STATUS OF THE WATER SUPPLY AT THE DEPARTMENT OF WILDLIFE'S GREEN RIVER REARING PONDS, NEAR KANASKET, WASHINGTON

Linton Wildrick

Open-File Technical Report 94-06

This Open-File Technical Report presents the results of a hydrologic investigation by the Water Resources Program, Department of Ecology. It is intended as a working document and has received internal review. This report may be distributed to other agencies and to the public, but it is not a formal Department of Ecology publication.

Author: Linton Wildrick

Reviewed by: Robert S. Garrigues

Supervisor: Gary E. Hansen

TABLE OF CONTENTS

ILLUSTRATIONS

PHOTOGRAPHS

STATUS OF THE WATER SUPPLY AT THE DEPARTMENT OF WILDLIFE'S GREEN RIVER REARING PONDS, NEAR KANASKET, WASHINGTON

INTRODUCTION

At the request of the Washington Department of Wildlife, I conducted a brief investigation of the water-supply conditions at a hillside spring (Wolschlagel Spring #1) located on the Department of Wildlife's property at the Green River Rearing Ponds near Kanasket, Washington. In addition to supplying a portion of the water supply to the rearing ponds, this spring provides water to a number of nearby homes (surface-water right S1-00290C, 1971). In particular, I was asked to investigate whether the fish-rearing operations at the ponds have reduced the spring's discharge, as alleged by some of the neighbors.

METHODS

On September 22, 1993, I inspected files at the Attorney General's Department of Wildlife office in a search for technical information concerning the water supply at the ponds and spring. I reviewed a related technical report on the Flink Water Supply, written September 2, 1992, by Mark Utting of Pacific Groundwater Group (the Flink Water Supply comes from Wolschlagel Spring #1). I also reviewed water-quality data on samples from the ponds and springs and reviewed other related letters.

On September 23, 1993, I visited the Green River Rearing Ponds facility in order to view the geologic and hydrologic conditions in the area and to learn more about the water-supply operations from Stewart Mercer, manager. Later, Mr. Mercer sent me the data for the weir through which the ponds discharge to Spring Creek.

In addition, I gathered information on the surficial geology, topography, climate, and water wells in the vicinity. I obtained several well logs from Department of Ecology files for the area within one mile of the rearing ponds.

FINDINGS

Location

The Green River Rearing Ponds occupy a floodplain terrace on the banks of the Green River, Township 21 North, Range 7 East, section 10, in King County, near the villages of Kanasket and Palmer, Washington (Figure 1).

Physiography

Prominent features near the ponds include:

* the Green River channel, about 100 feet wide,
* the flood plains on both sides of the river (variable width from 10 to several hundred feet),
* a steep slope, approximately 50 feet high, on the north side of the rearing ponds and bounding the north side of the river valley, and
* upland terraces above and on both sides of the river valley.

The Green River meanders through this glaciated region, having scoured away a well-defined valley through glacial sediments and, in places, into bedrock. Less than one mile downriver from the rearing ponds, the river occupies the Green River Gorge, an even deeper, steep-sided chasm cut into bedrock.

Geology

Near the rearing ponds, both glacial sediments and bedrock outcrop on the steep northeastern wall of the valley. Only glacial sediments -- composed of course-grained sand, gravel, and cobbles -- can be seen immediately adjacent to the ponds. The springs flow from this material and supply the ponds and nearby residents. Most of the wells in the area produce water from these materials. Well yields vary but generally are less than 100 gallons per minute (gpm). All the wells situated up-slope (and up-gradient in the aquifer) of the springs produce only small volumes of water for single homes. Department of Ecology has no information indicating aquifer depletion in the area.

Luzier (1969) found that the glacial deposits in the area range from 0 to 300 feet thick, however, he had only a few driller's logs on which to base this estimate. Well logs from Ecology's files at the Northwest Regional Office indicate that few wells were drilled down to bedrock.

Sedimentary bedrock of the Puget Group outcrops a couple

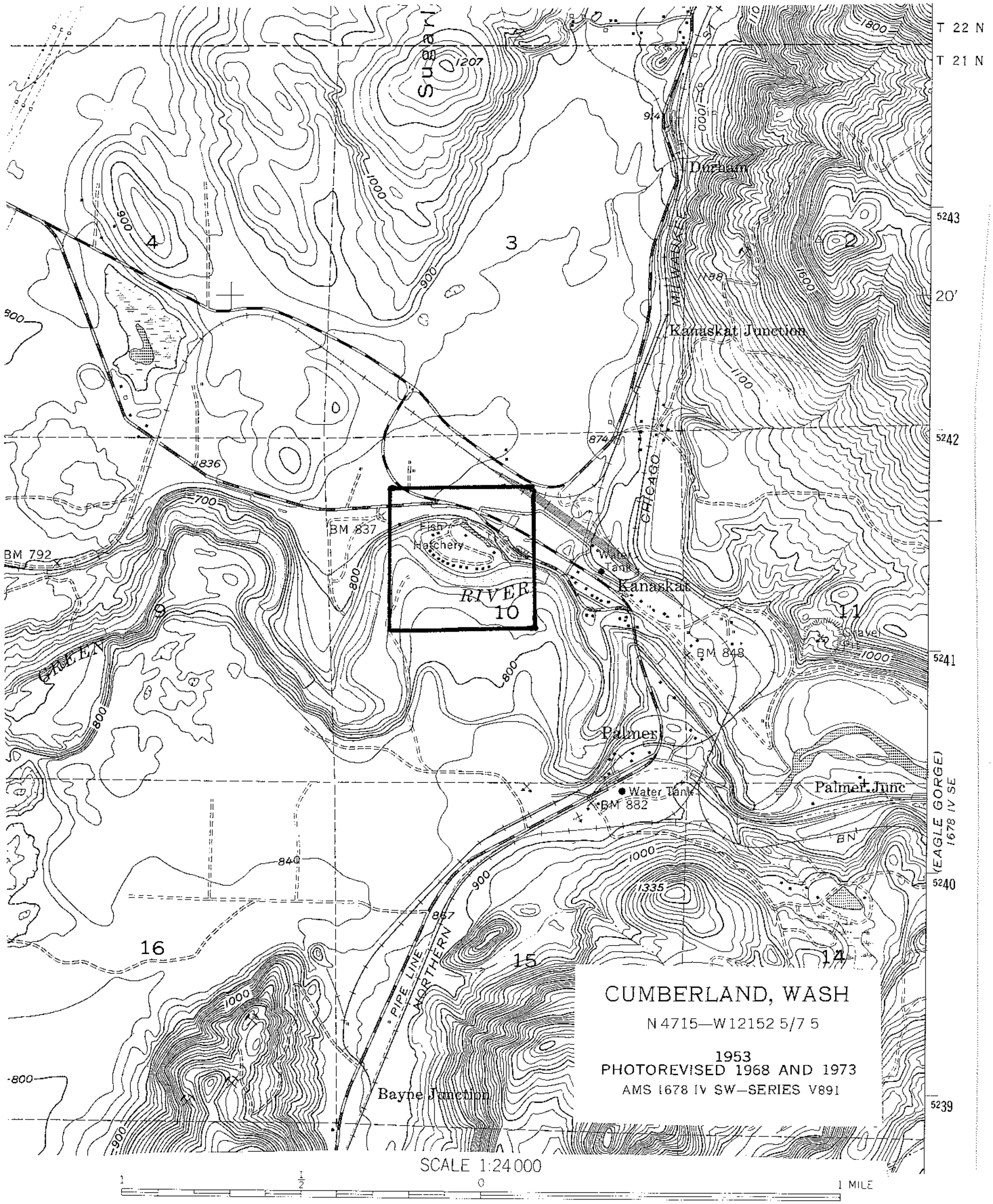

Figure 1. Map of Green River Rearing Ponds (site located inside box at center) and surrounding terrain

Sedimentary bedrock of the Puget Group outcrops a couple hundred yards upstream (east) and downstream (west) of the rearing ponds (Luzier, 1969; Gower and Wanek, 1963). A small block of volcanic rock crops out east of the ponds in the midst of the sedimentary rocks. The bedrock contains fractures but generally supplies only small amounts of ground water to wells (Luzier, 1969). The Green River Tavern obtained a small supply - 2½ gallons per minute (gpm) - from the sandstone bedrock east of the rearing ponds. More recent logs for wells within a mile of the rearing ponds indicate a variable depth to bedrock of 38 to 100 feet. In places, such as in part of the State Park across the Green River from the rearing ponds, exploratory wells found no water in the glacial sediments above bedrock, probably where the sediments thinned above bedrock rises.

The glacial deposits in the area have not been mapped in great detail. Because of the economic interest in the coal deposits within the Puget Group rocks, the geologic maps for the area focus mostly on the details of the bedrock. As a result, I found no published information on the layering and character of the glacial sediments comprising the steep hillside adjacent to the ponds. Heavy vegetation and colluvium[1] covers most of the hillside. During a cursory examination of the slope, I observed unstratified, poorly sorted sands, gravels, and cobbles.

<u>Climate</u>

The climate in the area is typical of the Puget Sound Region. The usually abundant water supply depends largely on the wet, cool but otherwise mild winters. The lack of rain and high evapotranspiration during the cool, dry summers results in low streamflow and reduced discharge of ground water from springs during late summer and early fall.

The annual precipitation from 1931 through 1992 varied between 58 and 126 inches (Figure 2) and averaged about 86 inches. Annual precipitation appears to randomly vary but does not exhibit a long-term increase or decrease. The recent period 1982-1992 experienced approximately average precipitation with six years above average and 5 years below average.

---

[1] Material eroded from upslope.

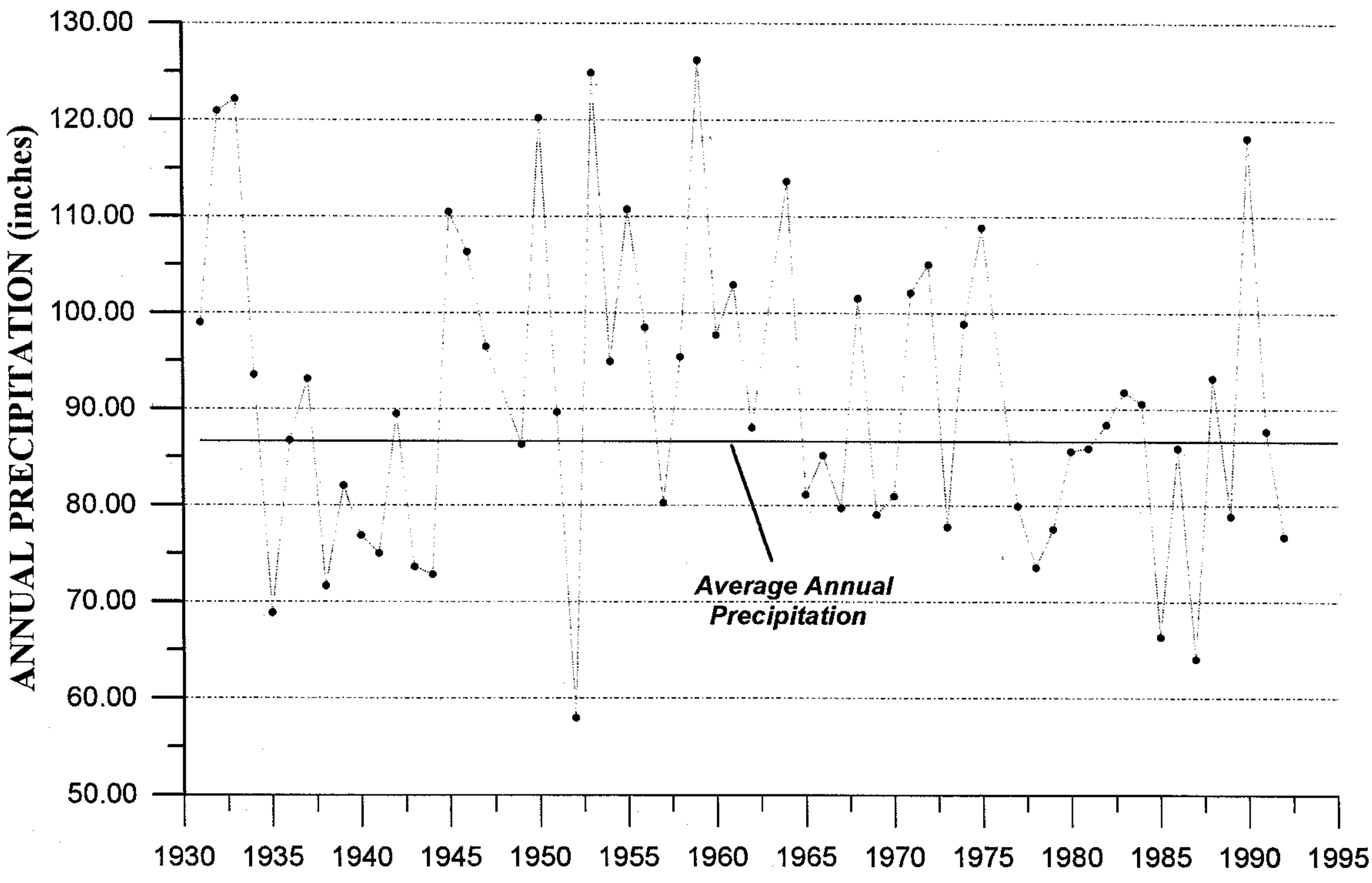

Figure 2. Total Precipitation (Rain + Snow) at Palmer 3 ESE Weather Station (EarthInfo, 1993)

Ground-Water Occurrence and Flow

Ground water in the vicinity of the rearing ponds originates as precipitation. Throughout the glaciated Puget Lowlands, the ground-water levels (head) in the shallower aquifers rise within days or weeks following heavy storms, as the water percolates from the surface down to the aquifer. Between storms, the ground water drains away toward streams and the heads gradually decline. Thus, the rise and fall of ground-water levels correlates well with seasonal or monthly precipitation (Figure 3).

Topography Controls Ground-Water Flow

The lowest topographic feature in the area near the rearing ponds is the Green River channel. The river valley cuts entirely through the glacial sediments, exposing the bedrock. Therefore, all but the deepest ground water (flowing through the bedrock) drains to the Green River. This accounts for the numerous springs distributed along the bluff next to the rearing ponds. Probably, only a tiny fraction of the ground water penetrates into the relatively non-conductive (aka impermeable) bedrock and flows toward more distant river reaches.

Discharge From Springs in the Area Surrounding the Rearing Ponds

Hydraulic gradient -- the change in head, or ground-water level, extending from within the aquifer to the point of discharge -- drives the rate of ground-water discharge at springs and other seepage points along valleys or low areas. When the head rises in the aquifer, the hydraulic gradient increases which, in turn, increases the ground-water-flow rate and rate of discharge to springs and seeps. Head in an aquifer rises during the period of greatest recharge and falls during the period of lowest recharge.

Measurements of ground-water levels (Figure 3) demonstrate that the highest water levels near the Green River occur as a result of recharge during the winter. The hydrograph of discharge for water years 1962 through 1965 from spring 21N/7E-30N1s (Figure 3), located about 4 miles southwest of the rearing ponds, exhibits the same pattern of seasonal fluctuations as does ground-water head. This demonstrates the direct relationship between rises in ground-water levels and increased discharge from springs in the area.

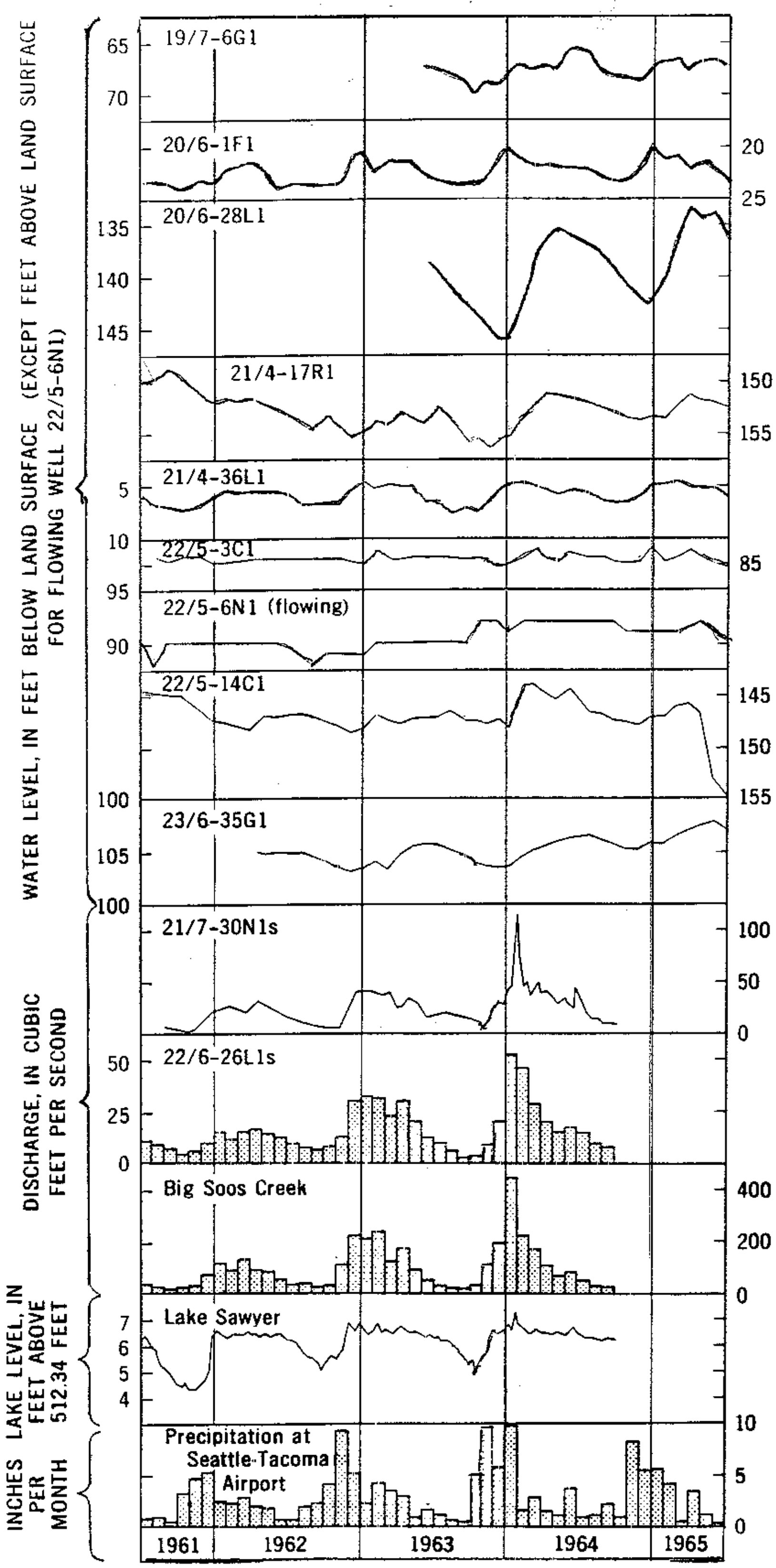

Figure 3. Hydrographs of wells, springs, Big Soos Creek, Lake Sawyer, and monthly precipitation at Seattle-Tacoma Airport, 1961-65 (reproduced from Luzier, 1969)

Construction and Operation of the Rearing Ponds

Prior to construction of the present rearing ponds during 1969, another privately-owned hatchery operated at the site. Four small ponds occupied the approximate area of the what is now the Upper Pond (map of the Topography and Grading Plan, Department of Game, February, 1968). Water-surface elevations of the former ponds ranged from about 104 feet in the eastern-most pond to about 100 feet in the western-most pond. These ponds were fed by springs along the bluff. Five of these springs emerged between elevations 100 to 105 feet; another four springs emerged between elevations 105 to 110; one spring emerged at elevation 117; and two springs, including Wolschlagel Spring #1, emerged between 120 to 122 feet. During my visit, I observed flow or seepage only from the spring at 117 feet and from Wolschlagel Spring #1.

The present rearing facility contains two ponds, referred to as the Upper Pond and the Lower Pond.

The Upper Pond (Photo 1) covers about 0.4 acre to a maximum depth of 12 to 13 feet and drains to the west into the Lower Pond. The pond's surface lies at elevation 109 feet, that is, about 5 to 9 feet higher than the former ponds. At this elevation, the Upper Pond submerges 7 or 8 of the springs which fed the former ponds. A discharge pipe through the eastern embankment of the Upper Pond drains to a small creek flowing eastward into the Green River (Photo 2). This drain operates only when the manager wishes to empty the Upper Pond. Several springs discharging from the glacial sediments and some leakage from the Upper Pond create a small, perennial creek which flows eastward into the Green River (Photo 3).

The Lower Pond covers approximately one acre to a maximum depth of 7 to 8 feet (Photo 4). The grading plan indicates that, formerly, five springs emerged from the bluff between elevations 101 to 103; these spring flowed directly into Spring Creek. The Lower Pond's surface lies at about 105 feet and submerges the five springs. I observed a few seeps along the bluff above the pond. These are not shown on the grading plan and may indicate a hydrologic change. Mr. Mercer, the site manager, explained that these springs flow noticeably during wetter seasons.

At its west end, the Lower Pond discharges into a drop box and culvert which leads to a concrete flume (Photo 5). At the downstream end of the flume, a dual, sharp-crested weir (Photo 6) discharges into another drop box and buried culvert. The culvert then discharges westward, forming the headwaters of Spring Creek, which flows only a few hundred feet before joining the Green River.

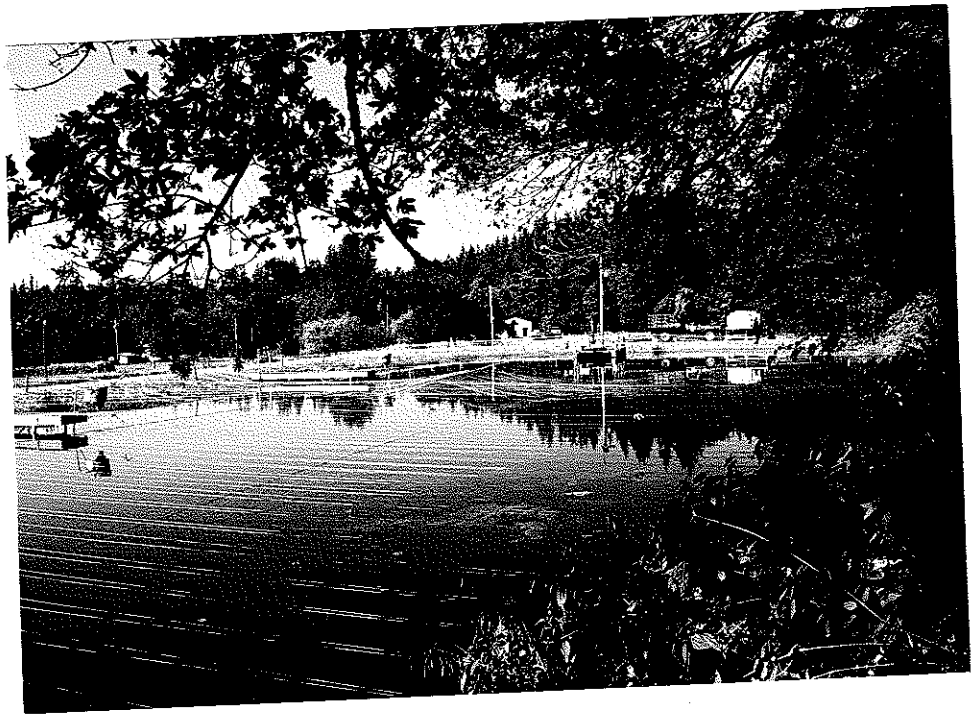

Photo 1. View west from base of bluff across Upper Pond.

Photo 2. View looking east at drain device for Upper Pond. Green River located about 100 feet beyond end of parking area.

Photo 3. View looking east along small stream draining from Upper Pond and from springs along base of bluff.

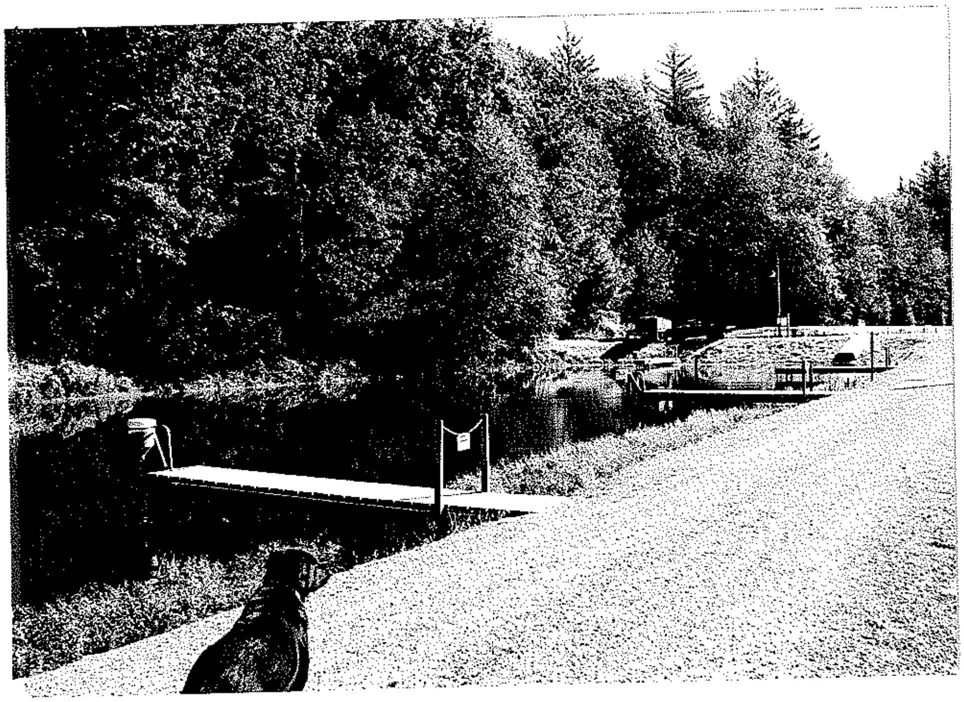

Photo 4. View looking northeast across Lower Pond. Berm of Upper Pond in background. Bluff to the left.

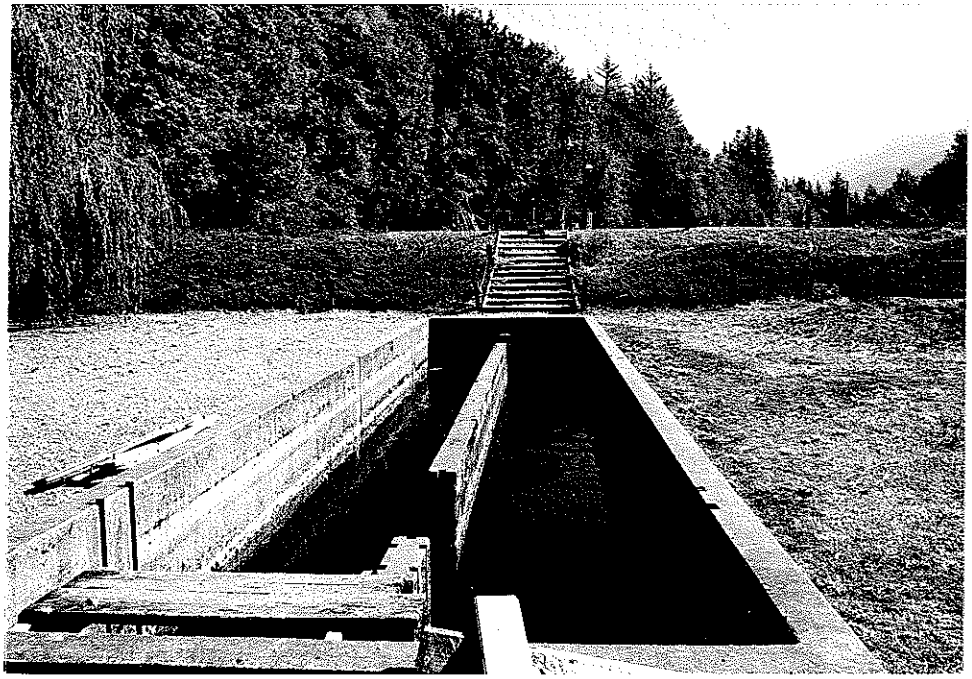

Photo 5. View looking east toward berm of Lower Pond. Flow in flume draining Lower Pond is toward the camera.

Photo 6. Double, sharp-crested weir and dropbox at west end of flume.

Discharge from Wolschlagel Spring #1 and Other Springs Near the Rearing Ponds

At Wolschlagel Spring #1, a metal barrel, about 20 inches in diameter and partially buried in the gravelly sediment, prevents debris from blocking the flow (Photo 7). From the barrel, the water courses eastward through a 6-inch iron pipe (Photo 8) to a concrete reservoir (Photo 9) located at the base of the bluff and adjacent to the east end of the Upper Pond. I observed flow from the reservoir's overflow pipe into the pond. The Topographic and Grading Plan indicates two springs, located about 10 feet apart, in the approximate location of the current spring. A 6-inch-wide wooden flume carried water from the spring at elevation 122 and a 6-inch-diameter iron pipe carried water from the spring at elevation 120. The latter is probably the present-day Wolschlagel Spring #1 and the iron pipeline may be the same as indicated on the Topographic and Grading Plan.

I found no records of measurements of the flow from Wolschlagel Spring #1. The only records for the vicinity consist of measurements, starting in 1986, at the weir where the rearing ponds spill into Spring Creek.

Photo 7. Top of metal drum surrounding Wolschlagel Spring #1.

Photo 8. Six-inch diameter iron pipe from Wolschlagel Spring #1. Spring in upper center.

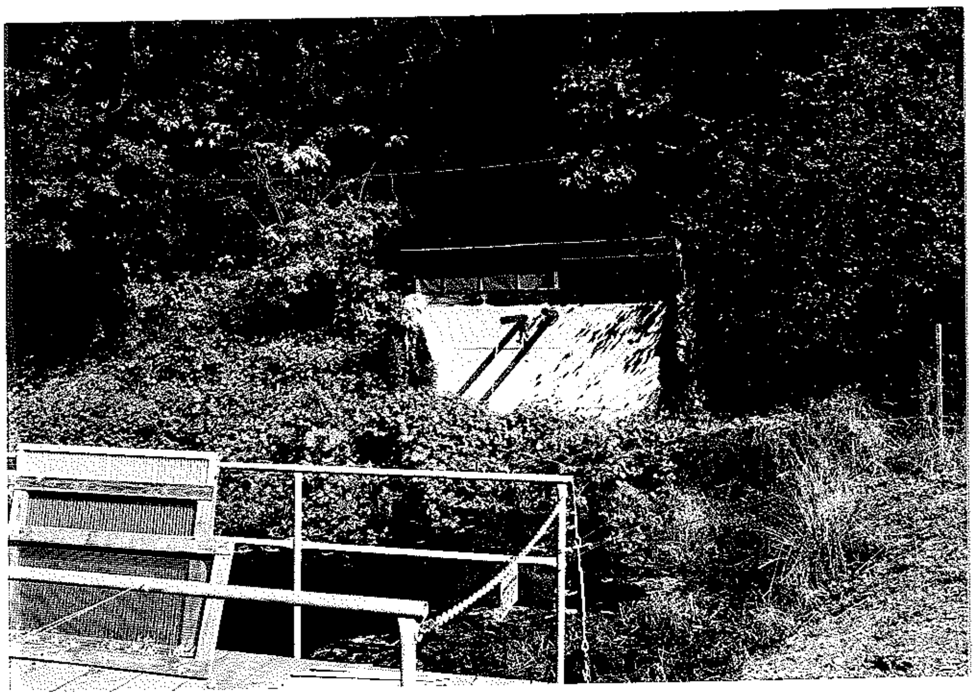

Photo 9. Reservoir for Wolschlagel Spring #1. Note stream of water from pipe on left. Upper Pond in left foreground and berm in right foreground.

CONCLUSIONS

Submerged Springs Continue to Supply Water to Rearing Ponds

As indicated by the Topographic and Grading Plan, many springs that emerge near the base of the bluff were submerged when the Upper and Lower Ponds were built. During my visit, I observed only two springs flowing into the Upper Pond and none flowing into the Lower Pond from the bluff. The two springs flowing into the Upper Pond were the Wolschlagel Spring #1 (as overflow from the reservoir) and a nearby smaller spring, located about 50 feet west and five feet lower on the slope, which flows directly into the pond. I also observed that the flow through the weir to Spring Creek greatly exceeded the combined flow from both springs. Therefore, I conclude that the submerged springs still feed the ponds.

Weir Measurements Indicate Relative Variations in Discharge From the Springs

The weir measurements indicate relative changes, over time, in the combined discharge from all the springs feeding the ponds. All the springs appear to discharge from the same unconfined aquifer and, therefore, would exhibit simultaneous fluctuations of discharge in response to changes in the aquifer's hydraulic gradient. Each spring would respond in different proportion, depending on its elevation on the hillside. A given change in gradient would affect the upper springs more than the lower ones. Therefore, the flow from Wolschlagel Spring #1, located highest on the hillside, would be the most affected by reduced recharge and reduced head during drier seasons or years.

Variation in Discharge From the Springs Corresponds to Variations in Precipitation and Ground-Water Recharge

Given the grain-size distribution -- sand, gravel, and cobbles -- of the glacial drift which covers the uplands and outcrops in the river bluff, one would expect that local rain and snowmelt will percolate to the water table within a few weeks following a storm. This expectation is supported by the hatchery manager's observations that, during the fall, the flow from the springs increases within a few weeks after the first large storms in the Fall.

The weir measurements further indicate that the discharge to and from the ponds fluctuates considerably, both throughout the year and from year to year. However, the discharge follows roughly the same seasonal pattern each year. Also, the discharge corresponds very closely to the seasonal variation in precipitation (Figure 4). The lowest discharges usually occur at the end of the dry season; that is, sometime during the period September to November. Conversely, the highest discharges occur during and following the wet season; that is, sometime between November and April.

No Decline in Discharge From the Springs

The weir measurements for the period of record, January 1986 through October 1993, provide no evidence for a decline in the discharge from the ponds, and by direct inference, from Wolschlagel Spring #1 and the other springs which feed the ponds. Instead, the records closely mirror the fluctuations in rainfall, and thus, ground-water recharge, over this period (Figure 4).

Construction of the Ponds Did Not Reduce Discharge From the Springs

The construction operations which enlarged and raised the water levels of the rearing ponds apparently did not interfere with the discharge from springs at the base of the bluff. I found no records to indicate that the Department of Wildlife encountered any water-supply problems as a result of the construction. I observed no evidence of construction debris or sediments in the vicinity of Wolschlagel Spring #1 which might impede the flow. Given the coarse-grained nature of the glacial sediments in the hillside, only a concerted effort could plug any of the springs. Even then, the ground water would flow around the blockage and find a different escape point, most likely at other nearby springs.

Formerly, Wolschlagel Spring #1 emerged about 20 feet above the old rearing ponds. Today the spring still lies 11 feet above the Upper Pond. Simply raising the pond level by nine feet, while not submerging the spring, could not reduce its flow; more likely, the new ponds would have slightly enhanced its flow by raising the head at the lower springs (now submerged below pond surface) and, thereby, raising the ground-water level (water table) in the hillside. The new seeps which I observed in the bluff above the Lower Pond may indicate a rise in the water table by a few feet.

The weir-discharge data indicates neither an increase nor a decrease in the springs' combined discharge over the years since construction of the ponds. Any serious water-supply problems would have manifested themselves within the first year following construction. But, 25 years later, the water supply from the springs to the ponds remains relatively constant.

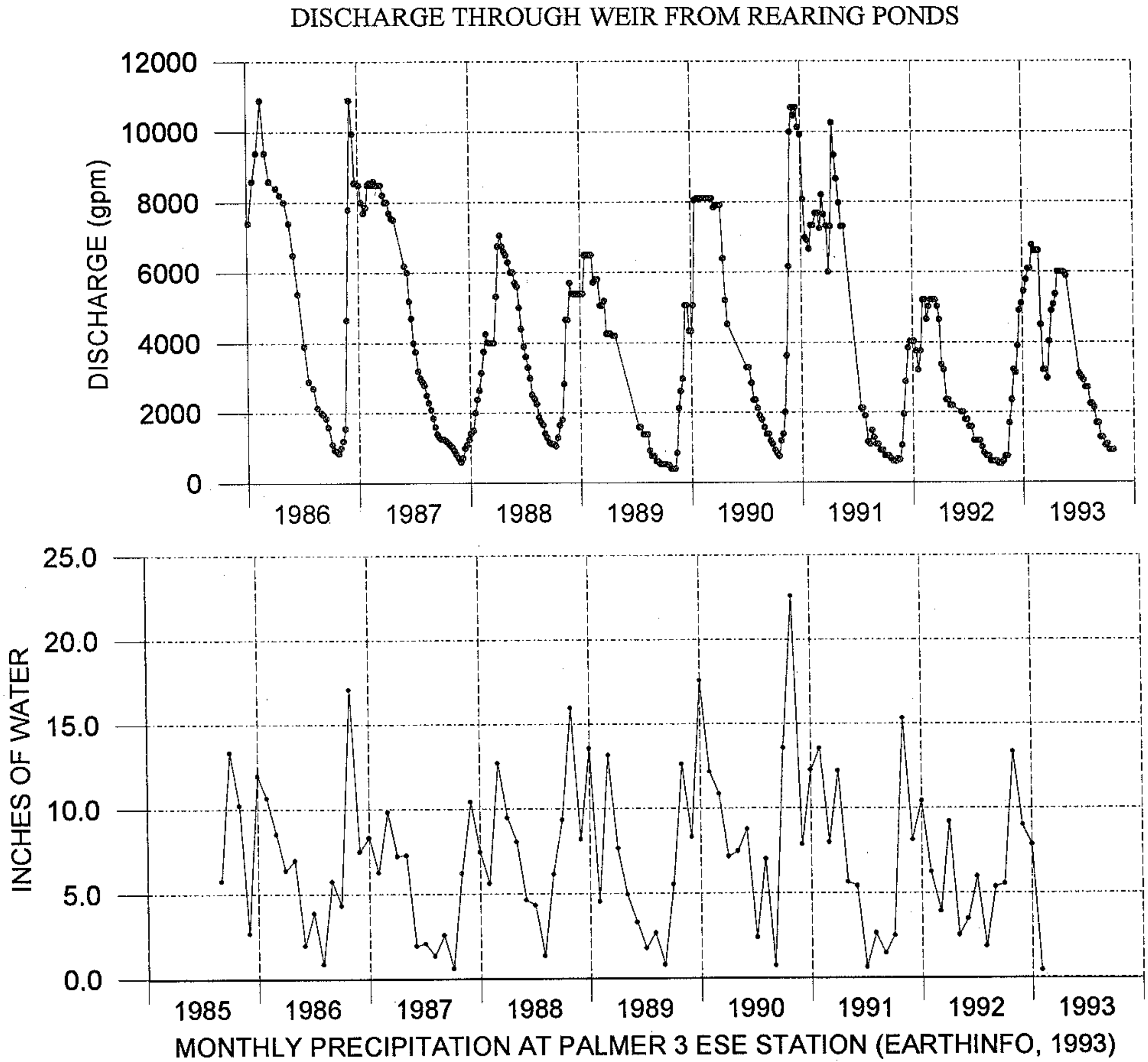

Figure 4. Weir Discharge Compared to Monthly Precipitation.

SUMMARY

In 1971, Department of Ecology issued water-right (S1-00290C) to neighboring homes for use of a portion of the discharge from Wolschlagel Spring #1. Since that time, the pond levels have not been changed, nor has any major construction occurred near the spring which might affect its flow. I found no evidence to indicate the flow from the spring has declined over the years.

REFERENCES

EarthInfo, Inc.(1993) "National Climatic Data Center, Summary of the Day, West 2, 1993": CD-ROM data disk, Boulder, CO.

Gower, H. D. and Wanek, A. A. (1963) "Preliminary Geologic Map of the Cumberland Quadrangle, King County, Washington": Division of Mines and Geology, Geologic Map GM-2, Olympia, Wa.

Luzier, J. E. (1969) Geology and Ground-Water Resources of Southwestern King County, Washington: Department of Water Resources, Water-Supply Bulletin No. 28, Olympia, Wa., 260 p.