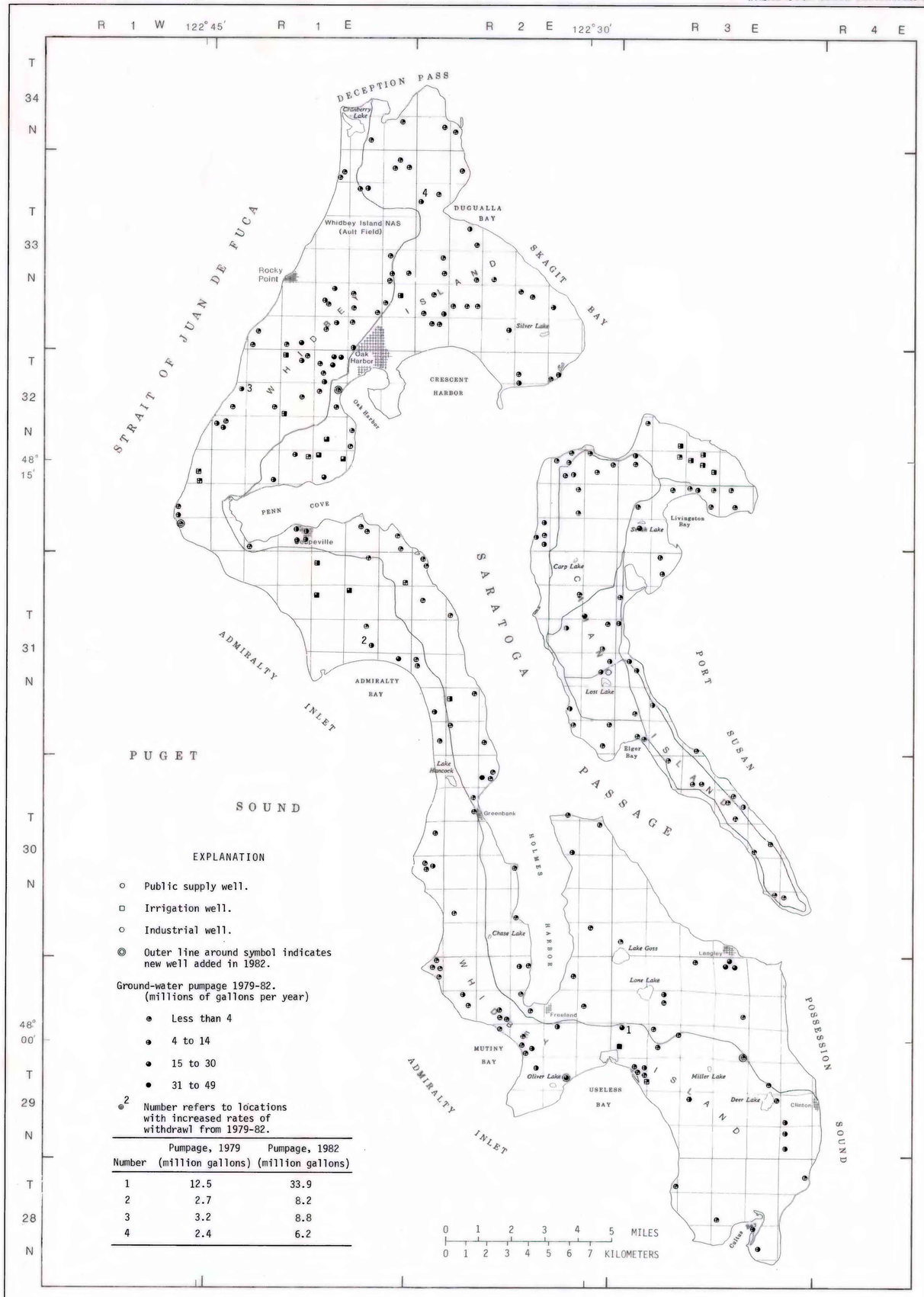

EXPLANATION

- ○ Public supply well.
- □ Irrigation well.
- ○ Industrial well.
- ◎ Outer line around symbol indicates new well added in 1982.

Ground-water pumpage 1979-82.
(millions of gallons per year)

- ● Less than 4
- ● 4 to 14
- ● 15 to 30
- ● 31 to 49
- ● 2 Number refers to locations with increased rates of withdrawl from 1979-82.

Number	Pumpage, 1979 (million gallons)	Pumpage, 1982 (million gallons)
1	12.5	33.9
2	2.7	8.2
3	3.2	8.8
4	2.4	6.2

Ground-Water Occurrence and Use

RECHARGE AND DISCHARGE

The idealized movement of freshwater in the ground-water reservoir is shown in figure 1. As indicated by the arrows, recharge derived from precipitation infiltrates into the ground and percolates downward to the water table. Ground water discharges from the aquifer through streams, springs, the sea bottom, and evapotranspiration, and by pumping from wells.

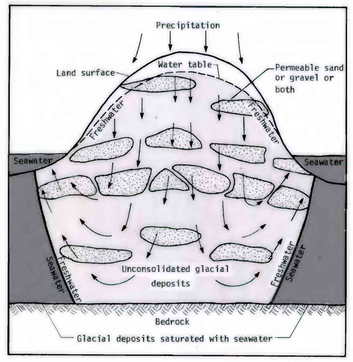

FIGURE 1.--Idealized movement of ground water in a vertical section. (Arrows indicate direction of movement)

Most recharge occurs during winter and spring months when precipitation is high and when water consumption by evaporation and plants is low. On the basis of land use and precipitation estimates, 20 to 70 percent of the yearly precipitation of Island County actually recharges the aquifers; the remainder either runs off in streams or is lost by evaporation and plant transpiration. In general, recharge is high in areas with sand or gravel from the land surface to the aquifer, and lower in areas of silt and clay. The county has few areas where manmade structures have reduced recharge on a regional basis.

Ground-water outflow to the sea and from wells probably accounts for most of the ground-water discharge in Island County. There are few streams in the county and no stream discharge data are available. There are many springs along the sea cliffs and shoreline, but very little information exists on the amount of spring discharge. The springs are located in the following areas.

1) Discontinuously along the west coast of Camano Island;
2) The west coast of Livingston Bay, Camano Island;
3) The northeast coast of Whidbey Island near Dugualla Bay;
4) The east coast of Crescent Harbor, Whidbey Island;
5) Discontinuously along the west coast of Whidbey Island, south of Rocky Point;
6) The east coast of Useless Bay on southern Whidbey Island;
7) Discontinuously along the southeast coast of Whidbey Island from Langley to Cutlus Bay;
8) Discontinuously along the west coast of Whidbey Island south of Admirality Bay;
9) In a small area on the west coast of Whidbey Island south of Coupeville.

WATER LEVELS

Water levels fluctuate in response to changes in the rates of recharge and discharge. In a typical year, ground-water levels are lowest in late summer when precipitation is low and when pumping and evapotranspiration are high. Conversely, water levels are highest in early spring following recharge from winter rains and when pumpage and evapotranspiration are low. An analysis of water-level data for units C and D collected in 1980 revealed an average decline of about 1 foot from April to August. The ranges in water levels for each aquifer are listed in table 1, sheet 2.

The long-term effects of pumping on ground-water levels in the county are presently unknown. A comparison of the water-level data collected in April 1980 with the water-level data for a few wells also measured in the early 1960's indicated that 1980 water levels were generally within 1 or 2 feet of the water levels measured in the 1960's at those locations. Although no consistent pattern of water-level change was observed for the period 1964-80 throughout most of the county, there is an area of heavy pumping immediately west of Oak Harbor where water levels have dropped 4 to 5 feet since 1964.

Water levels were measured in aquifer units C, D, and E from 1980 to 1983. The number of wells measured during this time ranged from 194 in April 1980 to 147 in August 1980. Water levels in units A and B were based on the water-level measurements taken from the piezometers placed in the eight test wells drilled in 1983.

The pumping water level in a well is lower than the non-pumping water level, and those wells drilled below sea level can potentially be affected by seawater intrusion. Ground-water withdrawals from an aquifer that discharges below sea level can lower the water level in that aquifer and decrease the amount of freshwater which discharges to the ocean, thereby allowing seawater to intrude the aquifer. Water-level declines in a pumping well can cause the upward movement of seawater that exists beneath the freshwater zone underneath the island. This upward movement can result in seawater intruding a well or wells, depending on such factors as duration of pumping, depth of the well, drawdown in the well, and distance to the underlying seawater.

The primary sources of ground water for Island County, and the most productive zones found to date, are the unconsolidated sand deposits of units C and D (see sheet 3). Wells that tap units C and D generally have non-pumping water levels that are less than 30 feet above sea level in most areas of Whidbey and Camano Islands.

Water levels in wells that tap unit E may experience considerably larger fluctuations in response to seasonal changes in recharge than wells tapping units C and D, because of its limited vertical and areal extent compared to the other two aquifers.

GROUND-WATER USE

Distribution and rates of ground-water withdrawals were estimated for 1979 through 1982. Table 1 shows the annual pumpage for public supply, domestic, irrigation, and industrial use from Island County for the period 1979 to 1982.

Water is also imported from the Skagit River by the Skagit River pipeline service on the mainland to supply the domestic needs for part of northern Whidbey Island (table 2).

TABLE 1.--Total pumpage for Island County, 1979-1982.

Year	Population	Pumpage, in million gallons per year: Public supply	Domestic	Irrigation	Industrial	Total pumpage, in billion gallons per year
1979	40,200	1,000	97	420	10	1.53
1980	44,048	1,003	168	420	10	1.60
1981	45,200	1,040	187	420	10	1.66
1982	46,000	1,100	200	420	10	1.73

TABLE 2.--Annual importation of water from the Skagit River, 1979-82.

Year	Water imported, in million gallons per year
1979	629
1980	589
1981	609
1982	565

Public Supply

For the purpose of this investigation, all water-supply systems classified as class 1, 2, and 3 by the State of Washington Department of Ecology were designated as public supplies. Class designations are based on the number of services, and are as follows:

- Class 1 - community system, 100 services or more
- Class 2 - community system, 10 to 99 services
- Class 3 - noncommunity system, at least 25 people
- Class 4 - community and noncommunity systems, 2 to 9 services or less than 25 people.

Ground-water withdrawals for public supplies totaled an estimated 1 billion gallons of water for 1979.

Domestic

The amount of ground water withdrawn for domestic use from privately owned wells and class 4 water sytems in 1979 was estimated to be 97 million gallons. The domestic and class 4 pumpage estimate was computed by taking the total Island County population for each year, subtracting the persons served by the Skagit River pipeline service, and multiplying by 100 gallons per day per person.

Irrigation

From 1979 to 1982, an estimated 420 million gallons per year of irrigation water was pumped (table 1). This rate of withdrawal represents an increase of 38 percent over that reported for 1963 (Anderson, 1968). The major irrigated areas are at the northern end of Camano Island and near Oak Harbor and Coupeville on northern Whidbey Island (see map).

Most of the 21 irrigators shown on this map begin pumping in mid-May and pump an average of 12 days a month through the middle of September (fig. 2). Most of the wells are pumped at a rate of 200 to 300 gallons per minute, and the average annual application rate is 1 acre-foot of water per acre.

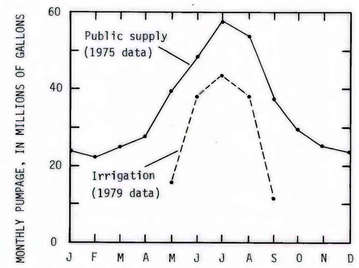

FIGURE 2.--Seasonal variation in pumpage rates in Island County.

Industrial

Industrial activities in Island County from 1979 to 1982 were small. Based on the survey done in 1983, an estimated 10 million gallons of water was used each year for commercial and industrial purposes from 1979 to 1982 for gravel washing, chicken raising, and egg processing.

Shown on the map are the pumpage distribution and rates for public supply, irrigation, and industrial wells for 1979 to 1982. Domestic and class 4 public-supply wells are not shown.

Total pumpage in 1980 increased by 5 percent over 1979 (table 1), mostly because of increased withdrawals from domestic wells. Total pumpage in 1981 and 1982 increased by 4 percent over 1980 and 1981, respectively, because of increases in withdrawal for public supply and domestic wells.

The total pumpage in 1982 was 1.73 billion gallons, an increase of 204 million gallons or a 13 percent increase over 1979.

Analysis of data collected during this study show that the population of the county increased by 14 percent and the total ground-water withdrawal increased by 13 percent. The largest increase was in domestic supply pumpage which more than doubled. Public supply pumpage increased by 10 percent and no significant increases occurred in irrigation and industrial supply pumpage.

OCCURRENCE OF GROUND WATER AND POTENTIAL FOR SEAWATER INTRUSION, ISLAND COUNTY, WASHINGTON

By M. A. Jones

1985

ITEM 1
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BASE SHEET. TYP
for PLATES 1, 2,