# PRELIMINARY EVALUATION OF WATER-QUALITY CONDITIONS OF JOHNSON CREEK, OREGON

By T.K. Edwards and D.A. Curtiss

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## CONVERSION FACTORS AND VERTICAL DATUM

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Volume | |
| cubic foot ($ft^3$) | 0.02832 | cubic meter ($m^3$) |
| | Flow | |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second ($m^3/s$) |

SEA LEVEL: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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## ABSTRACT

In October 1988, the city of Portland, Bureau of Environmental Services and the U.S. Geological Survey began a multi-step cooperative assessment of water-quality characteristics of Johnson Creek at and near Portland, Oregon. Step 1 of this study was an assessment of historical data. Step 2 was a reconnaissance-level evaluation of water quality in Johnson Creek based on trace elements and organic compounds in bottom material. Plans for step 3 include synoptic sampling during storm-runoff and low-flow periods to appraise concentrations of trace elements and organic compounds.

In the urban part of the Johnson Creek basin below river mile 10.25, copper, lead, and zinc concentrations in bottom material in Johnson Creek were above background concentrations found in the Willamette River basin bottom material. Maximum concentrations of copper, chromium, lead, and mercury were 2 to 10 times larger in bottom material in Johnson Creek than was found historically in the lower Willamette River.

Dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyl (PCB) are the most widespread organic compounds detected in Johnson Creek basin. Most of the organic compounds detected in bottom material occurred below river mile 10.25, but DDT and PCB also were detected above river mile 10.25. The largest concentration of DDT plus metabolites (81.4 parts per million) was at the most upstream sampling site at river mile 17.4, in the predominantly agricultural land-use area.

Historically, large concentrations of nutrients and high fecal-coliform bacteria counts have been observed in Johnson Creek. During 1970-75, for example, the Oregon Department of Environmental Quality reported nitrate concentrations (as N) as large as 9.4 milligrams per liter at the mouth of Johnson Creek. Daytime dissolved-oxygen concentrations in Johnson Creek were as low as 57 percent saturation.

## INTRODUCTION

Johnson Creek flows in a westerly direction over its 24-mile reach through a heterogeneous mixture of land uses from a predominantly agricultural headwater area southeast of Gresham, Oregon, through the cities of Gresham, Portland and Milwaukie, where it discharges to the Willamette River (fig. 1). Runoff characteristics of Johnson Creek are typical of streams in the area with summer low flows increasing into high flows during winter rainstorms, and flows between storms receding steadily until the next storm.

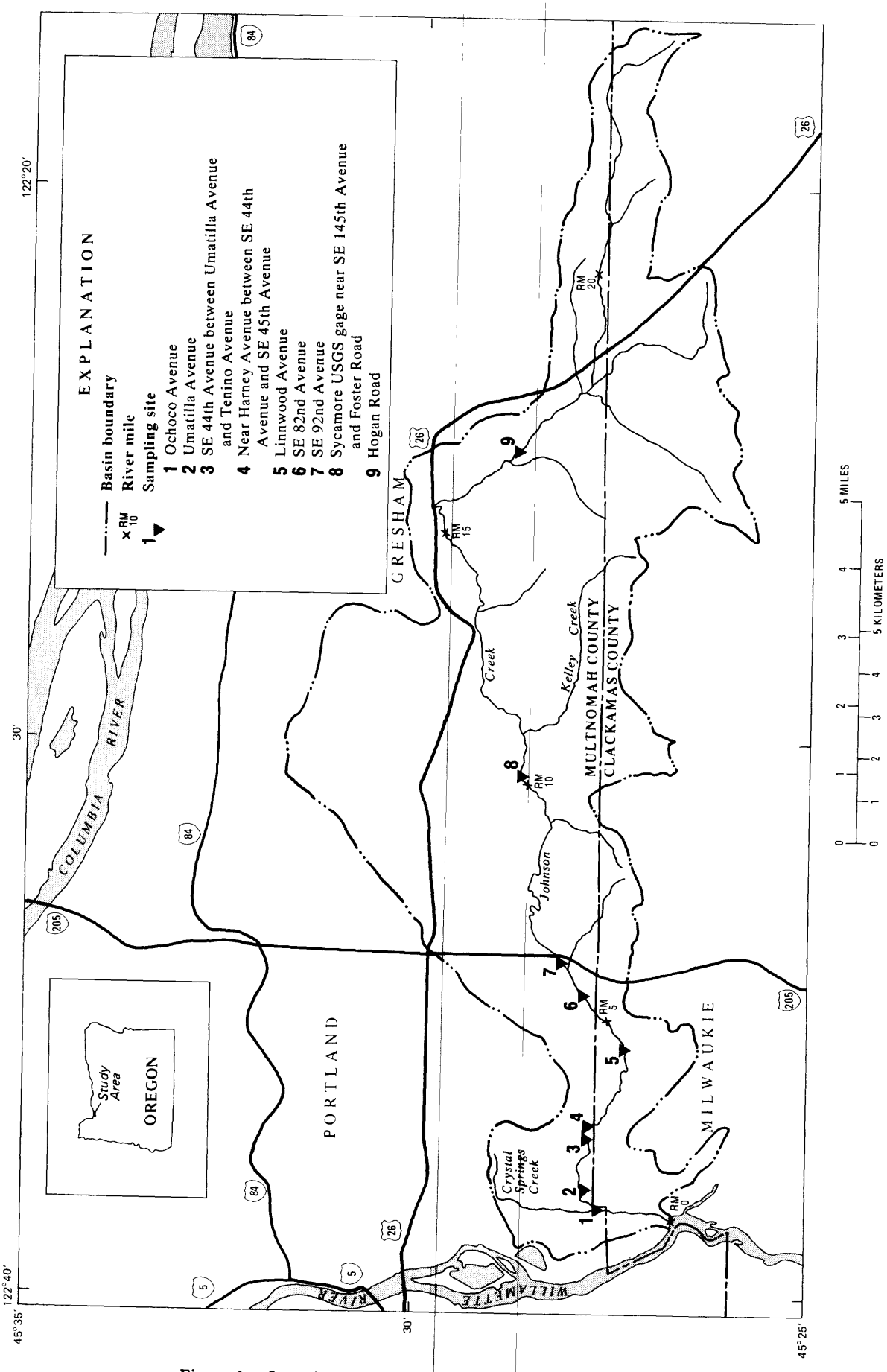



Figure 1.—Location of sampling sites in the Johnson Creek basin.

Contaminants, such as trace elements and organic compounds, originate from extensive and varied land-use activities in the basin and are carried into Johnson Creek and ultimately discharged into the Willamette River. Large concentrations of selected trace elements, organic compounds, and nutrients found in Johnson Creek are contributed in part by septic-tank seepage, runoff from agricultural lands, and storm-sewer discharges from residential, commercial, and industrial areas. In October 1988, the city of Portland's Bureau of Environmental Services (PBES) and U.S. Geological Survey (USGS) began a multi-step cooperative assessment of water-quality characteristics of Johnson Creek. Step 1 of this study was an assessment of historical data. Step 2 was reconnaissance sampling for trace elements and manmade-organic compounds in bottom material. The purpose of the reconnaissance was to identify constituents at enriched concentrations in Johnson Creek bottom material.

Plans for step 3 will include synoptic sampling during storm runoff and low flow to further investigate trace-element and manmade organic-compound concentrations detected in Johnson Creek during the reconnaissance study.

## Purpose

This report describes water-quality information from previous studies and presents the results of a 1988 synoptic survey of trace elements and manmade-organic compounds in Johnson Creek bottom material. The results presented in this report will be used to develop a study plan for step 3 of the Johnson Creek Water-Quality Assessment Study designed to provide pertinent information to managers to evaluate possible water-quality control procedures.

## Previous Investigations

The results of two previous water-quality investigations for Johnson Creek were reviewed and are summarized below.

(1) Oregon Department of Environmental Quality (DEQ) did an investigation of the lower 17 miles of Johnson Creek from 1970 to 1975 to determine the extent of water-quality problems of Johnson Creek at that time (Oregon Department of Environmental Quality, 1975). Those problems included nutrient loading that caused undesirable growths of algae and aquatic weeds and esthetic problems, low dissolved-oxygen concentration during summer low-flow conditions, and coliform-bacteria counts that exceeded State of Oregon water-quality standards for contact recreational safety. The water-quality problems resulted from: (1) aggravated flooding caused by poor basin drainage and by runoff from impervious areas; (2) erosion and siltation during high flow and subsequent siltation and channel clogging; (3) an inadequate combined sanitary- and storm-sewer system unable to accommodate runoff during high rainfall; (4) low streamflow during summer months causing ponding and stagnation; and (5) subsurface seepage of sewage to Johnson Creek during high rainfall from unsewered areas. Water-quality data collected during this study included temperature, pH, specific conductance, color, turbidity, dissolved solids, alkalinity,

hardness, total dissolved solids, dissolved oxygen (DO), biochemical-oxygen demand (BOD), nutrients, total and fecal-coliform bacteria, sodium and potassium, dissolved zinc, dissolved iron, and dissolved lead, phenols, and oil and grease. Measurements and samples were collected during high and low flow.

(2) Researchers from Portland State University collected water-quality data for Johnson Creek from the fall of 1979 to the spring of 1981. This study resulted in four reports (Portland State University, 1981a-d): a data summary (1981a), an interpretative water-quality report (1981b), a report discussing suggested future monitoring of storm-water runoff (1981c), and a report on the effectiveness of small lakes on a tributary to Johnson Creek for improving water quality in the Creek (1981d). Water-quantity and quality data collected during the study include streamflow, pH, specific conductance, turbidity, alkalinity, major ions, dissolved and total recoverable iron, manganese, and zinc, total non-filterable residue, settleable solids, and fecal-coliform and fecal-streptococcal bacteria. Water-quality measurements and samples were collected during high- and low-flow conditions. The Portland State University study does not provide information on trace elements (except zinc) or organic compounds.

## PRELIMINARY EVALUATION OF WATER-QUALITY CONDITIONS

During a low-flow period in August 1988, reconnaissance sampling was done by personnel of PBES and USGS to determine concentrations of trace elements and organic compounds in bottom material in Johnson Creek. Because many trace-element and organic compounds sorb onto sediment, analysis of bottom material collected during low flows commonly is used to determine the presence or absence and the general location of contaminant sources. Water-column samples collected at nine sites during July and August 1988 were analyzed for temperature, specific conductance, pH, DO, alkalinity, fecal-coliform and fecal-streptococci bacteria, nutrients, and organic compounds; these data were compared with water-quality data collected in earlier studies. In addition, turbidity data were collected at 10 sites during an April 1988 storm.

### Trace Elements in Bottom Material

During the USGS and PBES investigation in 1988, bottom-material samples were collected at nine sites in the Johnson Creek reach from Hogan Road at site 9, RM (river mile) 17.40 to Ochoco Avenue at site 1, RM 1.05 (fig. 1). Twenty to thirty randomly selected subsamples were collected at each site and composited. Two size fractions of each sample were separated by wet sieving through a 63 $\mu$m (micrometer) mesh plastic sieve. Determinations for total concentration (total digestion) of aluminum, antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, titanium, and zinc were made on both size fractions from each site. Surface area and total-organic-carbon content also were determined for both size fractions at each site.

At all sites, the concentrations of iron were commonly larger in the >63 μm (greater than 63 micrometers) size fraction; concentrations of aluminum, cobalt, manganese, and titanium were not appreciably different between size fractions; and antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc concentrations were generally larger in the <63 μm (less than 63 micrometers) size fraction (table 1).

For elements having large concentrations in the <63 μm size fraction, a ranking of sites by analytical results shows that samples from site 3 (RM 2.60) had the larger concentrations, followed by site 5 (RM 3.85), site 2 (RM 1.37), and site 6 (RM 5.5). Site 3 at RM 2.60 is just below the S.E. Umatilla Street storm-water outfall. The smallest concentrations were detected at site 9 (RM 17.40), and the next smallest concentration at site 8 (RM 10.25). In general, an increase in the concentration of these elements was noted in a downstream direction from RM's 17.40 to 2.60, with generally smaller concentrations below RM 2.60. An unusually large concentration of mercury was recorded at site 8 (RM 10.25); a replicate sample verified the large concentration, which is unexplainable at this time.

Normal-probability plots of zinc, copper, and lead concentrations in bottom material (<20 μm size particles), Willamette River basin, were presented by Rickert and others (1977) to distinguish naturally occurring background concentrations from concentrations associated with anthropogenic activities. Rickert and others (1977) collected bottom-material samples from 44 sites during September 1973; thirty-one samples were from collected from the Willamette River, and 13 samples were collected from tributaries. Zinc, copper, and lead concentrations in Johnson Creek bottom material (<63 μm size particles) and break-point concentrations in the rest of the Willamette River basin is listed in table 2. Concentrations of zinc and lead exceed the Willamette River basin break-point concentrations at all sites on Johnson Creek downstream from site 8 (RM 10.25). Johnson Creek concentrations of copper exceed the Willamette River basin break-point concentration at site 6 (RM 5.5), site 5 ( RM 3.85), site 3 (RM 2.60), and site 2 (RM 1.37). These Johnson Creek sites are all within the cities of Portland and Milwaukie and are affected by urban runoff and effluent from light industrial activities among other unidentified potential contaminant sources.

Using data from a number of streams across the United States, Horowitz (1985) has shown that as sediment-particle size decreases trace-metal concentration generally increases. Therefore, trace-metal concentrations in <20-μm-size particles from the lower Willamette River could be expected to exceed concentrations in <63-μm-size particles from Johnson Creek subbasin. To the contrary, however, the largest concentrations shown in figure 2 for copper, lead, chromium, and mercury are for <63-μm-size particles from Johnson Creek and exceed the concentrations for <20-μm-size particles from the lower Willamette River by factors of 2.0, 3.6, 10 and 3.5, respectively. The interquartile ranges for lead and chromium concentrations in Johnson Creek exceed those in the lower Willamette River (fig. 2). It appears, therefore, that the largest trace-metal concentrations in Johnson Creek sediments exceed those in the lower Willamette River sediments, but the median

Table 1.--Concentrations of major and trace elements in Johnson Creek bottom materials, August 1988

[Concentrations in ppm (parts per million) or wt% (percent by weight). A concentration of 1.0 wt% = 10,000 ppm. TOC = total organic carbon, μm = micrometers, < = less than, > = greater than, $m^2/g$ = square meters per gram, # = number]

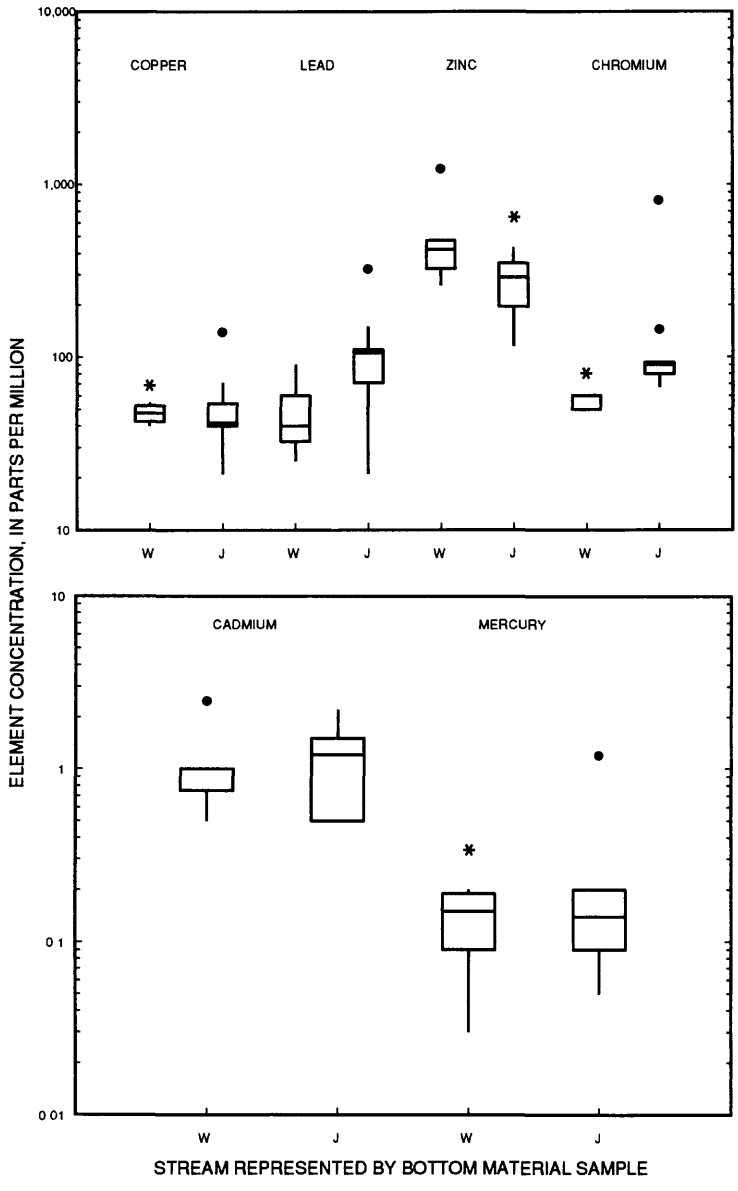
| Site number and name | River mile | Particle size (μm) | Copper (ppm) | Lead (ppm) | Zinc (ppm) | Nickel (ppm) | Cobalt (ppm) | Cadmium (ppm) | Chromium (ppm) | Aluminium (wt%) | Iron (wt%) | Manganese (wt%) | Titanium (wt%) | Mercury (ppm) | Selenium (ppm) | Antimony (ppm) | Arsenic (ppm) | Total organic carbon (wt%) | Surface area ($m^2/g$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-Ochoco Avenue | 1.05 | >63 | 27 | 47 | 147 | 30 | 24 | <0.5 | 52 | 6.9 | 6.0 | 0.10 | 1.04 | 0.02 | <0.1 | 4.1 | 3.5 | 0.4 | 15.1 |
| | | <63 | 40 | 71 | 195 | 42 | 18 | <.5 | 80 | 8.0 | 4.6 | .08 | .77 | .14 | .2 | 1.0 | 3.6 | 2.4 | 15.4 |
| 2-Umatilla Avenue | 1.37 | >63 | 29 | 51 | 170 | 36 | 22 | <.5 | 63 | 8.8 | 5.8 | .10 | .71 | <.01 | <.1 | 1.5 | 2.3 | .8 | 14.9 |
| | | <63 | 71 | 110 | 350 | 96 | 23 | 1.5 | 145 | 7.1 | 4.7 | .10 | .73 | .11 | <.1 | 1.1 | 4.1 | 4.2 | 17.5 |
| 3-SE 44th at Umatilla | 2.60 | >63 | 34 | 48 | 300 | 350 | 34 | <.5 | 230 | 7.3 | 5.2 | .08 | .99 | <.01 | <.1 | .7 | 2.1 | .6 | 13.2 |
| | | <63 | 140 | 150 | 640 | 1300 | 83 | 1.2 | 810 | 7.3 | 5.3 | .12 | .94 | .20 | .3 | 2.0 | 4.1 | 4.9 | 13.6 |
| 4-SE 44th above Harney | 2.70 | >63 | 40 | 62 | 175 | 43 | 20 | <.5 | 72 | 7.3 | 4.0 | .10 | .57 | .08 | <.1 | .5 | 1.6 | 4.4 | 10.9 |
| | | <63 | 41 | 86 | 290 | 55 | 19 | 1.2 | 90 | 7.5 | 4.3 | .10 | .62 | .07 | <.1 | .8 | 3.1 | 3.8 | 13.9 |
| 5-Linnwood Avenue | 3.85 | >63 | 24 | 82 | 150 | 25 | 23 | <.5 | 48 | 7.1 | 5.6 | .10 | .74 | <.01 | <.1 | .5 | 1.5 | .7 | 6.6 |
| | | <63 | 54 | 325 | 430 | 45 | 26 | 2.2 | 91 | 7.0 | 4.9 | .20 | .66 | .20 | .1 | 1.3 | 3.5 | 4.5 | 12.9 |
| 6-SE 82nd Avenue | 5.5 | >63 | 20 | 19 | 170 | 30 | 29 | <.5 | 62 | 8.5 | 6.9 | .20 | .77 | .02 | .1 | .4 | 4.1 | .4 | 32.5 |
| | | <63 | 50 | 105 | 340 | 42 | 32 | 1.9 | 93 | 8.4 | 6.1 | .30 | .71 | .15 | .1 | 1.0 | 2.4 | 3.5 | 21.2 |
| 7-SE 92nd Avenue | 5.82 | >63 | 30 | 100 | 200 | 29 | 23 | <.5 | 58 | 7.0 | 5.0 | .11 | .83 | .04 | .1 | .8 | 2.6 | 3.7 | 8.1 |
| | | <63 | 42 | 105 | 235 | 30 | 20 | <.5 | 80 | 8.6 | 4.6 | .11 | .66 | .09 | .2 | 1.0 | 3.0 | 3.2 | 15.0 |
| 8-Sycamore gage site | 10.25 | >63 | 17 | 13 | 125 | 23 | 21 | <.5 | 51 | 8.5 | 4.9 | .12 | .48 | .17 | .1 | .4 | 3.2 | .9 | 21.5 |
| | | <63 | 25 | 23 | 150 | 25 | 17 | 0.7 | 75 | 7.0 | 4.0 | .12 | .68 | 1.20 | <.1 | .6 | 3.0 | 2.2 | 14.6 |
| 9-Hogan Road | 17.40 | >63 | 16 | 10 | 83 | 21 | 20 | <.5 | 42 | 8.3 | 4.4 | .09 | .56 | .04 | .1 | .4 | 2.0 | 1.9 | 16.7 |
| | | <63 | 21 | 21 | 115 | 22 | 17 | <.5 | 67 | 7.2 | 3.4 | .08 | .62 | .05 | .2 | .6 | 2.1 | 1.8 | 15.9 |
| Site #8 Replicate | | >63 | 16 | 12 | 105 | 25 | 19 | <.5 | 45 | 8.2 | 4.5 | .11 | .47 | .17 | <.1 | .3 | 3.6 | 1.1 | 13.5 |
| | | <63 | 23 | 31 | 140 | 21 | 17 | <.5 | 73 | 6.7 | 3.7 | .12 | .67 | 1.10 | .2 | .6 | 2.4 | 2.1 | 13.9 |

Table 2.--Locations and concentration values of trace elements in bottom material in Johnson Creek greater than background concentrations in bottom material from the Willamette River Basin, August 1988

[Concentrations in ppm (parts per million). Data are for particle-size fraction less than 63 micrometers]

| Constituent | Break-point 1/ concentrations | Johnson Creek River Mile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.05 | 1.37 | 2.60 | 2.70 | 3.85 | 5.5 | 5.82 | 10.25 | 17.40 |
| Copper | 43 | -- | 71 | 140 | -- | 54 | 50 | -- | -- | -- |
| Lead | 43 | 71 | 110 | 150 | 86 | 325 | 105 | 105 | -- | -- |
| Zinc | 145 | 195 | 350 | 640 | 290 | 430 | 340 | 235 | -- | -- |

1/ Estimated on the basis of the break in slope data of a normal probability plot of bottom-material data for Willamette River and tributaries (Rickert and others, 1977)




## EXPLANATION

**Interquartile range equals the value of the 75th percentile minus the value of the 25th percentile.**

* **More than 3 times the interquartile range from the 75-percentile value**

• **1.5 to 3 times the interquartile range from the 75-percentile value**

**Less than 1.5 times the interquartile range from the 75-percentile value**

**75-percentile value**

**Median value**

**25-percentile value**

**Less than 1.5 times the interquartile range from the 25-percentile value**

Figure 2. – Selected trace-elements concentrations in Willamette River (W) and Johnson Creek (J) bottom material.

concentrations are not substantially different. This is an entirely plausible relation because the distance from sources in the Johnson Creek basin to the Johnson Creek channel is short compared with the source-to-channel distance of the Willamette River. This distance factor is actually a sediment-dilution term translating to smaller concentrations in stream sediments as distance from a source increases. In this case, dilution in the Willamette River is even more dramatic because the flow in the Willamette River is considerably greater than the flow in Johnson Creek.

## Organic Compounds in Bottom Material

Bottom-material samples for organic-compound determination also were collected in 1988 from the nine sites listed in table 1. The same sampling procedure was used for trace-element and organic-compound determinations. The bottom material from each site was passed through a stainless-steel 63-$\mu$m-mesh sieve to separate the >63 $\mu$m and <63 $\mu$m particle-size fractions; each size fraction was analyzed separately. Determinations of selected organochlorine insecticides and PCBs polychlorinated biphenyls (PCBs) and of acid-base/neutral extractable compounds were made on each size fraction by the DEQ Laboratory.

Concentrations of organochlorine insecticides and PCBs are listed in table 3. Of the concentrations that exceed the analytical detection level, there is no strong relation to particle size, but there are more exceedences in the >63-$\mu$m-size fraction. As with trace elements, larger concentrations of organic compounds usually are expected in the finer size fraction, but that does not appear to be the case for Johnson Creek. Comparison of surface-area measurements for the >63-$\mu$m-size and the <63-$\mu$m-size fractions for each sample indicates little difference in surface area between the size fractions (table 1). Usually the surface area of the smaller size fraction is considerably larger than the surface area of the larger size fraction for a given sample. The trend toward large organic-compound concentrations in coarse material appears to predominate at the seven sites below RM 10.25, where 69 percent of the largest concentrations are in the >63-$\mu$m fraction. In contrast, 43 percent of the largest concentrations at site 8 (RM 10.25) and site 9 (RM 17.40) are in the >63-$\mu$m fraction.

The largest concentrations of all organochlorine insecticides, except DDT plus metabolites and methoxychlor, were measured in bottom material from Johnson Creek below RM 10.25. Similar to DDT plus metabolites and methoxychlor, the largest concentration of PCBs were at RM 17.40, even though there were a number of occurrences in the lower Johnson Creek basin below RM 3.85.

Concentrations of acid-base/neutral extractable compounds in bottom material are listed in table 4. Detectable concentrations were found for eight compounds; all but one detection occurred at or below RM 2.70.

Selected organic compounds and EPA's interim bed-sediment criteria (U.S. Environmental Protection Agency, 1988) are listed in table 5. Concentrations that exceed bed-sediment criteria can cause adverse environmental effects even if concentrations in water are less than established water-quality criteria (U.S. Environmental Protection Agency, 1988). DDT plus metabolites and PCBs were the most frequently

Table 3.--Concentration of organochlorine insecticides plus polychlorinated biphenyls (PCBs) in bottom material, Johnson Creek basin, August 1988

[ppm = parts per million, um = micrometers, > = greater than, and < = less than; BHC = benzene hexachloride; DDE = dichlorodiphenyldichloroethylene; DDD = dichlorodiphenyldichloroethane; DDT = dichlorodiphenyltrichloroethane; # = number]

| Site number and name | River mile | Particle size (um) | alpha-BHC (ppm) | beta-BHC (ppm) | Lindane (ppm) | Heptachlor (ppm) | Aldrin (ppm) | Heptachlor epoxide (ppm) | p,p'-DDE (ppm) | Endrin (ppm) | p,p'-DDD (ppm) | p,p'-DDT (ppm) | p,p'-Methoxychlor (ppm) | Dieldrin (ppm) | Chlordane (ppm) | PCB Arochlors Group 4 (ppm) | PCB Arochlors Group 5 (ppm) | PCB Arochlors Total (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-Ochoco Avenue | 1.05 | >63 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.29 | 0.29 | 0.09 | 0.38 |
| | | <63 | .011 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.05 | <.05 | <.05 | <.10 |
| 2-Umatilla Avenue | 1.37 | >63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .012 | <.005 | .016 | .015 | .02 | <.005 | <.05 | .40 | <.05 | .40 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .016 | <.005 | <.05 | <.05 | 0.25 | .25 |
| 3-SE 44th at Umatilla | 2.60 | >63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.05 | .29 | <.05 | .29 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.05 | .42 | <.05 | .42 |
| 4-SE 44th above Harney | 2.70 | >63 | <.005 | .013 | .006 | .007 | .008 | <.005 | .009 | <.005 | .010 | <.005 | <.005 | <.005 | <.05 | <.05 | .10 | .10 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .005 | .006 | .006 | .007 | .15 | .009 | <.05 | <.05 | <.05 | <.10 |
| 5-Linnwood Avenue | 3.85 | >63 | .009 | <.005 | .005 | <.005 | <.005 | .005 | .005 | .006 | <.005 | .007 | .015 | <.005 | <.05 | <.05 | <.05 | <.10 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | .005 | .008 | <.005 | .008 | .007 | <.005 | <.005 | <.05 | <.05 | <.05 | <.10 |
| 6-SE 82nd Avenue | 5.5 | >63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .011 | <.005 | <.05 | <.05 | <.05 | <.10 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .008 | <.005 | .007 | <.005 | <.005 | <.005 | <.05 | <.05 | <.05 | <.10 |
| 7-SE 92nd Avenue | 5.82 | >63 | <.005 | 0.008 | <.005 | <.005 | .006 | <.005 | .01 | <.005 | .015 | .009 | .016 | <.005 | <.05 | <.05 | <.05 | <.10 |
| | | <63 | .007 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | <.05 | <.05 | <.05 | <.10 |
| 8-Sycamore gage | 10.25 | >63 | .006 | <.005 | <.005 | <.005 | <.005 | <.005 | .007 | <.005 | .008 | .006 | .012 | <.005 | <.05 | <.05 | <.05 | <.10 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .011 | <.005 | .013 | .007 | <.005 | <.005 | <.05 | <.05 | <.05 | <.10 |
| 9-Hogan Road | 17.40 | >63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .062 | .005 | .092 | .144 | <.005 | <.005 | .128 | .48 | .15 | .63 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .388 | <.005 | .568 | .226 | .366 | <.005 | <.05 | <.05 | .23 | .23 |
| Site #8 Replicate | | >63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .009 | <.005 | .011 | .009 | .022 | <.005 | <.05 | <.05 | <.05 | <.10 |
| | | <63 | <.005 | <.005 | <.005 | <.005 | <.005 | <.005 | .012 | <.005 | .015 | .009 | .017 | <.005 | <.05 | <.05 | <.05 | <.10 |

Table 4.--Concentrations of acid-base/neutral extractable compounds in bottom material, Johnson Creek basin, August 1988

[ppm = parts per million, μm = micrometers, > = greater than, < = less than, # = number]

| Site number and name | River mile | Particle size (μm) | Phenanthrene (ppm) | Di-N-butylphthalate (ppm) | Fluoranthene (ppm) | Pyrene (ppm) | Benzo(a)anthracene (ppm) | Chrysene (ppm) | Benzo(b)fluoranthene (ppm) | Bis-(2-ethylhexyl)-phthalate (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-Ochoco Avenue | 1.05 | >63 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | | <63 | <.2 | .3 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 2-Umatilla Avenue | 1.37 | >63 | .6 | <.2 | 1.0 | .9 | .4 | .7 | .4 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 3-SE 44th at Umatilla | 2.60 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 4-SE 44th above Harney | 2.70 | >63 | <.2 | .3 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | .3 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 5-Linnwood Avenue | 3.85 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 6-SE 82nd Avenue | 5.5 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 7-SE 92nd Avenue | 5.82 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 8-Sycamore gage | 10.25 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | .3 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| 9-Hogan Road | 17.40 | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| Site #8 Replicate | | >63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |
| | | <63 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 | <.2 |

Table 5.--Concentrations of selected organic compounds in bottom material which exceeded interim quality criteria, Johnson Creek basin, 1988 (U.S. Environmental Protection Agency, 1988, table 4)

[Concentrations in ppm (parts per million). Computed values for individual sites are based on constituent and total organic carbon concentrations. > = less than; < = greater than; DDT = dichlorodiphenyltrichloroethane; PCB = polychlorinated biphenyls; -- = less than criterion concentration]

| Constituent (criterion) | Particle size fraction | Johnson Creek River Mile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.05 | 1.37 | 2.60 | 2.70 | 3.85 | 5.5 | 5.82 | 10.25 | 17.40 |
| DDT plus metabolites (0.183) | >63μm | -- | 5.4 | -- | 0.6 | 2.4 | -- | 0.9 | 2.5 | 15.7 |
| | <63μm | -- | -- | -- | .5 | .5 | 0.6 | -- | 1.6 | 65.7 |
| Dieldrin (0.00976) | >63μm | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | <63μm | -- | -- | -- | .2 | -- | -- | -- | -- | -- |
| Endrin (0.00654) | >63μm | -- | -- | -- | -- | .9 | -- | -- | -- | .3 |
| | <63μm | -- | -- | -- | .2 | -- | -- | -- | -- | -- |
| Heptachlor (0.148) | >63μm | -- | -- | -- | .2 | -- | -- | -- | -- | -- |
| | <63μm | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lindane (0.0394) | >63μm | -- | -- | -- | .1 | .7 | -- | -- | -- | -- |
| | <63μm | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PCB (1254) (3.87) | >63μm | 72.5 | 50.0 | 48.3 | -- | -- | -- | -- | -- | 25.3 |
| | <63μm | -- | -- | 8.6 | -- | -- | -- | -- | -- | -- |
| Phenanthrene (32.6) | >63μm | -- | 75.0 | -- | -- | -- | -- | -- | -- | -- |
| | <63μm | -- | -- | -- | -- | -- | -- | -- | -- | -- |

detected manmade organic compounds in the basin. All constituent concentrations that exceed the criteria are in the >63 μm fraction except for DDT at site 6 (RM 5.5), and site 9 (RM 17.40), and dieldrin and endrin at site 4 (RM 2.70). Most of the organic compounds in bottom material were detected at sites below RM 10.25, but DDT, endrin, and PCBs also were detected at sites at or above RM 10.25. The largest concentration of DDT plus metabolites was detected at the most upstream sample site (site 9, RM 17.4) and in the predominantly agricultural land-use area. For all other constituents, maximum concentrations were detected downstream from RM 10.25 in the urban and industrial land-use areas; however, specific sources of these organic compounds are not known.

## Nutrients in Water

Personnel of the Oregon Department of Environmental Quality (1975) collected water samples from 1970-75 for nutrient analysis at six sites in Johnson Creek during high- and low-flow conditions. Samples were analyzed to determine concentrations of dissolved ammonia, nitrate, and orthophosphate, and total phosphorus (table 6).

Historically, DEQ has suspected nutrient loading to Johnson Creek to be caused by agricultural runoff, urban runoff, and septic-tank seepage. The concentrations of phosphorus and nitrate nitrogen have been sufficient to cause massive, unsightly algal growths, which have often caused odor problems as they decomposed (Oregon Department of Environmental Quality, 1975).

Table 6.--Summary of dissolved and total nutrient concentrations in Johnson Creek, 1970-88

[DEQ = Oregon Department of Environmental Quality; USGS = U.S. Geological Survey; mg/L = milligrams per liter]

| Site | River mile | Dissolved ammonia as nitrogen (mg/L) | Dissolved nitrate as nitrogen (mg/L) | Dissolved orthophosphate as phosphate (mg/L) | Total phosphate as phosphate (mg/L) |
|---|---|---|---|---|---|
| **DEQ high flow (winter months, 1970-75)** | | | | | |
| Mouth | 0.0 | 0.03-0.18 | 2.5-9.4 | 0.09-0.20 | 0.3-0.8 |
| Ochoco | 1.0 | .04- .09 | 1.4-3.0 | .05- .09 | -- |
| SE 45th | 3.5 | .10- .13 | 1.22-1.76 | .07- .18 | .2-.5 |
| SE 100th | 7.0 | .13 | 1.56 | .06 | .4 |
| SE 190th | 12.8 | .11- .12 | 1.20-1.76 | .05 | .2-.3 |
| Regner | 16.2 | .25- .30 | 1.41-1.95 | .03- .15 | .4-.7 |
| **USGS high flow (March 1981)** | | | | | |
| Sycamore | 10.25 | .081 | 1.28 | .012 | .43 |
| **DEQ low flow (summer months, 1970-75)** | | | | | |
| Mouth | 0.0 | .01-.06 | 4.8-8.8 | .22-.24 | .2-.69 |
| Ochoco | 1.0 | .01-.05 | .03-4.0 | .16-.19 | -- |
| SE 45th | 3.5 | .01-.14 | 3.4-4.4 | .02-.24 | .2-.62 |
| SE 100th | 7.0 | <.01 | .54 | .17 | .5 |
| SE 190th | 12.8 | .03-.18 | .22-.23 | .11-.19 | .2-.26 |
| Regner | 16.2 | .08-.11 | .07-.16 | .06-.14 | .02-.1 |
| **USGS low flow (August 1988)** | | | | | |
| Ochoco | 1.05 | .04 | 4.06 | .09 | .31 |
| Sycamore | 10.25 | .01 | 1.08 | <.03 | .18 |

A single water-quality sample collected by the USGS in 1981 during a moderately intense storm showed that almost 100 percent of the nutrients were associated with fine suspended sediment or the dissolved phase (J. Rinella, U.S. Geological Survey, written commun., 1988). Ammonia and nitrate were dissolved in the water, and most of the organic nitrogen, orthophosphate, and phosphorus were transported on the suspended-sediment fines.

Water-quality sampling in Johnson Creek in 1988 during low-flow conditions has shown nutrient concentrations to be similar to those reported historically by DEQ, suggesting little change in low-flow nutrient concentrations since the early 1970's.

## Fecal-Coliform Bacteria in Water

Fecal-coliform contamination has been a historic problem in Johnson Creek. It was not unusual to find high-flow concentrations 3 to 5 times larger than during low flow (Oregon Department of Environmental Quality, 1975; Portland State University, 1981b). In 1988, the USGS observed low-flow fecal-coliform counts as large as those reported by DEQ, suggesting little change in fecal concentrations since the early 1970's. Fecal-coliform bacteria data collected by DEQ and USGS indicate that

concentrations exceed State of Oregon water-quality criteria for contact recreation of greater than 200 colonies per 100 mL of water (Oregon Department of Environmental Quality, 1988). Although no current fecal-coliform data for storm-water runoff are available, it is anticipated that large concentrations would be observed during present-day storm-water runoff conditions.

Large concentrations of fecal coliform generally are considered to be associated with overland flow because of bacterial association with particulates, and because the percolation of bacteria-contaminated water through soils for any distance will typically filter out most bacteria. Historical data show concentrations of fecal coliform several times greater during high flows than at low flows (Oregon Department of Environmental Quality, 1975).

## Turbidity and Suspended Sediment

U.S. Geological Survey turbidity data were collected during a storm in April 1988. During the storm, turbidity values ranged from 96 to 216 NTUs (Nephelometric Turbidity Units) at 10 sites in Johnson Creek (fig 3). Suspended-sediment samples collected during a moderately intense storm in February 1981 by J.F. Rinella (U.S. Geological Survey, written commun., 1988) contained mostly silt and clay; 97 percent of the 200 mg/L suspended sediment in the <63 $\mu$m size fraction and about 72 percent of the sediment was in the <16 $\mu$m size fraction.

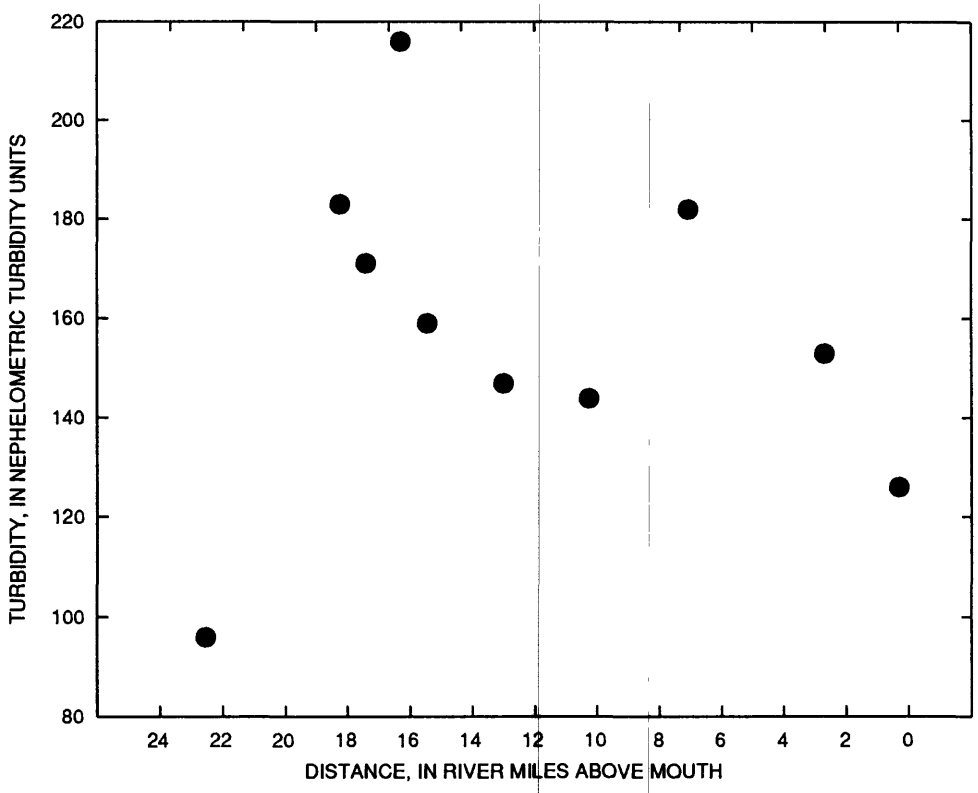



Figure 3.—River-mile variation of turbidity values for Johnson Creek, April 21, 1988.

Oregon Department of Environmental Quality (1975) and Portland State University (1981b) also have collected turbidity data during low-flow and high-flow conditions in Johnson Creek. These values cannot be compared directly with USGS turbidity values because turbidity values expressed in NTUs are not equivalent to DEQ and PSU turbidity values expressed in JTUs (Jackson Turbidity Units).

Oregon Department of Environmental Quality (1975) high-flow turbidity values collected at six sites in Johnson Creek ranged from to 2 to 33 JTUs, while low-flow turbidity values ranged from 1 to 12 JTUs.

Portland State University (1981b) found turbidity values and suspended-sediment concentration to be extremely low during baseflow as compared with storm runoff. Median low-flow turbidity values at PSU's 27 sites ranged from 5 to 20 JTUs, with 100 percent of the suspended sediment in the <18 $\mu$m size fraction. During moderately intense storms, peak turbidity could range from 200 to 400 JTUs. Portland State University (1981c) noted a strong correlation between turbidity and suspended-sediment concentration during storms, a correlation that would be expected because of the predominance of small particle sizes in transport.

### Dissolved Oxygen

Oregon Department of Environmental Quality (1975) reported that dissolved-oxygen (DO) concentrations varied with flow and season. The highest and lowest DO concentrations were observed during late summer (July through October). Percent saturation ranged from 57 to 165 percent with most readings from 90 to 110 percent. The lowest readings were between RM 5.85 and RM 13.0; DEQ attributed the low readings to high oxygen demand from the decomposition of organic matter in stagnant pools. It is possible that oxygen-depleted ground water contributing to baseflow may be causing low-percent saturation levels because nearly a 100 percent increase in the baseflow has been measured between RM 13.0 and RM 5.5 during summer low flow (M. Crumrine, U.S. Geological Survey, written commun., 1988). Dissolved-oxygen concentrations measured by the USGS during July and August, 1988, at a time of extreme low flow, ranged from 9.0 to 9.8 mg/L, which corresponded to 91.4 to 102 percent saturation.

Extremely low DO concentrations can adversely affect the survival of many desirable aquatic organisms. For example, a minimum DO concentration of 5.0 mg/L is required to maintain and support productive fish populations (U.S. Environmental Protection Agency, 1976). Low DO concentrations also affect redox potentials and can result in the release of toxic trace elements from bottom material.

## SUMMARY AND CONCLUSIONS

In August 1988, the U.S. Geological Survey, in cooperation with the city of Portland, Bureau of Environmental Services, collected bed-material samples at nine sites in Johnson Creek and analyzed the samples for trace elements and organic compounds. Copper, lead, zinc, nickel, cobalt, chromium, aluminum, iron, manganese, titanium, mercury, antimony, and arsenic were detected at all sites. Concentrations of zinc, lead, and copper exceeded Willamette River basin break-point oncentrations at most sites on Johnson Creek downstream from site 8, RM 10.25. Maximum

concentrations of chromium and mercury in bottom material from Johnson Creek exceeded maximum concentration of bottom material from lower Willamette River basin by factors of 10 and 35, respectively.

Analyses of bottom-material samples collected in August 1988 indicated the presence of manmade organic compounds. Concentrations of organochlorine insecticides (DDT plus metabolites, dieldrin, endrin, heptachlor, and lindane) plus PCBs, and an acid-base/neutral extractable compound (phenanthrene) exceeded, in some cases, U.S. Environmental Protection Agency interim bed-sediment-quality criteria for organic compounds. DDT plus metabolites and PCBs are the most widespread organic compounds detected in the bottom material of Johnson Creek. DDT plus metabolites concentrations at the upper end of the basin exceeded the largest DDT concentration documented in the Yakima River basin in Washington, considered to be one of the basins most affected by agriculture in the Nation. PCBs are found in bottom material from Johnson Creek in the urban and industrial part of Johnson Creek basin below RM 10.25. Specific sources of manmade organic compounds are not known, and data describing their relation with suspended sediment are lacking. Identification of channel reaches adversely affected by point and nonpoint sources of organic compounds and a description of the relation between suspended sediment and these organic compounds is essential to adequately assess the water quality of Johnson Creek and develop a plan to improve water quality in the basin.

Nutrients (ammonia, nitrate, orthophosphate, and total phosphorous) concentrations in the Johnson Creek basin are large, as measured by the Oregon Department of Environmental Quality and the U.S. Geological Survey, 1970 to 1988. Dissolved nitrate (as N), for example, was reported as large as 9.4 mg/L at the mouth. Specific sources of these nutrients are unknown, but data indicates that nutrient loading is contributed by agricultural and urban runoff, and septic-tank effluent seepage.

Fecal-coliform bacteria data collected by the Oregon Department of Environmental Quality and the U.S. Geological Survey indicate concentrations exceed State of Oregon water-quality criteria for contact recreation (>200 colonies/100 ml sample) during low-flow conditions. During high flows, DEQ reported concentrations of fecal-coliform bacteria from 3 to 5 times higher than at low flow.

High turbidity occurs in Johnson Creek during storm runoff. Turbidity and suspended sediment can adversely affect aquatic organisms and the aesthetic quality of a stream. Insufficient turbidity and suspended-sediment data are available for Johnson Creek. A complete understanding of suspended-sediment transport in the Johnson Creek basin is needed to control contaminants associated with sediment.

Low DO concentrations can adversely affect aquatic organisms and could cause the release of constituents sorbed to bottom material. The Oregon Department of Environmental Quality observed DO in Johnson Creek as low as 57-percent saturation; the data could represent periods of high biological oxygen demand or the influx of ground water depleted in DO. All DO data collected in 1988 by the U.S. Geological Survey exceeded 90-percent saturation and represent daytime conditions when algal photosynthesis is occurring.

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