M E M O R A N D U M
May 5, 1982

To: Carl Nuechterlein

From: Lynn Singleton and Joe Joy

Subject: Mill Creek Receiving Water Survey

Introduction

A receiving water survey was conducted February 3 and 4, 1981 on Mill Creek, Walla Walla County, by Lynn Singleton and Joe Joy, Water Quality Investigations Section, Washington State Department of Ecology (WDOE). A Class II inspection of the Walla Walla Sewage Treatment Plant (STP) was conducted concurrently and is covered in a separate memorandum (Yake, 1981). The primary purpose of the receiving water survey was to evaluate the STP discharge impact upon Mill Creek during winter low-flow conditions and determine the sources of any other inputs which may affect water quality. Information gained during this survey is analyzed to estimate water quality conditions under different stream flows and effluent qualities. These findings will provide information to aid in the development of the forthcoming updated NPDES permit. As you are aware, the plant is currently operating under an expired permit.

Background

Mill Creek flows from the western slopes of the Blue Mountains, through the City of Walla Walla, and empties into the Walla Walla River five miles downstream of the city. Between river mile (r.m.) 4.5 and 11.5, the creek bank and bed have been channelized and groined to various degrees by the Army Corps of Engineers (A.C.E.) for flood control. Those modified portions of the stream not having a concrete bottom are usually covered with gravel and rubble. The seven-mile channelized reach begins upstream of the city and terminates on the western edge of the residential district.

The Mill Creek waters are heavily used for potable water supply and irrigation supply. The City of Walla Walla municipal water intake is located at r.m. 25.2. The intake includes a dam and impoundment. The

greatest irrigation demand occurs in spring, summer, and early fall when
the entire flow of Mill Creek may be diverted to Yellowhawk and Garrison
creeks via a diversion dam at r.m. 10.5 (Figure 1). Flows downstream of
the diversion may be less than 1 cfs. They are maintained by ground-
water intrusion, incidental leakage, and irrigation return. Minor point
source inputs may also contribute to flows during this period. Diver-
sion of Mill Creek generally begins in May and terminates around De-
cember (Hansen, 1981). A division dam is located just upstream of this
diversion, and is used for flood control.

The Walla Walla STP has the only NPDES permit currently in force on Mill
Creek. The STP discharges to Mill Creek from about October 15 to April 15.
The water district has the water rights on the STP effluent. They can
divert the entire effluent from the creek to the irrigation district
channels if it is needed, but are under no obligation to do so (Peter-
son, 1981). Water which is not used by irrigators is wasted back into
Mill Creek at three different locations. The discharge points are
located: (1) just upstream of the STP outfall; (2) above Case Street;
and (3) below Case Street. Other tailwaters are also discharged to
Doan and Cold creeks (Prouty, 1981). Cold Creek enters Mill Creek at
r.m. 1.7 and Doan Creek enters at r.m. 0.3.

Fishery

Mill Creek maintains a sport fishery with native populations of steel-
head and rainbow trout. Rainbow and steelhead eggs and fry, and Dolly
Vardon fry have been stocked in the stream during the recent past by the
Washington State Department of Game (WDG); however, a regular stocking
program is not in practice.

Migrating adult salmonids are occasionally blocked by the A.C.E. dams.
When this occurs, WDG personnel net the fish and release them upstream
(Vail, 1981). The A.C.E. has received funding to construct fish ladders
to improve passage and alleviate the need for netting. Construction
should be completed by 1983.

The State of Washington has adopted the national goal of making all
waters fishable, swimmable by 1983. This responsibility includes
maintenance of minimum flows during key periods of the year so that
adequate water and water quality exists to allow fish passage in Mill
Creek. Migrating adults are probably in the Walla Walla River in
September; however, they have to wait until adequate water is present
in Mill Creek before entering. Migration up the creek generally occurs
from December through May. Spawning is confined to the drainage above
the dams. Juveniles usually remain in the creek for one year and
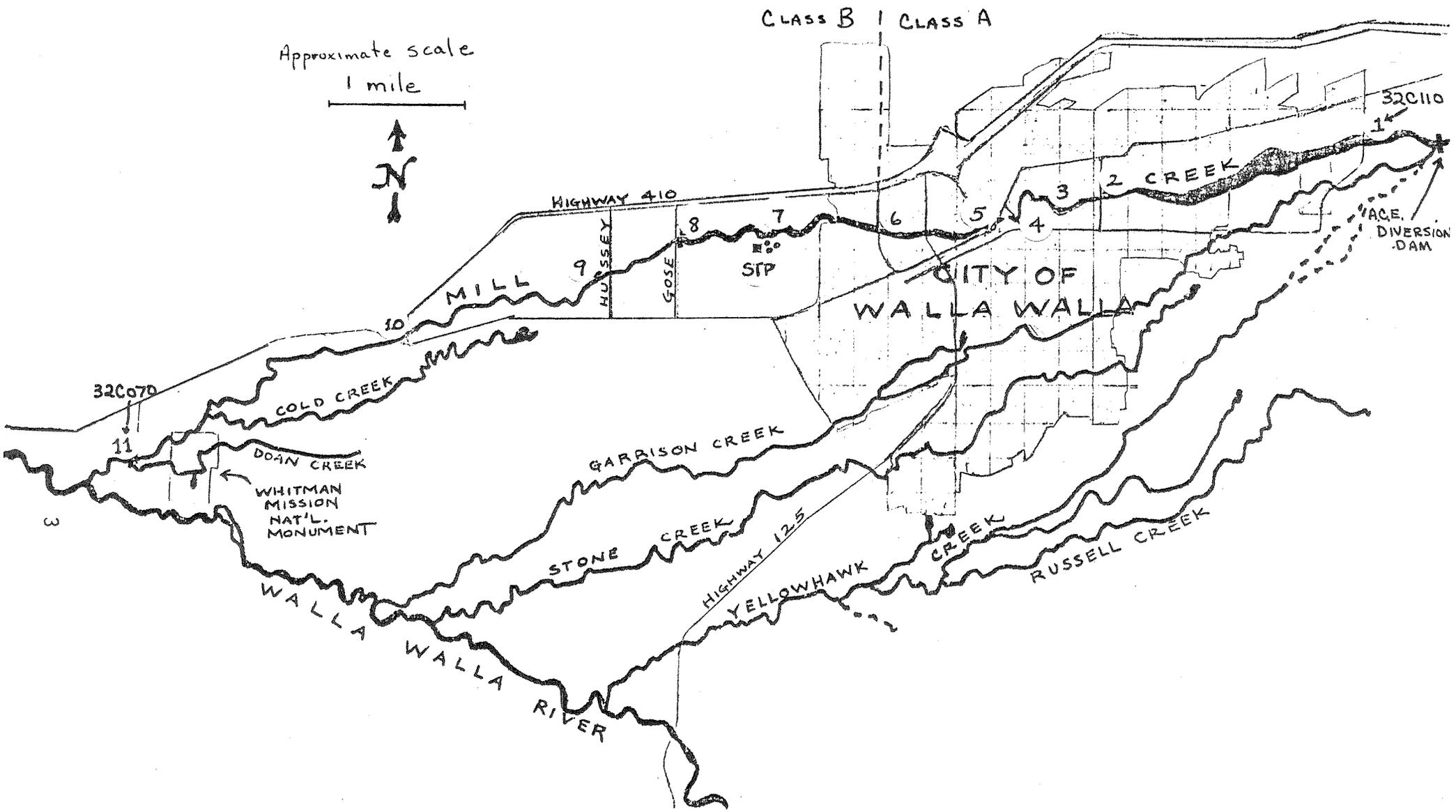migrate downstream from January through May.

Figure 1. Map of the study area, Walla Walla, Washington.

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                              J  F  M  A  M  J  J  A  S  O  N  D
Juvenile Residence           _____
Juvenile Migration           _____
Adult Migr. & Spawn          _____                      __
STP Eff. Discharged          _____           _____
STP Eff. Diverted                         _____
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The fishery appears to be maintained during summer low flows in the
waters upstream of the diversion dam and in Yellowhawk and Garrison
creeks. Those fish which survive in Mill Creek below the dam, do so
because of groundwater input. Fishkills have been reported during the
summer low-flow periods below the dams (Vail, 1981). However, the
extent, dates, and causes of the fishkills apparently have not been
documented.

Water Classification

Mill Creek waters have been placed in three classifications. Mill Creek
from the confluence of the Walla Walla River to the 13th Street bridge
(r.m. 6.3) is designated Class B; the waters from 13th Street to the
City of Walla Walla waterworks dam (r.m. 25.2) are Class A; and all
waters upstream are Class AA. The Class B designation has a special
proviso stating that a concentration of 5.0 mg/L dissolved oxygen (D.O.)
or 50 percent saturation will be maintained (WDOE, 1977). This study
involves only the Class A and B waters. Definitions of the specific
classifications may be found in Appendix I.

Historical Data

    Flows

    Table 1 gives the monthly mean flows and exceedence probabilities
    determined from USGS discharge records (1966-1980) at station
    14015002 (WDOE station 32C110). These data illustrate the dis-
    charge norms for the creek. It is important to note that discharge
    from June through November changes little as recurrence frequency
    increases. The 1-in-10-, 1-in-5-, or the 1-in-2-year low flows for
    these months are very similar.

    Discharge measurements were also made at USGS station 14015400
    (WDOE station 32C070) for a short period of time. These data may
    be found in Appendix II.

Table 1. Monthly low flow recurrence interval for USGS station
14015002 covering 1966 to 1980 discharge records.

| | Stream flow (cfs) | | | |
| | Recurrence Interval - low monthly flow | | | |
Month	2 year	5 year	10 year	20 year
January	185.0	90.3	57.7	38.3
February	170.8	85.9	49.4	28.0
March	163.4	98.4	72.4	55.0
April	144.3	78.5	55.1	40.4
May	71.5	14.7	4.9	1.7
June	10.4	1.9	0.7	0.3
July	1.5	0.4	0.2	0.1
August	1.3	0.6	0.4	0.2
September	0.7	0.2	0.1	0.0
October	1.1	0.2	0.1	0.0
November	11.7	2.4	1.0	0.5
December	86.8	33.3	19.1	11.7

Water Quality

Water quality data have been collected by WDOE from two sites on
Mill Creek from 1972 to 1975. Station 32C070 is located at r.m.
0.4 and station 32C110 is located at r.m. 10.0. Appendix II con-
tains the available WDOE records. The waters below the 13th Street
bridge, represented by 32C070, have been in violation of Class B
standards for pH, dissolved oxygen, temperature, and fecal coliform
bacteria. Un-ionized ammonia concentrations were calculated during
the Water Quality Index (WQI) analysis (Singleton and Joy, 1981)
and found to be greater than the 0.016 mg/L criteria (USEPA, 1976)
in five percent of the samples taken at 32C070 (unpublished data).
The upstream Class A waters, represented by station 32C110, had
temperature, pH, and fecal coliform standards violations. Nu-
trients were in excess at both stations. This analysis indicates
Mill Creek had the seventh worst WQI, 46.1, in the state. Clearly,
Mill Creek has experienced water quality violations in the recent
past. Land use and wastewater discharge practices have not changed
appreciably since the last routine WDOE monitoring occurred in 1975
(Farrell, 1981). This suggests that the problems are still present.

Methods

Water quality samples were taken at 11 stations within the study area,
beginning with 1 at r.m. 10.0 and ending with 11 at r.m. 0.4 (Figure 1).

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Grab samples were taken at seven sites above the outfall (stations 1
through 7) and four sites below the outfall (stations 8 through 11). In
addition, 24-hour composite samples were taken at stations 1 and 9 with
Manning field compositors set to collect 250 mls every 30 minutes.

Field analyses of the following parameters were performed at each
station: temperature (°C); dissolved oxygen using the Winkler method;
total residual chlorine (TRC) using DPD ferrous titrametric method;
specific conductivity and pH by field meters. In addition, water
quality samples were collected, packed in ice, and transported to arrive
at the Tumwater WDOE analytical laboratory within 24 hours. Selected
combinations of the following analyses were performed on those samples:

pH (S.U.)	Total Solids (mg/L)
Specific Conductivity (μmhos/cm)	Total Non-volatile Solids (mg/L)
Chemical Oxygen Demand (mg/L)	Total Suspended Solids (mg/L)
Biochemical Oxygen Demand 5, 12, 15,	Total Non-volatile Susp. Solids
20 (mg/L)	(mg/L)
Nitrate-N (mg/L)	Turbidity (NTU)
Nitrite-N (mg/L)	Fecal Coliform (org/100 ml)
Ammonia-N (mg/L)	Total Copper (mg/L)
Orthophosphate-P (mg/L)	Total Zinc (mg/L)
Total Phosphate-P (mg/L)	Total Iron (mg/L)
Chloride (mg/L)	Dissolved Nickel (mg/L)
	Dissolved Chromium (mg/L)
	Dissolved Cadmium (mg/L)
	Dissolved Lead (mg/L)
	Dissolved Manganese (mg/L)

All laboratory analyses were performed according to procedures stated in
Methods for Chemical Analysis of Water and Wastes (USEPA, 1979). Un-
ionized ammonia fractions of total ammonia were calculated using field
temperature and pH values (Thurston, Russo, and Emerson, 1979).

Stream discharge was determined at stations 8, 9, and 11. A Marsh-
McBernie Magnetic Flow Meter and stream dimension measurements of two
to four feet were used for each cross-section.

Discharge for station 1 was obtained from the Army Corps of Engineers'
gaging station located at r.m. 10.5. Measurement of flow was attempted
at station 7; however, the series of closely spaced, broad, gravel,
weir-like structures and undercut banks in the area made the estimates
inaccurate. Flows at this site were estimated from the mean of the
discharge at stations 8 and 9 less the estimated STP discharge. The STP
discharge was estimated by comparing plant flows given by Yake (1981)
with the results of a mass balance using station 9 as the complete mix
area. For the purpose of our calculations, the discharge from the STP
was taken to be 10.2 cfs.

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Results and Discussion

Upstream of Walla Walla STP

Survey results are given in Table 2. Seven stations and two point
sources are included. Station 1 indicated the upstream condition
for this waterway. All constituents monitored were within Class A
water quality standards. The BOD5 of 1.2 and 1.7 mg/L is somewhat
high for an undisturbed creek (Velz, 1970); however, the basin
upstream of station 1 is not a remote area and is undoubtedly
impacted by mans' activities. The dissolved oxygen was at 88
percent saturation. Below station 1, the creek enters its groined
concrete channel. The data indicate that the turbulence caused by
the groins effectively raised the concentration of dissolved
oxygen.

Water quality remained relatively constant between stations 1 and
7. Nitrate-N increased slightly as the creek passed through Walla
Walla. This increase may have been due to groundwater recharge in
areas not covered by concrete or from groundwater infiltration of
the many stormwater discharge pipes entering the creek (Farrell,
1981). Additional point sources also may have been present and
partially responsible for the increases; however, this was not
verified. The flows at stations 1 and 7 are quite similar and
therefore do not reflect any change in stream flow. However,
withdrawal was occurring during the survey. One large pipe (18 to
24 inch diameter) was found withdrawing water from Mill Creek and
there was a likelihood of others as well. Water withdrawal and
selective discharge practices present in Mill Creek make a mass
balance calculation of the system above the STP impossible within
the scope of this survey.

Two previously unknown point sources (Peterson, 1981) with rela-
tively small discharges were found during the survey. The first
was located at about r.m. 8.2 and appeared to be cooling water from
Whitman College. This source was warm, contained few nutrients,
and had a higher dissolved ion concentration than the creek. The
second point source was located on the downstream side of the 13th
Avenue bridge (station 6). It appeared to originate from the
Jones-Scott Company, a sand and gravel operation. This discharge
was highly turbid and contained large amounts of solids and oil,
probably from the trucks and machinery located at the site. Nu-
trients were higher than in-stream levels. The impact of the first
point source was negligible during the survey; however it may
impact the creek's temperature during the very low-flow conditions
in the summer. The second point source aesthetically impacted the
creek in the area immediately downstream; however no deleterious
effects were observed at station 7 (0.9 mile downstream). The
impacts may be greater if this source discharges during the summer
low-flow period.

Walla Walla STP and Downstream

The Walla Walla STP outfall discharges to Mill Creek at r.m. 5.4.
At a plant flow of 10.2 cfs, the stream/effluent dilution ratio was
5:1, much lower than the 20:1 ratio recommended in the dilution
zone guidelines (WDOE, 1980). A minimum flow of 204 cfs would have
been required to meet the guidelines. Under present conditions,
this could be difficult to obtain in some years. During the period
when the STP is permitted to discharge directly to Mill Creek, mid
October to mid April according to the expired permit, the guideline
is rarely met. During the water years 1973-1980 (USGS, 1972; 1973;
1974; 1975; 1976; 1977; 1978; 1979; and 1980) only 16 percent of
the months in the October-April period had a mean discharge greater
than 200 cfs. Many times in October and November the discharge was
below 10 cfs (see Table 1). This, at best, is a dilution ratio of
1:1. The expired NPDES permit states that a minimum flow require-
ment of 25 cfs (as measured below the plant) is required for dis-
charge. This represents a dilution ratio of only 1.5:1. A 1-in-2-
year October flow of 1.1 cfs indicates this guideline is rarely met
if STP discharge occurs in October.

Mass balance calculations indicated that mixing of the STP effluent
was complete at station 9. The plant's impact upon the in-stream
concentrations of BOD, COD, nutrients, solids, chloride, and con-
ductivity below the plant was very apparent. The dissolved oxygen
concentration and percent saturation began to decline below the
plant as the carbonaceous and nitrogeneous oxygen demand were
exerted. This process will be discussed in greater detail later in
the text. The ammonia concentration decreased steadily as distance
from the plant increased. Nitrification through the actions of the
nitrifying bacteria *Nitrosomonas* and *Nitrobacter* probably influenced
this decrease according to the following reactions:

$$NH_4^+ + 1 1/2\ O_2 \xleftrightarrow{\textit{Nitrosomonas}} 2H^+ + NO_2^- + H_2O$$

$$NO_2^- + 1\text{-}1/2\ O_2 \xleftrightarrow{\textit{Nitrobacter}} NO_3^-$$
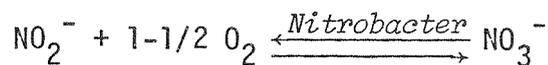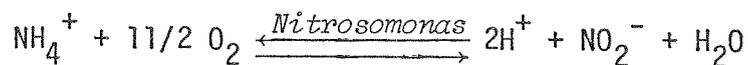
The nitrification process consumes dissolved oxygen and releases
hydrogen ions (Hines *et al.*, 1977). Each station below the outfall
showed progressive increases in nitrate-N and declines in ammonium-
N; however, the decrease in pH was not observed. Un-ionized
ammonia levels were calculated (Table 2) and found to be below
levels harmful to aquatic life (USEPA, 1976).

The effluent concentration of total residual chlorine (TRC) allowed
in the proposed NPDES permit is 0.5 mg/L. The STP effluent was
analyzed at three different times and found to contain 0.45, 0.45
(Yake, 1981) and 0.37 mg/L TRC. The mean, 0.42 mg/L, had a theo-
retical complete mix in-stream concentration of 0.06 mg/L. TRC at
station 8, taken 0.6 mile downstream of the outfall, was 0.05 mg/L.
No TRC was detected 1.05 miles downstream (station 9). A concen-
tration of 0.06 mg/L is 30 times greater than the level (0.002
mg/L) required to protect salmonids (USEPA, 1976). Chlorine
toxicity is a problem that deserves consideration. Had the dilu-
tion zone guidelines of 20:1 been met, the theoretical complete mix
would have been 0.021 mg/L TRC and the impacted area considerably
less than what was observed. Avoiding chlorine toxicity in Mill
Creek may require dechlorination at the STP.

The data indicate additional polluting source(s) may exist between
station 9 and station 10. Conductivity, chloride, and nitrate-N
all increased at station 10. Similar increases were observed
between station 10 and 11. Cold Creek enters Mill Creek between
stations 10 and 11 and is the likely source of the increase. It
is, however, difficult to determine whether Cold Creek is solely
responsible for the increases or not, as the Mill Creek bank was
not walked. The increases in nitrate-N were greater than what
would be expected from the nitrification of ammonia.

Dissolved Oxygen Model

During this survey, dissolved oxygen (D.O.) depletion was observed
downstream of the STP. Although the loss was small, field measure-
ments and sample results gave some indication of D.O. sag which may
occur from wastes introduced by the STP.

Carbonaceous and nitrogeneous wastes exert a certain amount of
oxygen depletion when introduced into a stream. These are the
carbonaceous biochemical oxygen demand (CBOD) and nitrogeneous
oxygen demand (NOD), as mentioned earlier. The stream's ability to
assimilate these demands is dependent on certain physical charac-
teristics of the water and stream channel. Also important are the
NOD and CBOD loads occurring: upstream of; from; and after the
point source.

In order to assess the capacity of Mill Creek to assimilate these
oxygen demands under a variety of flow and loading regimen and
still maintain the 5.0 mg/L D.O. content or 50 percent saturation,
a mathematical stream model was utilized. The model that was
chosen to depict the changes in D.O. in Mill Creek is a relatively
simple one. Taken into account were: the reaeration rate (K_2);

CBOD decay rate (K_1); NOD decay rate (K_3); temperature compensations for K_1 and K_2; and changes in velocity, channel depth and width under four discharges. Not taken into account were: effects of photosynthesis and respiration; benthic oxygen demand; influences of Cold Creek or changes in the STP outfall location when tailwater wastage back to Mill Creek occurs; temperature compensation for the NOD (K_3); and the reaeration effect of the series of groins between the outfall and station 9.

The central equation for the model was based upon equations in the literature (Hammer and MacKichan, 1980; Yake, 1981b), and was as follows:

$$D = C_0 - \frac{K_1 L_0}{K_2 - K_1} \exp(-K_1 t)\exp(-K_2 t) + \frac{K_3 N_0}{K_2 - K_3} \exp(-K_n t) - \exp(-K_2 t) +$$

$$D_0 \exp(-K_2 t)$$

where D = predicted oxygen concentration
C_0 = dissolved oxygen concentration after complete mix
L_0 = ultimate CBOD (mg/L)
N_0 = ultimate NOD (mg/L)
D_0 = $P - C_0$
t = time (days)
K_1 = CBOD decay rate, base e (day^{-1})
K_2 = reaeration rate, base e (day^{-1})
K_3 = NOD decay rate, base e (day^{-1})
$\exp$ = log base e
P = dissolved oxygen at 100 percent saturation

Rates for CBOD, K_1, and NOD, K_3, were calculated from BOD and ammonia concentrations found during the receiving water study. The K_1 rate was the slope of the line determined graphically by plotting time versus [time/BOD] $\cdot 33$, the BODs being those of the nitrification inhibited STP effluent. The NOD rate, K_3, was determined by calculating the theoretical conversion rate of ammonia nitrogen to nitrate nitrogen downstream of the STP. This was accomplished by plotting ammonia concentration versus time of passage in days, downstream of the STP. Stream temperature and winter-season conditions eliminated the need for a photosynthetic rate correction factor on the NOD rate. During other seasons, this correction factor would need to be found. Both K_1 and K_3 were then converted into Naperian, log base e, rates for their use in the central equation.

The ultimate CBOD (L_0) and ultimate NOD (N_0) are the potential levels of carbonaceous and nitrogeneous oxygen-demanding material to be assimilated by the stream. The ultimate CBOD was calculated

from the theoretical complete mixing concentration of CBOD based on the STP effluent and station 7, upstream of the STP. These two values were back-calculated from the K_1 rates found for the STP effluent and station 7. The ultimate NOD is the theoretical complete mixing concentration of ammonia downstream of the STP multiplied by 4.3 mg/L O_2, the quantity of oxygen used in the ammonia to nitrate conversion. Stoichiometrically, the conversion requires 4.57 mg of oxygen for each mg of ammonia; however, conversions using bacteria cultures have utilized only 4.3 mg of oxygen (Hammer and MacKichan, 1980).

The reaeration rate, K_2, is the stream's ability to oxygenate itself through physical means. It is ultimately dependent on channel configuration, bed slope, bed material, and depth of the stream. During the winter months, it is the primary source of oxygen entering the stream, while in other months photosynthesis may become so. The reaeration rate was calculated from a formula and using current data collected in the field and unpublished data from USGS (Table 3). It was necessary to estimate velocity (V) as it relates to discharge (Q). A linear regression of discharge versus velocity (V = 0.01 Q + .96, r^2 = .83) was used to satisfy this need. The reaeration rate formula is as follows (Hammer and McKichan, 1980):

$$K_2 = 2.2 \times [v/(H \exp(1.33))]$$

where K_2 is the reaeration rate, per day
and   v = mean velocity, meters per second
and   H = mean depth of flows, meters

The rates for demand and reaeration are temperature-mediated. Rate formulas are designed for 20°C and temperature compensation formulas are used to adjust for field or seasonal differences in temperature. The formulas for temperature compensation used were:

$$K_{1,t} = K_{1,20} (1.047)^{(T-20)}$$

$$K_{2,T} = K_{2,20} (1.022)^{(T-20)}$$

where $K_{1,20}$ and $K_{2,20}$ are the CBOD and reaeration rates found earlier. And $K_{1,T}$ and $K_{2,T}$ are the desired rates at the desired temperature.

Table 3. USGS unpublished data for station 14015400
         (WDOE station 32C070).

Date	Velocity (ft/second)	Discharge (cfs)
09/25/73	0.6	5.9
11/21/73	3.6	179
01/11/74	3.2	117
03/01/74	3.7	203
04/24/74	4.1	3.5
06/20/74	2.8	123
08/13/74	0.6	2.6
10/03/74	0.5	3.4
11/22/74	1.4	37.5
01/16/75	5.3	499
03/14/75	3.2	150
05/15/75	3.4	344
06/09/75	0.4	7.8
07/11/75	0.9	26.1
09/03/75	0.4	5.3

Finally, the time of passage, t, is calculated using the channel volume method (Velz, 1970). The value expresses the time taken in days for an entire given volume of water to move past a point downstream. The formula uses mean depth, width, and discharge for the length of stream from the STP outfall to stations 8 through 11, considered to be a hydrologically uniform reach of water. The formula is as follows:

$$\frac{length\ (ft)\ x\ width\ (ft)\ x\ depth\ (ft)}{discharge\ (ft^3/sec)} = time\ (sec)$$

The time, t, in seconds is then converted into days and used in the central dissolved oxygen model equation.

The computer model (Appendix III) has definite limitations; however, if its use is confined to somewhat similar conditions, it can provide an estimate of the dissolved oxygen system in Mill Creek. These estimations are useful for planning and help explain some of the past observations made on Mill Creek. Additional field and laboratory observations would be necessary to further evaluate the influences of such seasonal and daily factors as: the photosynthetic rate; impact of the groins during low-flow conditions; transferring the waste discharge to another point farther downstream; and the diel oxygen pattern.

Model Input Assumptions

Nine input values are required by the first version of the model,
Mill 1. They are as follows: (1) STP discharge; (2) upstream
temperature; (3) STP effluent temperature; (4) upstream dissolved
oxygen concentration; (5) STP effluent D.O.; (6) upstream NH_3-N;
(7) effluent NH_3-N; (8) upstream BOD; and (9) effluent BOD. All of
the above parameters are held constant within a given output. All
input data were obtained from the field work for the initial model
calibration.

The upstream flow in Mill Creek is set at four different levels in
the output presented in Appendix IV. A zero upstream flow is used
to represent the condition which could occur under the proposed
NPDES permit. The draft permit will not have a minimum creek flow
requirement before the Walla Walla STP can discharge to the creek
(Peterson, 1981). This situation would occur if water was com-
pletely diverted upstream and the STP began to discharge, or di-
version occurred while the STP was already discharging. A zero
upstream discharge produces an anaerobic condition in the stream.
It should be noted that when there is no D.O. present in the
stream, the demand cannot be exerted and is delayed. If this
condition were present, a greater downstream area would be affected
than the model indicates. The model does not adequately account
for demand once the stream becomes anaerobic.

The second flow represents the conditions specified in the expired
NPDES permit where a minimum downstream flow of 25 cfs must be
present while discharging. The purpose for the 25 cfs downstream
flow was to prevent toxic conditions resulting from the STP ef-
fluent. The mean low flow of 1.1 and 11.7 cfs for the 1-in-2-year
monthly flow for October and November, respectively, indicates that
the 25 cfs stipulation may not have been observed if discharge
occurred in either month. The model indicated in-stream levels of
D.O. are above the criterion for the discharge and physical con-
ditions present during the February survey; however, the same
discharge quality and quantity may cause in-stream D.O. problems
during warmer weather.

The third flow was observed during the field survey. This output
corresponds to field data and is the measure of the model's ability
to reproduce natural conditions.

The fourth flow represents the quantity of upstream discharge
required to maintain the 20:1 ratio for the dilution zone guidelines.

Cause of D.O. Depression in Mill Creek

Four factors in the STP effluent can affect the downstream D.O.
level: (1) D.O. concentration; (2) temperature; (3) BOD_5 concentration; and (4) NH_3-N concentration. Each factor was analyzed for
its individual impact in terms of the compensating stream flow
required.

1. The D.O. concentration of the effluent is important because
   the stream D.O. will drop if effluent water of a lower D.O. is
   mixed with it. The January, 1980 to November, 1981 DMRs
   indicate the mean effluent D.O. for the period was 7.7 mg/L.
   If this concentration is used with an STP discharge of 10.2
   cfs, a 1 mg/L increase in effluent D.O. concentration would
   reduce the amount of stream water needed by 1 cfs. The effluent D.O. concentration adjustment appears to be a minor
   point, but may become a viable alternative if the STP were
   allowed to discharge during low stream flow.

2. The temperatures of the effluent and the stream are important
   because warmer temperatures increase reaction rates and may
   under some conditions decrease the quantity of oxygen present.
   However, temperature is not easily controlled, so it would not
   be considered a viable method to regulate effluent quality and
   in-stream water quality conditions.

3. Alteration of the BOD_5 concentration has a minor impact if the
   difference in required stream water is considered. A discharge containing 30 mg/L BOD_5 would require 1 cfs more stream
   water than a discharge containing 12 mg/L. Because of the
   relatively small difference (assuming the stream water is
   present), the 30 mg/L BOD effluent limit is used in Appendix V
   analyses.

4. Mill Creek's in-stream D.O. concentration appears to be impacted most by the effluent ammonia concentration. An increase in effluent ammonia concentration of 1 mg/L would
   require from 4 to 6 cfs more stream discharge to maintain the
   in-stream D.O. criterion. Ammonia is also important because
   it is toxic at certain concentrations in the un-ionized form.
   Conditions controlling the conversion of total ammonia to the
   un-ionized form varies with pH and temperature.

A method developed by Yake and James (1981) establishes effluent
limitations for ammonia based upon specified conditions of stream
flow, plant discharge, and the pH and temperature norms for an

area. The pH and temperatures are used to calculate the percentage
of ammonia in the un-ionized form (Table 4).

Table 4. Monthly mean percent un-ionized ammonia and standard
deviation from WDOE station 32C110, Mill Creek.

Month	Mean	Standard Deviation
January	0.336	0.297
February	0.265	0.852
March	0.689	0.132
April	0.471	0.299
May	2.130	0.823
June	3.963	0.812
July	5.550	0.850
August	5.307	1.779
September	6.721	1.530
October	5.560	0.998
November	0.880	0.833
December	0.640	0.611

This method was used to determine permissible monthly effluent
ammonia concentrations which could be discharged to Mill Creek by
the Walla Walla STP. A 10 percent recurrence interval was used for
the percent un-ionized ammonia with the 1-in-10-year low monthly
flow.

The input and output data are presented in Table 5 and Appendix V,
respectively. The monthly effluent ammonia-N limits range from
<0.1 to 16.5 mg/L. Values in Table 5 represent amounts of NH_3-N
which can be discharged and still maintain an in-stream un-ionized
NH_3-N concentration below 0.016 mg/L-N. These values do not con-
sider in-stream D.O. levels in terms of their impacts on the stream's
D.O. standard. With the exception of January, these values would
not cause in-stream D.O. violations. A minimum flow analysis using
a modification of the D.O. model Mill 1 indicates that the in-
stream D.O. standard would be maintained in January if the STP
effluent contained 11 mg/L instead of 16.5 mg/L NH_3-N.

The ammonia effluent limitations in Table 5 for October, November,
December, and possibly April are probably unattainable by the STP
as it is now operated and designed. The model indicates that an
effluent containing 3.6 mg/L NH_3 would cause D.O. violations in

Table 2. Water quality data from Mill Creek receiving water survey. Concentrations are given in mg/L unless otherwise noted.

Parameter	Date	1 Tausick Road	2 Division Street	Point Source	3 Park street	4 Colville Street	5 4th Ave. Bridge	6 13th Ave. Bridge	Point Source	7 Upstream of STP	STP Effluent	8 Gose Street Bridge	9 Hussy Road Bridge	10 Highway 410	11 Mission Road
River Mile		10.0	8.1	7.8	7.7	7.4	6.9	6.3	6.2	5.6	5.4	4.8	4.35	2.7	0.4
Flow (cfs)	2/3	61	--	--	--	--	--	--	--		10.2				
	2/4	57	--	--	--	--	--	--	--	60.7		73	69	--	73
Temperature (°C)	2/3	2.0	2.0	19.4	2.0	3.8	3.0	3.0		2.0	10.4	4.0	3.0	3.0	3.0
	2/4	2.0	2.0		3.0	3.0	3.0	3.0	4.8	2.5		3.5	3.5	3.5	3.5
pH (S.U.)	2/3	7.9	7.7	8.4	7.7	7.8	7.9	8.0		7.9	7.5*	8.0	8.0	7.7	7.8
	2/4	8.1	8.1		7.9	8.1	8.1	8.3	7.9	8.0		8.0	8.0	7.8	7.9
Dissolved Oxygen	2/3	11.8	12.1		12.1	12.2	12.4	12.7		13.3	9.1	12.1	12.4	11.6	11.4
	2/4	12.2	12.4		12.6	12.7	12.8	13.3	--	13.3		12.5	12.5	11.9	11.7
% Dissolved Oxygen Sat.	2/3	88	90		90	96	95	97		99	81*	95	95	89	87
	2/4	91	93		97	97	98	102		101		97	97	92	91
Conductivity (umhos/cm) Field Data	2/3	75	79	215	85	89	86	83		84		120	111	150	172
Lab Data	2/3	73	70	209	76	79	78	80		85		110	112	124	165
Field Data	2/4	80	78		85	87	85	90	83	90		120	115	155	175
Lab Data	2/4	73	71		78	78	79	79	79	91*	265*	115	125*	144	164
Tot. Residual Chlorine	2/3										0.45	0.05	N.D.		
	2/4											0.05	N.D.		
Turbidity (NTU)	2/3	4				5				4	10*		4		2
	2/4	4				4				6*			5*		3
COD	2/3	9				4				9	55*		13		13
	2/4	9				9				13*			26*		17
BOD5	2/3	1.2				4.9				1.7	11*		1.9		1.6
	2/4	1.7				1.6				2.3*			3.9*		1.2
BOD12	2/3	1.9				7.5				2.8			4.5		
	2/4	2.3				2.6				3.3*			8.7*		
BOD15	2/3	1.9				7.8				2.9			5.4		
	2/4	2.4				3.5				3.3*			9.3*		
BOD20	2/3	2.4				8.1				3.4			6.2		
	2/4	2.6				4.5				4.0*			10.0*		
Fecal Coliform (org/100 ml)	2/3	6**	9**	<2**	20**	9**	17**	5**		10**	540	29**	140	9**	7**
	2/4	<2**	4**		<2**	6**	7**	10**	5**	8**	260	68	6**	8**	2**
NO3-N	2/3	0.34	0.34	<0.01	0.38	0.41	0.42	0.42		0.45	5.35*	1.40	1.10	1.60	1.90
	2/4	0.39	0.35		0.38	0.40	0.40	0.43	0.38	0.47*		1.30	1.10*	1.70	2.20
NO2-N	2/3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.05*	0.03	0.02	0.02	0.03
	2/4	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.02	<0.01*		0.02	0.03*	0.03	0.03
NH3-N	2/3	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	3.6*	0.60	0.21	0.20	0.13
	2/4	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.02	<0.01*		0.37	0.44*	0.28	0.18
Un-ionized NH3-N	2/3										0.022*	0.007	0.002	0.001	0.001
	2/4								<0.001			0.004	0.005*	0.002	0.002
O-PO4-P	2/3	0.03	0.03	0.01	0.03	0.03	0.03	0.03		0.03	2.45*	0.42	0.32	0.31	0.32
	2/4	0.04	0.03		0.03	0.03	0.04	0.04	0.09	0.04*		0.35	0.39*	0.35	0.35
T-PO4-P	2/3	0.05	0.06	0.03	0.05	0.06	0.03	0.05		0.05	3.10*	0.56	0.40	0.37	0.36
	2/4	0.06	0.05		0.06	0.05	0.06	0.06	0.09	0.06*		0.43	0.50*	0.41	0.40
Total Solids	2/3	85				89				88	218*		110		140
	2/4	87				94				95*			120*		150
T. Non-Vol. Solids	2/3	58				75				71	140*		86		98
	2/4	59				69				75*			82*		100
Total Suspended Solids	2/3	3				4				2	11*		2		5
	2/4	4				1				2*			3*		2
T. Non-Vol. Susp. Solids	2/3	<1				<1				<1	2*		<1		<1
	2/4	<1				1				<1*			<1*		<1
Chlorides	2/3	1.5	<1.0	1.5	1.5	1.5	<1.0	2.3		2.3		3.1	3.1	6.9	9.2
	2/4	2.0	<1.0		2.0	2.0	1.0	2.0	1.5	2.0*		5.0	4.0*	8.0	9.0
T. Recoverable Copper	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	<0.01								<0.01*			<0.01*		<0.01
T. Recoverable Zinc	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	0.03								0.02*			0.02*		<0.01
T. Recoverable Iron	2/3	0.38								0.37			0.19		0.19
	2/4	0.40								0.40*			0.33*		0.22
T. Recoverable Nickel	2/3	0.05								<0.03			<0.03		<0.03
	2/4	<0.03								<0.03*			0.05*		0.05
T. Recoverable Chromium	2/3	<0.02								<0.02			<0.02		<0.02
	2/4	<0.02								<0.02*			<0.02*		<0.02
T. Recoverable Cadmium	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	<0.01								<0.01*			<0.01*		<0.01
T. Recoverable Lead	2/3	<0.07								<0.07			<0.07		<0.07
	2/4	<0.07								<0.07*			<0.07*		<0.07
T. Recoverable Manganese	2/3	<0.02								<0.02			<0.02		<0.02
	2/4	<0.02								<0.02*			<0.02*		<0.02

*24-hour composite.
**Estimated counts.

October and November (Appendix V). Un-ionized ammonia toxicity
would result October through December. The in-stream water quality
violations under design conditions can only be adequately evaluated
if and when the range of monthly effluent ammonia concentrations
from the STP are determined. More data are needed to establish the
plant's nitrification capabilities. When these data become avail-
able, additional evaluations can be made.

Recommendations

1. Require analysis of influent and effluent NH_3-N 24-hour composite
   samples at least weekly.

2. Determine level of NH_3-N and the nitrification efficiency when the
   plant treats BOD_5 to 30 mg/L and/or 12 mg/L.

3. When the above data become available, establish a discharge limit
   on NH_3-N which varies by month and a set BOD_5 limit of 30 mg/L,
   when discharging to the creek. The NH_3-N limitation should be a
   function of the 10-year low monthly flow or the minimum flow re-
   quirement during the months the STP discharges to the creek.

4. Investigate methods to eliminate STP discharge to Mill Creek during
   October and November. If discharge to Mill Creek during October
   and November is allowed, a minimum upstream flow of 20 cfs should
   be established. This will probably prevent in-stream ammonia
   toxicity and D.O. sags downstream of the STP. It could be adjusted
   when the additional ammonia data become available. A rating curve
   should be developed and a gage installed upstream of the STP to
   determine flows. Daily reporting of stream flows should be in-
   cluded on the monthly summaries and DMRs.

5. The STP does not report the date when the irrigation district takes
   the effluent. The date and percent of flow taken should be re-
   ported as the NPDES permit states.

6. Coordinate with the water master and require the water district(s)
   to provide adequate advance warning when they decide to divert the
   effluent. This time period for advance warning would be determined
   by the amount of time the STP requires to change plant processes
   such that the irrigation permit limitations could be met. The same
   notice would be required when the district discontinues use of the
   discharge.

7. Should investigate the possibility that the irrigation district
   continue to take the STP effluent until such time when adequate
   flow in Mill Creek exists. This, of course, would have obvious
   benefits to Mill Creek particularly during the late fall and spring

months when stream flows are very low. There would be offsetting
considerations; i.e., possibly higher STP treatment costs and
public opinion regarding the use of irrigation districts' waterways
in preference to Mill Creek itself.

8. Coordinate with the water master to eliminate excess or unneeded
    diversion of Mill Creek waters to Yellowhawk and Garrison creeks
    during November and December.

9. In-stream chlorine toxicity needs to be alleviated.

Future Water Quality

As is evidenced in this memorandum, there have been conflicts with the
beneficial uses of water in Mill Creek.

These low-flow conditions in Mill Creek are the result of the current
irrigation practices. The effect of low flows combined with the addi-
tion of Walla Walla STP discharge can, and do, result in toxic con-
ditions at times when fish passage may occur. These conflicts will
undoubtedly remain and some planning is needed to mediate problems to
enhance the quality of Mill Creek. Conversations with the water master,
Harold Hansen; the treatment plant operator, Al Prouty; and the WDG
indicate that very little, if any, coordination has ever occurred to
minimize these impacts. It is quite likely that coordination could
maximize water released to Mill Creek at times when the STP was dis-
charging. This would ensure the greatest dilution possible and help
resident and migrating fish.

LRS:JJ:cp

Attachments

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(1) CLASS AA (EXTRAORDINARY).

(a) General Characteristic. Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

(b) Characteristic Uses. Characteristic uses shall include, but are not limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picknicking, hiking, fishing, swimming, skiing, and boating).

(iv) General marine recreation and navigation.

(v) Fish and shellfish reproduction, rearing, and harvesting.

(c) Water Quality Criteria.

(i) Fecal Coliform Organisms.

(A) Freshwater - Fecal Coliform Organisms shall not exceed a median value of 50 organisms/100 ml, with not more than 10 percent of samples exceeding 100 organisms/100 ml.

(B) Marine water - Fecal Coliform Organisms shall not exceed a median value of 14 organisms/100 ml, with not more than 10 percent of samples exceeding 43 organisms/100 ml.

(ii) Dissolved Oxygen.

(A) Freshwater - Dissolved Oxygen shall exceed 9.5 mg/l.

(B) Marine water - Dissolved Oxygen shall exceed 7.0 mg/l except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.

(iii) Total dissolved gas - the concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - water temperatures shall not exceed 16.0° Celsius (freshwater) or 13.0° Celsius (marine water) due to human activities. Temperature increases shall not, at any time, exceed $t = 23/(T+5)$ (freshwater) or $t = 8/(T-4)$ (marine water).

When natural conditions exceed 16.0° Celsius (freshwater) and 13.0° Celsius (marine water), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius.

For purposes hereof, "t" represents the permissive temperature change across the dilution zone; and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

Provided that temperature increase resulting from non-point source activities shall not exceed 2.8° Celsius, and the maximum water temperature shall not exceed 16.3° Celsius (freshwater).

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.2 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any use.

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(2) CLASS A (EXCELLENT).

(a) General Characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic Uses. Characteristic uses shall include, but are not limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picknicking, hiking, fishing, swimming, skiing, and boating).

(iv) Commerce and navigation.

(v) Fish and shellfish reproduction, rearing, and harvesting.

(c) Water Quality Criteria.

   (i) Fecal Coliform Organisms.

      (A) Freshwater - Fecal Coliform Organisms shall not
           exceed a median value of 100 organisms/100 ml, with
           not more than 10 percent of samples exceeding 200
           organisms/100 ml.

      (B) Marine water - Fecal Coliform Organisms shall not
           exceed a median value of 14 organisms/100 ml, with
           not more than 10 percent of samples exceeding 43
           organisms/100 ml.

   (ii) Dissolved Oxygen.

      (A) Freshwater - Dissolved Oxygen shall exceed 8.0 mg/l.

      (B) Marine water - Dissolved Oxygen shall exceed 6.0
           mg/l, except when the natural phenomenon of upwelling
           occurs, natural dissolved oxygen levels can be
           degraded by up to 0.2 mg/l by man-caused activities.

   (iii) Total Dissolved Gas - the concentration of total dis-
          solved gas shall not exceed 110 percent of saturation at
          any point of sample collection.

   (iv) Temperature - water temperature shall not exceed 18.0°
         Celsius (freshwater) or 16.0° Celsius (marine water) due
         to human activities. Temperature increases shall not, at
         any time, exceed $t = 28/(T+7)$ (freshwater) or $t = 12(T-2)$
         (marine water).

         When natural conditions exceed 18.0° Celsius (freshwater)
         and 16.0° Celsius (marine water), no temperature increase
         will be allowed which will raise the receiving water
         temperature by greater than 0.3° Celsius.

         For purposes hereof, "t" represents the permissive tempera-
         ture change across the dilution zone; and "T" represents
         the highest existing temperature in this water classification
         outside of any dilution zone.

         Provided that temperature increase resulting from nonpoint
         source activities shall not exceed 2.8° Celsius, and the
         maximum water temperature shall not exceed 18.3° Celsius
         (freshwater).

   (v) pH shall be within the range of 6.5 to 8.5 (freshwater)
        or 7.0 to 8.5 (marine water) with a man-caused variation
        within a range of less than 0.5 units.

(vi)   Turbidity shall not exceed 5 NTU over background tur-
       bidity when the background turbidity is 50 NTU or less,
       or have more than a 10 percent increase in turbidity when
       the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentra-
       tions shall be below those of public health significance,
       or which may cause acute or chronic toxic conditions to
       the aquatic biota, or which may adversely affect any
       water use.

(viii) Aesthetic values shall not be impaired by the presence of
       materials or their effects, excluding those of natural
       origin, which offend the senses of sight, smell, touch,
       or taste.

(3) CLASS B (GOOD).

   (a) General Characteristic. Water quality of this class shall
        meet or exceed the requirements for most uses.

   (b) Characteristic Uses. Characteristic uses shall include, but
        are not limited to, the following:

      (i)   Industrial and agricultural water supply.

      (ii) Fishery and wildlife habitat.

      (iii) General recreation and aesthetic enjoyment (picknicking,
            hiking, fishing, and boating).

      (iv) Stock watering.

      (v)   Commerce and navigation.

      (vi) Shellfish reproduction and rearing, and crustacea (crabs,
            shrimp, etc.) harvesting.

   (c) Water Quality Criteria.

      (i) Fecal Coliform Organisms.

         (A) Freshwater - Fecal Coliform Organisms shall not
              exceed a median value of 200 organisms/100 ml, with
              not more than 10 percent of samples exceeding 400
              organisms/100 ml.

         (B) Marine water - Fecal Coliform Organisms shall not
              exceed a median value of 100 organisms/100 ml, with
              not more than 10 percent of samples exceeding 200
              organisms/100 ml.

(ii) Dissolved Oxygen.

    (A) Freshwater - Dissolved Oxygen shall exceed 6.5 mg/l or 70 percent saturation whichever is greater.

    (B) Marine water - Dissolved Oxygen shall exceed 5.0 mg/l or 70 percent saturation, whichever is greater, except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.

(iii) Total Dissolved Gas - the concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - water temperature shall not exceed 21.0° Celsius (freshwater) or 19.0° Celsius (marine water) due to human activities. Temperature increases shall not, at any time, exceed $t = 34/(T+9)$ (freshwater) or $t = 16/T$ (marine water).

When natural conditions exceed 21.0° Celsius (freshwater) and 19.0° Celsius (marine water), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius.

For purposes hereof, "t" represents the permissive temperature change across the dilution zone; and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

Provided that temperature increase resulting from non-point source activities shall not exceed 2.8° Celsius, and the maximum water temperature shall not exceed 21.3° Celsius (freshwater).

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) and 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.5 units.

(vi) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which adversely affect public health during characteristic uses, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water uses.

(viii) Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

APPENDIX II

DEPARTMENT OF ECOLOGY

328070   MILL CREEK AT MISSION STREET   14015400

STORET MINOR BASIN: LOWER COLUMBIA   STORET SUB BASIN: WALLA WALLA

LATITUDE: 46 02 32.0   ELEVATION (FEET):   610   WATER CLASS: B
LONGITUDE: 118 22 12.0   COUNTY: WALLA WALLA   SEGMENT: 15-32-04

AGENCY: 21540000   STATE: WASHINGTON   STA TYPE: STREAM

TERMINAL 1ST LEV 2ND LEV 3RD LEV 4TH LEV 5TH LEV 6TH LEV
 STREAM   MILES   MILES   MILES   MILES   MILES   MILES

 1310001 313.50   035.80   000.40

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	00300 DISSOLVED OXYGEN mg/l	31504 TOTAL COLIFORM /100ml MF	31616 FECAL COLIFORM /100ml MF	31672 FECAL STREP /100ml PC	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00080 COLOR PT-CO UNITS
72/07/11	1115			19.0	11.1	8000	801		7.7	17.0	565	84
72/07/25	0955			20.0	7.4	16000	400		7.9	18.0	483	81
72/08/08	0835			20.0	7.3	7000	600		7.7	11.0	475	63
72/08/22	0815			18.2	5.0	4000	230		7.5	4.0	449	55
72/09/12	0845			14.6	6.3	2000	100		7.7	7.0	415	37
72/09/27	0830			10.2	6.9	14000	350		7.6	5.0	387	36
73/10/17	1425		6.2	14.6	14.7	18000			8.6	3.0	410	22
73/10/30	1250		2.5	10.2	10.2	8600			7.8	2.0	370	20
73/11/13	1320			8.3	9.6	100000			7.5	30.0	83	84
73/11/27	1320			7.6	9.3	16000			7.4	10.0	140	29
73/12/11	1255		340.0	5.0	11.5	65000			7.6	12.0	104	46
73/12/18	1345		670.0	6.5	11.2	82000	20000	2700	7.6	30.0	75	54
74/01/08	1500		200.0	0.0	12.7				7.5	15.0	180	24
74/01/22	1400		640.0	5.3	12.1	30000	590	1100	7.5	15.0	100	50
74/02/05	1315		540.0	5.6	12.6	3800	250	200	7.6	25.0	91	63
74/02/20	1300			7.1	12.1	11000	100	50	7.6	10.0	110	41
74/03/05	1315		215.0	7.2	11.3	2800	180	150	7.7	6.0	110	33
74/03/19	1330		440.0	7.5	12.0	24000	100	20	7.6	19.0	86	34
74/04/02	1340		520.0	6.7	12.1	6100	60	400	7.4	72.0	82	85
74/04/16	1240		392.0	10.2	11.6	8500	60	18	7.5	10.0	90	27
74/05/07	1300		390.0	14.1	10.6	2100	0M	50	7.6	24.0	84	24
74/05/21	1220		93.0	14.3	12.3	1300	400	70	8.3	10.0	130	36
74/06/04	1205		157.0	12.4	10.7	3500	170	150	8.0	6.0	93	26
74/06/19	1315		150.0	21.0	8.5	400000	0M	100	7.7	11.0	107	29
74/07/02	1310		55.0	22.6	10.3	30000	350	150	8.0	4.0	220	22
74/07/23	1310		3.0	25.9	13.5	60000B	240B	230	8.6	4.0	430	35
74/08/06	1415		2.2	23.3	16.2	60000B	140	280B	9.3	4.0	390	
74/08/20	1415		0.2	23.7	17.4	50000B	50	30	9.1	5.0	520	34
74/09/04	1300		1.9	20.6	15.2	20000B	210	40	8.9	5.0	450	30
74/09/17	1445		2.5	22.3	16.0	400B	230	160B	8.8	6.0	420	39
74/10/08	1620		2.9	11.4	15.3	16000L	750		8.7	4.0	450	30
74/10/22	1350		2.9	12.9	14.3	310000	30		8.6	3.0	430	19
74/11/05	1350		15.0	11.4	12.6	300000B	80		7.8	4.0	380	21
74/11/19	1315		20.0	10.3	12.7	70000	700B		8.1	4.0	330	28
74/12/03	1305		54.0	7.9	12.1	140000	100B		8.0	4.0	200	15
74/12/17	1255		56.0	7.7	11.2	63000	400B		7.4	20.0	150	35

DATE	TIME										
75/01/07 1510	88.0	4.2	10.9	5008	178	7.6	9.0	150	18
75/01/21 1310	230.0	5.6	12.4	5508	110	7.3	12.0	100	38
75/02/05 0835	122.0	1.7	12.0	2500	170	7.1	6.0	140	24
75/02/11 1515	117.0	5.9	11.0			7.0	54.0	160	110
75/03/04 1510	427.0	8.0	11.8	16001	801	7.6	9.0	94	30
75/03/18 1350	178.0	8.1	10.3	400008	1700	7.7	70.0	130	35
75/04/08 1435	65.0	9.9	11.9	14000	7000	7.3	4.0	130	19
75/04/22 1430	117.0	13.8	11.1	6300	450	7.4	5.0	100	26
75/05/06 1430	150.0	13.7	10.9	8500	70	8.2	6.0	97	20
75/05/20 1315	207.0	17.2	11.7	7800	34	7.7	12.0	105	17
75/06/03 1445	17.0	21.0	10.4	26000	2600	8.5	3.0	140	25
75/06/17 1415	6.8	16.1	10.9	17000	750	8.2	4.0	150	21
75/07/15 1225	0.2	22.2	8.2	27000	7000	8.4	9.0	260	54
75/07/22 1505	0.08	29.0	2.5	6000I	1900	7.9	6.0	500	67
75/08/05 1450	0.08	21.6	1.8	4000	200	7.3	2.0	520	21
75/08/19 1440	0.08	23.4	12.9	4500	740	8.1	5.0	370	25
75/09/09 1425	0.08	23.4	12.9	4000	480	8.4	6.0	700	13
75/09/23 1355	1.1	19.4	13.2	1008	84	8.6	2.0	410	13

DATE FROM TO	TIME	DEPTH METERS	00625 KJELDAHL NITROGEN T mg/l N	00630 NITROGEN NO2 + NO3 mg/l	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHORUS mg/l P	00665 TOTAL PHOSPHORUS mg/l P	00915 CALCIUM DIS Ca mg/l	00925 MAGNESIUM DIS Mg mg/l	00930 SODIUM DIS Na mg/l
72/07/11 1115					0.80	0.08	0.26	0.22	0.72	40.5	145.0	38.50
72/07/25 0855					0.98		0.32	0.27	0.93	16.5	11.0	33.00
72/08/08 0835					1.12	0.01	0.14	0.24	0.27	16.4	13.3	32.50
72/08/22 0815					0.90	0.01	0.08	0.17	0.44	19.1	10.6	32.00
72/09/12 0845					0.91	0.08	0.08	0.32	0.65	17.9	150.0	31.00
72/09/27 0830					1.22		0.06	0.46	0.81	8.7	9.8	30.80
73/10/17 1425			0.790		2.30	0.01	0.07	0.27	0.31	28.0	12.0	29.00
73/10/30 1250			0.380		3.30	0.01	0.10	0.55	0.50	25.0	11.0	25.00
73/11/13 1320			0.640		0.61	0.01	0.15	0.07	0.30	6.3	2.6	4.00
73/11/27 1320			0.570		1.10	0.02	0.05	0.22	0.32	11.0	4.2	9.10
73/12/11 1255			0.430		1.10	0.01	0.02	0.14	0.26	8.2	3.3	5.40
73/12/18 1345			0.340		0.55	0.01	0.21	0.04	0.25	6.2	2.4	3.40
74/01/08 1500			0.540		2.40	0.01	0.14	0.24	0.30	13.0	5.4	8.90
74/01/22 1400			0.370		1.20	0.01	0.10	0.06	0.18	7.8	3.3	12.00
74/02/05 1315			0.650		0.04	0.01	0.12	0.09	0.20	7.3	3.0	4.40
74/02/20 1300			0.760		1.10	0.01	0.06	0.10	0.16	8.5	3.5	5.50
74/03/05 1315			0.280		1.30	0.01	0.16	0.16	0.21	9.4	3.5	5.90
74/03/19 1330			0.360		0.73	0.01	0.10	0.09	0.19	6.6	2.6	3.90
74/04/02 1340			1.100		0.57	0.02	0.08	0.03	0.50	6.2	2.3	3.70
74/04/16 1240			0.320		0.75	0.01	0.07	0.13	0.15	7.2	2.7	4.30
74/05/07 1300			0.540		0.48	0.01	0.07	0.06	0.21	6.0	2.7	4.50
74/05/21 1220			0.490		0.83	0.01	0.12	0.17	0.24	9.3	3.4	6.20
74/06/04 1205			0.270		0.43	0.01	0.11	0.07	0.08	5.7	2.3	4.10
74/06/19 1315			0.350		0.73	0.01	0.08	0.12	0.17	7.1	2.9	4.70
74/07/09 1310			0.790		1.40	0.01	0.06	0.26	0.30	16.0	6.2	13.00
74/07/23 1310			0.480		0.91	0.01	0.10	0.14	0.20	30.0	13.0	29.00
74/08/06 1415			0.500		0.23	0.01	0.08	0.14	0.18	28.0	12.0	26.00
74/08/20 1415			0.480		0.15	0.03	0.11	0.11	0.14	34.0	15.0	31.00
74/09/04 1300			0.840		0.27	0.02	0.26	0.11	0.15	30.0	14.0	28.00
74/09/17 1445			0.460		0.88	0.01	0.05	0.17	0.25	31.0	14.0	28.00
74/10/08 1620				1.80			0.07	0.10	0.18	32.0	12.0	31.00
74/10/22 1350				3.20			0.12	0.17	0.26	42.0	12.0	27.00
74/11/05 1350				5.60			0.09	0.26	0.27	32.0	9.7	26.00
74/11/19 1315				4.20			0.05	0.27	1.10	26.0	9.8	23.00
74/12/03 1305				2.60			0.06	0.50	0.64	18.0	5.8	11.00
74/12/17 1255				1.50			0.16	0.24	0.66	13.0	4.7	8.20
75/01/07 1510				1.20			0.23	0.26	0.27	13.0	4.9	7.50
75/01/21 1310				0.91			0.14	0.12	0.13	10.0	3.0	4.80
75/02/05 0835				1.70			0.11	0.09	0.26	10.0	4.9	13.00
75/02/11 1515				1.70			0.06	0.28	0.44	11.0	4.7	8.90

DATE									
75/03/18 1350		0.37			0.09	0.11	0.20	76.0	5.0	4.40
75/04/08 1435		1.30			0.12	0.19	0.26	9.7	4.3	5.80
75/04/22 1430		1.30			0.08	0.24	0.30	10.0	4.0	6.20
75/05/06 1430		0.77			0.06	0.13	0.22	9.6	3.5	5.70
75/05/20 1315		0.59			0.07	0.08	0.16	8.0	3.0	4.70
75/06/03 1445		0.79			0.06	0.11	0.18	8.3	2.8	5.70
75/06/17 1415		1.10			0.06	0.18	0.26	11.0	4.0	7.20
75/07/15 1225		1.10			0.09	0.18	0.22	14.0	5.3	8.20
75/07/22 1505	0.950	1.20		0.08	0.15	0.47	0.50	31.0	11.0	22.00
75/08/05 1450		2.30			0.15	0.64	0.88	34.0	14.0	31.00
75/08/19 1440		0.52			0.17	0.18	0.22	43.0	20.0	36.00
75/09/09 1425		2.00			0.08	0.15	0.21			25.00
75/09/23 1355		0.53			0.10	0.07	0.09	23.0	4.2	11.00
		1.60			0.05	0.14	0.19	35.0	13.0	27.00

DATE FROM TO	TIME	DEPTH METERS	00440 BICARB HCO3 ION mg/l	00945 SULFATE TOT SO4 mg/l	00940 CHLORIDE Cl mg/l	00935 POTASSIUM DIS K mg/l	00900 HARDNESS TOT CaCO3 mg/l	00902 HARDNESS NC CaCO3 mg/l	00410 ALKALINI T CaCO3 mg/l	00445 CARBONATE CO3 ION mg/l
72/07/11 1115			199	14.0	56.0	8.40	200.0		163	
72/07/25 0055			156	11.0	24.0	9.10	87.0		128	
72/08/08 0835			161	9.0	87.0	9.00	132.0		96	0
72/08/22 0815			150	10.0	72.0	11.00	122.0		91	0
72/09/12 0845			152	11.0	15.0	9.10	125.0		660	0
72/09/27 0830			135	12.0	42.0	8.50	40.3		111	0
73/10/17 1425			151	18.0	31.0	7.10	120.0		124	
73/10/30 1250			128	16.0	27.0	7.20	110.0	0	105	
73/11/13 1320			41	3.4	2.6	2.70	28.0	3	34	
73/11/27 1320			60	4.5	5.9	4.10	45.0	0	49	
73/12/11 1255			48	4.1	3.2	2.00	34.0	0	39	
73/12/18 1345			35	2.9	2.0	2.00	26.0	0	29	
74/01/08 1500			62	7.6	7.6	3.30	55.0	4	51	
74/01/22 1400			41	3.7	3.3	2.20	33.0	0	34	
74/02/05 1315			37	4.0	2.6	2.10	31.0	0	30	
74/02/20 1300			43	4.0	3.5	2.30	36.0	0	35	
74/03/05 1315			46	4.1	3.8	2.00	32.0	0	35	
74/03/19 1330			35	2.8	1.6	2.10	27.0	0	29	
74/04/02 1340			34	2.5	1.9	1.90	25.0	0	28	
74/04/16 1240			37	3.3	1.6	2.10	29.0	0	30	
74/05/07 1300			36	3.4	2.4	2.30	24.0	0	29	
74/05/21 1220			50	5.3	4.2	2.60	37.0	0	41	
74/06/04 1205			39	3.9	2.8	3.10	24.0	0	32	
74/06/19 1315			42	3.5	3.2	1.80	30.0	0	34	
74/07/09 1310			86	9.7	11.0	4.40	65.0	8		
74/07/23 1310			172	20.0	31.0	6.70	130.0	0	141	
74/08/06 1415			153	17.0	32.0	5.70	120.0	0	126	
74/08/20 1415			182	17.0	36.0	2.00	150.0	0	145	
74/09/04 1300			170	17.0	35.0	7.10	140.0	0	139	
74/09/17 1445			170	17.0	31.0	5.10	140.0	0	139	
74/10/08 1620			165	20.0	32.0	6.50	130.0	0	135	
74/10/22 1350			142	18.0	30.0	6.30	150.0	38	116	
74/11/05 1350			118	16.0	24.0	6.10	120.0	23	97	
74/11/19 1315			102	13.0	22.0	6.10	110.0	16	85	
74/12/03 1305			73	7.1	10.0	4.00	63.0	9	60	
74/12/17 1255			59	5.9	6.4	3.50	52.0	7	48	
75/01/07 1510			60	5.7	6.5	3.60	53.0	3	49	
75/01/21 1310			38	6.8	2.8	2.40	37.0	6	31	
75/02/05 0835			46	6.3	7.5	6.50	45.0	7	38	
75/02/11 1515			50	7.0	7.2	3.30	43.0	1	43	
75/03/06 1510			40	4.1	6.4	2.30	45.0	4	41	
75/03/24 1140			50	4.7	4.2	2.80	42.0	1	41	
75/04/08 1435			53	4.3	5.8	2.60	41.0	0	43	
75/04/22 1430			45	3.3	3.4	2.30	18.0	1	37	
75/05/06 1430			44	3.4	2.1	2.60	55.0	0	8	

75/06/03 1445		60	4.7	6.0	2.80	6.0	0	46
75/06/17 1415	67	4.2	5.8	2.00	57.0	2	49
75/07/15 1225	149	16.0	17.0	7.40	170.0	0	55
75/07/22 1505	174	24.0	24.0	8.40	160.0	12	122
75/08/06 1450	264	26.0	28.0	9.60	200.0		143
75/08/19 1440	122	14.0	20.0	6.10	170.0		217
75/09/03 1425	105	8.0	4.0	4.30	75.0		106
75/09/23 1355	162	17.0	31.0	6.20	140.0		86
							133

AGENCY 21540000 RETRIEVAL --- 19 MARCH 1982

OFFICE OF WATER PROGRAMS
WATER QUALITY MANAGEMENT DIVISION
WATER QUALITY INVESTIGATIONS SECTION

320110   MILL CREEK AT TAUSICK WAY   14015002

STORET MINOR BASIN: LOWER COLUMBIA   STORET SUB BASIN: WALLA WALLA

LATITUDE: 46 04 34.0   ELEVATION (FEET): 1140   WATER CLASS: A
LONGITUDE: 118 16 58.0   COUNTY: WALLA WALLA   SEGMENT: 15-32-04

AGENCY: 21540000   STATE: WASHINGTON   STA TYPE: STREAM

TERMINAL STREAM	1ST LEV MILES	2ND LEV MILES	3RD LEV MILES	4TH LEV MILES	5TH LEV MILES	6TH LEV MILES
1310001	313.50	035.80	010.00	°	·	°

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	00300 DISSOLVED OXYGEN mg/l	31504 TOTAL COLIFORM /100ml MF	31616 FECAL COLIFORM /100ml MF	31672 FECAL STREP /100ml PC	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00080 COLOR PT-CO UNITS
72/07/11	0940			16.6	11.0	800	80		7.8	4.0	113	22
72/07/25	0755			18.0	7.7	4000	80L		7.8	4.0	102	18
72/08/08	0730			22.4	6.9	6000	330		7.5	5.0	118	27
72/08/22	0715			18.5	7.5	9000	340		7.7	3.0	118	44
72/09/12	0750			13.1	8.5	7000	250		4.0			19
72/09/27	0730			9.8	9.2	5000	250		7.7	3.0	105	16
73/10/17	1245			12.6	11.2	630			7.9	2.0	110	18
73/10/30	1100			9.2	10.7	580			7.8	2.0	110	20
73/11/13	1110			7.6	10.8	2000			7.7	21.0	65	73
73/11/27	1125			6.0	12.0	1800			7.8	10.0	84	25
73/12/11	1140			5.3	12.2	560			7.6	11.0	69	51
73/12/18	1130		538.0	6.2	11.5	1600	40	40	7.6	17.0	59	52
74/01/08	1305		87.0	0.0	13.1				7.6	30.0	92	29
74/01/22	1140		202.0	4.5	12.2	480	13B	2B	7.6	15.0	67	52
74/02/07	1130		460.0	4.3	12.9	1200	10B	12B	7.6	25.0	63	55
74/02/20	1135		280.0	4.0	13.3	730	4B	3B	7.6	15.0	67	37
74/03/05	1130		172.0	5.7	11.6	340	8B	6B	7.7	7.0	72	37
74/03/19	1215		146.0	6.1	12.5	660	2B	5B	7.5	11.0	74	34
74/04/02	1220		460.0	4.8	12.7	2000	100	300	7.4	81.0	64	66
74/04/16	1110		353.0	7.6	12.4	640	4B	4B	7.6	10.0	65	28
74/05/07	1155		331.0	11.4	11.4	340	10B	20	7.9	12.0	56	21
74/05/21	1120		108.0	10.7	11.7	200	5B	4B	8.3	6.0	75	20
74/06/04	1115		214.0	10.5	10.8	8000L	10L	200	7.6	26.0	59	77
74/06/19	1155		128.0	16.7	9.1	1700B	40B	36B	7.6	12.0	63	21
74/07/09	1210		20.0	16.7	9.8	3700	100	40	7.8	4.0	88	7
74/07/23	1205		0.3	19.8	10.1	14000	40	100	8.3	3.0	120	23
74/08/06	1305		0.4	18.6	9.2	4000	50	60	8.3	5.0	110	
74/08/20	1320		0.3	17.7	10.9	8000	20	90	8.3	4.0	130	16
74/09/04	1205		0.3	18.1	10.0	2500L	70	160	8.2	5.0	120	13
74/09/17	1320		0.3	18.3	10.6	16000	128	260	7.9	3.0	120	22

DATE FROM TO	TIME	DEPTH METERS	00625 KJELDAHL NITROGEN T mg/l N	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00915 CALCIUM DIS Ca mg/l	00925 MAGNESIUM DIS Mg mg/l	00930 SODIUM DIS Na mg/l	00440 BICARB HCO3 ION mg/l

DATE TIME									
72/07/11 0040		0.29	0.000	0.08	0.02	0.05	10.4	3.6	4.00	60
72/07/25 0755		0.10	0.000	0.04	0.04	0.06	1.8	2.9	3.40	54
72/08/08 0730		0.40	0.00	0.04	0.06	0.07		3.6	4.20	59
72/08/22 0715		0.17	0.01	0.06	0.01	0.06	2.7	1.7	4.20	62
72/09/12 0750		0.13	0.00	0.00	0.03	0.06	2.5	3.3	4.20	62
72/09/27 0730		0.11		0.00	0.03	0.05	2.3	3.2	4.60	57
73/10/17 1245	0.160	0.11	0.00	0.07	0.03	0.04	3.5	4.0	4.60	64
73/10/30 1100	0.190	0.09	0.00	0.08	0.04	0.05	3.7	4.0	4.60	63
73/11/13 1110	0.400	0.46	0.00	0.17	0.02	0.14	5.7	2.3	2.90	33
73/11/27 1125	0.200	0.70	0.00	0.04	0.04	0.06	7.3	2.7	3.70	43
73/12/11 1140	0.210	0.59	0.00	0.06	0.04	0.08	5.8	2.3	2.90	36
73/12/18 1130	0.310	0.29	0.00	0.15	0.02	0.12	5.1	1.8	2.30	31
74/01/08 1305	0.510	1.20	0.00	0.12	0.05	0.17	7.2	2.9	3.50	40
74/01/22 1140	0.250	0.73	0.00	0.09	0.04	0.10	5.6	2.3	3.00	31
74/02/05 1130	0.500	0.55	0.01	0.10	0.04	0.14	5.3	2.1	2.60	29
74/02/20 1135	0.220	0.55	0.00	0.11	0.04	0.08	5.7	2.3	3.10	30
74/03/05 1130	0.220	0.60	0.01	0.10	0.04	0.06	6.2	2.2	3.20	34
74/03/19 1215	0.170	0.28	0.01	0.08	0.03	0.09	5.0	1.9	2.80	28
74/04/02 1220	0.520	0.31	0.01	0.10	0.02	0.26	5.1	1.7	3.40	27
74/04/16 1110	0.170	0.38	0.00	0.04	0.04	0.05	5.8	2.0	3.00	32
74/05/07 1155	0.160	0.11	0.00	0.03	0.01	0.06	4.3	1.5	2.70	28
74/05/21 1120	0.220	0.07	0.00	0.05	0.02	0.04	5.8	2.2	3.10	37
74/06/04 1115	0.580	0.15	0.01	0.10	0.02	0.15	4.6	1.7	2.50	29
74/06/19 1155	0.220	0.13	0.01	0.04	0.03	0.12	4.5	1.6	2.20	31
74/07/09 1210	0.160	0.22	0.01	0.05	0.04	0.06	7.6	2.8	2.90	47
74/07/23 1205	0.370	0.29	0.00	0.09	0.04	0.04	10.0	3.8	4.40	65
74/08/06 1305	0.330	0.36	0.01	0.08	0.04	0.06	10.0	4.6	5.10	62
74/08/20 1320		0.22	0.01	0.04	0.03	0.04	12.0	4.2	4.40	61
74/09/04 1205	0.300	0.21	0.01	0.03	0.04	0.04	11.0	4.1	5.90	64
74/09/17 1320	0.220	0.19	0.01	0.03	0.04	0.05	9.9	5.0	3.80	64

DATE FROM TO	TIME	DEPTH METERS	00945 SULFATE TOT SO4 mg/l	00940 CHLORIDE CL mg/l	00935 POTASSIUM DIS K mg/l	00900 HARDNESS TOT CACO3 mg/l	00902 HARDNESS NC CACO3 mg/l	00410 ALKALINT T CACO3 mg/l	00445 CARBONATE CO3 ION mg/l
72/07/11 0040			3.0	1.0	2.60	41.0		49	
72/07/25 0755			0.0	1.0	2.60	16.0		44	
72/08/08 0730			0.0	1.0K	3.00	48.0		2	0
72/08/22 0715			0.0	2.0	0.30	46.0		22	0
72/09/12 0750			1.0	2.0	2.40	51.0		20	0
72/09/27 0730			9.0	1.0	2.50	18.9		47	0
73/10/17 1245			2.7	0.8	2.90	40.0	0	52	
73/10/30 1100			1.6	1.3	2.90	41.0	0	52	
73/11/13 1110			2.9	1.2	1.90	24.0	0	27	
73/11/27 1125			3.0	1.9	2.10	29.0	0	35	
73/12/11 1140			2.4	0.8	1.80	24.0	0	30	
73/12/18 1130			2.4	1.0	1.60	21.0	0	25	
74/01/08 1305			2.9	1.1	2.00	30.0	0	33	
74/01/22 1140			2.4	1.1	1.70	23.0	0	25	
74/02/05 1130			2.7	1.1	1.60	22.0	0	24	
74/02/20 1135			2.4	0.9	1.80	24.0	0	26	
74/03/05 1130			2.1	0.8	1.80	25.0	0	28	
74/03/19 1215			1.9	0.3	1.70	20.0	0	23	
74/04/02 1220			1.9	1.3	1.60	20.0	0	22	
74/04/16 1110			2.0	0.3	1.70	23.0	0	26	
74/05/07 1155			2.3	0.8	1.50	17.0	0	23	
74/05/21 1120			2.4	0.8	1.70	24.0	0	30	
74/06/04 1115			2.8	1.5	1.00	18.0	0	24	
74/06/19 1155			1.5	0.7	1.20	18.0	0	25	
74/07/09 1210			3.1	0.9	2.30	31.0	0	39	
74/07/23 1205			3.6	2.0	3.00	41.0	0	53	
74/08/06 1305			4.6	2.2	2.40	44.0	0	51	
74/08/20 1320			2.9	1.4	2.90	47.0	0	50	

APPENDIX III

```
0010   DEFFN'30 "Q$=";HEX(22);"MILL1";HEX(223A);"SCRATCH F Q$";HEX(0D)
0020   DEFFN'31 "SAVE DC F$(Q$)Q$";HEX(0D)
0030 REM %

PROGRAM NAME --- MILL1

0040 REM THIS MODELS THE DO CONCENTRATION IN MILL CREEK NR. WALLA WALLA
0050 REM PROGRAMMER LYNN SINGLETON
0060 REM APRIL, 1981
0070 REM SOURCES; HAMMER AND MACKICHAN, 1980 AND YAKE, 1981
0080 P1=760
0090 REM %

*-*-*-*-*-*-*-*-*   INPUT MODULE   *-*-*-*-*-*-*-*-*

0100 INPUT "PLANT FLOW (CFS)",F2
0110 INPUT  "TEMP UP,PLANT TEMP",T1,T2
0120 INPUT "D.O. UP,PLANT D.O.",D1,D2
0130 INPUT "NH3-N UP, PLANT NH3-N",N1,N2
0140 INPUT "IS BOD FIVE DAY (1) OR ULTIMATE (2)",C
0150 INPUT "ENTER BOD UP, PLANT BOD",C1,C2
0160 INPUT "ENTER CALCULATION INTERVAL (MILES)",I5
0170 PRINT HEX(0C0A0A)
0180 REM %

*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*

0190 FOR I=1 TO 4
0200 READ F1,V,Z
0210 IF I=2 THEN F1=25-F2
0220 GOSUB 540
0230 D6=5
   : IF D5/2>5 THEN D6=D5/2
0240 GOSUB 750
0250 FOR T5 =0 TO 5.4 STEP I5
0260 GOSUB 1050
0270 IF X=1 THEN 300
0280 PRINT "RIVER MILE","DAYS","D.O.","DEFICIT"
0290 X=1
0300 PRINT ROUND(R,2),ROUND(T,2),ROUND(D,2),ROUND(D9,2)
0310 NEXT T5
0320 X=0
0330 PRINT HEX(0C)
0340 IF Y=1 THEN 410
0350 NEXT I
0360 IF R1>=20 THEN 410
0370 F1=20*F2
   : Y=1
   : GOTO 220

0380 REM UPSTREAM FLOW, MEAN VEL., MEAN DEPTH, AND REPEATS
0390 DATA 0,43,.6,15,.92,.9,61,2.26,.9,204,3.7,1.4
```

```
0400 REM ********** MINIMUM FLOW ANALYSIS **********
0410 PRINT
0420 FOR F1=6.1 TO  5 STEP -1
0430 V=.01*(F1+F2)+.96
     : Z=.9
0440 GOSUB 540
0450 FOR T5=0 TO 5.4 STEP .2
0460 GOSUB 1050
0470 IF D>D6 THEN 500
0480 PRINT "MINIMUM FLOW UNDER SPECIFIED CONDITIONS IS ";F1;"CFS"
0490 GOTO 530

0500 NEXT T5
0510 NEXT F1
0520 PRINT "NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE"
0530 END

0540 REM %

***   INITIAL   CALCULATIONS   SUBROUTINE   ***

0550 R1=F1/F2
0560 CO=(F1*D1+F2*D2)/(F1+F2)
0570 TO=(F1*T1+F2*T2)/(F1+F2)
0580 NO=((F1*N1+F2*N2)/(F1+F2))*4.33
0590 REM ********** D.O. % SAT **********
0600 P=(P1-4.87922*EXP(.06378*TO))/(760-4.87922*EXP(.06378*TO))
0610 D5=(14.6214-.4026*TO+6.8516E-03*TO^2+2.2619E-04*TO^3-2.4998E-05*TO^4+8.5254
     E-07*TO^5-1.0513E-08*TO^6)*P
0620 K1=.09
0630 K1=K1*1.047^(TO-20)
0640 K2=2.2*(V/Z^1.33)
0650 K2=K2*1.022^(TO-20)
0660 K3=9.82
0670 IF C=2 THEN 710
0680 R1=C1/(1-EXP(-5*K1))
0690 R2=C2/(1-EXP(-5*K1))
0700 GOTO 720

0710 R1=C1
     : R2=C2
0720 LO=(F1*R1+F2*R2)/(F1+F2)
0730 DO=D5-CO
0740 RETURN

0750 REM %

*****   PRINT   SUBROUTINE   *****

0760 PRINT HEX(OE);TAB(4);"MILL CREEK D.O. MODEL"
0770 PRINT HEX(OE);TAB(7);"INSTREAM D.O. CRITERION";ROUND(D6,2);"MG/L"
0780 PRINT
0790 PRINT "********************** INPUT ECHO **********************"
```

```
0800 PRINT  "PLANT FLOW (CFS)       ",F2
0810 PRINT  "TEMP UP,PLANT TEMP",T1,T2
0820 PRINT "D.O.  UP,PLANT D.O.",D1,D2
0830 PRINT "NH3-N UP, PLANT NH3-N",N1,N2
0840 IF C=2 THEN 870
0850 PRINT "FIVE DAY BOD UP, PLANT BOD=",C1,C2
0860 GOTO 890

0870 PRINT "ULTIMATE BOD UP, PLANT BOD=",C1,C2
0880 B1=C1
   : B2=C2
0890 PRINT "***************************************************************"
0900 PRINT HEX(0A0A)
0910 PRINT "UPSTREAM FLOW (CFS)        ";F1
0920 PRINT "PLANT FLOW (CFS)           ";F2
0930 PRINT "DOWNSTREAM FLOW (CFS)      ";F1+F2
0940 PRINT "DILUTION RATIO             ";ROUND(R1,2)
0950 PRINT "MIXED ULT. BOD (MG/L)      ";ROUND(LO,2)
0960 PRINT "MIXED ULT. NOD (MG/L)      ";ROUND(NO,2)
0970 PRINT "MIXED TEMPERATURE (C)      ";ROUND(TO,2)
0980 PRINT "MIXED D.O. (MG/L)       ";ROUND(CO,2)
0990 PRINT "D.O. 100% SAT =         ";ROUND(D5,2)
1000 PRINT "K1=                     ";ROUND(K1,2)
1010 PRINT "K2=                     ";ROUND(K2,2)
1020 PRINT "K3=                     ";ROUND(K3,2)
1030 PRINT HEX(0A0A)
1040 RETURN

1050 REM %

****  STREAM MODEL SUBROUTINE  ****

1060 R=5.4-T5
1070 T=(T5/V)*(5280/86400)
1080 IF T5=0 THEN T=.00001
1090 D9=(K1*L0)/(K2-K1)*(EXP(-K1*T)-EXP(-K2*T))+(K3*NO)/(K2-K3)*(EXP(-K3*T)-EXP(
     -K2*T))+DO*EXP(-K2*T)
1100 D=D5-D9
1110 RETURN
```

APPENDIX IV

```
************** INPUT DATA **************
PLANT FLOW (CFS)                10.2
TEMP UP,PLANT TEMP              2.2         10.4
D.O. UP,PLANT D.O              12.2          9.1
NH3-N UP, PLANT NH3-N           0            3.6
ULTIMATE BOD UP, PLANT BOD=     4.1         22.2
****************************************
```

```
UPSTREAM FLOW (CFS)        0
PLANT FLOW (CFS)           10.2
DOWNSTREAM FLOW (CFS)      10.2
DILUTION RATIO             0
MIXED ULT. BOD (MG/L)      22.2
MIXED ULT. NOD (MG/L)      15.50
MIXED TEMPERATURE (C)      10.4
MIXED D.O. (MG/L)          9.1
D.O. 100% SAT =            11.23
K1=                        .06
K2=                        1.51
K3=                        9.50
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	9.1	2.13
5.2	.03	5.44	5.79
5	.06	2.84	8.39
4.8	.09	1.04	10.19
4.6	.11	-.18	11.41
4.4	.14	-.95	12.18
4.2	.17	-1.39	12.62
4	.2	-1.59	12.82
3.8	.23	-1.61	12.84
3.6	.26	-1.5	12.73
3.4	.28	-1.3	12.53
3.2	.31	-1.04	12.27
3	.34	-.73	11.96
2.8	.37	-.38	11.67
2.6	.4	-.03	11.26
2.4	.43	.33	10.9
2.2	.45	.7	10.53
2	.48	1.06	10.16
1.8	.51	1.43	9.8
1.6	.54	1.78	9.45
1.4	.57	2.12	9.1
1.2	.6	2.46	8.77
1	.63	2.78	8.44
.8	.65	3.1	8.13
.6	.68	3.4	7.83
.4	.71	3.69	7.54
.2	.74	3.97	7.26
0	.77	4.24	6.99

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION G.M. MAX

```
************* INPUT DATA *********************
PLANT FLOW (CFS)                  10.2
TEMP UP,PLANT TEMP                7.3          10.4
D.O. UP,PLANT D.O.                12.3         9.1
NH3-N UP, PLANT NH3-N             0            3.6
ULTIMATE BOD UP, PLANT BOD=       4.1          72.2
*********************************************


UPSTREAM FLOW (CFS)       14.8
PLANT FLOW (CFS)          10.2
DOWNSTREAM FLOW (CFS)     25
DILUTION RATIO            1.45
MIXED ULT. BOD (MG/L)     11.48
MIXED ULT. NOD (MG/L)     6.36
MIXED TEMPERATURE (C)     5.6
MIXED D.O. (MG/L)         11.59
D.O. 100% SAT =           12.6
K1=                       .05
K2=                       1.7
K3=                       9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.59	1.01
5.2	.01	10.83	1.77
5	.03	10.19	2.41
4.8	.04	9.65	2.95
4.6	.05	9.18	3.42
4.4	.07	8.8	3.8
4.2	.08	8.47	4.13
4	.09	8.21	4.39
3.8	.11	7.99	4.61
3.6	.12	7.82	4.78
3.4	.13	7.68	4.92
3.2	.15	7.57	5.03
3	.16	7.5	5.1
2.8	.17	7.44	5.16
2.6	.19	7.41	5.19
2.4	.2	7.39	5.2
2.2	.21	7.4	5.2
2	.23	7.41	5.19
1.8	.24	7.44	5.16
1.6	.25	7.47	5.13
1.4	.27	7.51	5.09
1.2	.28	7.56	5.04
1	.29	7.62	4.98
.8	.31	7.68	4.92
.6	.32	7.75	4.85
.4	.33	7.81	4.79
.2	.35	7.88	4.72
0	.36	7.96	4.64

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.65 MG/L

```
************************* INPUT FOR ***********************
PLANT FLOW (CFS)                    10.2
TEMP UP,PLANT TEMP                  2.3              10.4
D.O. UP,PLANT D.O.                  12.3             9.1
NH3-N UP, PLANT NH3-N               0                3.6
ULTIMATE BOD UP, PLANT BOD=         4.1              22.2
*********************************************************
```

```
UPSTREAM FLOW (CFS)         61
PLANT FLOW (CFS)            10.2
DOWNSTREAM FLOW (CFS)       71.2
DILUTION RATIO              5.98
MIXED ULT. BOD (MG/L)       6.69
MIXED ULT. NH3 (MG/L)       2.33
MIXED TEMPERATURE (C)       3.46
MIXED D.O. (MG/L)           12.7
D.O. 100% SAT =             13.32
K1=                         .04
K2=                         3.99
K3=                         9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	12.7	.62
5.2	.01	12.6	.72
5	.01	12.5	.82
4.8	.02	12.41	.9
4.6	.02	12.33	.98
4.4	.03	12.26	1.05
4.2	.03	12.2	1.12
4	.04	12.13	1.18
3.8	.04	12.08	1.24
3.6	.05	12.03	1.29
3.4	.05	11.98	1.33
3.2	.06	11.94	1.37
3	.06	11.91	1.41
2.8	.07	11.88	1.44
2.6	.08	11.85	1.47
2.4	.08	11.82	1.49
2.2	.09	11.8	1.51
2	.09	11.79	1.53
1.8	.1	11.77	1.55
1.6	.1	11.76	1.56
1.4	.11	11.75	1.57
1.2	.11	11.74	1.58
1	.12	11.73	1.58
.8	.12	11.73	1.58
.6	.13	11.73	1.59
.4	.14	11.73	1.58
.2	.14	11.73	1.58
0	.15	11.74	1.58

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 9.8 MG/L

```
************************* INPUT DATA ************************
PLANT FLOW (CFS)                  10.2
TEMP :IP,PLANT TEMP               2.3              10.4
D.O. :IP,PLANT D.O.               13.3             9.1
NH3-N IP, PLANT NH3-N             0                3.6
ULTIMATE BOD IP, PLANT BOD=       4.1              22.2
**********************************************************
```

```
UPSTREAM FLOW (CFS)          204
PLANT FLOW (CFS)             10.2
DOWNSTREAM FLOW (CFS)        214.2
DILUTION RATIO               20
MIXED ULT. BOD (MG/L)        4.96
MIXED ULT. NOD (MG/L)        .74
MIXED TEMPERATURE (C)        2.69
MIXED D.O. (MG/L)            13.1
D.O. 100% SAT =              13.59
K1=                          .04
K2=                          3.57
K3=                          9.22
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	13.1	.49
5.2	0	13.08	.51
5	.01	13.06	.53
4.8	.01	13.05	.55
4.6	.01	13.03	.56
4.4	.02	13.02	.58
4.2	.02	13	.59
4	.02	12.99	.6
3.8	.03	12.98	.62
3.6	.03	12.97	.63
3.4	.03	12.96	.64
3.2	.04	12.94	.65
3	.04	12.94	.66
2.8	.04	12.93	.67
2.6	.05	12.92	.67
2.4	.05	12.91	.68
2.2	.05	12.9	.69
2	.06	12.9	.7
1.8	.06	12.89	.7
1.6	.06	12.89	.71
1.4	.07	12.88	.71
1.2	.07	12.88	.72
1	.07	12.87	.72
.8	.08	12.87	.73
.6	.08	12.86	.73
.4	.08	12.86	.73
.2	.09	12.86	.73
0	.09	12.86	.74

APPENDIX V

October stream conditions under Table 5 effluent limitation of
0.1 mg/L NH$_3$-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5 MG/L

```
******************** INPUT ECHO ********************
PLANT FLOW (CFS)                    14
TEMP UP,PLANT TEMP                  10.9              16.2
D.O. UP,PLANT D.O.                  12                7.2
NH3-N UP, PLANT NH3-N               0                 .1
FIVE DAY BOD UP, PLANT BOD=         2                 30
***************************************************
```

```
UPSTREAM FLOW (CFS)        .1
PLANT FLOW (CFS)           14
DOWNSTREAM FLOW (CFS)      14.1
DILUTION RATIO             .01
MIXED ULT. BOD (MG/L)      94.83
MIXED ULT. NOD (MG/L)      .43
MIXED TEMPERATURE (C)      16.16
MIXED D.O. (MG/L)          7.23
D.O. 100% SAT =            9.91
K1=                        .08
K2=                        2.56
K3=                        9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.23	2.67
5.2	.01	7.19	2.72
5	.02	7.15	2.76
4.8	.03	7.11	2.8
4.6	.04	7.08	2.83
4.4	.06	7.05	2.85
4.2	.07	7.03	2.88
4	.08	7.01	2.9
3.8	.09	6.99	2.91
3.6	.1	6.98	2.93
3.4	.11	6.97	2.94
3.2	.12	6.96	2.95
3	.13	6.95	2.96
2.8	.14	6.94	2.96
2.6	.16	6.94	2.97
2.4	.17	6.93	2.97
2.2	.18	6.93	2.98
2	.19	6.93	2.98
1.8	.2	6.93	2.98
1.6	.21	6.93	2.98
1.4	.22	6.93	2.98
1.2	.23	6.93	2.97
1	.24	6.93	2.97
.8	.26	6.94	2.97
.6	.27	6.94	2.97
.4	.28	6.94	2.96
.2	.29	6.95	2.96
0	.3	6.95	2.96

NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE

October stream conditions under observed effluent NH$_3$-N concentration of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5 MG/L

```
********************** INPUT ECHO **********************
PLANT FLOW (CFS)                 14
TEMP UP,PLANT TEMP               10.9              16.2
D.O. UP,PLANT D.O.               12                7.2
NH3-N UP, PLANT NH3-N            0                 3.6
FIVE DAY BOD UP, PLANT BOD=      2                 30
*******************************************************


UPSTREAM FLOW (CFS)         .1
PLANT FLOW (CFS)            14
DOWNSTREAM FLOW (CFS)       14.1
DILUTION RATIO              .01
MIXED ULT. BOD (MG/L)       94.83
MIXED ULT. NOD (MG/L)       15.48
MIXED TEMPERATURE (C)       16.16
MIXED D.O. (MG/L)           7.23
D.O. 100% SAT =             9.91
K1=                         .08
K2=                         2.56
K3=                         9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.23	2.67
5.2	.01	5.66	4.25
5	.02	4.28	5.62
4.8	.03	3.1	6.81
4.6	.04	2.07	7.83
4.4	.06	1.2	8.71
4.2	.07	.45	9.46
4	.08	-.18	10.09
3.8	.09	-.71	10.62
3.6	.1	-1.15	11.06
3.4	.11	-1.51	11.42
3.2	.12	-1.8	11.7
3	.13	-2.02	11.93
2.8	.14	-2.19	12.1
2.6	.16	-2.31	12.22
2.4	.17	-2.39	12.29
2.2	.18	-2.43	12.33
2	.19	-2.43	12.34
1.8	.2	-2.41	12.32
1.6	.21	-2.36	12.27
1.4	.22	-2.29	12.2
1.2	.23	-2.21	12.11
1	.24	-2.1	12.01
.8	.26	-1.99	11.89
.6	.27	-1.86	11.77
.4	.28	-1.72	11.63
.2	.29	-1.57	11.48
0	.3	-1.42	11.33

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 15 CFS

November stream conditions under Table 5 effluent limitation of
0.5 mg/L NH$_3$-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.22 MG/L

```
***************** INPUT ECHO ****************************
PLANT FLOW (CFS)                14
TEMP UP,PLANT TEMP             6.8              14.2
D.O. UP,PLANT D.O.            12.4              7.4
NH3-N UP, PLANT NH3-N          0               .5
FIVE DAY BOD UP, PLANT BOD=    2                30
*********************************************************
```

```
UPSTREAM FLOW (CFS)        1
PLANT FLOW (CFS)           14
DOWNSTREAM FLOW (CFS)      15
DILUTION RATIO             .07
MIXED ULT. BOD (MG/L)      98.33
MIXED ULT. NOD (MG/L)      2.02
MIXED TEMPERATURE (C)      13.71
MIXED D.O. (MG/L)          7.73
D.O. 100% SAT =            10.43
K1=                        .07
K2=                        2.45
K3=                        9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.73	2.7
5.2	.01	7.53	2.9
5	.02	7.35	3.08
4.8	.03	7.2	3.24
4.6	.04	7.06	3.37
4.4	.06	6.95	3.48
4.2	.07	6.85	3.58
4	.08	6.77	3.67
3.8	.09	6.7	3.74
3.6	.1	6.64	3.79
3.4	.11	6.59	3.84
3.2	.12	6.55	3.88
3	.13	6.52	3.91
2.8	.14	6.5	3.93
2.6	.15	6.48	3.95
2.4	.17	6.47	3.96
2.2	.18	6.47	3.97
.2	.19	6.46	3.97
1.8	.2	6.47	3.97
1.6	.21	6.47	3.96
1.4	.22	6.48	3.95
1.2	.23	6.49	3.94
1	.24	6.5	3.93
.8	.25	6.52	3.91
.6	.26	6.54	3.9
.4	.28	6.55	3.88
.2	.29	6.57	3.86
0	.3	6.59	3.84

NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE

November stream conditions under observed effluent NH$_3$-N concentration
of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.22 MG/L

**************** INPUT ECHO ************************
PLANT FLOW (CFS)   14
TEMP UP,PLANT TEMP   6.8   14.2
D.O. UP,PLANT D.O.   12.4   7.4
NH3-N UP, PLANT NH3-N   0   3.6
FIVE DAY BOD UP, PLANT BOD=   2   30
****

UPSTREAM FLOW (CFS)   1
PLANT FLOW (CFS)   14
DOWNSTREAM FLOW (CFS)   15
DILUTION RATIO   .07
MIXED ULT. BOD (MG/L)   98.33
MIXED ULT. NOD (MG/L)   14.55
MIXED TEMPERATURE (C)   13.71
MIXED D.O. (MG/L)   7.73
D.O. 100% SAT =   10.43
K1=   .07
K2=   2.45
K3=   9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.73	2.7
5.2	.01	6.26	4.17
5	.02	4.98	5.45
4.8	.03	3.87	6.56
4.6	.04	2.91	7.52
4.4	.06	2.08	8.35
4.2	.07	1.38	9.06
4	.08	.78	9.66
3.8	.09	.27	10.16
3.6	.1	-.15	10.58
3.4	.11	-.49	10.93
3.2	.12	-.77	11.21
3	.13	-.99	11.43
2.8	.14	-1.16	11.6
2.6	.15	-1.29	11.72
2.4	.17	-1.37	11.8
2.2	.18	-1.42	11.85
2	.19	-1.43	11.87
1.8	.2	-1.42	11.86
1.6	.21	-1.39	11.82
1.4	.22	-1.33	11.77
1.2	.23	-1.26	11.69
1	.24	-1.17	11.6
.8	.25	-1.07	11.5
.6	.26	-.96	11.39
.4	.28	-.83	11.27
.2	.29	-.7	11.14
0	.3	-.57	11

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 14 CFS

December stream conditions under Table 5 effluent limitation of
3.0 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.8 MG/L

*********************** INPUT ECHO ***************************
PLANT FLOW (CFS)   14
TEMP UP, PLANT TEMP   5.8   13.3
D.O. UP, PLANT D.O.   12.4   8.1
NH3-N UP, PLANT NH3-N   0   3
FIVE DAY BOD UP, PLANT BOD=   2   30
****

UPSTREAM FLOW (CFS)   19.1
PLANT FLOW (CFS)   14
DOWNSTREAM FLOW (CFS)   33.1
DILUTION RATIO   1.36
MIXED ULT. BOD (MG/L)   58.28
MIXED ULT. NOD (MG/L)   5.49
MIXED TEMPERATURE (C)   8.97
MIXED D.O. (MG/L)   10.58
D.O. 100% SAT =   11.61
K1=   .05
K2=   2.57
K3=   9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	10.58	1.03
5.2	.01	10.09	1.51
5	.02	9.66	1.94
4.8	.03	9.28	2.33
4.6	.04	8.94	2.66
4.4	.05	8.64	2.96
4.2	.06	8.38	3.22
4	.07	8.16	3.45
3.8	.08	7.96	3.65
3.6	.09	7.79	3.82
3.4	.09	7.64	3.97
3.2	.1	7.52	4.09
3	.11	7.41	4.19
2.8	.12	7.33	4.28
2.6	.13	7.25	4.35
2.4	.14	7.2	4.41
2.2	.15	7.16	4.45
2	.16	7.13	4.48
1.8	.17	7.1	4.5
1.6	.18	7.09	4.51
1.4	.19	7.09	4.52
1.2	.2	7.09	4.51
1	.21	7.1	4.5
.8	.22	7.12	4.48
.6	.23	7.14	4.46
.4	.24	7.17	4.44
.2	.25	7.2	4.41
0	.26	7.23	4.37

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 12 CFS

December stream conditions under observed effluent NH$_3$-N concentration
of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.8 MG/L

```
************************ INPUT ECHO ************************
PLANT FLOW (CFS)              14
TEMP UP,PLANT TEMP           5.8          13.3
D.O. UP,PLANT D.O.           12.4         8.1
NH3-N UP, PLANT NH3-N        0            3.6
FIVE DAY BOD UP, PLANT BOD=  2            30
**********************************************************
```

```
UPSTREAM FLOW (CFS)      19.1
PLANT FLOW (CFS)         14
DOWNSTREAM FLOW (CFS)    33.1
DILUTION RATIO           1.36
MIXED ULT. BOD (MG/L)    58.28
MIXED ULT. NOD (MG/L)    6.59
MIXED TEMPERATURE (C)    8.97
MIXED D.O. (MG/L)        10.58
D.O. 100% SAT =          11.61
K1=                      .05
K2=                      2.57
K3=                      9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	10.58	1.03
5.2	.01	10	1.61
5	.02	9.48	2.13
4.8	.03	9.02	2.58
4.6	.04	8.62	2.99
4.4	.05	8.26	3.35
4.2	.06	7.95	3.66
4	.07	7.68	3.93
3.8	.08	7.44	4.17
3.6	.09	7.24	4.37
3.4	.09	7.06	4.55
3.2	.1	6.91	4.69
3	.11	6.79	4.82
2.8	.12	6.68	4.92
2.6	.13	6.6	5
2.4	.14	6.53	5.07
2.2	.15	6.48	5.12
2	.16	6.45	5.16
1.8	.17	6.42	5.18
1.6	.18	6.41	5.2
1.4	.19	6.41	5.2
1.2	.2	6.41	5.19
1	.21	6.43	5.18
.8	.22	6.45	5.16
.6	.23	6.47	5.13
.4	.24	6.51	5.1
.2	.25	6.54	5.06
0	.26	6.58	5.02

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 16 CFS

January stream conditions under Table 5 effluent limitation of 16.5 mg/L NH_3-N.

```
         MILL  CREEK  D.O.  MODEL
    INSTREAM  D.O.  CRITERION  5.49  MG/L

****************** INPUT ECHO *********************
PLANT FLOW (CFS)              14
TEMP UP, PLANT TEMP           2.3           13.3
D.O. UP, PLANT D.O.           13.2          7.8
NH3-N UP, PLANT NH3-N         0             16.5
FIVE DAY BOD UP, PLANT BOD=   2             30
**************************************************


UPSTREAM FLOW (CFS)        57.7
PLANT FLOW (CFS)           14
DOWNSTREAM FLOW (CFS)      71.7
DILUTION RATIO             4.12
MIXED ULT. BOD (MG/L)      37.77
MIXED ULT. NOD (MG/L)      13.95
MIXED TEMPERATURE (C)      4.45
MIXED D.O. (MG/L)          12.15
D.O. 100% SAT =            12.98
K1=                        .04
K2=                        3.03
K3=                        9.82


RIVER MILE     DAYS            D.O.          DEFICIT
 5.4            0             12.14           .83
 5.2            .01           11.2           1.78
 5              .01           10.34          2.64
 4.8            .02            9.56          3.42
 4.6            .03            8.85          4.13
 4.4            .04            8.21          4.76
 4.2            .04            7.64          5.34
 4              .05            7.12          5.85
 3.8            .06            6.66          6.31
 3.6            .07            6.25          6.73
 3.4            .07            5.89          7.09
 3.2            .08            5.56          7.42
 3              .09            5.28          7.7
 2.8            .09            5.03          7.95
 2.6            .1             4.82          8.16
 2.4            .11            4.63          8.34
 2.2            .12            4.48          8.5
 2              .12            4.35          8.63
 1.8            .13            4.24          8.74
 1.6            .14            4.16          8.82
 1.4            .15            4.09          8.88
 1.2            .15            4.05          8.93
 1              .16            4.02          8.96
 .8             .17            4             8.97
 .6             .17            4             8.97
 .4             .18            4.02          8.96
 .2             .19            4.04          8.94
 0              .2             4.08          8.9


MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS  80 CFS
```

February stream conditions under Table 5 effluent limitation of
10.4 mg/L NH₃-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.23 MG/L

```
****************** INPUT ECHO ******************
PLANT FLOW (CFS)               14
TEMP UP, PLANT TEMP            4.6            11.1
D.O. UP, PLANT D.O.            13.6           8.4
NH3-N UP, PLANT NH3-N          0              10.4
FIVE DAY BOD UP, PLANT BOD=    2              30
***********************************************
```

```
UPSTREAM FLOW (CFS)       49.4
PLANT FLOW (CFS)          14
DOWNSTREAM FLOW (CFS)     63.4
DILUTION RATIO            3.53
MIXED ULT. BOD (MG/L)     38.79
MIXED ULT. NOD (MG/L)     9.94
MIXED TEMPERATURE (C)     6.04
MIXED D.O. (MG/L)         12.45
D.O. 100% SAT =           12.46
K1=                       .05
K2=                       2.98
K3=                       9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	12.45	.01
5.2	.01	11.73	.74
5	.02	11.07	1.4
4.8	.02	10.47	1.99
4.6	.03	9.93	2.53
4.4	.04	9.45	3.02
4.2	.05	9.01	3.45
4	.05	8.62	3.84
3.8	.06	8.28	4.19
3.6	.07	7.97	4.5
3.4	.08	7.69	4.77
3.2	.08	7.45	5.01
3	.09	7.24	5.23
2.8	.1	7.05	5.41
2.6	.11	6.89	5.57
2.4	.12	6.76	5.71
2.2	.12	6.64	5.82
2	.13	6.54	5.92
1.8	.14	6.47	6
1.6	.15	6.4	6.06
1.4	.15	6.36	6.11
1.2	.16	6.32	6.14
1	.17	6.3	6.16
.8	.18	6.29	6.17
.6	.18	6.29	6.18
.4	.19	6.3	6.17
.2	.2	6.31	6.15
0	.21	6.34	6.13

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 48 CFS

March stream conditions under Table 5 effluent limitation of
12.8 mg/L NH$_3$-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.08 MG/L

```
****************** INPUT ECHO *********************
PLANT FLOW (CFS)                 14
TEMP UP, PLANT TEMP              5.9           12.8
D.O. UP, PLANT D.O.              12.6          7.8
NH3-N UP, PLANT NH3-N            0             12.8
FIVE DAY BOD UP, PLANT BOD=      2             30
*************************************************
```

```
UPSTREAM FLOW (CFS)       72.4
PLANT FLOW (CFS)          14
DOWNSTREAM FLOW (CFS)     86.4
DILUTION RATIO            5.17
MIXED ULT. BOD (MG/L)     29.77
MIXED ULT. NOD (MG/L)     8.98
MIXED TEMPERATURE (C)     7.02
MIXED D.O. (MG/L)         11.82
D.O. 100% SAT =           12.16
K1=                       .05
K2=                       3.48
K3=                       9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.82	.34
5.2	.01	11.26	.91
5	.01	10.74	1.43
4.8	.02	10.26	1.9
4.6	.03	9.83	2.33
4.4	.03	9.44	2.72
4.2	.04	9.09	3.07
4	.05	8.77	3.39
3.8	.05	8.48	3.68
3.6	.06	8.22	3.94
3.4	.07	7.99	4.17
3.2	.07	7.79	4.38
3	.08	7.6	4.56
2.8	.09	7.44	4.72
2.6	.09	7.3	4.86
2.4	.1	7.18	4.99
2.2	.11	7.07	5.09
2	.11	6.98	5.18
1.8	.12	6.91	5.26
1.6	.13	6.85	5.32
1.4	.13	6.8	5.37
1.2	.14	6.76	5.4
1	.15	6.73	5.43
.8	.15	6.72	5.45
.6	.16	6.71	5.46
.4	.17	6.71	5.46
.2	.17	6.71	5.45
0	.18	6.73	5.44

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 64 CFS

April stream conditions under Table 5 effluent limitation of
6.5 mg/L NH₃-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.95 MG/L

```
****************** INPUT ECHO ******************
PLANT FLOW (CFS)                 14
TEMP UP,PLANT TEMP               6.2              14.2
D.O. UP,PLANT D.O.               13.1             7.4
NH3-N UP, PLANT NH3-N            0                6.5
FIVE DAY BOD UP, PLANT BOD=       2                30
*************************************************
```

```
UPSTREAM FLOW (CFS)        55.1
PLANT FLOW (CFS)           14
DOWNSTREAM FLOW (CFS)      69.1
DILUTION RATIO             3.94
MIXED ULT. BOD (MG/L)      33.83
MIXED ULT. NOD (MG/L)      5.7
MIXED TEMPERATURE (C)      7.82
MIXED D.O. (MG/L)          11.95
D.O. 100% SAT =            11.93
K1=                        .05
K2=                        3.21
K3=                        9.82
```

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.94	-.02
5.2	.01	11.54	.39
5	.01	11.17	.76
4.8	.02	10.83	1.1
4.6	.03	10.53	1.4
4.4	.04	10.25	1.68
4.2	.04	10	1.93
4	.05	9.78	2.15
3.8	.06	9.58	2.35
3.6	.07	9.4	2.53
3.4	.07	9.24	2.69
3.2	.08	9.1	2.83
3	.09	8.98	2.95
2.8	.1	8.87	3.06
2.6	.1	8.77	3.15
2.4	.11	8.69	3.24
2.2	.12	8.62	3.31
2	.13	8.56	3.36
1.8	.13	8.52	3.41
1.6	.14	8.48	3.45
1.4	.15	8.45	3.48
1.2	.16	8.42	3.51
1	.16	8.41	3.52
.8	.17	8.4	3.53
.6	.18	8.39	3.54
.4	.19	8.39	3.54
.2	.19	8.4	3.53
0	.2	8.41	3.52

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 31 CFS