancouver Barracks from Fort Lewis to be of assistance. Weekend holidays were cancelled for employees of the Division and District Corps of Engineers offices in Portland. Thirteen persons had by now lost their lives.

By May 29 water had risen an additional 1 1/2 feet at Vancouver, and was predicted to rise four more feet. That would be over the top of the 29-foot levees by two feet. Additional roads and communication systems along the river were put out of service. Evacuation operations in many places were further increased. Sandbags were sent to Cathlamet for emergency protection. Additional Corps of Engineers personnel were assigned for patrol and supervisory duty at flood scenes and protection works.

The National Guard was mobilized in the Pasco-Richland-Kennewick area. Highways on the Washington shore were undermined between Bingen and Camas. Industrial and utility properties were reported flooded. Some looting was reported and National Guard units were assigned to police duty. Sandbags by the tens of thousands were shipped to danger spots. The shipyards and airport in Vancouver were under water. More troops arrived from Fort Lewis.

Water continued to rise through the night of May 29 and conditions worsened. The flood reached its peak at The Dalles on the night of May 29 -- at 1,010,000 cfs. Twelve days later the river would still not once have dipped below 900,000 cfs.

On May 30, Front Avenue in Portland was under six inches of water in several locations. Many hundreds of citizens and soldiers were frantically building up levees at locations throughout the lower Columbia area. Many bridges were closed except for emergency traffic. Trucks, bulldozers, and medical supplies were shipped into Portland. Seepage problems on many dikes and levees were becoming a serious problem, weakening the structures.

Then disaster struck a housing project located at Vanport, Oregon. It was extremely fortunate that loss of life was not a hundred times greater than it was. At about 4:00 p.m. the Seattle, Portland & Spokane-Union Pacific Railroad fill, which served as a protective dike, failed with water several feet from its top. Water levels inside the dike were at times 25 feet lower than the level outside.

Within minutes the breach had widened to about 600 feet. Within two hours 10-20 feet of debris-laden water completely inundated Vanport, a city of 18,700. While loss of public and private property was almost total, only 18 persons were killed. The tragedy occurred in the late afternoon of a Memorial Day Sunday. If it had happened at night during the week, loss of life would have been very high.
Looking northwest from the Oregon shore with the interstate railroad bridge in the upper right, this photograph shows the Vanport disaster. Upper center shows where railroad fill washed out and caused failure.
For the next 14 days the flood situation in the Lower Columbia River grew worse, although water levels declined somewhat from the May 29 peak. Constant, prolonged pressure on levees and dikes was threatening several areas. The Reynolds Aluminum plant at Troutdale was in considerable danger. The prospect of another Vanport was a sobering thought. Hundreds of additional troops arrived in the area. The Navy sent in men and equipment. Over one hundred thousand sandbags were issued each day. Portland District personnel advised all residents living behind dikes to move out immediately. Northern sections of Denver and Union avenues in Portland were under water.

During the next 14 days, several dikes, roadways and levees failed or were overtopped. A count on June 7 showed over 2,000 non Portland-area military personnel were fighting the flood. Twenty-five Corps of Engineers officers were dispatched from Fort Belvoir, Virginia to help. Thousands of civilians were on patrol and work shifts.

Rains on June 12 complicated flood-fight efforts. That night highest flood levels were reached at Longview, and all protection works held. Two days later, conditions began to improve. By June 17 demobilization and cleanup operations commenced. On June 23 the water was at safe levels and the flood was over.

The flood of June 1948 was the greatest single disaster in the history of the Columbia River Basin. The 20-day flood took lives of 32 persons in the Portland District; 7 others were never found. A city with a population of over 18,000 was completely destroyed. 50,000 people were forced to leave their homes; nearly 5,000 homes were destroyed. Suffering, hardship, social and economic dislocation, disease, and simple waste lay in the path of the powerful flood. 100,000 acres of intensively developed agricultural land were eroded. 15,000 acres of highly developed commercial, industrial or urban areas flooded, including 650 blocks of Portland. Measurable economic loss exceeded $100 million.

A resolution by the Commerce Committee of the United States Senate in April of 1943 had directed the Corps of Engineers to review in comprehensive fashion the existing "308" reports of the Columbia River Basin. While the Columbia was still at high flood stage in June 1948, President Truman ordered the plans of all federal agencies for development of the Columbia River to be coordinated and expedited. The Corps worked closely with the Bonneville Power Administration and the Bureau of Reclamation. By October 1948 the review was completed by the North Pacific Division and the Portland District. The plan was published by Congress in eight large volumes as House Document 531 in March 1950, after approval by the Chief of Engineers. A principal feature of the massive study was the Main Control Plan to provide flood control, electric power generation, navigation, irrigation capacity and other important purposes. The projects recommended in HD 531 were authorized by the River and Harbor and Flood Control Act of 1950.
In the period from 1858 to 1948, 12 floods with unregulated peak discharges have exceeded 800,000 cfs. The basic goal of House Document 531 was to control an 1894 project flood to 800,000 cfs measured at The Dalles. The 1894 flood of 1,240,000 cfs was the greatest flood of record. An 800,000 cfs flood would result in 27 foot stages at Vancouver.

Flood control was to be provided by two means. First was a system of upstream reservoirs to catch and confine flood runoff so as to reduce downstream peak discharge. About 21 million acre-feet of usable storage was to be provided by a series of nine new dams throughout the Columbia River Basin, and by modifications and additions to outlets at Grand Coulee Dam. The latter would allow Lake Roosevelt to be lowered more quickly to provide additional storage space. Of these projects, only John Day Dam was within the Portland District. As eventually built, its flood control contribution was 500,000 acre feet of usable storage.

The second component of the Main Control flood control plan was levee construction. This would confine flood waters up to 800,000 cfs within river channels. Twenty-six projects were approved to raise, strengthen, or extend existing levees. Additional levees, dikes, flood walls, revetments, and drainage facilities were recommended for six unprotected locations at Washougal, Camas, Vancouver and Kalama, Washington. 66 locations on the lower Columbia River flood plain were scheduled for bank protection. All of this work was located within the Portland District.

Some of the storage projects recommended in House Document 531 were not built. Others were built with different specifications. Others were built by private entities with greatly diminished flood control capacity, most notably the Hells Canyon Dam built by the Idaho Power Company on the Snake River. About 1.5 million acre-feet less flood control capacity resulted from this private development.

The effect of these changes in House Document 531 was that in the late 1950's only about 10.5 million acre-feet were built or under construction. This was about one-half of the capacity originally planned. This would control an 1894 project flood to only 1,030,000 cfs. To provide a greater margin of safety until additional authorized storage reservoirs could be constructed, levee construction on the lower Columbia was redesigned to protect against 940,000 cfs on an interim basis. Construction of authorized projects not then under construction would reduce an 1894 flood peak to 940,000 cfs. This approach was approved by the River and Harbor and Flood Control Act of 1962. Cost of the levee work under the 1950 Act, as modified in 1962, would be about $30 million.
The Dalles Dam, located on the Columbia River near The Dalles, Oregon, was completed in 1959 at a cost of over $247 million.
The Main Control Plan of House Document 531, as authorized by the River and Harbor and Flood Control Act of 1950, also authorized construction of The Dalles Dam -- the largest project ever built by the Portland District.

Justification for the project lay in several factors. The power which the dam would generate would help meet the rapidly growing electric loads in the region. Loads served by all utilities in the Northwest from 1937 to 1946 had tripled. Studies showed generating capacity would have to triple to meet a similar increase in load in the period 1947-1960. Large industrial customers of Bonneville Power Administration were consuming power as fast as they could obtain it. The industrial development of the region depended upon continued availability of low-cost electricity. Northwest homeowners were using considerably more electricity than the per capita average elsewhere in the nation. Greater sales of electric power would be a boost to the Columbia Basin irrigation project.

A navigation lock at The Dalles Dam would replace the small, outmoded The Dalles-Celilo Canal. Barge transportation was particularly hampered by the inadequate canal. Increased size of tows and minimal delays would result from a navigation lock at The Dalles Dam.

The slackwater pool behind the dam would help connect similar navigation waterways provided by Bonneville Dam and McNary Dam. It would also flood the numerous rock obstructions in the old open river channel.

Approximately 60,000 acres of land suitable for irrigation lay adjacent to the proposed reservoir. Water supply plus a pump lift diminished by about 88 feet would make irrigation of this area feasible.

Indian fishing rights at Celilo Falls were an important factor in The Dalles Dam project. Under treaties negotiated with the United States in 1855, the Yakima Nation and the Confederate Tribes, the Umatilla Tribes, and the Warm Springs Indians retained the rights of taking fish from streams within or bordering their reservations, and also the right to take fish at all other usual and accustomed places in common with the citizens of the territory, and to erect temporary buildings for curing fish. The three tribes had intermarried extensively and had, in turn, intermarried with Celilo, Cascade, Klickitat and Wasco Indians.

Construction of the dam would inundate the unique and ancient fishing grounds at and near Celilo Falls, villages at Celilo, Oregon and Spearfish, Washington, and other Indian lands. Over 5,000 Indians fished at Celilo Falls, in much the same manner as their ancestors. Tied to a primitive wooden platform, an Indian armed with a net or a spear could pull large numbers of fish from the roaring falls. The fish were caught primarily for subsistence, but also for commercial purposes.
The eventual settlement with the federal government awarded $23.5 million to Yakima, Umatilla, Warm Springs and Nez Perce Indians. The Yakima's were the largest and most active group; the Nez Perce the smallest. About $4,000 was distributed to each Indian. Walla Walla attorney Charles F. Luce, later to become Bonneville Power Administrator and Interior Under Secretary, was counsel for the Umatilla Indians.

Construction on the project started in February 1952. The work was broken down into seven prime contracts providing for the spillway dam, the navigation lock, non-overflow structures, fish passage facilities, the powerhouse substructure and superstructure, the closure dam and appurtenant work, and the installation of mechanized electrical equipment in the powerhouse.

By late summer in 1953 the cofferdam was completed, and excavation for the powerhouse was finished. Relocation plans for the Union Pacific Railroad and Highway 30 on the Oregon shore were also completed. By December the first concrete had been poured at the spillway and at the powerhouse.

Work on the navigation lock started in September 1954. Its dimensions were 675 feet long, 86 feet wide and 15 feet in depth over the sills, with a maximum lift of 87.5 feet. Construction on the spillway section, powerhouse and adjacent fish facilities ran ahead of schedule in 1955.

January 1956 saw the completion of the powerhouse substructure for generating units 1-14. In April the 1,380 foot long spillway section was completed with its twenty-three 50 foot wide, 43 foot high radial gates. The spillway dam was designed to pass a flood of 2,290,000 cfs. In June 1956 the powerhouse substructure for the last generating units, 15-22, was completed. By late summer 1956 the overall project was 60 percent completed.

By 1957 railroads were operating on the relocated lines. Most highway and bridge relocation work had also been finished. The nonoverflow structure was finished. Work on the concrete and steel foundations for the turbines and generators in the powerhouse was begun. Fish facilities were operating.

The river closure dam was completed by March 9, 1957, and the pool began to form behind the dam. One week later the navigation lock was opened. Normal pool level of 160 feet mean sea level was accomplished by July 15. The powerhouse superstructure for units 1-14 was 91 percent complete at the end of fiscal year 1957. By September 25, 1957 power from unit #1 had been put on the line. Unit #2 went on the line on October 31.

During fiscal year 1958, 1,225,031,000 kilowatt-hours of electricity were delivered to the Bonneville Power Administration. Units #3 and #4
The Dalles Dam has fourteen 78,000 kw generators installed, and has an authorized maximum capacity for eight additional units of 86,000 kw each. This will total 1,780,000 kw, or about 3½ times the capacity of Bonneville Dam.
Pleasure craft as well as commercial vessels pass through the lock at The Dalles Dam.
were in operation by April 1958. The superstructure for Units 1-14 was completed in September. The remaining ten units were scheduled to be installed in three month intervals. The project was about 90 percent complete by late summer 1958.

By 1959 all major structures were complete. Operations offices were being built, as well as fencing, lighting, roadways, and landscaping. About 3.4 billion kilowatt-hours of energy were delivered to the Bonneville Power Administration in fiscal year 1959. Over 200,000 persons visited the project.

When completed, the 8,700 foot long The Dalles Dam would contain 14 generating units of 78,000 kw each. The powerhouse substructure was completed to eventually hold eight additional units of 86,000 kw for a total of 1,780,000 kw capacity. The additional units are increasingly beneficial as new upstream storage reservoirs can improve minimum assured flows. Each new generator will need about 18,000 cfs to operate effectively.

The Dalles Dam was formally dedicated by Vice President Richard M. Nixon on a cold October 10, 1959. Chief of Engineers Lieutenant General Emerson C. Itschner was in attendance, plus the Governors of Oregon and Washington and several U. S. Senators. Representing the Portland District was District Engineer, Colonel Walter L. Winegar. Total cost of the huge project was $247 million.

E.

John Day Dam is situated on the Columbia River at the boundary between the Walla Walla District and the Portland District. The Walla Walla District built the project, but it is operated by the Portland District.

Like The Dalles Dam, John Day was originally authorized by the River and Harbor and Flood Control Act of 1950, in accordance with recommendations in House Document 531. A review of that authorization, however, was ordered by the Senate Committee on Public Works in 1953. Published two years later, the review resulted in recommendations to decrease the flood control storage at John Day from 2,000,000 acre feet to about 500,000 acre feet of usable storage and to greatly increase the power generating installation. This revised plan for John Day Dam was approved by the Board of Engineers for Rivers and Harbors in January 1956, and submitted to the Congress eight months later. The modified project was approved by Congress.

Construction began in June 1958. The lock at John Day was to have a maximum lift of 113 feet -- the highest single-lift lock in the world.
The Portland District operates John Day Lock and Dam, 26 miles upstream from The Dalles Dam on Columbia River.

Fish passage facilities at John Day
The slackwater pool extends upstream 75 miles to McNary Dam, greatly benefitting navigation. Petroleum products and fertilizers are the chief imports; grains the predominant export on this part of the Columbia River.

The powerhouse contains sixteen 135,000 kw generating units which will produce 2,160,000 kw. This is greater than existing Grand Coulee Dam capacity. Only one dam in the world is bigger -- Krasnoyarsk Dam in Russia. When the third powerhouse and other generation is built at Grand Coulee, it will be by far the greatest power dam in the world at 9.2 million kw.

Ultimately 20 units will be in the John Day Dam powerhouse for a total of 2,700,000 kw. As at The Dalles Dam, the additional units will be installed when upstream projects have been completed to the extent that increased river flows warrant installation. Operating on overload situations, John Day can then produce 3,105,000 kw. This is over three times the capacity of McNary Dam, and about six times the capacity of Bonneville Dam. First power went on the line from John Day in July 1968.

Over a mile wide straight across, John Day Lock and Dam was dedicated to the public on a beautiful September 28, 1968 by Vice President Hubert H. Humphrey. Chief of Engineers, Lieutenant General William F. Cassidy, who 30 years previous was working as a Corps of Engineers Lieutenant on the Bonneville project, spoke briefly to the large crowd. Senator Henry M. Jackson of Washington, a key individual in the development of the Columbia River, also addressed the crowd. Portland District Engineer, Colonel Robert L. Bangert, participated in the ceremonies. Total cost of the project was over $448 million.

F.

The work on the four projects on the Lower Snake, starting McNary Dam, the construction of Bonneville and The Dalles Dams, and the operation of John Day Dam constitute the role of the Portland District in the multiple purpose development of the Columbia River Basin.

In the roughly thirty-five years since the work started at Bonneville, the Columbia has been transformed from an untamed and, at times, destructive river to the economic base of the Pacific Northwest. Like other developing agencies in the region, this is the context into which the essential work of the Portland District ultimately fits.
Shown here are the major dams of the Columbia River and its tributaries, including the three Canadian Treaty dams and Libby Dam.
The lower Columbia River flood control efforts of the Portland District are part of a basin wide program. This program was greatly advanced in September 1964 when the Columbia River Development Treaty with Canada was consummated. The Treaty provides that Canada build three dams -- Mica, Duncan and Arrow -- and that the Corps of Engineer's Seattle District build one -- Libby Dam on the Kootenai in northwest Montana -- to produce about 20 million acre feet of usable storage. The name of Arrow has since been changed to Keenlyside Dam in honor of Dr. Hugh L. Keenlyside, for many years the Chairman of the Canadian operating entity under the Treaty. The storage capacity is divided between flood control and power purposes.

The storage provided by the four Canadian Treaty dams, plus two million acre feet at Dworshak Dam, built on the North Fork Clearwater in Idaho by the Walla Walla District, will greatly reduce flood threats on the Columbia River. Canada has been paid $64 million by the federal government for flood control benefits which accrue to the United States.

Flood control projects previously constructed by the Corps in accord with the 1950 and 1962 River and Harbor and Flood Control Acts can reduce an 1894 flood of 1,240,000 cfs to 940,000 cfs. Flood stages at Vancouver would be reduced from 37 feet to 31 feet by this work. The Canadian Treaty dams, plus Dworshak, will further control an 1894 flood to 720,000 cfs, and 26.5 foot stage at Vancouver. Given the present level of flood plain development on the lower Columbia, these projects will offer excellent flood protection. All five projects should be operating by 1974.

The Canadian Treaty dams will provide tremendous electric power benefits. The Columbia River has an annual run-off of about 180 million acre-feet. The physical control over the river represented by the 20 million acre-feet provided by Canadian Treaty storage allows the assured minimum flow of the Columbia to be increased. Translated into kilowatts, this improved flow will provide an additional 2.8 million kw at existing downstream generating facilities on the Columbia River. 2.8 million kw capacity is the equivalent to more than five Bonneville Dams. The 2.8 million kw figure does not include the 1,080,000 kw total authorized capacity to be installed at Libby and Dworshak Dams.

Under the Treaty, one-half of the downstream power benefits resulting from Canadian storage belong to Canada. The Canadians have sold their rights to this power for $254 million to Columbia Storage Power Exchange for thirty years. Columbia Storage Power Exchange is wholly owned by the 41 public and private utilities to which it distributes the purchased power. The Administrator, Bonneville Power Administration, is the Chairman of the United States operating entity under the Treaty.

Corps of Engineers generation projects have substantially contributed to the Federal Columbia River Power System, one of the finest electric systems in the world. Over two-thirds of the power marketed by the
Bonneville Power Administration comes from Corps of Engineers dams. The balance is from Bureau of Reclamation projects, mainly Grand Coulee. About half of the electricity used in the Pacific Northwest is from federal dams. Power from Corps projects flows through the control facilities and transmission grid system of the Bonneville Power Administration. Electricity in the Northwest is not only the cheapest in the nation, it is also the most reliable. Because the region lacks significant deposits of coal, oil or gas, cheap electrical energy is particularly valuable to the Northwest.

The Dalles Dam and John Day Dam combine with the total facilities of the Columbia River Power System and the Pacific Northwest-Pacific Southwest Intertie to make north central Oregon the power center of the world. The maximum overload capacity of these two dams is 5 million kw. The Intertie will be the longest direct current transmission line in the world. It is the greatest single transmission project of any kind ever undertaken in the United States.

The Intertie is a $660 million project of public and private utilities and the federal government. It connects loads and generation in Los Angeles and Arizona with loads and generation in the Federal Columbia River Power System. Two standard alternating current lines have been operating since early 1968. Several power supply emergencies at each end of the line have already been solved by 1,000 mile exchanges of energy or capacity. One of the two direct current lines is scheduled for operation in early 1970.

In addition to meeting power supply emergencies in each region, the Intertie will permit savings in plant investment in each region greater than the cost of the lines. This is possible because of the diversity in peak loads. The Northwest needs energy for heating in the winter. The Southwest needs energy for air conditioning and irrigation in the summer. In the early summer, when demand for energy is low in the Northwest and water supply is great, the Northwest hydro dams can provide power to be shipped to Los Angeles. In the winter when Northwest water supply is inadequate and demand for energy is high, the year-around output of the Southwest thermal steam plants can provide power to be shipped to the Northwest.

Another factor in this rather ideal investment is the fact that the interconnection helps keep Bonneville Power Administration rates low. Electrical sales must pay for most of the cost of federal dams. If sales are inadequate, rates must rise so the dams can be paid for within fifty years. Without the Intertie, Columbia River water poured over the spillways of Northwest hydro projects and rushed out to the sea. The water went over the spillway instead of through powerhouses because demand for energy in late spring and early summer is much less than available supply. The intertie connects the high Southern California demand for energy with the great supply of water in the Northwest hydro system. The resulting sale of electricity to California avoids a significant waste of resources. The sales of surplus electricity to California also help pay off the
The barge KENAI is barely able to pass through the 76-foot wide lock at Bonneville Dam.
federal Columbia River investment. This is how the Intertie keeps Bonneville Power Administration rates for the Northwest at low levels.

Navigation locks and slackwater pools at Portland District projects are part of a basin wide plan to extend waterborne commerce far up the Columbia and Snake rivers. Presently, the waterway on the Columbia extends 48 miles above McNary Dam to the Tri-Cities in Washington State. When Lower Granite Lock and Dam is completed in the mid-1970's, the Snake River waterway will extend to Lewiston, Idaho, 476 miles from the mouth of the Columbia River.

It has been proposed to install 86-foot wide and 675-foot long locks in the three non-federal dams on the Columbia River between the Tri-Cities and Wenatchee, Washington. An 86-foot by 675-foot lock would also be installed in the proposed federal Ben Franklin Dam, immediately upstream from the Tri-Cities. Adoption of this plan by the Congress would extend Columbia River navigation to Wenatchee, 465 miles from the Pacific Ocean.

The chief exports and imports of the Inland Empire are grains and petroleum products, respectively. Over 2.5 million tons of cargo passed through Bonneville Dam Lock in 1967.

A project under consideration is the construction of a new lock at Bonneville Dam. All but one of the locks on the Columbia and Snake Rivers have 86-foot by 675-foot plan dimensions. The lock at Bonneville Dam is only 76 feet by 500 feet. The obvious and general problem is the fact that the lowermost lock in the slackwater navigation system is a bottleneck for all traffic moving upstream or downstream. For example, a long log tow, or a tug with a multiple barge load cannot pass through the lock. An additional trip or trips must be made to get the entire load through. Ordinarily a lockage on the Columbia River requires one-half hour. Passage at Bonneville Dam for large loads -- the most economical size for passage on the river and through the other locks -- now averages 4-5 hours.

An additional problem is loss of control caused by currents at the upstream approach. The upstream gate of the 500-foot-long lock is near the powerhouse. Water pouring into the powerhouse pulls a downstream-bound barge away from the lock approach. A similar difficulty exists to a lesser extent at the downstream entrance.
Like its water, the finances of the basin development program are basically treated as a single, comprehensive unit. The benefits to irrigation which Portland District projects provide because of diminished pump lift load have been mentioned above.

Fish conservation and recreation purposes are discussed in chapters 20 and 21.
19. Post-war Multiple Purpose Development of the Willamette

Flood control continued to be emphasized in the multiple purpose development of the Willamette River Basin after World War II. The 1938 Flood Control Act, House Document 544, 75th Congress, 3d session, has remained the basic plan for this development. The Flood Control Acts of 1950 and 1962 enlarged upon the basic 1938 plan. Two large projects authorized by the 1938 Act -- each with its own reregulating dam -- were started directly after World War II. Five large projects have been completed under the 1950 Act, and several others have been authorized by the 1962 Act.

A great flood in December 1964 and another less severe flood in January 1965 tested the value of the projects completed up to that period. The result was flood prevention benefits amounting to $514 million -- over twice the cost of the projects then completed.

Under the 1938 Act, the first three reservoirs in the Willamette Basin were built. These were Fern Ridge, Cottage Grove and Dorena, each started before World War II. Two others were not built, the first because a more effective site on the same stream was eventually recommended, and the other because of fish conservation and scenic considerations. All of these projects are discussed in chapter 15.

Two important projects authorized by the 1938 Flood Control Act were started in 1947. Of these the first to be completed was Detroit Dam on the North Santiam River, with its reregulating dam, Big Cliff, about 3 miles downstream.
The rugged setting of Detroit and Big Cliff Dams on the North Santiam River.

Detroit Dam with its 100,000 kw powerhouse at left.
Detroit Dam, like Lookout Point and Green Peter, requires a reregulating dam so that releases from its large storage reservoir will not wildly disrupt the flow and level of the river downstream. Releases for electric generation peaking capacity are sudden and large. The reregulation dam protects downstream fish life, recreation, navigation and irrigation purposes. The reregulation dam also has generating capacity.

Detroit is a concrete gravity dam with a total storage capacity of 455,000 acre-feet, and usable flood control storage of 340,000 acre-feet. The difference between these two figures -- 115,000 acre-feet -- is termed inactive or dead storage. This is reservoir water which is not released because it must be retained to provide head for power generation. A large amount of dead storage is unavoidable in a 3,580-acre reservoir situated in rugged, uneven terrain.

The 1,580-foot-long, 463-foot-high Detroit Dam has two generating units with a total capacity of 100,000 kilowatts. Big Cliff has one unit of 10,000 kw. Detroit controls runoff from an area of 438 square miles. Its reservoir is 9 miles long and has a full-pool area of 3,580 acres. By comparison, Big Cliff Dam is 280 feet long, 191 feet high and its reservoir is 2.8 miles long.

Located 43 miles east of Salem on the west slope of the Cascade Range, Detroit and Big Cliff Dams were completed in 1960 at a total cost of $63 million.

The last project to be completed under the 1938 Flood Control Act -- and one of the most important in the Willamette Valley -- is Lookout Point. Dexter Dam, 2.8 miles downstream from Lookout Point, reregulates the flow of the Middle Fork Willamette River.

Lookout Point Reservoir, begun in 1947, has a total storage capacity of 456,000 acre-feet, and usable storage of 349,000 acre-feet. Three 40,000 kw generating units are installed at Lookout Point, and one 15,000 kw unit is at Dexter for a total of 135,000 kw capacity. This is slightly over 25 percent of the generating capacity of Bonneville Dam. The 248.5-foot-long spillway section has five gates. The 4,360-acre reservoir of Lookout Point Dam is 14.2 miles long.

The multiple uses of Lookout Point are consistent with each other. High pool levels are maintained during the recreation season of May through August. Starting in late August or early September, the pool is lowered by increased releases to provide additional power and offset draft on Columbia River power storage. This operation continues until the total flood control space of 337,000 acre-feet is available. Releases from the reservoir benefit electric power generation, navigation and irrigation as primary project purposes. Incidental benefits are provided for fish life and pollution control.
Lookout Point Dam, in the Willamette River Basin, has a storage capacity of 336,500 acre-feet.

Dexter Dam, with a storage capacity of 4,800 acre-feet, reregulates the releases from Lookout Point Dam, which can be seen in the background.
By November 15 the pool is drawn down to minimum flood control pool, approximately 100 feet below summer pool levels. Except as flood waters add to this pool, it will be maintained at minimum levels through the winter months. Flood waters are released immediately as high water periods are past. The pool starts to fill again on February 1, and reaches its maximum height by about May 10.

Located about 20 miles southeast of Eugene on State Highway 58, Lookout Point and Dexter Dams were completed in 1961 at a cost of $88 million. Annual maintenance costs are about $500,000 each year.

House Document 531, 81st Congress, 2d Session, as enacted by the Flood Control Act of 1950, is the major review of the 1938 "308" report. House Document 531 features the Main Control Plan for the Columbia River. Also included were several important multiple purpose and flood control projects for the Willamette River Basin. Two of these projects -- Hills Creek and Cougar -- were completed before the floods of December 1964 and January 1965.

Hills Creek Reservoir operates without a reregulation dam. Located 26 miles upstream from Lookout Point Dam, Hills Creek is built at the confluence of the Middle Fork Willamette River and Hills Creek. It has 249,000 acre-feet of usable flood control storage and two 15,000 kw generating units with Francis turbines.

Construction of Hills Creek Reservoir started in 1956. It is a 2,150-foot-long, 304-foot-high earth and gravel fill dam. Its three gates are designed to pass 141,000 cfs. The reservoir extends 8 miles up the Middle Fork Willamette River and about 3 miles up Hills Creek. The entire project lies within the Willamette National Forest which is managed by the United States Forest Service. The project was completed in 1963 at a cost of $46 million.

Construction of Cougar Dam on the South Fork McKenzie River started in 1956. When completed, 515-foot-high Cougar Dam was the highest rockfill structure in the world.

Cougar Dam is one of the three headwater tributary projects built in lieu of the Quartz Creek project which was authorized by the 1938 Act.

A multiple purpose project, Cougar has two 12,500 kw generating units which were put into service in 1964. Power generated at Cougar and delivered to the Bonneville Power Administration from July 1967 to June 1968 totaled 106,907,000 kilowatt-hours. Power revenues of $3,143,000 have been deposited in the United States Treasury up to June 1968. Of this total, $441,000 was for repayment of operation and maintenance, and $2,702,000 was for interest, amortization and replacement costs. Total
Hills Creek Reservoir, with a storage capacity of 243,600 acre-feet, is located at the confluence of Hills Creek and Middle Fork Willamette River.

515-foot high Cougar Dam stores 165,000 acre-feet of South Fork McKenzie River water.
The cost of Cougar Dam was $53 million.

The flood control features of the Cougar project were put into operation in 1963. Cougar Dam has a 1,300 acre reservoir with usable storage amounting to 165,000 acre-feet. During the floods of 1964-65 alone, Cougar Dam flood storage prevented about $59 million in damage.

B.

The winter of 1964-65 brought severe flooding in the Northwest, particularly in western Oregon. The area was hit not by one flood, but two: the most devastating in the last ten days of December, the other in the last week of January.

The Willamette Basin was hit hardest by the floods. Great damage was also incurred in the Lower Columbia Basin, the Rogue River Basin, the Umpqua and Coquille River Basins, on other coastal streams, and throughout the Great Basin on the east side of the Cascade Mountains in Oregon and northern California.

The weather conditions which caused the two floods of 1964-65 were basically the same and can be divided into four parts: (1) general and heavy rainfall which left the ground saturated; (2) low or record low temperatures which froze the ground; (3) heavy, wet snowfall; (4) heavy precipitation and sudden warming which melted snowpack up to 10,000 feet.

The Willamette Basin is subject to frequent winter floods. The 1861 flood was the greatest in magnitude and the first for which any meaningful data are available. Other noteworthy basin-wide floods were those of 1890, 1923, 1945, 1955 and the recent flood of December 1964 which, had it not been regulated by upstream storage, would have been comparable to the flood of 1861.

In December 1964 most unregulated tributaries of the Willamette experienced 100-year frequency floods. Every stream tributary to the Willamette reached major flood stage. Several locations on the Willamette River below major tributaries experienced 100-year floods. Except in the Eugene area, which greatly benefitted from regulation by upstream storage reservoirs, major flood stages on the main Willamette River were exceeded by as much as 8 feet. Even with protection at Eugene, the period of days during which flood waters remained above bankfull stages greatly exceeded like periods of any floods in the 20th Century. This was also true at Albany and Salem. In most instances, record peak discharges also were established on the Willamette River and rivers tributary to it.
Flood damage to residential section of Keizer, Oregon.

Another residential section of Keizer. Note the strong current at right, and that house in center is afloat.
The previous maximum flow of record for Willamette River at Wilsonville was 248,000 cfs. On Christmas Day 1964, the flow at Wilsonville was 332,000 cfs. All of the following streams experienced record discharge in December 1964, some exceeding the previous record by as much as 50 percent: Willamette River at Wilsonville; Coast Fork Willamette, Row, McKenzie and Blue Rivers; Lookout Creek; Marys, Calapooia, North Santiam, Middle Santiam, South Santiam, Luckiamute and Yamhill Rivers; Mill Creek; Willamina Creek; Molalla, Scoggins, Tualatin and Clackamas Rivers; Johnson Creek; and Sandy River. The Sandy empties into the Columbia River about 10 miles east of Portland. It is included here because its location and runoff characteristics are similar to streams which flow into the Willamette River from the east. The fact that so many of the tributaries of the Willamette experienced record flooding simultaneously is what made the December 1964 flood so destructive.

Of the $148 million in damages in the Portland District resulting from the two floods, about $71 million were in the Willamette Valley. Agricultural assets were the hardest hit, with about 215,000 acres inundated. The loss was over $16 million. Transportation, industrial, residential and commercial losses followed closely behind agriculture.

Vast areas of the acreage cited above suffered serious erosion or lost topsoil. Much livestock was lost. River banks were disfigured or destroyed. Debris consisting of logs, trees, brush and destroyed property was a major problem. Orchards were completely devastated in many areas, and intensively farmed specialty crop fields such as berries, snap beans, seeds, hops, fruit, mint, corn and other vegetables were washed away or silted under.

North Albany was evacuated and incurred serious industrial losses. 300 houses were flooded by water up to 9 feet deep in the north section of Salem. The Salem municipal sewage plant was destroyed by the flood, spreading an obnoxious and harmful pollutant over wide areas. The disrupted sewage service caused damage to downtown Salem. The Memorial Hospital of Salem was evacuated, as were many residences, commercial establishments and offices.

Simultaneous flooding on the Columbia and Willamette Rivers caused considerable damage in the Portland area.

Portland experienced its highest winter stages in history. This was partly the result of backwater from the Columbia River. At the same time the Willamette River was at or near record stages, the stretch of the Columbia River from Bonneville Dam to its mouth was experiencing its largest winter flood of history. The same combination of saturated ground conditions, freezing snowfall and heavy, warm rainfall started floods on the Lower Columbia River. If there had been no upstream storage on the Columbia, the December 1964 flood would have been the second largest flood of record for the entire river, exceeding even the June 1948 flood. Regulated stages at Vancouver were 27.7 feet.
Flood waters at the Portland seawall on Christmas Day 1964. Without Portland District reservoir storage, flood waters would have reached 9th Avenue, one-half mile from the seawall.

Flood waters completely inundate 45-foot Willamette Falls at Oregon City. Note high water levels at paper mills on each side of the falls.
Willamette Falls were almost completely submerged by the flood. The major paper plants on both banks of the falls were inundated, with damage running into the millions of dollars. Motors, equipment and stock were ruined or damaged, causing prolonged shut-downs.

A major shopping area in Oregon City was flooded under several feet of water. Disposal of contaminated foodstuffs and other items was a large problem here and in similarly affected areas.

Residential losses along the Lower Willamette were high. A warehouse in Lake Oswego was covered with 12 feet of backed up water. Industrial losses between the Sellwood and Hawthorne Bridges were high. Many warehouse and manufacturing plants were flooded in Portland's lower east side. Residential areas on the west side were under water. Wharf and dock facilities were greatly damaged, and ship movement in the harbor was made dangerous by debris.

There was great damage on the Lower Columbia River. The Deschutes River experienced a peak discharge twice that of the previous record. Records were also established on the Hood, Washougal, and the Klickitat rivers. The previous record on the White Salmon was equalled.

Transportation was the hardest hit category, with over $7 million in damages. Highways and bridges were washed out and destroyed. Railroads lost trackage and rolling stock. The town of Rufus, on the eastern edge of the Portland District, suffered severe damage.

On the Rogue Basin, 13 of 16 gaging stations reported record highs in peak discharge or flood stage. Complete records were unavailable because some of the measuring gages were washed away. Total damages exceeded $25 million. Along one stretch of the Rogue 250 homes and 30 commercial establishments were destroyed or heavily damaged. Many homes were flooded to their eaves. Every bridge crossing the Rogue River was either destroyed or greatly damaged. Many sawmills were damaged severely or permanently put out of business. Eight feet of water covered the finest residential section of Grants Pass, Oregon. Considerable damage was incurred at residential, commercial and marine facilities located in Gold Beach at the mouth of the Rogue River.

Runoff on the Umpqua River exceeded previous record levels at 14 of 24 stations. $29 million of damages were caused, mainly in the central valley, and at Reedsport at the mouth of the Umpqua River. At Reedsport the violent floodwaters overtopped the levee and poured 8 feet of debris-laden water on most of the town. In Roseburg, Oregon a junior high school and a convalescent home were among the many victims of the flood. Five hundred and fifty homes were flooded and many barns, sheds, garages and trailer houses were completely destroyed. Three miles of Interstate Highway 5 were flooded near Myrtle Creek. Agriculture and log and lumber losses were important.
A destroyed home forms part of the debris which threatened the Morrison bridge in Portland. All bridges except the St. Johns would have been washed away if existing reservoirs had not been available.

The December 1964 flood caused great damage to railroad and other transportation facilities in the Portland area.
Previously recorded stages on the Coquille River were exceeded at 5 of 6 measuring stations by the near 100-year flood of December 1964. Half of the $3,073,000 damages in the Coquille River Basin were to agriculture and about one quarter to industry.

Near record flows on inland streams in the Great Basin and on coastal streams in addition to those discussed caused about $11.5 million damage, principally to agriculture.

Under Public Law 99/84, authority is delegated to the District Engineer to perform flood-fight and rescue operations as may be required by a flood situation. When floods reach a predetermined level, an existing plan goes into effect. Operations are directed from District Control and Disaster Operations Centers. As in the Columbia River flood of 1948, District employees played a significant role in flood-fight activities. Over 212 employees from District and project offices were involved in inspection, construction, control and maintenance of permanent and temporary flood control projects. Considerable assistance was given to state and local agencies. No emergency activities were necessary for the January 1965 flood. Total cost of federal emergency flood-fight activities was $215,148, most of which was spent in the Willamette River Basin.

Existing Corps of Engineers flood control projects prevented $514 million in damages in the Willamette Valley during the floods of 1964-65. Storage reservoirs were responsible for nearly all of this prevention, with bank protection, levees and channel improvements accounting for about $4 million. Damages prevented by storage at individual reservoirs are as follows:

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<thead>
<tr>
<th>Reservoir</th>
<th>Damage Prevented</th>
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<tr>
<td>Cottage Grove</td>
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<td>Dorena</td>
<td>53,581,000</td>
<td>Row</td>
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<td>Lookout Point</td>
<td>124,487,000</td>
<td>Middle Fk Willamette</td>
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<td>Cougar</td>
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<td>Detroit</td>
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If the 1964-65 floods would have been unregulated by storage, flooded agricultural areas would have doubled to 500,000 acres. Flood stages at Eugene were decreased by storage reservoirs from 39.0 foot natural levels to 24.2 feet. Stages were reduced 7 feet at Salem, 3 feet at Oregon City and 4.5 feet at Portland. These stage reductions prevented extensive damages to residential and mill properties in the Eugene-Springfield area, the thorough inundation of downtown Salem, and greater damage of low-lying industrial development in Oregon City.
Diversion tunnel at Green Peter Dam, on the north shore of the Santiam River, under construction.

Green Peter Dam nearing completion. The reservoir holds 330,000 acre-feet of usable storage, and the powerhouse provides 80,000 kw of generating capacity.
Portland Harbor would have been completely clogged with logs and debris. Moving at high flood velocities, debris and logs probably would have destroyed every bridge crossing on the Willamette River except the St. Johns. Damage to moored vessels would have been tremendous. Even with the regulation provided by storage, some of the bridges were closed at the peak of the flood because of danger of sudden collapse.

Railroad switching yards, terminals and track would have suffered extreme damage, as would have highway terminals, harbor docks and associated facilities. This represents a virtual crippling of the transportation resources of a commercial hub serving half of the Pacific Northwest.

Under natural conditions, the 1964 flood would have exceeded the record stages of the 1894 Columbia River flood by one foot at Portland to 34.4 feet. This water would have overflowed the Portland seawall and covered the downtown core area from S.W. 9th Avenue at Burnside Street in west Portland to S.E. Grand Avenue in east Portland. This would have completely inundated the major commercial, financial, retail, industrial and communication installations of the city.

All underground heating, electric and communication systems would have been out of service. A serious fire hazard would have resulted from the immobilized fire department. The health of the area's citizens would have been directly threatened by failure of sewage systems, contamination of water supplies, unavailability of foodstuffs, disruption of hospital and medical facilities, and the destruction of several thousand residences.

Without the existing storage on the Willamette River and, to a somewhat lesser extent, the Columbia River, Portland would have experienced a disaster of nationally historic proportions for an extended period of time.

C.

Since the floods of December 1964 and January 1965, three multiple-purpose reservoir projects have been completed by the Portland District in the Willamette River Basin. Several other projects were authorized by the 1962 Flood Control Act and are presently in the design stage.

Of the three most recently completed projects, Green Peter Dam is the most important. It is operated, as a unit, with the downstream Foster multiple-purpose dam, which also serves to provide reregulation of power releases from Green Peter.
195-foot-high Fall Creek Dam, on Fall Creek near Lowell, Oregon, is almost one mile long. It has a storage capacity of 115,000 acre feet.

Debris and logs collecting behind the $30 million Blue River Dam on Blue River. It has a storage capacity of 85,550 acre feet.
Construction started at the $83 million Green Peter and Foster project in 1961. Progress was set back for several months when the record December 1964 flood destroyed the two cofferdams and bridge trestle. Destruction of the cofferdam was caused by a large mass of logs passing downstream. In addition, the powerhouse draft tube was filled with rock and debris, and the pumping plant was ruined. Flood damage at Green Peter was almost $1 million.

Green Peter is located on the Middle Santiam River about 5.5 miles above its confluence with the South Santiam River, and about 30 miles southeast of Albany. Foster Dam is built about 1.5 miles downstream from the confluence of the two streams.

The 3,700-acre reservoir behind Green Peter has about 330,000 acre-feet of usable storage and controls runoff from about 280 square miles. The powerhouse of 80,000 kw is operated to provide peaking capacity.

Foster, besides reregulating releases from Green Peter, provides 33,600 acre-feet of usable storage and includes one 20,000 kw generating unit. Green Peter is a 385-foot-high concrete structure. Foster is a 145-foot-high rockfill embankment with an impervious core. Work was finished on the two dams in 1968.

Fall Creek Reservoir was started in 1962. It was authorized by the Flood Control Act of 1950. Fall Creek is the third project (in addition to Lookout Point and Hills Creek) which controls flood waters of the Middle Fork Willamette River. The project is built on Fall Creek about 7 miles upstream from the confluence of Fall Creek and the Middle Fork Willamette River, 22 miles southeast of Eugene.

Fall Creek is a 195-foot-high, 5,100-foot-long rockfill and earth embankment structure which has a gated spillway in its left abutment and outlet works in the right abutment. The 1,900-acre reservoir provides 115,000 acre-feet of usable storage and controls runoff from about 184 square miles. Reservoir storage at this $21 million project began in October 1965.

Blue River Reservoir is the third multiple-purpose project completed by the Portland District since the floods of 1964-65. It was started in May 1963. Like Cougar Dam, Blue River was one of the three tributary dams selected in place of the Quartz Creek project authorized by the 1938 Flood Control Act. Blue River Dam is built on the Blue River, a tributary of the McKenzie.

Blue River is a 320-foot-high embankment dam with 2 gates and outlet works on the left abutment. The reservoir covers 1,000 acres and provides 85,000 acre-feet of usable storage controlling runoff from 90 square miles. Reservoir storage went into operation at the $30 million Blue River project in October 1968. The project was completed the following year.
The Flood Control Act of 1950 also authorized Holley Dam and Reservoir on the Calapooia River. In addition to Holley Dam, the Act provided for two separate, but related, channel improvements on the downstream reaches of the river. Because of lack of local cooperation, the channel improvement projects could not be constructed. As a result, planning for the Holley project as a whole was discontinued in 1958.

The following year a review study of the Calapooia River was authorized. This was begun in 1962. The study will determine the feasibility of constructing a modified Holley Reservoir with provisions for realization of additional project benefits.

The second major review of the basic 1938 plan for development of the Willamette River Basin was completed in 1958. As published in House Document 403, 87th Congress, 2d Session that review recommended three new projects in the Willamette Valley. Those projects were authorized by the Flood Control Act of 1962.

Gate Creek Dam and reservoir will be built on Gate Creek one-half mile above its confluence with the McKenzie River. It is the third of the tributary sites selected in lieu of the Quartz Creek project authorized in 1938.

Gate Creek will be a 270-foot-high earth and gravel embankment. Its 50,000 acre-feet of usable storage space controls runoff from 50 square miles. The project will cost about $30 million.

Hydrology and meteorology design memorandum for Gate Creek was approved in December 1968. Relocation, real estate and preliminary master plan memorandums are presently being prepared.

Cascadia will be built on the South Santiam River. Together with Green Peter and Foster, it completes the three-dam plan alternative to the originally authorized Sweet Home Dam.

Cascadia will be located 8 miles upstream from the confluence of the South Santiam and Middle Santiam Rivers, 38 miles southeast of Albany. The 255-foot-high dam will provide 145,000 acre-feet of usable storage space, and will control runoff from 180 square miles. The cost of the project will be about $48 million.

Strube reregulating dam is the third project authorized for the Willamette River Basin by the 1962 Flood Control Act. As a part of the Cougar Dam and Reservoir project, Strube will be built on the South Fork McKenzie River, 2 miles downstream from Cougar Dam, and about 45 miles east of Eugene.

The primary benefit of the Strube project is electric power generation. Strube will have one generating unit of 4,500 kw. The main power benefit will be realized at Cougar Dam. With Strube able to reregulate
the large releases incident to peaking operations, Cougar's present capacity can be increased from 25,000 kw to 60,000 kw.

Strube will consist of an 80-foot-high gravel embankment and a gate-controlled, concrete chute spillway. The cost of the Strube project, including the additional generating capacity at Cougar, will be about $20 million.

D.

Since the first plan for the comprehensive development of the water resources of Willamette River Basin in 1938, the Willamette River has been changed from an occasionally uncontrollable threat to human welfare to an increasingly valuable asset. A series of dam and reservoir projects, built or authorized, provide 2,175,000 acre-feet of usable storage, with total storage amounting to about 2.8 million acre-feet. This will provide a reasonable degree of control over the Willamette River since its average annual runoff is about 22 million acre-feet.

The cost of the completed Willamette River Basin development as now authorized will be more than $500 million. Yet flood damage prevention benefits alone have already amounted to $612 million. When all authorized projects are completed, about 40 percent more usable storage will exist than was available during the destructive flood of December 1964.

These reservoir projects provide many important benefits in addition to flood control. 408,000 kw of generating capacity is available to the Federal Columbia River Power System from Portland District projects in the Willamette Valley. Navigation, fishlife and pollution abatement are benefited from storage releases during low-flow summer periods. In recent years almost one-half of the water in the Willamette River from July to October came from reservoir storage. Reservoir water from these projects will be adequate to irrigate 500,000 acres in the Willamette Valley. Separate chapters discuss the efforts to maintain and improve fish runs, and the important recreational benefits resulting from reservoir construction.
Rogue River Basin is located in southwestern Oregon. The stream rises on the west slope of the Cascade Range, near Crater Lake. It flows generally to the west and south for 150 miles to empty into the Pacific Ocean at Gold Beach, about 28 miles north of the California-Oregon border. Its principal tributaries are Applegate and Illinois Rivers, both of which rise in the Siskiyou Range along the Oregon-California border.

Along its course to the ocean, Rogue River flows through the valley of the Rogue, between the Cascades and the Coast Range. Downstream from Grants Pass, it penetrates the fastnesses of an almost roadless area of the Coast Range in a narrow, precipitous canyon, passable only on foot or by boat. An 84-mile stretch of river and canyon, from the mouth of Applegate River downstream to the mouth of Lobster Creek, is managed for preservation of natural environment under the Wild and Scenic Rivers Act of 1968.

Since early in the 20th century Rogue River has been nationally and internationally famed for its steelhead trout and salmon runs. In more recent years, however, man's multiple uses of the stream and the watershed have led to a decline in the fishery resource. A principal factor has been the reduction of summer flows and the accompanying warming of the water. At present, water temperatures of 80°F. or more, can be expected annually in the Coast Range canyon section of the stream.

During the same time that reduced flow and increased temperature problems developed, other water-related needs also arose. Increasing population and development along the stream increased the flood-damage potential to the extent that the major flood of December 1964 caused more than $16 million of damages. Concurrently, there was increasing need for water for irrigation, and for municipal and industrial use, for improved water quality for general public use of the stream, for electric power, and for additional water- and land-associated recreation development.
Rogue River Basin Map

Artist's Rendition of Lost Creek Dam
Following a disastrous flood on the entire west coast north of San Francisco in 1955, the Congress appropriated Fiscal Year 1957 funds for initiation of a Corps of Engineers study of Rogue River Basin. During the study period the Congress also adopted legislation recognizing fish and wildlife enhancement, water supply, water quality control and recreation as potential purposes of Federal projects. Taking advantage of the opportunity afforded by newly enacted legislation, the Corps's study included consideration, in cooperation with other resource agencies, of all the basin's recognized needs. Most significant among the cooperating agencies was the work of Oregon State's Water Resources Board and Game Commission, and of the Federal Fish and Wildlife Service's Bureau of Sport Fisheries and Wildlife. Working with those agencies, and with a local association which represented substantially all of Rogue River Basin, a plan was formulated. That plan was physically and economically feasible, and was supported by a majority of local residents and by the National Wildlife Federation and the Izaak Walton League of America. That situation was a complete reversal of conditions attendant on an earlier study by another agency; at that time, basin residents organized, and enlisted nationwide support, in opposition to construction of any dams on Rogue River.

In 1962, on the basis of recommendations resulting from the Portland District's study, the Congress authorized the construction of three multiple-purpose dams in Rogue River Basin. Those dams, located as shown on the accompanying map, are Lost Creek, on upper Rogue River; Elk Creek, on the stream of that name; and Applegate, on upper Applegate River. In total they will provide almost 650,000 acre-feet of storage space.

Authorized primary project purposes include flood control, irrigation, power generation, fish and wildlife enhancement, water supply, water quality control, and recreation. Of those seven, the latter four represent new functions recognized by the Congress during the course of the study and added by the district in response to the needs of the basin.

Of the latter four project purposes, the fish and wildlife enhancement function was the most significant from the standpoint of converting past opposition to present support for the projects. It also contributed substantially to project economic justification. To provide fishery benefits, sites were selected which would be upstream from the principal salmon-spawning areas; that factor eliminated much opposition. Further, the projects were planned to provide increased low-water flows at selected reduced temperatures. For example, the low-water flow at Grants Pass will be approximately tripled, and 45°F releases at Lost Creek are expected to reduce stream temperatures by about 20°F at Marial, 100 miles downstream. Also, the Lost Creek project will include a fish hatchery, to provide restitution for loss of spawning and rearing areas and fish to build up the present runs, which will be the largest in Oregon and one of the largest in the world. All of those features combine to permit the project to enhance greatly the fish habitat and fish populations of Rogue River.
Artist's Rendition of Elk Creek Dam

Artist's Rendition of Applegate Dam
The local people, the National Wildlife Federation, and the Izaak Walton League have followed their initial support for project authorization with continuing support for appropriation of planning and construction funds. To date (1969) Congress has appropriated detailed planning funds for all three projects, and initial construction funds for Lost Creek. The fish hatchery will be the first major item of construction, followed by the dam and appurtenances at Lost Creek.
This happy fisherman pulls his catch from Dorena Reservoir to its full length.
21. Fish Conservation

In the Pacific Northwest, a land of marvels, one wonder in particular has always stood out in my memory. On one of those bright and glorious early summer days which occur in the mountains, my wife and I trudged along a foaming creek near the headwaters of the great Salmon River in Idaho. The Salmon is a snow-cradled conduit of the Columbia Basin.

This morning, the creek was a maelstrom of churning, thrashing chinook salmon. They fought, furiously and savagely, to complete the cycle of their lives in the beds of scoured gravel -- the females to lay the eggs, the lean males to fertilize them with milt. That done, their mission was completed. Their bodies battered from 500 miles of bruised travel, they drifted downstream in the trilling water. Within a matter of hours, most of them would be dead.

Thoughts raced through my mind. Could anything be more unfathomable than this strange pilgrimage of the chinooks? These were fish which themselves had been spawned in the riffles of Bear Valley Creek four or five years earlier. Now they were back from the sea, to the exact spot of their own nativity. Without pausing for food or rest -- goaded by but a single dominating impulse -- they had journeyed for weeks against the current to achieve this goal. By what mysterious alchemy had they avoided all the other countless creeks, estuaries and shoals of the Columbia and Snake and Salmon Rivers, to attain at last the place of their destiny?

-- United States Senator Richard L. Neuberger of Oregon.
The Pacific Northwest is famous for its fish. The salmon, particularly the Chinook, is a prize catch for any sport or commercial fisherman. For many years, fishermen from all over the country have hoped to make at least one fishing trip to the Pacific Northwest. There simply is no better fishing anywhere in the United States. For residents, the immediate availability of such superb recreation is one of the many reasons why Northwesterners express such intense affection for the region.

The fish of the Northwest cannot be discussed without also mentioning the Columbia River. The tributaries and sub-tributaries of the Columbia -- extending into Canada through the Okanogan and into Hells Canyon on the Snake -- are the spawning grounds of most of the region's anadromous fish resources. If the Columbia River is the greatest hydroelectric river in North America, and a key Pacific Coast shipping arterial as well, it is also a magnificent fish stream.

It is on the Columbia River and its tributaries that the fish and the Corps of Engineers meet each other. To the fish, having no need for electricity and being basically self-sufficient in terms of navigation, a huge dam offers few benefits. It is simply another of the many difficulties which he must overcome.

For the Corps, it is different. Fish are regarded by the Corps of Engineers as an extremely valuable resource, one which must be protected and maintained. The Corps has long been aware of the pleasure which the fish provides sportmen, and the profits it offers commercial fisheries. The Corps also appreciates the "mysterious alchemy" to which Senator Neuberger alluded.

The time and effort invested in the Corps of Engineers fish protection program, however, is not geared to the interests of sportmen and profit seekers alone. The fish is conserved also because it is a part of nature which is valuable in and of itself. The timeless struggle of the salmon is one of Nature's most dramatic rituals. Only the cold of heart are without admiration for that struggling and fatal obedience to impulse which possesses the salmon. Like the aura of the sea, or of the deep forest -- or of much else in Nature -- the salmon is an inspiration for man's thoughts. Away from the necessary frenzy and routine of daily life, in Nature one may still develop sensitivity, perspective, humility and wisdom.

Perhaps Corps of Engineers projects are not officially discussed in such terms in Congressional hearings or engineer planning rooms. But this makes their impact no less real. Suppose a dam were planned which would eliminate forever most of the fish runs on the Columbia River. If all those who valued the fish for sport or business were somehow fully compensated financially for their loss, opposition to such a project clearly would still be completely overwhelming. Profits and sportmen aside, the citizens of the Northwest simply would not tolerate the destruction of the Columbia River fish runs.
The Corps of Engineers has spent nearly $150 million in the Pacific Northwest to protect and conserve fish runs. Of this total, the Portland District has spent $55 million. Most of the latter amount has been applied to fish ladders and associated facilities at multiple purpose projects on the Columbia River. Nearly $10 million has been spent by the Portland District on passage facilities and hatcheries in the Willamette River Basin.

A.

Since Bonneville Dam began operating in 1938 about one million fish have passed up the ladders each year. Throughout the 1960's, fish have been passing upstream at a rate slightly higher than that average.

Of the roughly one million fish which pass upstream each year, about 60 percent are salmonid -- a classification which includes steelhead trout. Of these salmonid, about one half have been the prized Chinook (or King Salmon, or Tyee as it is also called).

The Chinook ranges in weight from ten to 45 pounds, and is up to five feet long. A large Chinook may battle for up to an hour before being hauled into a boat by some lucky fisherman.

The life of a salmon begins as an orange-pink blob about the size of a rounded kernel of corn. This is a salmon egg. It is most likely to be found nestled between pieces of gravel on the bottom of a mountain stream or lake. Upon hatching, a salmon is known as a "fry". It is less than an inch long, and it feeds on the yolk sac from which it has just emerged. When the sac is gone, the small fish will leave his gravel nest and forage for other types of food. This is usually in the winter or early spring, depending partially on water temperature.

By mid or late spring, after the salmon has reached four-inch or "fingerling" size, it will begin its swim to the sea. If the fingerling can avoid being eaten by trout, birds, squawfish or other predators; can avoid entering the trap posed by an unscreened irrigation ditch; and can successfully pass through the spillway, powerhouse or, preferably, the bypasses of man-made dams -- if he can do all this he will eventually reach the Pacific where he will spend his adult life.

Once in the Pacific, abundant food and relatively tranquil waters provide a welcome change for the salmon. Survival here depends upon avoiding predators such as the sea lion, large fish and hungry birds. A salmon may travel as far south as the California border, and as far north as Sitka, Alaska off Baranof Island.
If a salmon were capable of language, he would not blush to discuss the topic of sex. This is because the sex life of a salmon is a mixture of nostalgia, travel-fever, heroics and suicide. When a salmon reaches sexual maturity, it is instinctively driven to the mouth of the coastal stream from whence he came as a fingerling, and from there upstream eventually to the very waters in which he was hatched several years previous.

How the salmon, from far in the Pacific, is able to return to the Columbia and, once there, to discern between the Cowlitz, the Lewis, the Klickitat, and the White Salmon and so on -- this age-old feat has remained a mystery to fish biologists and all other scientists. Even if the salmon does find, say, the Willamette, by what sensitivity does he reject all the similar-appearing incorrect streams, but enter the right one and return to the exact spot of his birth? This is indeed a very impressive phenomena.

The mature Chinook will usually return to the Columbia when it is four years old, though this ranges from three to seven years. A medium-sized run occurs in the spring, a small one in the summer, and a large one in the fall. Large Alaskan Chinook weigh up to 80 pounds or more. A large Columbia River Chinook is about 45, or sometimes 50, pounds with 20 to 25 pounds being the average size.

The silver salmon, or coho, is smaller than the Chinook, averaging about eight pounds in weight. The Silver matures in three years and migrates in the fall. By many accounts, the Silver is the most delicious of the Columbia River salmon.

The Sockeye salmon (or Blueback or Kokanee) is smaller than the Silver, weighing about four pounds. The Sockeye is unique among the fish discussed here in that it spawns only in streams having lakes as the headwaters. June and July are the months during which the Sockeye enters the Columbia River.

The Steelhead trout, another salmonid, averages seven to nine pounds. It is somewhat leaner than the above-described salmon. The Steelhead runs from July through September.

The Shad is not a native to the Pacific Coast, having been introduced here by Easterners in 1871. Within five years it made its appearance in the Columbia River. Since counting began at Bonneville Dam, the Shad has usually accounted for at least one quarter of the fish passing upstream through the ladders. Shad are from two to eight pounds in weight.

The White Sturgeon is the largest fresh water fish to spawn in the Columbia River. It reaches lengths up to 20 feet and weighs as much as 1,200 pounds. The White Sturgeon rarely spawns before 15 years of age, and some of these huge fish reach 80 years of age. Very few are counted
Ash and Barrett's fish wheel taken in 1891. A fish wheel could take 3,000 fish out of the river in one day during runs.
at the dams. White Sturgeon can be seen in special pools maintained at Bonneville Dam.

When the indomitable salmon enters the Columbia River to begin the journey to its natal waters, it faces formidable obstacles. In the first place, the salmon is in a race against time. It will generally not feed while moving upstream in fresh water. The salmon survives, instead, by means of the limited supply of fat which it has accumulated while feeding in the Pacific.

Spring runs will encounter the powerful current of the flood stage runoff. While runoff from the Cascades is in winter, any stream with headwaters rising in the Selkirks or the Rockies will be a torrent of surging, rushing water in Spring. Falls and cascades must be passed, and of course animal predators must be avoided.

From time immemorial, the journeys of many salmon have been cut short by the net or spear of an Indian fishermen. Enough fish were caught and smoked to provide victual for a year, with a surplus for barter. The white man introduced horse-pulled skein nets and the vicious fish wheel. These were outlawed by the turn of the century since they would have destroyed the fish runs, which by then had already declined seriously. A single fish wheel could take 3,000 fish per day out of the river when the fish were running. Today's fishermen are regulated. But to swim into a commercial gillnet, or to strike at an inviting herring attached to a sportsman's hook is the fatal error of many salmon.

Land and water uses present obstacles to the fingerling and spawner alike. Agriculture is one culprit. Clearing and plowing the land allows silt and sediment to pour into waterways. Riverbottom hatching areas are destroyed or smothered. Fertilizers and pesticides are among the chief river polluters. Irrigation use has constantly diminished water supply, some streams being dried up completely. Water used for irrigation returns to the Columbia much warmer than when it left. Overgrazing of sheep and cattle has diminished the capacity of the soil to hold water, resulting in uneven runoff.

Logging operations also add sediment and debris to the streams and, by denuding the hillsides, heighten irregular runoff rates. In this regard, low flows are the most injurious since, if they occur in the summer, the water is much more easily heated, and much more easily polluted, too. Loss of shade trees along the streams also raises the temperature of the water. In days past, great log jams accumulated in the streams of logging areas and were simply left. This closed off fish runs.

Industrial waste from pulp and paper mills, and municipal sewage dumping, have combined to nearly destroy the fall Chinook runs on the Willamette River. The oxygen content of the low water in the fall is depleted by pollutants and is inadequate to support fish life. Spring
Fish ladder on Bradford Island at Bonneville Dam. Approximately one million fish pass up the ladders each year.

The fish ladders are a significant tourist attraction.
runs have been preserved only because water levels are high. Hydraulic mining operations have also damaged fish streams.

If the salmon is not stopped by one of these natural or man-made obstacles, he may be overcome by simple exhaustion, poor health or mishap. Many salmon which succeed in reaching their destinations are bruised and battered, their skin torn and patched with fungus.

Having reached the exact place of their birth, the male and female salmon each perform their final act. The female will deposit eggs into a small ditch which she has formed with her tail on the stream bottom. The male then approaches the female and releases his sperm which settles down over the eggs and fertilizes them. The female will attempt to continue this reproductive function, but she will die within several days. Like the female, the male is spent and will soon die, his noble mission completed.

Since the Corps of Engineers first began building dams in the Pacific Northwest, much time and money have been spent to preserve the great fish runs of the region.

The first efforts were at Bonneville Dam in 1933. Studies showed that no less than $7 million worth of passage facilities would be required to adequately handle the fish runs. The main feature of the work is the fish ladder.

A fish ladder is a long stairway consisting of 16-foot long and 40-foot wide pools, each being one foot higher than the last. Inclining openings between the pools, and regulated jets of water encourage the fish to swim rather than jump from pool to pool -- thereby avoiding injury. There are three fish ladders at Bonneville Dam: one on the Washington side; two others start at the south end of the spillway and at the north end of the powerhouse, joining on Bradford Island and emptying into the south channel upstream from the powerhouse. By passing up these ladders, the fish are able to get to the 70-foot high pool behind the dam, and to the spawning grounds beyond.

Migrating adult fish are naturally attracted to the strong flow coming from the powerhouse and, in the late spring, from over the spillway. Jets of water, streaming at right angles to the Columbia, entice the fish into channels which lead to elaborate collecting troughs. From there the fish easily finds its way to the ladder.

Downstream fingerling are helped by means of by-pass channels, three to eight feet wide. There are five of these, one at each end of the powerhouse and at each end of the spillway. The fifth begins upstream of the locks on the Oregon shore and leads several thousand feet through man-made waterways to the mouth of Tanner Creek below the dam.
A large Chinook passes upstream past the viewing window at John Day Dam.
A unique system of fish lifts or elevators were installed to supplement the fish ladders. Each had a planned capacity of 30,000 fish per day, and was designed to lift the fish, in water, from the foot of the dam to the upstream reservoir. These have rarely been used since design capacity is not realistic and the ladders are much more effective in passing fish.

The fish are counted as they pass upstream. At the top of the ladders are the two fish counting stations at Bonneville Dam. At one point the passage narrows over a white flashboard, slightly raised and lighted. As the fish pass in front of observation windows at this spot, they are counted and identified as to species. Tallies are made by hand. This daily census serves as a fish resources inventory on which conservation policies are based.

The ladders were completed by 1938. When winter had passed, engineers and fish biologists anxiously awaited the spring salmon runs which would test the elaborate installations. Few were disappointed. The fish readily found their way from transport channel, to collecting trough, and up the ladders to the reservoir behind the dam.

Since 1938, approximately one million fish have passed up the ladders at Bonneville Dam each year. In recent years the total has been slightly higher. In this decade, more than one million tourists and sightseers have visited Bonneville Dam each year to watch the fish pass upstream.

Over $15 million has been spent for fish passage facilities at The Dalles Dam project. The three fish ladders are the main installations. These are located at each end of the powerhouse and on the north side of the spillway. As at Bonneville, there is a collecting system at the base of the powerhouse. The existence of The Dalles Dam has actually made it easier for the fish to pass upstream at this location since Celilo Falls have been inundated by the project. Not only has a physical difficulty been eliminated, but the fish no longer need to expose themselves to Indian spears and nets. At both The Dalles Dam and Bonneville Dam, annual operation and maintenance cost amounts to about $58,000. In 1967, over one million fish were counted at The Dalles Dam. Of these, about 554,000 were salmonid. The Dalles Dam was dedicated in 1959.

The Portland District also operates massive John Day Dam. Here the fish facilities cost $23 million. This includes two fish ladders, the collecting, transporting and bypass facilities, and an underwater observation room open to the public. Included in fish protection plans at John Day is the enlargement and operation of two fish hatcheries. Annual operation and maintenance of the fish facilities is over $550,000, much of which is applied to the hatcheries. John Day Dam was constructed by the Walla Walla District, and dedicated on September 28, 1968.

All Corps of Engineer projects on the Columbia and Snake Rivers contain fish passage facilities. In addition to those discussed, these include McNary on the Columbia, and Ice Harbor, Lower Monumental, Little
Netting fish for egg-taking below Dexter Dam on the Willamette River.

Taking eggs from a ripe female.
Goose and Lower Granite on the Lower Snake. Over 400,000 salmonid passed through McNary fish ladders in 1967. McNary Dam is 77 miles upstream from John Day.

In the Willamette River Basin, the Portland District has spent about $6 million for fish facilities at six dams, and has constructed four hatcheries -- three for salmon and steelhead, and one for trout -- which cost another $3,286,000.

Fern Ridge, Cottage Grove and Dorena were the three projects built by the Portland District in the Willamette Valley before World War II. No significant runs of anadromous fish passed upstream at the sites of these projects so no fish facilities were required.

At Green Peter Dam on the Middle Santiam River upstream migrants are attracted to a short fish ladder. The ladder leads into a hopper which lifts the fish over the dam and to the reservoir on the upstream side. A trucking service is provided fish who arrive at Green Peter Dam late in the spawning season. If the fish appears to be too ripe to have time to swim the length of the reservoir, a special water-filled truck is ready to assist him. Runs have been made with only one-fish loads.

Downstream migrants at Green Peter are collected by a horn-shaped device which can be raised or lowered to suit the fluctuating reservoir. Both of these experiments at Green Peter have appeared to work quite well.

Foster Dam reregulates the discharge of Green Peter Dam. Located on the South Santiam, Foster has a similar lift facility as Green Peter, but smaller. The cost of the fish works at Green Peter and Foster total $3,400,000.

Downstream from the Green Peter-Foster complex is the South Santiam Hatchery. It was completed in 1968 and cost $400,000. The South Santiam Hatchery is designed for an expansion capability of more than double the existing size as conditions warrant.

The job of a hatchery is essentially to relocate, assure and protect the reproduction processes of fish. Migrating adults are taken from the water as they swim toward spawning areas. Eggs are taken from the fertile females and at once fertilized by sperm from the males. Eggs and young fish are cared for at the hatchery until they are released as fingerlings. Once released they join natural downstream migrants heading for the Pacific Ocean where they spend their adult life.

The fish runs above Lookout Point on the Middle Fork Willamette are maintained by the large Oakridge Hatchery. The egg-taking station for Oakridge is located downstream from Dexter Dam, the reregulation dam for Lookout Point. Oakridge Hatchery cost over $1 million.
The Leaburg trout hatchery on the McKenzie River.
Detroit Dam on the North Santiam is a huge, 454-foot high structure. The water level behind the dam varies about 120 feet each year. Since the dam is so high and its reservoir fluctuates so greatly, fish runs on the North Santiam are maintained by the Marion Forks Hatchery. Like other fish hatcheries built by the Corps of Engineers, Marion Forks is operated by the State of Oregon. Marion Forks was completed in 1950 and cost $853,000. Annual costs, paid by the Corps of Engineers, amount to $73,000. The egg-taking station for Marion Forks is at Minto Pool below Big Cliff Dam, the reregulating dam for Detroit Dam.

The fourth Portland District hatchery is Leaburg on the McKenzie. It cost $1.1 million and takes $117,999 each year for operation and maintenance. Leaburg is a trout hatchery, and it helps maintain the world-famous McKenzie trout fishing.

Fall Creek Dam is located at the confluence of Fall and Winberry Creeks, tributaries of the Middle Fork Willamette. Spring chinook salmon and steelhead trout use Fall Creek and its tributaries for spawning and rearing. Fall Creek Dam includes unusual facilities to pass migrant adults upstream and fingerlings downstream.

A fish trap collects upstream migrants at the foot of the dam. From here, fish are transported upstream to the reservoir in specially designed tank trucks. The fish are released in Fall Creek and Winberry Creek to spawn naturally upstream from the reservoir.

A fingerling working its way downstream passes Fall Creek Dam by means of a collection system and fingerling bypass conduits. Intakes to the collection system are set at three different elevations so that the fingerling have easy access at all reservoir levels. Fish are attracted to the upstream and downstream collection systems by artificially created water flows.

Completed in 1967, the passage facilities at Fall Creek Dam cost about $1.5 million.

Blue River Dam is located on Blue River, a tributary of the McKenzie. A large natural waterfall just above the dam site has always blocked significant fish runs on the Blue River. Hence it was not necessary to add fish facilities on Blue River Dam, now nearing completion.

Passage facilities at the huge Cougar Dam on the South Fork McKenzie River have not provided adequate service. A hatchery is being planned to maintain the runs originating in that stream.

Cascadia, Gate Creek, Holley and Lost Creek are future projects of the Portland District which will need fish facilities. All planning is done in coordination with fishery agencies to determine the most effective method of preserving the runs. It is possible that some of the reservoirs of the first three projects will be utilized as huge rearing ponds for
juvenile salmon to be released each year when the reservoirs are drained in preparation for flood season.

The Lost Creek project has the emphatic support of conservation groups such as the Izaak Walton League because it will render a positive benefit to fish on the Rogue River. Low flows on the Rogue during the summer are a menace to the fish because water temperature becomes intolerably high. The Lost Creek project is being designed to release water from the lower, colder levels of its reservoir. These releases will cool and increase the otherwise warm, low flows of the Rogue River.

The passage and hatchery projects built by the Portland District on the Columbia and Willamette Rivers have been greatly helped by the fish research program of the North Pacific Division. Since 1951 over $4,500,000 has been spent on research to learn more of the nature and habits of Northwest fish. One quarter million dollars is spent each year for this program. Many fish preservation structures are also designed and tested with the assistance of the Hydraulic Laboratory located at Bonneville Dam.

The Corps of Engineers is by no means the only agency in the Northwest concerned with the protection of fish runs. Nor were its projects the first to be constructed. The first salmon hatchery in the entire Columbia Basin was established on the Clackamas River by the State of Oregon in 1877. By the turn of the century the State of Washington had 15 major hatcheries. The main Oregon hatchery was at Bonneville, Oregon. This was enlarged several decades later by the Portland District when Bonneville Dam was built. The first fishways were constructed by the State of Oregon at Willamette Falls in 1885. They have been maintained to the present day by the Oregon Fish Commission.

Many may be surprised by these early dates. They show that concern with the preservation of Pacific Northwest fish runs did not begin in the period of large dam construction in the 1930's, but much earlier. Commercial fishing and canning began in earnest in the late 1860's. Packed in 48-pound cans, over 100,000 cases of salmon were sold in 1869. This doubled by 1871, and doubled again to over 450,000 cans in 1876. The peak was reached in 1883 when 630,000 cans of salmon were packed, over 43 million pounds altogether. Most of the fish caught were spring Chinook, and it has never recovered from these devastating catches. Regulation of fishing gear, and time and place restrictions began in Washington State in 1877, and in Oregon the following year. Some of the more objectionable trap and net devices were also outlawed.

Early commercial and Indian catches, agricultural and logging practices and, more recently, (30 years) industrial and municipal pollutants have all greatly hindered the fish runs of the Columbia Basin. Because these activities are historic, or because damage is done indirectly or invisibly, a disproportionate share of the blame for damage to fish runs is ascribed to Corps of Engineers dam projects.
Hardly anyone today repeats the old saw that the dams will destroy the fish runs. The amount of fishing which is done each year on the Columbia and its tributaries has long since laid that notion aside. But what few people realize is that from Bonneville to McNary, the numbers of fish passing over the dams is not slowly decreasing, but is slowly increasing -- and in almost all varieties. Fish facilities constructed by the Corps of Engineers have not only overcome most of the difficulties caused by the dams, but are helping to relieve the pressure on fish runs posed by threats from other sources.

Fish preservation will continue to be an integral part of the Portland District construction mission. Performance of facilities at existing projects is constantly being checked and improved. Only the most imaginative and effective fish facilities will be installed at new projects.
22. Recreation

As citizens of the Northwest have discovered, many Corps of Engineers water resource projects offer excellent recreation opportunities. Measured by visitor days, the Corps of Engineers produces more recreation areas nationwide than any other agency in the United States.

The first legislation authorizing this activity was the Flood Control Act of 1944. This allowed the Corps to provide recreation facilities at reservoirs as incidental project purposes. This included roads, sanitary facilities, picnic areas, parking lots, boat launch ramps, first aid provisions, campgrounds and safety aids. If a reservoir was likely to be visited and used by people, the Corps, under the 1944 legislation, could undertake to provide recreational facilities such as those listed above.

The 1944 Flood Control Act also authorized local or state agencies to build recreation facilities on federally owned land at Corps of Engineers projects under lease agreements.

The most important legislation affecting Corps of Engineers recreation activities was contained in Section 207 of the 1962 Flood Control Act and in Public Law 89-72, the Federal Water Projects Recreation Act of 1965. Both of these Acts amended or added to the concepts of the 1944 Act. The 1962 Act established recreation as a potential primary project purpose. That is, to the extent that recreational use of any Corps of Engineers water resource project could be expressed as an economic benefit, it could help justify construction of the project. Hence, including recreation as a project purpose will allow some projects to be more readily authorized. This was a declaration by Congress that the development of public recreation facilities would be provided by federal money.

The 1965 Federal Water Project Recreation Act provided a generous formula by which the federal government would undertake to assume up to 50 percent of the separable recreation costs of a project sponsored
Horsethief Lake Park upstream from The Dalles Dam.

Small sport fishing boats in tailwater of Bonneville Dam powerhouse during heavy run.
and maintained by a local agency on federal water project lands. This would include all costs for land purchase, specifically for recreation and construction. Under this legislation, the same formula was made applicable to the water resource projects of the Bureau of Reclamation of the Department of Interior.

Within the Portland District, the leading recreational attraction on the Columbia River is Bonneville Dam. In 1968 nearly 1,250,000 visited this project to view the fish ladders, or to swim, boat, ski, or fish in Bonneville reservoir. Many sightseers just enjoyed the beautiful scenery. The entire State of Oregon has only about 1.9 million people by comparison. The years of greatest growth in this visitor rate have been in the 1960's, almost doubling.

There are nine developed recreational areas on the Bonneville Dam Reservoir. Attractive picnic areas, tours of the powerhouse, fish-viewing and fish-catching areas, and a visitors house are provided by the Portland District at the dam site. The Klickitat Port Commission operates Bingen Boat ramp near the mouth of the White Salmon River. Cascade Locks Park is maintained by the Port of Cascade Locks. This is the site of the first navigation locks on the Columbia River, built by the Portland District. Eagle Creek Campground, immediately upstream from Bonneville Dam on the Oregon side, is one of the most beautiful parks on the Columbia River. It is maintained by the Forest Service. The Port of Hood River and the Port of The Dalles operate two very fine boat basins. Koberg Beach State Park and Mayer State Park are each run by the State of Oregon.

The Portland District is now in the process of cooperating with the State of Washington, Department of Parks to develop an additional recreational site on Bonneville reservoir at Home Valley. Land acquisition is presently underway. The State of Washington will assume not less than 50 percent of the costs involved. Home Valley will offer boating, swimming, camping and picnic activities.

Horsethief Lake is located on the Washington State side of the pool behind The Dalles Dam. The Portland District created a lake for small boats here, as well as an excellent picnic, fishing and swimming area. The Corps has provided rest room facilities, a boat launch area, and picnic grounds, and has done the landscaping. The State of Washington maintains these facilities. Additional recreational areas at The Dalles Dam are Seufert Park and Celilo Park on the Oregon shore, and parks at Avery and Maryhill on the Washington shore. About 400,000 persons visited The Dalles Dam project in 1968.

The Portland District operates huge John Day Dam. The City of Arlington, Oregon is maintaining a park on the reservoir, as is Umatilla, Oregon. Plans for a park similar to Horsethief Lake have been made for the John Day reservoir. Of course, boaters, skiers, swimmers and fishermen can enjoy the water in the reservoir at many undeveloped locations.
This twosome enjoys sailing at Fern Ridge Reservoir on the Long Tom River.

Small boat facilities at Dexter Reservoir.
Fern Ridge Reservoir before development of Orchard Point recreation area.

Orchard Point Park, now completed, provides swimming, boating and picnic facilities.
On the Lower Columbia there are many beach areas on the Washington shore which have been improved by deposit of the fine-sand dredge materials.

At Fort Canby, near the head of the north jetty at the mouth of the Columbia, plans have been made for campgrounds, picnic areas, a boat launch area, rest rooms and roads. This will be done in cooperation with the State of Washington. Salmon fishermen will find this to be a most convenient park. The Fort Canby recreational area is situated on sand accretions lying on the north side of the jetty.

Many of the finest recreation areas in the Portland District are in the Willamette River Basin.

Of these, Fern Ridge Reservoir is the most outstanding. A small dam on the Long Tom River has created a beautiful reservoir of about 9,000 acres. The large size of the reservoir, plus the favorable winds which prevail here, make Fern Ridge one of the finest sailing areas in the entire West Coast. Many tournaments and regattas are held here, including competition in Olympic trials. The Eugene Yacht Club is located on the west shore of Fern Ridge Reservoir.

Lane County and the Corps have developed the very excellent Orchard Point Park at Fern Ridge. The Corps provided the land, and participated in construction of facilities for swimming, boating, picnicking, public parking and has done the landscaping.

The State of Oregon maintains two parks at Fern Ridge - Perkins Peninsula and Point Enterprise. One of the favorite sports at the reservoir is water skiing.

In 1965 the San Francisco District Engineer visited Fern Ridge Reservoir, accompanied by several California congressmen. They were interested to see this show-piece recreation development first-hand, and to learn how the cooperation between the state and local agencies had been carried out so effectively.

Located close to the Eugene-Springfield area, Fern Ridge attracted more than 1,280,000 visitors in 1968. It is one of the most popular recreation sites in the State of Oregon. Fern Ridge Reservoir was completed in 1941.

Dexter Dam is the reregulating dam for the huge Lookout Point project. Behind Dexter Dam is a large, calm pool which is excellent for water skiing. Major water skiing exhibitions have been held here. The University of Oregon crew practices and competes on Dexter Reservoir.

Detroit Dam, on the North Santiam, is another very popular recreational area. The Forest Service of the United States Department of Agriculture maintains the facilities here since the reservoir is located
Swimming at Dorena Reservoir on the Row River

Picnicking at Detroit Dam on the North Fork Santiam River.
in a national forest. Camping and picnic areas are provided, and the boating is excellent. The State of Oregon has leased land from the Forest Service, and it maintains two parks on the Detroit reservoir. In 1968 about 600,000 persons visited this beautiful area.

Somewhat smaller, but still excellent, recreational areas exist at Dorena, Cottage Grove, Hills Creek and Fall Creek. A total of about 700,000 persons visited these fine boating, swimming and sightseeing areas in 1968. Portland District has worked with Lane County to develop Winberry Creek Park at Fall Creek Reservoir.

The mountain areas behind the Green Peter and Cougar projects are very steep and rugged. Access roads are maintained at each location. At Green Peter, facilities for camping and day use activities have been provided by the Portland District and are administered by Linn County. A small camping area and a boat launch are maintained by the Forest Service on the Cougar Reservoir.

The planned Cascadia project on the South Santiam River has an unusual recreational aspect. The original design of the reservoir would have resulted in flooding a unique mineral hot springs. A review of the plans and consultation with citizens of nearby areas, plus a hearing held in September 1969 has resulted in plans being made to preserve the springs.

There are many recreation attractions on the Oregon Coast which have been provided by projects of the Portland District. In addition to projects designed specifically for recreation, efforts to open the Oregon Coast to commercial navigation also provide recreational opportunities.

Excellent small boat basins and harbors have been built at Astoria, Depoe Bay and Winchester Bay. Owners of fishing boats or other pleasure craft have been provided safe, protected water and mooring facilities which would not otherwise have been available. The cost of these three projects totals about $2 million.

Additional River and Harbor legislation has provided for numerous small boat basins to be dredged in several bays on the Oregon Coast and on the Lower Columbia River. These have been discussed in detail in chapter 17, "Navigation Improvements, 1912-1962".

Entrances to eleven rivers or bays on the Oregon Coast have been improved by jetty work. Recreational boating is not aided so much by greater depths as it is by calm waters over a bar and outer reaches of an entrance channel. Without the great jetties, many Oregon coastal fishermen would have to turn to the rough Dory fishing -- out through the surf -- as has been done at Pacific City for decades. At most locations, entrances would be no safer than surf conditions without jetty protection.
Winberry Creek Park on the Fall Creek Reservoir near Lowell, Oregon.

Lakeside Park on the Cottage Grove Reservoir near Cottage Grove, Oregon.
Taking the Pacific Northwest as a whole, the number of Corps of Engineers reservoir projects has doubled in the past decade, while recreation visitor-days have increased seven-fold -- to over 7,585,000 in 1967. The Portland District alone accounts for nearly two-thirds of that total. Over three million persons visited Portland District projects in the Willamette Valley in 1968.

Rising population, increased standards of living, and the continuing trend to city and suburban living areas will produce even greater demand for wholesome, stimulating, and inexpensive outdoor recreation. The reservoirs of Portland District water resource projects are valuable assets in the effort to meet that demand in Oregon. New projects with recreational attractions are either under construction, or are in the planning and survey report stages.
23. Conclusion

The Portland District maintains dredge floating plant and moorings to serve nearly all the west coast of the United States, and many points in the Pacific Ocean. About $100 million has been spent to open the rivers and harbors of the Oregon Coast to navigation by constructing jetties. The jetty at the mouth of the Columbia River remains one of the largest in the world. Columbia River navigation channel development has improved natural depths from 17 feet to the present project depth of 40 feet. This nearly one-hundred year effort has allowed Portland to become the second most important port on the Pacific Coast.

Five hundred million dollars will have been spent to complete a multiple purpose development of the Willamette River Basin, consisting of 17 dams and reservoirs. Flood control, as well as navigation, power, irrigation and recreation are essential to the prosperity, well-being and safety of northwestern Oregon.

The most imposing Portland District accomplishments are Columbia River dams. Construction of historic Bonneville Dam by the Portland District represents the earliest major federal development on the mighty Columbia. John Day and The Dalles dams are among the world's greatest dams. John Day was built by the Walla Walla District and is operated by the Portland District. The Federal Columbia River Power System is the world's finest and largest hydro-power system. Efforts are currently being made to improve the system further by adoption of Bonneville Power Administration's hydro-thermal program. Under this plan, the higher-cost thermal generation of public and private utilities would be melded with lower-cost federal hydroelectric power and transmission resources so as to enjoy economies of scale. This would ensure the lowest possible power rates for the region's consumer and industries.
A series of locks and slackwater pools has connected navigation with rich agricultural produce of the Inland Empire, and provided cheap import capacity for petroleum products. Efforts of the Corps of Engineers are the principal feature of world famous and unique effort to preserve and maintain the fish resources of the Pacific Northwest.

This impressive variety of projects forms part of a basin-wide development which is the economic backbone of the Northwest. Like any other asset or productive resource, these great regional public work projects yield a large return to the citizens of the Northwest. Inexpensive power, protection from floods, improved transportation capacity, irrigation, fish conservation, recreation and water supply are the specific elements of the return. The general result is a more prosperous, stable and mature regional economy.
### APPENDIX A

#### CHRONOLOGICAL LISTING OF DISTRICT ENGINEERS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DISTRICT ENGINEER</th>
<th>DESIGNATION AND</th>
<th>LOCATION, DIV. ENG</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1866</td>
<td>Major (Bvt. Lt. Col.)</td>
<td>APPARENTLY NONE</td>
<td>San Francisco, entire coast</td>
<td>There are no reports available prior to 1866. At that time all lands west of the Rocky Mts. were under the Engineer Officer in San Francisco, work being carried on under the caption &quot;Rivers and Harbors of the Pacific Coast.&quot;</td>
</tr>
<tr>
<td>1867</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>Annual Reports according to the various works and projects assigned, until 1907, at which time the present system of numbering and naming districts was initiated.</td>
</tr>
<tr>
<td>1868</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>There does not appear to have been a Division Engineer until 1876, all works assigned to the District Engineer prior to that date appear to have been prosecuted directly under the supervision of the Chief of Engineers.</td>
</tr>
<tr>
<td>1869</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>In 1871-72-73, &quot;Improvement of Rivers in Oregon.&quot;</td>
</tr>
<tr>
<td>1871</td>
<td>Maj. Williamson</td>
<td>ditto ditto</td>
<td>ditto ditto</td>
<td></td>
</tr>
<tr>
<td>1872</td>
<td>Major H. M. ROBERT</td>
<td>ditto ditto</td>
<td>ditto ditto</td>
<td></td>
</tr>
<tr>
<td>1873</td>
<td>Major Robert succeeded by Major N.</td>
<td>ditto ditto</td>
<td>ditto ditto</td>
<td></td>
</tr>
<tr>
<td>1874</td>
<td>Major N. Michler</td>
<td>ditto ditto</td>
<td>ditto ditto</td>
<td>&quot;Improvement of Rivers in Oregon and in Washington Territory.&quot;</td>
</tr>
<tr>
<td>1875</td>
<td>Maj. N. Michler, succeeded by Major J.M. Wilson</td>
<td>ditto ditto</td>
<td>ditto ditto</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>YEAR</th>
<th>DISTRICT ENGINEER</th>
<th>ENGINEER</th>
<th>DESIGNATION AND LOCATION, DIV. ENG.</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>1876</td>
<td>Major J.M. Wilson</td>
<td>Lt. Col. B. S.</td>
<td>&quot;Senior Engineer; &quot;Improvement of Rivers in Oregon Coast Territory; and in Washington Territory.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1877</td>
<td>Maj. Wilson</td>
<td>ditto</td>
<td>ditto</td>
<td>&quot;Improvement of Rivers in Oregon Coast Territory; and in Washington Territory, and construction of Cascades Canal, Columbia River.&quot;</td>
</tr>
<tr>
<td></td>
<td>Maj. Wilson</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maj. Wilson</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maj. G.L. Gillespie</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1879</td>
<td>Maj. G. L. Gillespie</td>
<td>Apparently</td>
<td>none.</td>
<td></td>
</tr>
<tr>
<td>1880</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1881</td>
<td>Maj. G. L. Gillespie</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1882</td>
<td>Capt. C. F. Powell</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1883</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>1884</td>
<td>(Two offices in operation, beginning August 5, 1884</td>
<td>Lt. Col. G. H.</td>
<td>&quot;Supervising Engineer; &quot;Improvement of Rivers in Oregon &amp; Lower Willamette, Mouth Columbia River, Coos Bay, Yaquina Bay, Ent. to Coquille R., Oregon, and of Skagit, Steilacoomish, Nootsack, Snohomish, and Snoqualmie Rivers, Washington Territory.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maj. W. A. Jones</td>
<td>Capt. C. F. Powell</td>
<td>exact date not ascertained</td>
<td></td>
</tr>
<tr>
<td>1885</td>
<td>Capt. C. F. Powell</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>DISTRICT ENGINEER</td>
<td>DIVISION</td>
<td>DESIGNATION AND</td>
<td>LOCATION, DIV. ENG.</td>
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<tr>
<td>1885</td>
<td>Capt. C.F. Powell</td>
<td>Lt. Col. G.H. Mendell</td>
<td>&quot;Supervising Engineer&quot;</td>
<td>SAN FRANCISCO</td>
</tr>
<tr>
<td></td>
<td>Maj. W.A. Jones</td>
<td></td>
<td></td>
<td>CALIFORNIA</td>
</tr>
<tr>
<td>1886</td>
<td>Capt. C.F. Powell</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Powell took over from Maj. Jones the construction of Cascades Canal</td>
</tr>
<tr>
<td></td>
<td>Maj. W.A. Jones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1887</td>
<td>(Three offices in</td>
<td>operation, all in</td>
<td>PORTLAND, OREGON)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capt. W. Young,</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Young: Ent. to Coos Bay, Yaquina Bay, Mouth Coquille River and Umpqua River.</td>
</tr>
<tr>
<td></td>
<td>July 16, 1887</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1888</td>
<td>Capt. C.F. Powell</td>
<td>ditto</td>
<td>&quot;Division Engineer, Pacific&quot;</td>
<td>Maj. Handbury: Same as Capt. Powell.</td>
</tr>
<tr>
<td></td>
<td>T. H. Handbury,</td>
<td></td>
<td>Division, SAN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>April, 1888</td>
<td></td>
<td>FRANCISCO, CALIF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capt. W. Young,</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Young: Same as 1887, with Tillamook Bay and Bar added.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>operation</td>
<td></td>
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<tr>
<td></td>
<td>Dec. 4, 1889</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capt. W. Young(until Dec. 4, 1889)</td>
<td>ditto</td>
<td>ditto</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capt. Thos. W. Symons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>DISTRICT ENGINEER</td>
<td>ENGINEER</td>
<td>LOCATION, DIV ENGR</td>
<td>REMARKS</td>
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<td>---------</td>
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<tr>
<td>1891</td>
<td>Capt. T. W. Symons</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Symons: Same as for 1890.</td>
</tr>
<tr>
<td>1892</td>
<td>Capt. T. W. Symons</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Symons: Same as for 1891.</td>
</tr>
<tr>
<td></td>
<td>J. C. Post, Nov. 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1894</td>
<td>Capt. T. W. Symons</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Symons: Same as for 1893.</td>
</tr>
<tr>
<td></td>
<td>and then by Capt. R. Suter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR</td>
<td>DISTRICT ENGINEER</td>
<td>ENGINEER</td>
<td>DESIGNATION AND LOCATION, DIV. ENGR.</td>
<td>REMARKS</td>
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</tr>
<tr>
<td>1896</td>
<td>Capt. W. L. Fisk</td>
<td>Col. Chas. R.</td>
<td>&quot;Division Engineer, Pacific Division&quot; SAN FRANCISCO, CALIF.</td>
<td>Capt. Fisk: Same as in 1895 until April 30, after which time his work covered &quot;Improvement of Rivers and Harbors in Oregon, and Lower Columbia River, Oregon and Washington&quot;.</td>
</tr>
<tr>
<td></td>
<td>Capt. H. Taylor,</td>
<td>ditto</td>
<td>ditto</td>
<td>Capt. Taylor: Same as for 1895 until April 30, when he was transferred to Seattle, carrying with him charge of the work formerly under his charge in the Portland District. After April 30, part of the works formerly under Capt. Taylor were transferred to Capt. Fisk.</td>
</tr>
</tbody>
</table>

A-5
<table>
<thead>
<tr>
<th>YEAR</th>
<th>DISTRICT ENGINEER</th>
<th>DESCRIPTION</th>
<th>LOCATION, DIV. ENGR.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>Capt. W. W. Harts</td>
<td>Col. Mansfield</td>
<td>&quot;Division Engineer&quot;, Oregon, of Columbia River above mouth of Willamette, including Snake River, and of Clearwater River.</td>
<td>Same as 1899.</td>
</tr>
<tr>
<td></td>
<td>(Temporarily)</td>
<td></td>
<td>Maj. Langfitt: Same as in 1903.</td>
<td></td>
</tr>
<tr>
<td>1906</td>
<td>Lt. Col. S. W. Roessler</td>
<td></td>
<td>2nd Portland District.</td>
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</tr>
<tr>
<td></td>
<td>Roessler</td>
<td>(PORTLAND)</td>
<td>(PORTLAND)</td>
<td></td>
</tr>
<tr>
<td>1908</td>
<td>Col. Roessler succeeded by Maj. J. F. Biddle (Temporarily), July 11, 1908.</td>
<td>San Francisco</td>
<td>1st Portland District</td>
<td>2nd Portland District.</td>
</tr>
<tr>
<td>YEAR</td>
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<td>LOCATION, DIV. ENGR.</td>
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<td></td>
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<td></td>
<td>Cavanaugh, Sept. 3.</td>
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<td></td>
<td>to Nov. 10,</td>
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<td></td>
<td></td>
<td>1909, then by Capt.</td>
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<td></td>
<td>A. Williams, Nov. 10, 1909 to Dec. 21, 1909.</td>
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<tr>
<td></td>
<td>Maj. J. F. McIndoe</td>
<td></td>
<td></td>
<td>2nd Portland District</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Morrow.</td>
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<td></td>
<td></td>
<td>Maj. J. F. McIndoe</td>
</tr>
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<td></td>
<td>2nd Portland District</td>
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<tr>
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<td>Rees.</td>
</tr>
<tr>
<td></td>
<td>Maj. J. F. McIndoe</td>
<td></td>
<td></td>
<td>2nd Portland District</td>
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<td></td>
<td></td>
<td></td>
<td>Rees.</td>
</tr>
<tr>
<td></td>
<td>Maj. J. F. McIndoe</td>
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<td></td>
<td>2nd Portland District</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>Morrow, Dec. 3, 1913</td>
</tr>
<tr>
<td></td>
<td>Maj. McIndoe</td>
<td></td>
<td></td>
<td>succeeded by Maj. J. B. Biddle.</td>
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<td></td>
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<td></td>
<td>McKinstry.</td>
</tr>
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<td></td>
<td>May 13, 1914.</td>
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<td>May 13, 1914.</td>
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<td></td>
<td></td>
<td>McKinstry.</td>
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<td>Jan. 5, 1914.</td>
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<td>YEAR</td>
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<td>DESIGNATION AND YEAR</td>
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<tr>
<td></td>
<td>Lt. Col. C. H. McKinstry</td>
<td>succeeded by Lt. Col. J. J. Morrow (Mar. 31 to July 31) then by Maj. A. Williams</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1915</td>
<td>July 31 to Nov. 8, then by Lt. Col. C. L. Potter</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Potter on Nov. 8, 1915</td>
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<td></td>
<td></td>
<td>Remarked:</td>
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<tr>
<td></td>
<td></td>
<td>J. B. Cavanaugh succeeded by Col. G. A. Zinn</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>succeeded by Lt. C. L. Potter then by Lt. Col. J. B. Cavanaugh</td>
<td></td>
<td>2nd Portland District</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. L. Potter succeeded by Maj. H. C. Jewett on Feb. 29, 1916</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1917</td>
<td>Maj. H. C. Jewett</td>
<td>succeeded on Jan. 25 by Maj. A. A. Fries, then by Maj. E. J. Dent on Apr. 9, then by Col. G. A. Zinn on May 31</td>
<td>Portland, Oregon</td>
<td>1st Portland District</td>
</tr>
<tr>
<td></td>
<td>Lt. Col. Gavenh</td>
<td>succeeded by Maj. H. C. Jewett</td>
<td>2nd Portland District</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>succeeded by Col. G. A. Zinn on May 31</td>
<td></td>
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<tr>
<td>1918</td>
<td>Col. G. A. Zinn</td>
<td>succeeded by Col.</td>
<td>Portland, Oregon</td>
<td>1st Portland District</td>
</tr>
<tr>
<td></td>
<td>Col. G. A. Zinn</td>
<td>succeeded by Col. G. A. Zinn</td>
<td>2nd Portland District</td>
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<td>YEAR</td>
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<td>DESIGNATION AND ENGINEER</td>
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<tr>
<td>1919</td>
<td>Col. Zinn succeeded: Col. Zinn, succeeded by Lt. Col. J. B. Cavanaugh on Sept. 10.</td>
<td>1st Portland District</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
</tr>
<tr>
<td>1920</td>
<td>Lt. Col. J. B. Cavanaugh succeeded by Maj. R. Park on Aug. 17.</td>
<td>2nd Portland District</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
</tr>
<tr>
<td>1921</td>
<td>Lt. Col. J. B. Cavanaugh succeeded by Maj. R. Park.</td>
<td>1st Portland District</td>
<td>SEATTLE, WASH.</td>
<td>----</td>
</tr>
<tr>
<td>1922</td>
<td>Col. Cavanaugh succeeded by Maj. R. Park.</td>
<td>1st Portland District</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
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<tr>
<td>1924</td>
<td>Maj. George Mayo succeeded by Col. W. J. Barden.</td>
<td>1st Portland District</td>
<td>SEATTLE, WASH.</td>
<td>----</td>
</tr>
<tr>
<td>1925</td>
<td>Maj. Mayo succeeded by Maj. R. T. Coiner.</td>
<td>2nd Portland District</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
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<tr>
<td>1926</td>
<td>Maj. R. T. Coiner succeeded by Maj. R. T. Coiner.</td>
<td>1st Portland District</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
</tr>
<tr>
<td>1927</td>
<td>Maj. Coiner succeeded by Col. Barden.</td>
<td>Seattle</td>
<td>PORTLAND, OREGON</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>Maj. Coiner succeeded by Col. Barden.</td>
<td></td>
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<tr>
<td></td>
<td>Maj. Coiner succeeded by Col. Barden.</td>
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<td></td>
<td>Maj. Coiner succeeded by Col. Barden.</td>
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<tr>
<td></td>
<td>Maj. Coiner succeeded by Col. Barden.</td>
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**NOTE:** In 1926 the two districts were consolidated into the PORTLAND, OREGON, DISTRICT.
<table>
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<th>LOCATION, DIV. ENGR.</th>
<th>REMARKS</th>
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<tr>
<td></td>
<td>(Cont) 4/27/27 to 7/31/27</td>
<td>Maj. George Mayo</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>8-1-27 to 10-4-27</td>
<td></td>
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<tr>
<td>1929</td>
<td></td>
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<tr>
<td>1930</td>
<td>Lt. Col. G.R. Lukesh</td>
<td></td>
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<tr>
<td></td>
<td>succeeded by Major</td>
<td>Oscar O. Kuentz</td>
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<td></td>
<td></td>
<td>7-27-30</td>
<td></td>
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<tr>
<td></td>
<td>succeeded by Lt.</td>
<td>Col. T. M.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Robins, 8-31</td>
<td>San Francisco, Cal</td>
<td></td>
</tr>
<tr>
<td>1932</td>
<td>Maj. Oscar O. Kuentz</td>
<td>Lt. Col. T. M. Robins</td>
<td></td>
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<tr>
<td>1933</td>
<td>Maj. Oscar O. Kuentz</td>
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<tr>
<td></td>
<td>succeeded by Major</td>
<td>C. F. Williams</td>
<td></td>
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<td></td>
<td></td>
<td>7-21-33</td>
<td></td>
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<tr>
<td>1934</td>
<td>Maj. C. F. Williams</td>
<td></td>
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<td></td>
<td></td>
<td>San Francisco, North Pacific Div</td>
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<td></td>
<td></td>
<td>Customhouse, Portland, Oregon</td>
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<td></td>
<td>7-1-34</td>
<td></td>
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<tr>
<td>1935</td>
<td>Maj. C. F. Williams</td>
<td>Col. T. M. Robins</td>
<td>Portland, Oregon</td>
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<td></td>
<td>Portland, Oregon</td>
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<tr>
<td></td>
<td>District divided</td>
<td></td>
<td>Portland, Oregon, District</td>
<td>divided May 1, 1935, into two districts.</td>
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<td>May 1, 1935.</td>
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<tr>
<td></td>
<td>Maj. Milo P. Fox</td>
<td></td>
<td></td>
<td>First Portland District, Customhouse, Portland, Oreg.</td>
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<tr>
<td></td>
<td>Maj. C. F. Williams</td>
<td></td>
<td></td>
<td>Second Portland District, Pittock Block, Portland, Oreg.</td>
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<td></td>
<td>Maj. Williams pro-moted to Lt. Col., 8-1-35</td>
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<td></td>
<td>Maj. Fox promoted to Lt. Col. 8-1-35</td>
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A-10
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<tr>
<td>1937</td>
<td>Lt. Col. Fox</td>
<td>Col. T. M.</td>
<td>Portland, Oregon</td>
<td>Portland, Oregon, District, effective 7-1-37. (Formerly First Portland District.). Offices moved from Customhouse to Pittock Block, 1-1-38.</td>
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<tr>
<td></td>
<td>succeeded by Capt.</td>
<td>S.L. Robins</td>
<td>Damon, 6-3-37.</td>
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<tr>
<td></td>
<td>Capt. Damon</td>
<td></td>
<td>promoted to Major</td>
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</tr>
<tr>
<td></td>
<td>Lt. Col. C.F. Williams</td>
<td>&quot;</td>
<td></td>
<td>Portland, Oregon, District</td>
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<td>Lt. Col. Williams</td>
<td>&quot;</td>
<td>succeeded by Capt.</td>
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<tr>
<td></td>
<td>Colby M. Myers</td>
<td></td>
<td>6-11-37.</td>
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<td></td>
<td>Capt. Myers</td>
<td>&quot;</td>
<td>succeeded by Major</td>
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<td></td>
<td>Theron D. Weaver</td>
<td></td>
<td>7-8-37.</td>
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<tr>
<td>1938</td>
<td>Lt. Col. T. M.</td>
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<td>North Pacific Division.</td>
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<td>Robins succeeded</td>
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<td>Lt. Col. Lee</td>
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<td></td>
<td>succeeded by Major</td>
<td></td>
<td>Lee</td>
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<td></td>
<td>C. R. Moore</td>
<td></td>
<td>8-1-38.</td>
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<td>1939</td>
<td>Major Weaver</td>
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<tr>
<td>1940</td>
<td>Capt. Elliott</td>
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<td>promoted to Major</td>
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<td></td>
<td>3-1-40</td>
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<tr>
<td></td>
<td>Major Moore</td>
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<td>promoted to Lt. Col.</td>
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<td>8-9-40</td>
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<td>Maj. Elliott relieved, 12-27-40</td>
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<td>No successor</td>
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<td>1941</td>
<td>Lt. Col. Moore</td>
<td>Portland District</td>
<td>Portland District. Bonneville District consolidated with Portland District Jan. 1, 1941</td>
<td>GCE GO #10 - 12/27/40</td>
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<td>succeeded by Col. J. Leechey</td>
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<td>Lt. Col. Moore promoted to Col.</td>
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<td>12-24-41</td>
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<tr>
<td>1942</td>
<td>Col. Moore succeeded by Lt. Col. Leehey</td>
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<td></td>
<td>Leehey 4-4-42</td>
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<td></td>
<td>Lt. Col. Leehey promoted to Col.</td>
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<td>7-4-42</td>
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<tr>
<td></td>
<td>Col. R. Park</td>
<td>Salt Lake City, Seattle as Dist. Engr.</td>
<td>转移至犹他州, 12-1-42</td>
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<td></td>
<td>Warren T.</td>
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<tr>
<td>1943</td>
<td>Col. D.J. Leehey succeeded by Lt. Col. Hannum</td>
<td>Pacific Division</td>
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<td></td>
<td>R.A. Tudor 5-25-43</td>
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<td>YEAR</td>
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<tr>
<td>1944</td>
<td>Lt. Col. R.A. Tudor</td>
<td>Col. E.C. Kelton</td>
<td>Salt Lake City</td>
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<tr>
<td></td>
<td>promoted to Col.</td>
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<td>(temp) 1-1-44</td>
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<tr>
<td></td>
<td>Col. E.C. Kelton</td>
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<td>Division Office moved from Salt Lake City to S.F. Effective 2-28-44</td>
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<td></td>
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<td>Col. G.J. Zimmerman as Acting District</td>
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<td>Engineer 12/18/45</td>
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<td>succeeded by Col.</td>
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<tr>
<td></td>
<td>Col. R.A. Tudor</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>succeeded by Col.</td>
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<tr>
<td></td>
<td>Col. S.E. Nort-ner</td>
<td></td>
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<td>Engine 7-1-49</td>
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<td>D.S. Burns 11-15-49</td>
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<td>Col. O. E. Walsh</td>
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<td>Promoted to Brig. General on 1-24-51</td>
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