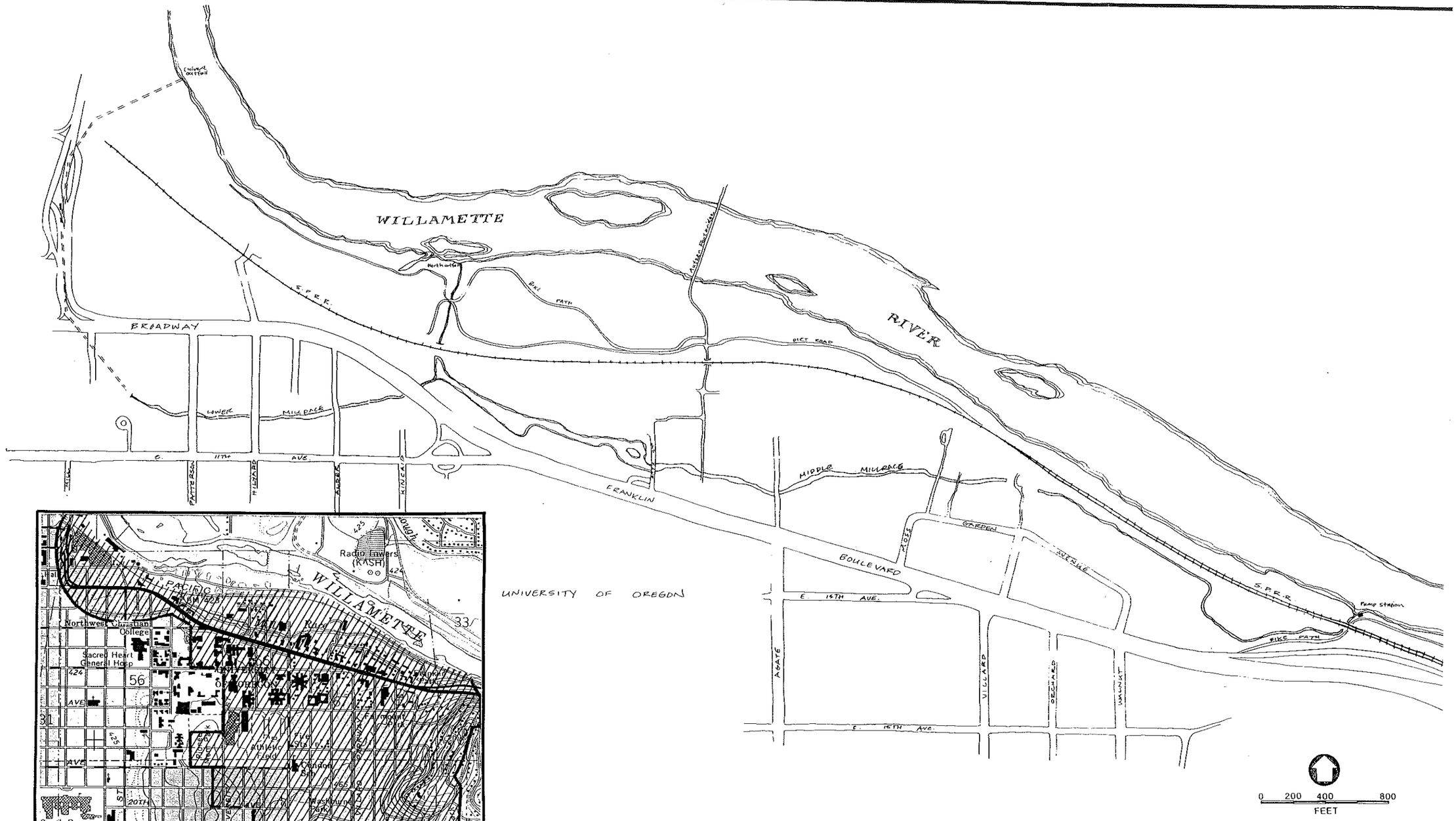
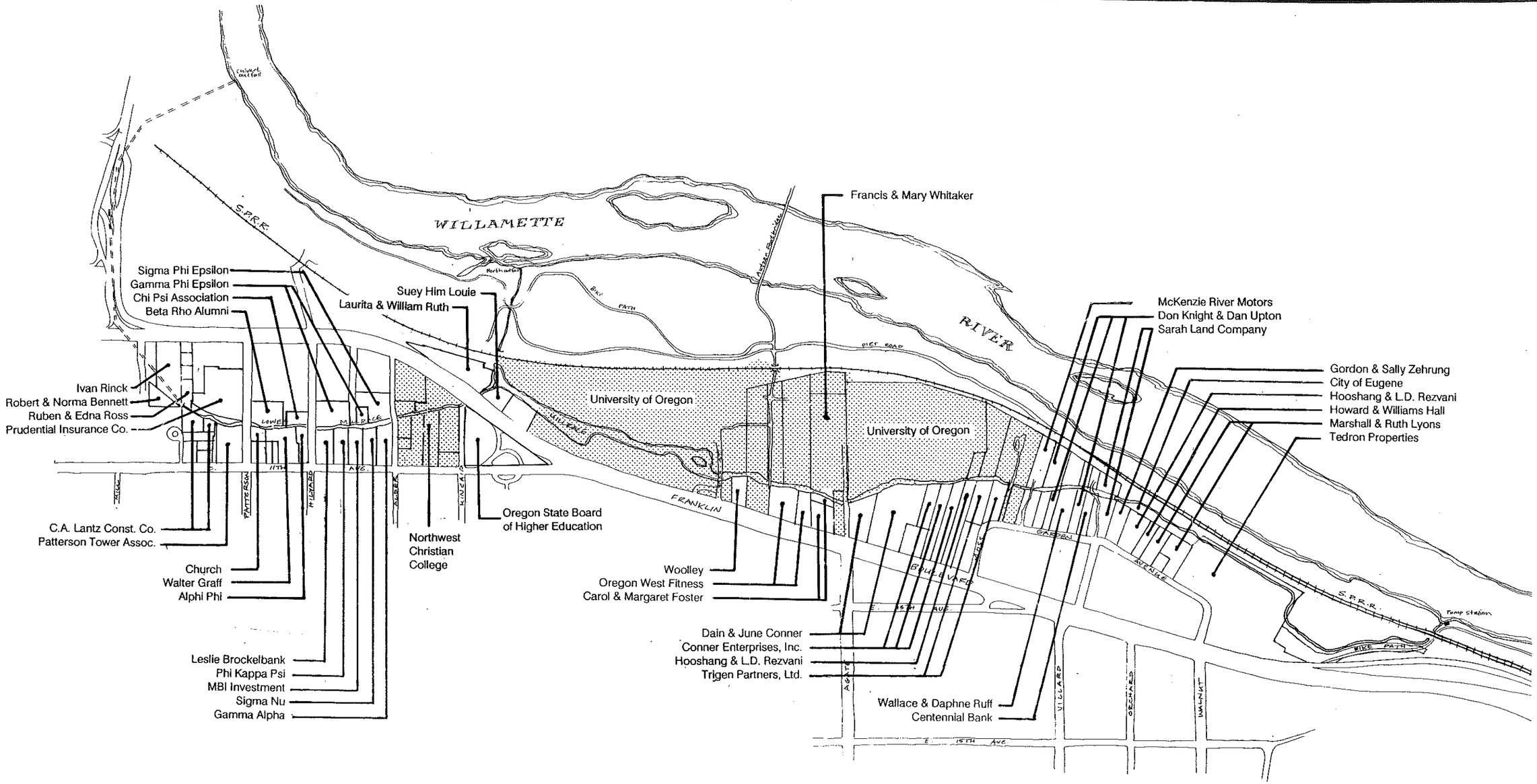


Study Area

EUGENE MILLRACE

FIGURE 1



Property Ownership

EUGENE MILLRACE

APPENDIX **B**

CATHY BRINER

MILLRACE ENHANCEMENT FEASIBILITY STUDY

EUGENE, OREGON

Prepared for:
CITY OF EUGENE
Eugene, Oregon

Prepared by:
Scientific Resources, Inc.
Lake Oswego, Oregon

in association with
Robert H. Foster Consultants
Lake Oswego, Oregon
and
Russ Fetrow Engineering, Inc.
Salem, Oregon

September 14, 1990

MILLRACE ENHANCEMENT FEASIBILITY STUDY

EUGENE, OREGON

Prepared for:
CITY OF EUGENE
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September 14, 1990

WAC Corporation, June 1988

THE MILLRACE

Eugene, Oregon

REPORT ABSTRACT

The consultant team of Scientific Resources, Inc., Robert H. Foster Consultants and Russ Fetrow Engineering, Inc. was contracted by the City of Eugene to assess the current character and existing conditions of the human and natural resource aspects of the Millrace, propose concepts for its enhancement, both aesthetically and ecologically, and explore the potential for funding these improvements. The study emphasizes the Middle Millrace, with consideration made to complement the work that has already been done in designing the Riverfront Research Park.

The Millrace is rather unique in having two watersheds that influence the quality of its water, the upper Willamette River watershed and the urban drainage basin. However, the urban setting of the Millrace has heavily influenced its character and drawn attention to its importance to humans.

The water quality of the Millrace during summer is highly influenced by the Willamette River because all water in the Millrace is from that source. During summer one of the two pumps provides around 27 cubic feet per second flow in the Millrace channel. At this typical summertime flow into the pond the flushing rate is around 3.5 times per day. This is sufficiently high that the Millpond does not have a life of its own, except for its waterfowl and their influence on bacterial densities and measurable nutrient increases.

Human activities in the Willamette River drainage have contributed to water of very poor quality the effects of which have been greatest at the Portland end of the river. However, water quality degradation had been seen in the Upper Willamette Basin as well. Fortunately there has been an improvement due to human action, and this associated improvement for Millrace water may still not be appreciated sufficiently to overcome previous images of very degraded Millrace water quality.

Stormwater runoff during winter strongly influences the hydrology of the Millrace and contributes nutrients and pollutants from the 660-acre catchment basin which influences water quality during this period.

A wide variety of plant and animal species, in addition to humans, use the Millrace aquatic and associated riparian and upland habitats. These range from benthic invertebrates in the sediments, to fish, including salmon and trout, and birds and mammals.

Use of the Millrace by humans was documened for six reaches that were defined by natural breaks or significant Millrace structures. Visualizations of these reaches were prepared which depicted both problems and opportunities along the waterway.

Finally, enhancement options were developed, with an eye to funding opportunities, both for human use and for the natural resource component. Signifcant opportunities were described for enhancing the upper reach and the reach adjacent to the proposed Riverfront Research Park area.

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1.0 INTRODUCTION

STUDY OBJECTIVES

The consultant team of Scientific Resources, Inc., Robert H. Foster Consultants and Russ Fetrow Engineering, Inc. was contracted by the City of Eugene to assess the current character and existing conditions of the human and natural resource aspects of the Millrace, propose concepts for its enhancement, both aesthetically and ecologically, and explore the potential for funding these improvements.

Continuing perceptions of Millrace water quality degradation and plans to develop the Riverfront Research Park on the north side of the central reach of the Millrace (University of Oregon/City of Eugene 1988) have prompted a reassessment of this historical, constructed urban waterway. The study emphasizes the Middle Millrace, with consideration made to complement the work that has already been done in designing the Riverfront Research Park. To a lesser degree, an assessment and enhancement concepts have been developed for the upper and lower reaches of the Millrace.

MILLRACE STUDY AREA

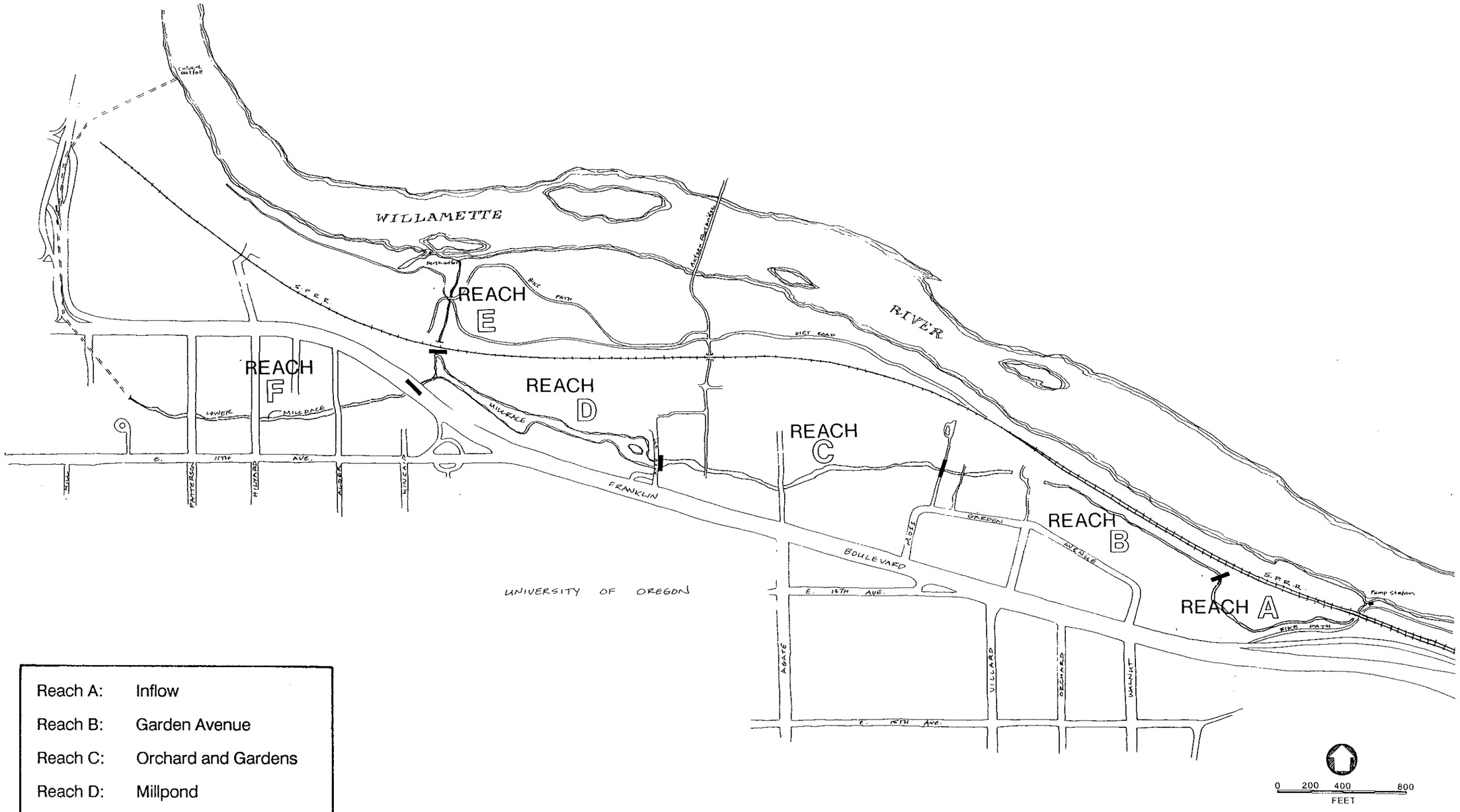
The Millrace is located east of downtown Eugene and north of the University of Oregon (Fig. 1). The Millrace extends through a varied landscape of woods, orchard and parks, housing and commercial development. Paralleling the course just to the north is the Willamette River and the Southern Pacific Railroad. Its drainage basin encompasses some 660 acres of residential and commercial properties, campus, parks and woodland.

Running parallel to the south bank of the Willamette River between the river and Franklin Boulevard (Fig. 1), its course is approximately 7600 feet of open waterway with some 2500 to 3000 feet of the final course culverted. The upper, unculverted portion begins at a pumping station on the Willamette River just west of the Interstate 5 bridge. Between Onyx Street and the junction with Franklin Boulevard, the Millrace widens to a pond edged by a University park. At the western end of the pond, the Millrace branches to two channels. A short channel drains north into the Willamette River. The other channel, called the lower Millrace, begins at Franklin Boulevard and drains to the west between small residential and commercial lots. Between Patterson and Ferry Streets, the Millrace enters a culvert and is piped under the city to its final outfall into the Willamette River.

HISTORICAL BACKGROUND

The information in this section has been taken primarily from the Metropolitan Civic Club (1966) report and the Master of Landscape Architecture dissertation by Judith Rees (1975).

The history of the Millrace dates back to around 1855 when Hillary Shaw and Avery Smith opened the first mill which was powered by water from the Millrace. Prior to that, in about 1851 or 1852, the course of what was to become the Millrace, started in a rupture of the Willamette River bank just below Judkins Point.



Reach A:	Inflow
Reach B:	Garden Avenue
Reach C:	Orchard and Gardens
Reach D:	Millpond
Reach E:	North Outflow
Reach F:	Lower Millrace

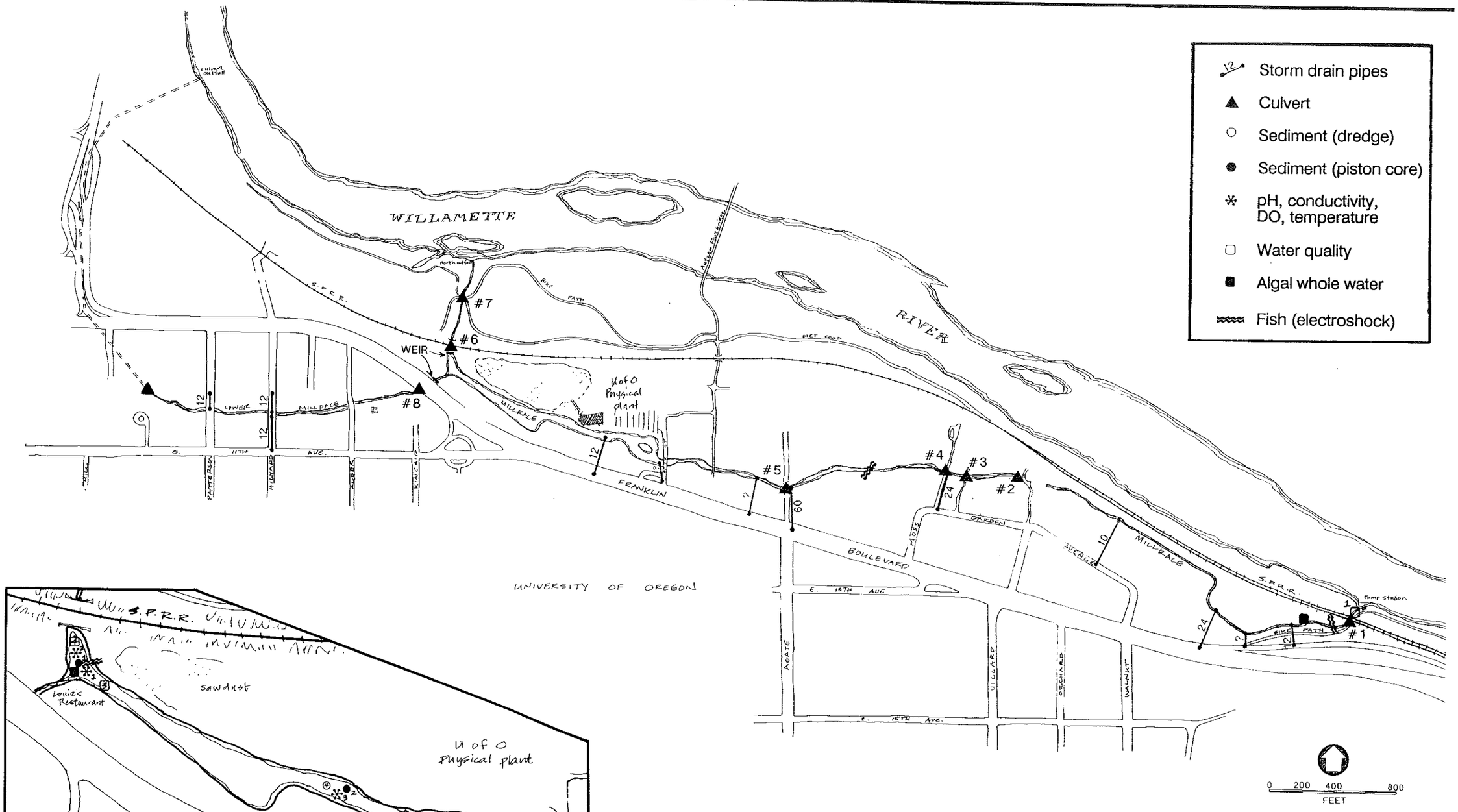
Source: W.A.C. Corp. aerial photograph, 6/14/88

Reaches

FIGURE 2

EUGENE MILLRACE

Scientific Resources, Inc. ● Robert H. Foster Consultants ● Russ Fetrow Engineering, Inc.



Enlargement of Millpond

Sampling Sites

FIGURE 3

EUGENE MILLRACE

Scientific Resources, Inc. ● Robert H. Foster Consultants ● Russ Fetrow Engineering, Inc.

held probe, and dissolved oxygen and temperature were determined with a YSI dissolved oxygen meter, model 50. No storm event data were collected due to lack of appreciable runoff during the project.

Three sediment cores were removed from the Millpond using a piston corer. Upper and lower sediment cores were analyzed in the laboratory for total volatile solids, total phosphorus, total Kjeldahl nitrogen, nitrate nitrogen, ammonia nitrogen, lead, zinc, copper, and arsenic.

Biological Resources

The length of the Millrace was toured both on foot and by canoe during several site visits on May 15, June 13, and July 25 and 29. Fig. 3 shows sampling locations for site-specific measurements and media assessments.

Vegetation

Site vegetation was sampled on June 13, 1990 (Reaches C and D) and on July 25, 1990 (Reaches A, B, E, and F) using the plant community concepts of Daubenmire (1968) and Franklin and Dyrness (1984). Visual estimates of plant community composition were made and a plant list was prepared. A plant list was prepared for each reach (see Appendix C-4). Background research was conducted and standard references were consulted to learn whether any sensitive plant species occurred on the site (Hitchcock and Cronquist, 1973: Meinke, 1987). An aerial photograph of the site from WAC Corporation (WAC, 1988; see frontispiece of this report) was also consulted in our investigation.

Wildlife

Animals were censused during daylight on June 13, 1990 (Reaches C and D) and on July 25, 1990 (Reaches A, B, E, and F). Species were recorded by observation (sight and/or call) as the observers walked Reaches A, B, E, and F and canoed Reaches C and D. Recorded data for birds included species, and habitat type in which the species was observed. Habitat components included canopy, shrub, and ground/understory layers. A wildlife list was prepared for each reach (see Appendix C-4). A supplemental wildlife list has been included of mammals and birds that are likely to use the Millrace during other seasons of the year (Appendix C-4).

A habitat assessment was performed by observation from a canoe and at particular access points along the upper, middle and lower Millrace. Photographs and qualitative observations were taken to document the conditions of wildlife habitat. The reaches correspond fairly well with changes in habitat types although two somewhat different habitat types are present within Reach B and Reach C.

SRI used the Wildlife Habitat Assessment (WHA) technique which was developed by a team representing the Audubon Society, U.S. Army Corps of Engineers (COE), U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Game (ODFW), and Wetlands Conservancy. Each reach was evaluated for wildlife habitat value. Reaches B and C were split into two segments (upstream and downstream) due to differences in habitat types within the reaches. Refer to *Preliminary Inventory of Eugene and Springfield* (Lev 1990) to compare relative habitat value with nearby sites . The WHA forms for each reach are provided in Appendix C-4. The WHA analyzes wildlife habitat value with regard to three

essential habitat components: water, food, and cover. Disturbance, interspersion with other nearby habitats, and unique features are also taken into account. These components are divided into sub-components, which are given a score. The sum total of all scores produce the final score.

Benthos

The benthos, comprised of bottom-dwelling invertebrate organisms and sediments, was sampled using an Eckman dredge at four locations in the Millpond around the island and adjacent to the power plant intake structure. Benthic organisms recovered by sieving the sediments were observed on site, and preserved in a labeled Nalgene bottle with formaldehyde for future analysis. Aquatic macrophytes on the Millrace bottom were collected from the sediments and identified.

Fish

An attempt was made July 29 to electroshock the Millrace for fish using a Smith-Root backpack; however, access was limited to waist-deep water. The upper Millrace below the pump was shocked, as well as the Millpond, and the section of the upper Millrace between culverts 2 and 3 (Fig. 3). Information was gathered from the Eugene office of the Oregon Department of Fish and Wildlife regarding fish species likely present in the Millrace. Anecdotal information on fish caught in the waterway was obtained from fishermen during site visits.

Perspective on Human Use

Existing conditions were noted and assessments made of problems and constraints along each reach (Fig. 2). These have been drawn on maps of the six reaches along with a list of various suggestions for enhancement. A photographic record (see Appendix A) was made of many different locations along the Millrace. Drawings and sketches were developed from photos taken and from an aerial photograph taken June 1988. Amenity values were determined in terms of human use of the Millrace, both in and around the water itself.

3.0 MILLRACE CHARACTER AND RESOURCES

PHYSICAL RESOURCES

Hydrology

Drainage Basin. The Millrace is unique in having two drainage basins: the Eugene drainage basin and the Willamette River drainage basin above the Millrace withdrawal point in the river at river mile 183.7.

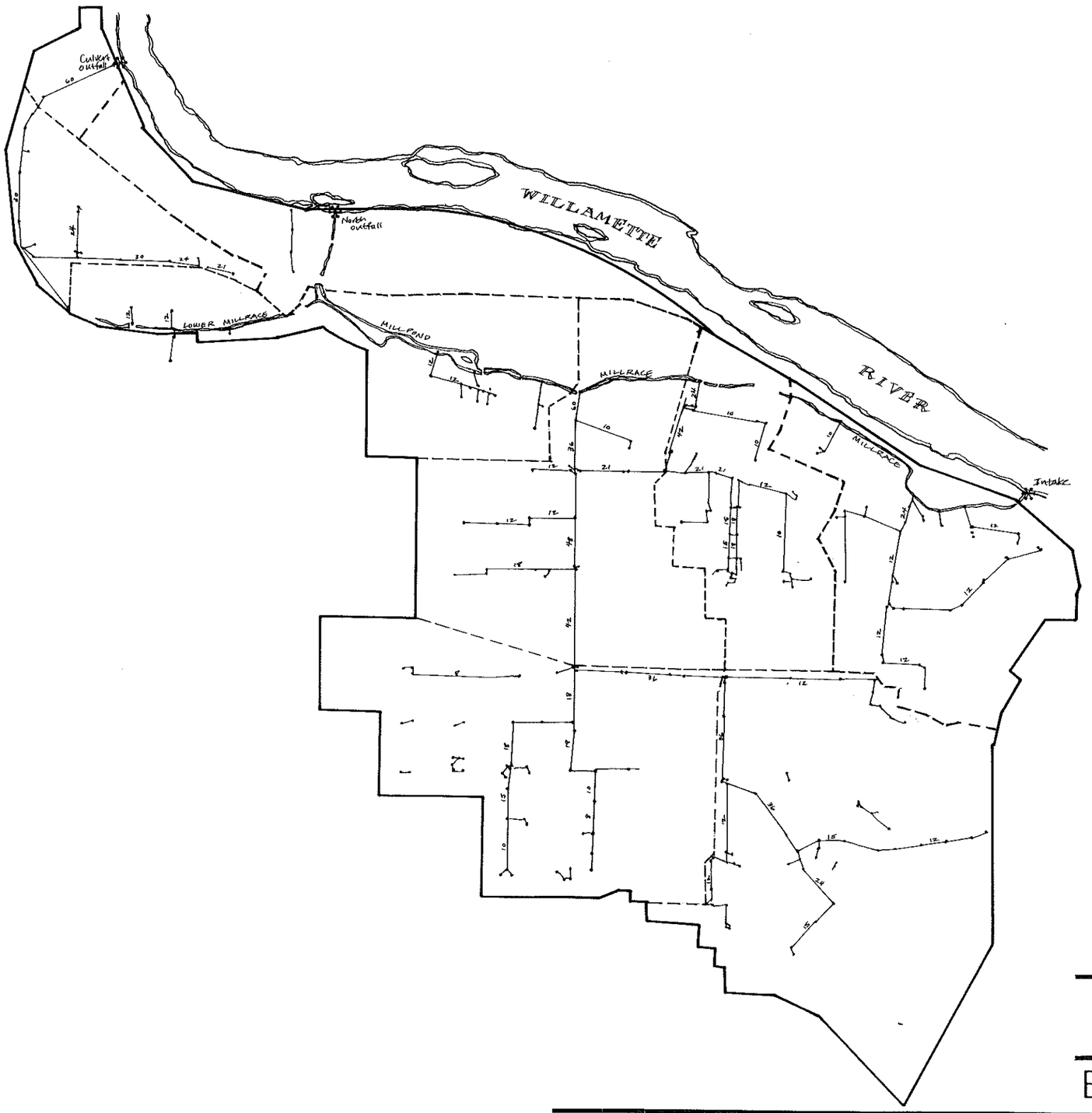
The drainage basin of the Millrace is approximately 660 acres, ranging from the 934-foot summit of Hendricks Park to the Willamette River at approximately 420 feet (Fig. 4). The majority of the basin is between 430 and 440 feet in elevation. The City of Eugene has divided the area into nine subbasins which drain storm runoff into the Millrace at three major (24-inch pipes or larger) and several minor locations. The location of the major stormwater drainageways is shown on Figure 4.

The Willamette River drainage basin is approximately 2,000 square miles comprising the basins of the Coast and Middle Forks of the Willamette River. Water is withdrawn from the River into the Millrace via two pumps (Fig. 3).

Stormwater Runoff. Because of the storm drains and the land use around the Millrace, the water level in the Millrace will respond within hours and even minutes to a storm event. Vegetative cover within the 660 acre catchment area in Eugene has an effect on storm runoff rates. Aerial photography shows that trees, shrubs and lawns cover nearly half of the residential properties (see land use analysis in this Section). The highest point in the drainage basin, Hendricks Park, is covered by forest. Other small city parks and a cemetery also are covered with trees and grass. The University property is a mix of buildings interspersed with walkways dotted with trees and lawns. Along Franklin Boulevard, where commerce dominates, large areas are covered by buildings, parking lots and maintenance yards with very little vegetative cover. The eastern stretch of the Millrace and much of the area to the north along the Willamette River are wooded.

Millpond Bathymetry and Flushing Rate. A bathymetric map was produced from depth measurements made along various transacts within the Millpond (Fig. 5). Upstream and downstream of the Millpond, an average depth was determined based on depths measured at various locations along the Millrace. The upstream average depth was 1.2 meters, and the downstream average depth was 1.5 meters. At the control weir at the west end of the Millpond, the depth of the water ranged from 1.8 to 2.3 meters. The volume of the Millrace above the Millpond was estimated to be about 14,700 cubic meters. The volume of the Millpond was estimated to be 18,700 cubic meters. At a typical summertime flow of around 27 cubic feet per second into the pond (66,065 cubic meters/day), detention time on a daily basis would be 6.8 hours. Expressed as flushing, the flushing rate would be 3.5 times per day.

Flow over the weir in the lower section of the middle Millrace at the Millpond outlet at the railroad tracks is regulated by the personnel at the University of Oregon Physical plant in order to maintain the water level in the Millpond at approximately 10 inches below the shore surface. Flow over the weir is not metered. The weir is operated to maximize flow in the middle Millrace.



0 400 800 1600
FEET

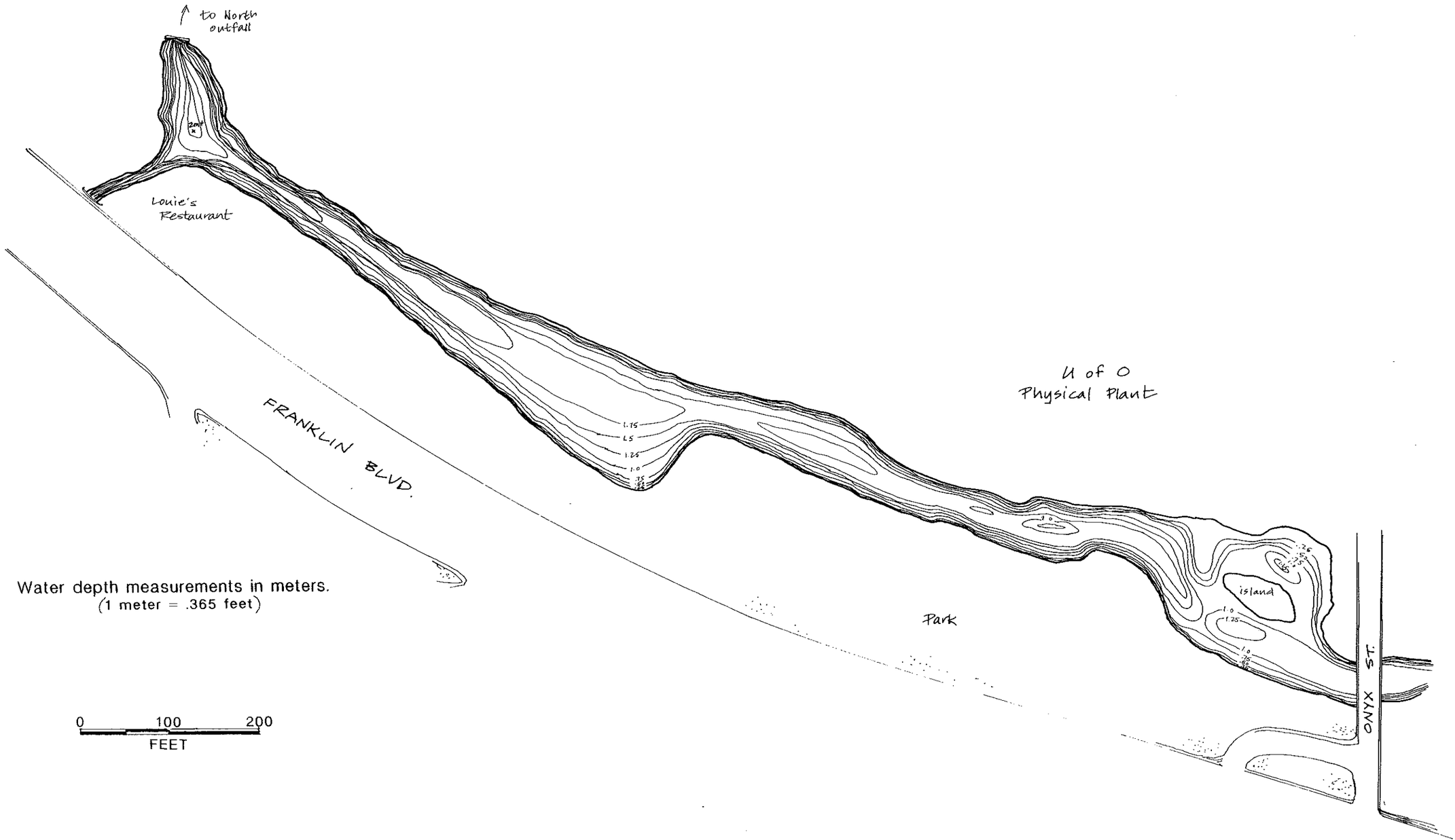
- Drainage subbasin
- Intake/outflow
- Storm drain pipe & size

Millrace Drainage System

FIGURE 4

EUGENE MILLRACE

Source: City of Eugene Drainage Basin, 10/5/87



Water depth measurements in meters.
(1 meter = .365 feet)

0 100 200
FEET

Millpond Bathymetry

FIGURE 5

EUGENE MILLRACE

Scientific Resources, Inc. ● Robert H. Foster Consultants ● Russ Fetrow Engineering, Inc.

Pump Station. Presently, the Millrace is supplied with Willamette River water by a pump station located at the railroad headgate structure. The pump station was constructed in 1959 and provides two 40-horsepower electric pumps with a capacity together to supply 50 cfs to the Millrace (CH2M-Hill 1974). Both pumps are operable. During summer low flow periods, only one pump can be operated at a time to supply water to the Millrace. This is because the intake structure in the Willamette is not deep enough and draws air if both pumps are operated simultaneously. Construction of a new intake structure that would access water across the shallow Willamette River in would be required to operate both pumps during the summer. During Willamette high flow periods, both pumps can operate simultaneously. Flow is then constrained by stormwater runoff which can require one of the pumps to be off-line.

Operating costs for the pumps last year(1988/89) were $8644. Electricity rates increased 10% during 1990, and pumping costs combined with maintenance are estimated to be from $10,000 to $15,000 for this year, or around $1200/month (Lois Egelton, personal communication, August 2, 1990).

Water Rights. Present water rights were granted for the Millrace in 1958 and are limited to 13.2 cfs for the condenser cooling at the University Physical plant (Certificate #29374) and 36.8 cfs for recreational use in the Millrace for a total of 50 cfs (Certificate #29375) (Mike Schmorde, personal communication, August 1, 1990). Rights for 150 cfs have been tentatively approved by the State of Oregon (Rosenthal and Kraeg 1982). Development of any enhancement alternative which increases flow in the Millrace will require acquisition of additional water rights from the Willamette.

The Physical plant is capable of using 33 cfs at capacity for cooling purposes, and is presently operating around 11 cfs. All of the water from the physical plant is returned directly to the Millrace in a pipe below the water surface located adjacent to the physical plant (Fig 3). The water temperature passing through the condenser can be raised as much as 15 degrees Fahrenheit. Expansion of the power plant is anticipated (Ron Neet, supervisor physical plant, personal communication, June 27, 1990) and will probably require more condenser water from the Millrace, depending on the expansion design.

Millrace Constrictions. Nine culverts were identified along the upper, middle, and lower sections of the Millrace (Appendix C-1). Five culverts, made of corrugated metal pipes, are located in the Middle Millrace. The smallest of the culverts on the Middle Millrace (culvert number 1) is 72 inches wide and 42 inches deep. The pipe which carries water from the lower Millrace into the Willamette is a 30-inch pipe which limits flow through this conduit to about 25 cubic feet per second (CH2M-Hill). A small 6-inch pipe adjacent to the physical plant returns water intermittently to the Millrace several inches above the water surface from another cooling source. Flow was measured in these culverts on July 25, 1990. Flow in culvert 1 (Fig. 3) just below the pumps was 29.9 cfs. Flow in culvert 7 (Fig. 3) on the diversion outlet was 14.8 cfs, and flow in culvert 8 was 11.6, totalling outflow of 26.4 cfs. Some water is expected to be lost due to seepage. A 10% seepage loss was estimated by Allen and Ulett (1954).

Feasibility of Flow of 100 cfs. In the 1974 CH2M-Hill report, several options are described for returning gravity flow to the upper Millrace, all with a maximum reasonable flow of 100 cfs and all requiring the redevelopment of the existing

diversion dam across the Willamette River near the Interstate 5 Bridge abutment. A flow of 100 to 150 cfs is estimated to be required to link the Millrace with the Amazon, part of the proposed Emerald Canal (Rosenthal and Kraeg 1982).

With the culvert constrictions at the end of Millrace as Reach F and E (30 inch and 48 inch respectively), it would be possible to pass flows of 100 cfs through the Millrace. This would require doubling the present pumping capacity and constructing a new intake structure. The use of both pumps now during summer could be facilitated with the construction of an intake structure that would access water across the river bottom during lower flows.

Water Quality

Due to the high flushing rate of the Millpond, the water quality of the Millrace and Millpond, particularly during summer and early fall, would be expected to reflect that of the daily quality of the Willamette River. During winter, stormwater runoff could be a major influence on Millrace water quality.

To observe possible changes in water quality along the length of the Millrace *field measurements were made of temperature, specific conductance, and dissolved oxygen*. Field measurements were made June 13, 1990 from a canoe along the Millrace (Fig 3). Initial readings were taken at 1240 hours in the Millpond. The temperature was 12.3 C and conductivity 30 umhos. At 1700 hours, readings were made in the upper Millrace. Temperature in this section was 14 C, conductivity 33 umhos, and dissolved oxygen 10.95 mg/l. At 1730, readings were taken in the lower section of the Millpond at two different depths. At 0.5 meters, temperature was 16.2, conductivity 32 umhos, and dissolved oxygen 9.32. At the same location 1.93 meters below the water surface, the temperature was 13.2 C and dissolved oxygen ranged from 4.5 to 8.56 mg/l.

The water quality parameter that would be expected to change the least along the course of the Millrace, conductivity, only varied from 30 to 33 umhos. Temperatures did change through the day reflecting the effect of sunlight in raising water temperatures

Water samples for laboratory analysis of additional parameters were collected at four locations along the Millrace on May 15, 1990 (Fig 3) These locations correspond to the intake structure at the upper end, the Millpond, the end of the Millpond (Louie's), and just before the conduit (culvert No. 9, Fig. 3). The water samples were analyzed for total phosphorus, orthophosphate, nitrate-nitrogen, total Kjeldahl nitrogen, ammonia-nitrogen, total suspended solids, turbidity, oil and grease, and fecal coliform bacteria. These parameters are of interest because of their concentrations as fertilizers for plant growth (nitrogen and phosphorus compounds), as evidence of stormwater influence (suspended solids, turbidity, oil and grease), and as evidence of possible pathogens (bacteria). Results are tabled in Appendix C-2.

Total phosphorus in the Millrace ranged from 0.071 to 0.097 mg/l, increasing in concentration from the upper Millrace to the lower. Orthophosphate exhibited a similar increase, from 0.035 to 0.039 mg/l.

Average total phosphorus concentrations in the Willamette River at the Springfield Bridge for 1987-1988 were 0.05 mg/l, with high values for December and July of 0.15 and 0.17 mg/l. Values for the Millrace in this study are within the range of values for the river. The slight increases suggest input from humans and waterfowl in the system. Results from the Nationwide Urban Runoff Program (NURP) for Eugene between 1979 and 1981 averaged 0.06 mg/l (range 0.036-0.103 mg/l) for the Millrace (Rosenthal and Kraeg 1982; [these data represent a semi-monthly water quality sampling program for the Millrace, and not storm-event data]). These concentrations of phosphorus, a nutrient essential for plant growth, suggest only moderately enriched water, again reflecting the quality of the Willamette River.

Nitrate-nitrogen, total Kjeldahl nitrogen, and ammonia-nitrogen all increased slightly down the Millrace length. Average nitrate/nitrite-nitrogen values for the Willamette are 0.05 mg/l (SRI 1989). Concentrations in the Millrace were found to range from 0.017 to 0.054 mg/l. The average Willamette River value for ammonia-nitrogen in 1987-88 was 0.04 mg/l . The Millrace inflow concentration was less than 0.01 mg/l, but increased to 0.20 at the lower Millrace outfall. The NURP study (Rosenthal and Kraeg 1982) found a nitrate-nitrogen average concentration of 0.13 mg/l (range 0.1-0.2 mg/l) in the Millrace between 1979-1981.

Total suspended solids increased 67% from the upper Millrace pump station to the lower Millrace outfall, from 7.3 to 22.2 mg/l. Turbidity, however, did not change greatly along the Millrace, ranging from 13.2 NTU's [nephelometric turbidity units] in the upper Millrace, to 15.5 in the Millpond, 14.0 at the end of the Millpond, and back to 13.2 at the lower Millrace outfall. Willamette River values in 1987-88 ranged from 0 to 17 NTU's, with an average of 3.0 (SRI 1989). According to Oregon administrative rules (Chapter 340, Division 41, Environmental Quality) no more than a 10% cumulative increase in natural stream turbidities shall be allowed. The NURP study (Rosenthal and Kraeg 1982) found the average turbidity to be 5.7 NTU (range 2.1 - 11) for the period 1979-1981. Total suspended solids (non-filterable residue) ranged from 2 to 18 mg/l in the NURP study.

Oil and grease was found to decrease along the Millrace, entering the Millrace at 1.1 mg/l, and exiting at 0.3 mg/l. The NURP study (Rosenthal and Kraeg 1982) found oil and grease levels to be approximately 4.5 mg/l in 1980.

Fecal coliform bacteria concentration increased notably for the three lower stations. Fecal coliform concentration was 98 colonies/100 ml upon entering the Millrace, which increased to 1200/100 ml in the Millpond and 1717/100 ml in the lower Millpond, and decreased to 1060/100 ml at the lower Millrace outfall. DEQ standards for Willamette Basin streams is no more than 200/100 ml (based on a minimum of 5 samples in a 30-day period with no more than 10% exceeding 400/100 ml in that 30-day period). DEQ data for the 1987-88 year on the Willamette range from 0 to 240/100 ml, with an average of 30/100 ml. *The large numbers of ducks and geese observed in and at the Millpond are the likely sources of these increased numbers of bacteria.*

Organic Compounds in the Millrace. In April 1990, a study of the Silva Area of the proposed Riverfront Research Park Development site was assessed for the presence of toxic materials. Samples of Millrace water were obtained from the upper and lower ends of the property adjacent to the Millrace, approximately at

the ends of Reach C. This study (L. R. Squier Associates, Inc. 1990) found no detectable levels of chlorinated pesticides, herbicides, PCBs or common chlorinated solvents in the Millrace water.

Stormwater Quality. The NURP studies conducted in Eugene 1976-1982 obtained limited information on the quality of the Millrace during periods when stormwater runoff would have influenced quality of the water. As noted above in comparisons of data from this study with the NURP data, the high end of the NURP value ranges are not unusually high for these parameters, or for metals measured (e.g. nickel, lead, copper, chromium, mercury). Daily precipitation data for the Eugene area (see Table in Appendix C-1) indicates no major storm events (greater than 1 inch) occurred during this period of this study from May 15. No stormwater runoff data was collected during this study.

Human activities in the Willamette River drainage have produced water of very poor quality the effects of which have been greatest at the Portland end of the river. However, water quality degradation had been seen in the Upper Basin as well. Construction of secondary effluent treatment facilities for towns above Eugene and improved treatment of mill effluent has resulted in major improvement in water quality (Gleeson 1972). Earlier observations of poor quality water in the Millrace ("algae-covered swamp or slough" in 1966, Metropolitan Civic Club report) have reflected poor quality Willamette River water. *Fortunately there has been an improvement due to human action, and this associated improvement for Millrace water may still not be appreciated sufficiently to overcome previous images of very degraded Millrace water quality.*

Sediment

The bottom of the Millrace is covered with 1 to 3+ feet of unconsolidated sediment. Some shallower depths of the Millpond are over a consolidated substrate, particularly in locations where sediment accumulation would not occur. The unconsolidated bottom sediment thickness is particularly great in the upper reaches of the Millrace. These sediments may be residue from previous floods that occurred in the early 1940's (Metropolitan Civic Club 1966).

The continuous withdrawal of Willamette River water with its seasonally varying suspended sediment load is also a likely source of these sediments. Using past data from the NURP studies (Rosenthal and Kraeg 1982) we can estimate quantities of sediment that may enter the Millrace during winter. Using a value of 18 mg/l for wintertime total suspended sediments in the Willamette River, during a three month period with both pumps running, the total amount of sediment (dry weight) imported to the Millrace would be around 218 tons (short). Not all sediment would precipitate in the Millrace due to the short retention time, but over time this would be an appreciable source, and particularly for the upper reaches of the Millrace.

To evaluate quality of this sediment in the Millpond, sediment cores were taken at three locations (Fig. 3) and analyzed in two separate sections, bottom 4 centimeters and bottom 4 centimeters, for the following parameters: wet weight, dry weight, total volatile solids, total phosphorus, total kjelkahl nitrogen (TKN), nitrate-nitrogen, ammonia-nitrogen, lead, zinc, copper, and arsenic (Appendix C-4). In most of the samples, levels of all these parameters increased with depth. The exception was total phosphorus, TKN, and nitrate-nitrogen, which decreased

with depth from the core taken at the lower end of the Millpond. The total phosphorus concentrations in the sediments are within the range of values for moderately to highly enriched lakes in the Pacific Northwest. Concentrations of copper in the sediments suggest that this metal may have been used as an algaecide in the Millpond. Concentrations of this metal and the others (arsenic, lead and zinc), however, do not suggest degraded conditions from other than typical stormwater runoff.

Aquatic Habitat

Vegetation. Algal production in the Millrace is low to negligible. The species identified were predominantly attached algae, which are the same species found in the Willamette dislodged upstream and carried into the Millrace. There was no increase in density or change in species in microscopic algae collected at the upper and lower reaches of the Millrace.

Submersed aquatic vegetation was observed in the upper Millrace which was typical of plant assemblages in the Willamette River, namely *Elodea densa* and *Potamogeton crispus*. Eurasian water-milfoil (*Myriophyllum spicatum*) and *Ceratophyllum demersum* were observed in the Millpond (sparse) and in Reach F. Eurasian water-milfoil is an invasive and nuisance species that has frustrated recreational use of the Delta Ponds area of Eugene (Scientific Resources, Inc. 1989a).

Fish. Fish access in the Millrace is limited by lack of an unobstructed opening to the Willamette River. Fish access from the Willamette is hindered by the pumps that provide water to the Millrace. Only a relatively short section of the northern outfall is accessible to fish before a 48-inch diameter culvert and a larger weir at the outflow from the middle Millrace. The lower Millrace may be inaccessible because of the 2200-foot, 30-inch culvert section that extends under the city and because a drop of approximately 2 feet exists between the open water of the lower Millrace and the culvert.

Despite these obvious limitations, the Oregon Department of Fish and Wildlife office in Eugene reported the presence in the Millrace of Coho salmon and trout. Observations of these fish have been made at various times over the past 20 years (D. Irish, ODFW, personal communication July 26, 1990). The Millrace appears to provide potentially good habitat for warm water fish. Dick Irish, of the Oregon Department of Fish and Wildlife, stated that redside shiners (*Richardsonius balteatus*), dace (*Rhinichthys* sp.), carp (*Cyprinus carpio*), squawfish (*Ptychocheilus grandis*), suckers (*Catostomus* sp.), and probably largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) occur in the Millrace (personal communication July 26, 1990). A brown bullhead (*Ictalurus nebulosus*) and a sculpin (*Cottus* sp.) were also both observed in the middle Millrace. Except for sculpin capture, no fish were raised by electroshocking the Millrace (Fig. 3). This is likely due to the fact that only shallow sections could be accessed with the backpack electroshocking equipment, and the day was very warm which causes the fish to remain in the cooler, deeper portions of the water. Carp were observed in the Millpond during site visits.

Invertebrates. The upper Millrace has overhanging, vegetated banks that could provide shade and increase the potential invertebrate food source for fish. The ponded areas of the middle and lower Millrace are probably more limited in their

potential habitat because of the increased human interaction with the waterway, the lack of overhanging vegetation, and decreased water quality within the ponded areas.

The invertebrate community of the Millrace appears to be dominated by insects. Damselflies and dragonflies were observed along all sections of the Millrace with damselfly nymphs found in sediment samples along the lower stretch of the upper Millrace. Sediment samples collected within the pond area contained a freshwater sponge (*Spongilla* sp.) growing on a submersed twig and a gastropod attached to a stand of *Elodea canadensis*. Although sediment samples did not contain oligochates or chironomid larvae, it is probable that these invertebrates are abundant within the Millrace.

Wildlife Habitat

Results of the surveys of the Millrace for its vegetation and wildlife are reported in Tables in Appendix C-4. Observations of species are tabled by the reaches described below. A total of 84 species of plants were noted along the Millrace.

Reach A. This reach supports a great diversity of vegetation which is valuable to wildlife which may be found in deciduous, riparian areas. The vegetation along this reach between a bicycle path adjacent to the Millrace and the railway has been left undisturbed. The width of this riparian-type habitat at its widest point is approximately 300 feet.

This reach can be described as a red alder (*Alnus rubra*) / Himalayan blackberry (*Rubus discolor*) plant community. Scouler's willow (*Salix scouleriana*) is also fairly common. Several large black cottonwoods (*Populus balsamifera*) are present at the upstream end. Two large oaks (*Quercus garryana* and *Quercus kelloggii*) are present at the downstream end. Large-leaved maple (*Acer macrophyllum*) and Oregon ash (*Fraxinus latifolia*) are both fairly common along the reach. The understory is comprised primarily of Himalayan blackberry. This reach offers the best wildlife habitat along the Millrace.

Reach B. This reach may be broken up into two separate habitat types. The upstream half of the reach is very narrow and adjacent to a parking lot. This half of the reach supports a rather uniform, low-diversity habitat type. Large (greater than 40 feet high) Lombardy poplar (*Populus nigra*) line the southern bank while Himalayan blackberry is abundant on both banks. Several large black cottonwoods are present at the upstream end. No tree layer is present on the northern bank. A row of lodgepole pine (*Pinus contorta*) has been planted on top of the southern bank.

The downstream half of the reach is much more diverse botanically and characterized by a dominance of Scouler's willow and Himalayan blackberry near the stream with more large-leaved maple and black cottonwood occurring away from the stream.

Reach C. This reach may also be broken up into two separate habitat types. The upstream half of the reach is botanically diverse supporting an overstory dominated by large-leaved maple with Oregon ash being less common. Western hazel (*Corylus cornuta*) is common in the shrub layer, while Himalayan blackberry is the dominant understory plant.

Vegetation along the downstream half of the reach is rather sparse. Himalayan blackberry is common along the bank. There is one large Oregon ash, several large introduced willows, and some introduced ornamental shrubs.

Reach D. This reach encompasses the pond-like middle Millrace (Riverfront Park). Many of the tree and shrub species present are introduced ornamentals. An overstory of black cottonwood and red alder with an understory of Himalayan blackberry occur on the north bank of the Millrace between the two pond areas. Some very large ponderosa pine (*Pinus ponderosa*) with a Himalayan blackberry understory are present on the southern bank near the downstream end of the reach.

Reach E. This reach is, by far, the fastest flowing reach of the Millrace. The banks are covered with an understory of Himalayan blackberry. Red alder, black cottonwood, and willow are all fairly common in the overstory. Sumac (*Rhus typhina*) is also present. Dogwood (*Cornus stolonifera*) is present at the downstream end of the reach.

Reach F. This reach, from the upstream end to the first bridge crossing, is characterized by an understory of Himalayan blackberry. One large alder and several ornamental shrubs are present. Downstream of the bridge to the end of the reach, the banks of the Millrace are lined by cement. Various trees, such as large-leaved maple, weeping willow (*Salix* sp.), and western red cedar (*Thuja plicata*) are present.

Wildlife Observations. A total of 19 bird species and two mammal species was observed along the Millrace during two daylight surveys June 13 and July 25 (see Appendix C-4). None of the plants or animals observed along the Millrace are considered threatened or endangered (Appendix C-4). Use of all habitat components was observed. The density and variety of birds observed was low to moderate. Single birds were generally observed. All species observed, except for the Northern oriole (*Icterus galbula*) (nest observed along reach C) are generally regarded as common in Western Oregon. In addition, river otters (*Lutra canadensis*) occur along the downstream part of Reach B (pers communication with local resident, July 25, 1990). A table of species not observed during this study but likely to occur in the Millrace is provided in Appendix C-4.

Wildlife Habitat Value. A comparison of the various reaches of the Millrace with other nearby habitats for wildlife habitat value may be made with areas assessed in *Preliminary Inventory of Eugene and Springfield* (Lev and Zika, 1988). In their paper, much of the Millrace has been grouped into one assessment area and given a score of 42. Their results are similar to those of SRI (see data forms in Appendix C-4). The average score of all of the areas assessed along the Millrace by SRI is 47.5. All reaches except Reach A and Reach F were assessed in Lev and Zika's general assessment of the Millrace area. Excluding Reach A and F, the average score of the areas assessed by SRI is 47. The area was described as "a mosaic of riparian vegetation along the Willamette and the Millrace, open fields, landscaped forest, playing fields and landscaped upland" by Lev and Zika.

The wildlife habitat with the highest rating occurs on the upper Millrace along Reach A. The Millrace, in general, supports reaches of native, typical Western Oregon riparian vegetation and reaches which have been planted largely with ornamentals. The Millrace along its entire length offers a permanent water supply

which is important to wildlife. Native vegetation dominates along reaches A, B (downstream), C (upstream), and E. Park-like settings with a dominance of ornamental trees and shrubs are found along reaches B (upstream), C (downstream), D, and F. The reaches which support a dominance of native vegetation received higher WHA scores and are used more heavily than the park-like areas by animals native to Western Oregon. The park-like reaches dominated by ornamental species tend to lack well developed understory layers, support trees and shrubs that are rather sparsely distributed and of limited use to native wildlife species, are more heavily canoed, have an abundance of domestic geese and ducks, and are associated with slow moving, rather stagnant water.

Human Perspective: Use and Opportunity

Land Uses. As noted in Section 2.0, the Millrace is unique in having two drainage basins or watersheds: the Willamette River Basin above Eugene, and the 660-acre drainage basin shown in Figure 1, enlarged in Figure 6. Changes in water quality associated with human activities in the Upper Willamette Basin have been noted above. Figure 6 provides an overview of the land uses in the heavily urbanized Eugene Millrace drainage basin. General land uses in this basin include retail, recreation/parks, government/education, industrial, residential and agriculture.

Patterns of land use, as indicated on aerial photography, appear to closely follow the City's zoning designations. In addition, the pattern roughly follows topography. Commercial property, including the University, is located at the lowest elevations along Franklin Boulevard and the Millrace while residential property is generally on higher ground on the flanks of Hendricks Park. There are a number of residential structures, including fraternities and sororities, along the Lower Millrace. A map of property ownership along the Millrace is provided as Appendix B.

Reach Assessment. Following visual on-site assessment of each reach, the existing condition of the reaches defined in Figure 2 has been addressed in graphic form by addressing its problems and constraints and suggesting possible improvements. General information on vegetation is provided in this section with the more specific observations provided in the previous sections on wildlife and aquatic habitat. Selected photographs of reaches are provided in Appendix A. This reach assessment emphasizes human use of the waterway

Reach A Inflow Area (Fig. 7). The Millrace is characterized in its highest reach by the natural vegetation along its banks and by the bike/foot path which follows the south bank from the pumping station to the entrance to the Black Angus Restaurant. This improved path is part of an extensive network of bicycle/pedestrian paths. This segment extends further east, after crossing under the railroad, on the abandoned Upper Millrace channel bottom all the way to the Willamette River bike/foot bridge at Interstate 5. The path continues east and west along the north side of the Willamette River completing a loop system of several miles back to the Autzen Bridge and beyond.

The western end of this reach affords opportunity on the Millrace for wildlife habitat improvement with the potential for an interpretive education facility. The 36-inch storm water/sewer outflow could be treated with the installation of a