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Effects On Receiving Waters Of Wastes Discharged From Three Sewage Treatment Plants In Southwest Washington

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EFFECTS ON RECEIVING WATERS OF WASTES DISCHARGED FROM THREE SEWAGE TREATMENT PLANTS IN SOUTHWEST WASHINGTON

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ABSTRACT

Water quality and biological surveys were conducted during summer low flow to evaluate the effects on receiving waters of wastes discharged from three sewage treatment plants (Winlock, Ryderwood, and Vader) scheduled for new construction or upgrading. Each facility had an impact on receiving waters, depending on the nature of the discharge and physical characteristics of the affected watercourse. It was recommended that provisions for total residual chlorine removal be required for each upgraded facility; however, unionized ammonia removal was not recommended.

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INTRODUCTION

The sewage treatment plants at Winlock, Ryderwood and Vader, three small communities located in the Olequa Creek watershed, Cowlitz County, are scheduled for upgrading during 1977. Such upgrading or new construction will provide secondary treatment as required under the provisions of Public Law 92-500. In addition, facilities for removal of total residual chlorine and unionized ammonia from wastewaters may be required by the State of Washington.

Chlorine removal can be accomplished at low cost; however, the cost of ammonia removal is relatively high, imposing excessive burdens on small towns with limited funds. The Department of Ecology therefore has elected to evaluate STP projects such as these on a case-by-case basis prior to upgrading, to ensure that such removal, if required, would provide benefits commensurate with costs.

This report documents results of surveys conducted by the DOE Biological/Chemical Evaluations Section during the September 1976 low flow period. The project objectives were to assess the impacts of wastewaters discharged from the Winlock, Ryderwood, and Vader STPs on the aquatic environment. Emphasis was on measurement of water quality criteria and biological data that could best be utilized by DOE management in making decisions concerning chlorine and ammonia removal.

Recommendations concerning total residual chlorine and unionized ammonia removal are given for the three sewage treatment facilities evaluated.

METHODS

The three sewage treatment facilities (Winlock, Ryderwood, Vader) were evaluated separately, however the same investigative format was used for each evaluation. This approach included four important aspects, namely (1) General Surveys, (2) Stream Surveys, (3) Water Quality Analysis, and (4) Biological Assessment. The basic methods employed for each of these are outlined below:

1. GENERAL SURVEYS. An initial survey was conducted to characterize the community and obtain a sewage treatment facility description. General information concerning the watershed and receiving waters also was obtained.

2. STREAM SURVEYS. The receiving waters were visually surveyed to locate and identify any point pollution sources, other than the facility being evaluated, which could influence the outcome of the overall evaluation. The stream zone immediately below the sewage treatment plant was carefully checked for visual evidence of water pollution. Stream and effluent flow rates (cfs) were calculated to obtain an effluent/stream dilution ratio.

3. WATER QUALITY ANALYSIS. Water quality samples were collected to establish the concentrations of certain chemicals in the wastewater discharge and in the stream above and below the sewage treatment facility.

Effluents discharged from small communities where no industries exist are relatively uniform in chemical composition; however, diurnal fluctuations do occur. For this reason water quality monitoring was conducted throughout one 20-hour period. Samples were collected bi-hourly at three locations:

Station 1. Control on the receiving stream 100 to 200 feet above the STP outfall.

Station 2. A sample of the STP effluent.

Station 3. On the receiving stream sufficient distance below the STP outfall to permit thorough effluent/stream water mixing.

At each of the three water quality sampling locations the following twelve chemical parameters were measured:

(1) Temperature (Centigrade)
(2) pH
(3) Specific Conductance (uhmos/cm)
(4) Unionized Ammonia (NH_3-N)
(5) Total Residual Chlorine
(6) Nitrates (NO_3-N)
(7) Nitrites (NO_2-N)
(8) Ortho-Phosphates (O-PO_4-P)
(9) Total Phosphates (T-PO_4-P)
(10) Total Kjeldahl Nitrogen
(11) Dissolved Oxygen
(12) Total Ammonia

Total Residual Chlorine was measured immediately after collection by the DPD colormetric method, sensitive to 0.1 ppm. Also measured in the field were Temperature, pH (by probe), specific conductance (by probe) and dissolved oxygen (Winkler Method). For the remaining five chemical parameters, a water quality sample was collected and packed in ice, then transported to the Department of Ecology Analytical Laboratory in Tumwater for analysis.

All laboratory analyses were conducted as per Standard Methods (American Health Association, et al., 1976) except for unionized ammonia content which was estimated (Thurston, et al., 1974).

4. BIOLOGICAL ASSESSMENT. Biological samples were collected at four stations. Stations 1 and 2 coincided with water quality sampling stations 1 and 3. Biological sampling sites 3 and 4 were spaced at equal intervals (about 200-foot) below station 2.

Biological sampling included three important aspects:

a. Quantitative Benthic Sampling. Quantitative benthic samples were collected to provide a measure of the diversity and abundance of benthic invertebrates above and below the sewage treatment facility. The sampling was limited to one habitat-type due to time limitations.

   For the effort, 12 stones of approximately equal shape and size were collected from the stream bed at locations 1 through 4. Each stone was washed with 70 percent alcohol into a dissecting tray and the insects collected were counted by Order. The average insect counts per rock were obtained for each station providing above and below STP outfall comparisons.

b. Fish Densities. Electrofishing was conducted at a sufficient number of sites to provide an indication of relative diversity and abundance of fish life inhabiting the stream above and below the STP facility.

c. 96-Hour *In situ* Bioassay. Two 96-hour *in situ* bioassays were conducted to determine the impact of chlorination on receiving waters. For the first test, wastewater remained chlorinated as during routine STP operations. The bioassay was then repeated; however, the chlorinator was turned off 24 hours before the test began and remained off during the 96-hour period.

   Twenty healthy juvenile coho salmon (Oncorhynchus kisutch) obtained from the Washington Department of Fisheries Cowlitz Fish Hatchery were placed in each livebox. The liveboxes were placed at stations 1 through 3.

RESULTS AND RECOMMENDATIONS

WINLOCK EVALUATION

GENERAL SURVEYS

Winlock is a small residential community of about 1,000 people located 16 miles south of Chehalis, Lewis County. There are no major industrial developments within the immediate area. Most of the people are employed at Weyerhaeuser in Longview, Skaker Town, Corp., several veneer mills, agriculture, or at one of the businesses downtown.

Sanitary wastes generated by Winlock are carried by gravity flow through a network of sewer tile to the sewage treatment plant located on the south side of town (Figure 1).

Upon arrival at the Winlock STP, sewage empties into a holding tank at the facilities pump house. Sewage is automatically pumped from the tank to a spirogester (combination digester and clarifier) where most solids settle out. The remaining liquids plus some solids are pumped through a trickling filter, then chlorine is added and the sewage is piped to a small clarifier where additional settling occurs. The remaining liquids are discharged into Olequa Creek.

The Winlock STP also has a bypass system that is activated during wet winter months when the STP's treatment capacity is exceeded. During these periods chlorine is added to the raw sewage as it enters the plant, then the material is discharged directly into Olequa Creek.

Olequa Creek near the Winlock STP measures 10 to 30 feet wide by 1 to 4 feet deep; late summer stream flows decline to 7 to 10 cfs. The gradient is gentle and the streambed is composed mainly of sandstone bedrock interspersed periodically with medium sized rocks and sediments. Dense vegetation grows along much of the stream except in areas where cleared farm land exists.

STREAM SURVEYS

Olequa Creek near Winlock appeared to be affected by relatively few sources of water pollution, other than Winlock STP's effluent. Small quantities of wastewater were observed entering the Creek at two locations along the 4-mile section of stream surveyed. The first case involved a private dwelling located near the Cougar Flats Grange (3.5 miles below Winlock STP) that was observed discharging what appeared to be laundry suds directly into the stream. Secondly, clear but foul-smelling water was observed seeping into the creek behind a barn located about 3.0 miles below the Winlock STP.

Several potential sources of water pollution also were noted, including stormwater culverts leading from the old Winlock-Vader Highway, cattle crossings and stormwater discharge pipes along the stream where it passes through Winlock.

It did not appear that the combined impact of the water pollution sources cited was significant enough to affect the results of the evaluation involving the Winlock STP and Olequa Creek.

However, wastewater discharged from the Winlock STP did have an obvious and visible impact on Olequa Creek. Gray-colored sediments had settled to the stream bed in an area that appeared to fan out below the outfall extending some 50 feet downstream and about 1/3 way across the stream. A sewage odor was also apparent near the outfall and for a significant distance downstream.

Stream flow in Olequa Creek near Winlock was estimated at 7.02 cfs at the time of the investigation documented herein. Winlock STP was discharging at 0.18 cfs providing a 1:40 effluent/stream dilution ratio. The ratio remained fairly constant by time of day.

WATER QUALITY ANALYSIS

The 20-hour water quality monitoring results for the two key chemical parameters measured, total residual chlorine and unionized (free) ammonia, are presented below:

	Total Residual Chlorine (ppm)			Unionized Ammonia (ppm)		
TIME	Olequa Creek above STP	STP effluent	Olequa Creek below STP	Olequa Creek above STP	STP effluent	Olequa Creek below STP
2000	ND[1]	.30	ND	T[2]	.001	T
2200	"	.90	"	"	.002	"
2400	"	.25	"	"	.002	"
0200	"	.25	"	"	.002	"
0400	"	1.60	"	"	.002	"
0600	"	.70	"	"	.002	"
0800	"	.50	"	"	.001	"
1000	"	.25	"	"	.001	"
1200	"	.25	"	"	.001	"
1400	"	.15	"	"	.002	"
Average	ND	.52	ND	T	.002	T

1/ ND = None detected.
2/ Trace amounts of less than .001 ppm.

Throughout the monitoring period total residual chlorine content in the receiving waters remained below the 0.1 ppm lower detection limit of the DPD Colormetric Test Kit. Based on the 1:40 effluent/stream flow dilution ratio total residual chlorine content in the receiving waters could have averaged .013 ppm and ranged from .004 to .040 ppm. The maximum allowable total residual chlorine level in receiving waters is .002 ppm according to EPA recommendations (EPA Quality Criteria for Water, 1976).

Unionized ammonia content in the Winlock STP effluent oscillated between .001 and .002 ppm throughout the 20-hour sampling period, with night readings being slightly higher than day. Only trace amounts (less than .001 ppm) were detected in Olequa Creek below the STP. EPA recommends that unionized ammonia levels in receiving waters not exceed 0.02 ppm (EPA Quality Critiera for Waters, 1976).

For the remaining ten water quality parameters measured, concentrations did not vary significantly by time of day, therefore, the 20-hour average values are given:

PARAMETER	LOCATION		
	Olequa Creek above STP	STP effluent	Olequa Creek below STP
Temperature (°C)	14.0	16.9	14.0
pH	6.9	6.2	6.8
Specific conductance (μhoms/cm)	109	299	118
Dissolved oxygen (ppm)	9.6	7.1	9.5
Nitrates (ppm)	0.30	8.53	0.47
Nitrites (ppm)	.02	.02	.02
Ortho-phosphates (ppm)	0.08	4.61	0.18
Total phosphates (ppm)	0.11	5.35	0.20
T. Kjeldahl nitrogen (ppm)	0.14	3.84	0.30
Total ammonia (ppm)	0.02	2.30	0.06

Effluent discharged from the Winlock STP did not appear to significantly alter temperature, pH, or specific conductance, nor the concentrations of dissolved oxygen or nitrites in the receiving waters. Concentrations of four parameters (nitrates, ortho-phosphates, and total phosphates, plus Kjeldahl nitrogen) were about two-fold higher in the stream below Winlock STP than above, whereas total ammonia content increased about three-fold.

BIOLOGICAL ASSESSMENT

The biological assessment included quantitative benthic sampling, fish densities, and 96-hour *in situ* bioassays.

Quantitative Benthic Sampling

The quantitative benthic sampling results, expressed in terms of organisms per 100 inch^2 surface area for the five insect orders considered, are given below:

LOCATION	Ephemeroptera (May flies)	Plecoptera (stone flies)	Trichoptera (Caddis flies)	Diptera (True flies)	Coleoptera (Beetles)	Total
Olequa Creek above STP	16	2	12	12	0	42
Olequa Creek 250 feet below STP	12	2	10	175	1	199
Olequa Creek 500 feet below STP	19	2	2	51	0	74

These data indicate wastewaters discharged from Winlock STP were imposing two important impacts on benthic insect communities inhabiting Olequa Creek. First, insect diversity was significantly altered for at least 500 feet below the facility. The pollution-sensitive trichoptera were fewer in numbers below the discharge point, whereas the number of Diptera (two-winged flies) increased in this area. Ephemeroptera numbers also declined below Winlock STP, but recovered within 500 feet below the outfall. Plecoptera did not appear affected.

Secondly, total insect numbers appeared to increase significantly below Winlock STP, when compared with the upstream area. A five-fold increase in insect numbers occurred 250 feet below the discharge point compared to the upstream area; however, this figure dropped to about two-fold 500 feet downstream.

Fish Densities

The electrofishing data indicated approximately the same number of salmonids (juvenile coho salmon and trout) per 100 linear feet of stream were inhabiting Olequa Creek above and below Winlock STP:

	Number fish captured per 100 linear feet of stream			
LOCATION	Salmonid	Sculpin	Dace	Total
100' above WSTP	19	16	2	37
150' below WSTP	22	45	1	68
250' below WSTP	23	40	2	65
350' below WSTP	22	6	0	28
450' below WSTP	21	5	0	26

Nongame fish increased about three-fold in numbers within the impact area for about 250 feet below STP, then dropped to above Winlock STP levels farther downstream.

96-Hour *In situ* Bioassay

No fish mortalities occurred in any of the liveboxes (20 coho salmon juveniles per box) whether or not the Winlock STP chlorinator was in operation.

RECOMMENDATIONS

Under present operating conditions, wastewater discharged from Winlock Sewage Treatment Plant appears to be adversely affecting water quality and altering the community structure of aquatic life inhabiting the receiving waters, during summer low flow periods.

The water quality data suggests total residual chlorine removal should be required for the new facility. Even with a fairly good effluent/ stream water dilution ratio, total residual chlorine levels in Olequa Creek below the facility significantly exceeded maximum levels allowable under the EPA recommendations. These levels will probably be exceeded with the upgraded facility if chlorine is used to control coliform bacteria unless stripping facilities are included.

The data indicates unionized ammonia removal is not necessary since concentrations were far below EPA recommendations. Only trace amounts were present in receiving waters below the Winlock STP outfall. Ammonia content would not be expected to change significantly with the upgraded facility.

RYDERWOOD EVALUATION

GENERAL SURVEYS

Ryderwood is a small retirement community of about 400 people located in northern Cowlitz County (Figure 1). The town has no industries, very little commercial development (one general store, post office, etc.) and is unincorporated. Generally, it is bordered to the south, east and west by second-growth timber with farm lands to the north.

The sewage treatment system was constructed in 1920 and last upgraded in about 1949. At present sewage wastes are collected by a network of 6-inch concrete pipes connected to an 8-inch main line which transports the material to four septic tanks located on the south side of town. After several hours retention, the sewage is pumped through a small trickling filter. which appeared to be inoperative during this study. Chlorine is then added and the material is piped to a Dortmund Tank from which it is discharged into Becker Creek, a small tributary in the Olequa Creek system.

Becker Creek measures about four miles in length and encompasses some three square miles of drainage area. It connects with the larger Stillwater Creek about 1/2 mile below Ryderwood. Stream flow in Becker Creek fluctuates considerably by time of year, ranging from over 10 cfs during high periods to less than one cfs during summer low flow.

STREAM SURVEYS

About 1/2 linear miles of Becker Creek and 2 1/2 miles of Stillwater Creek were visually surveyed in an attempt to identify point discharges other than the Ryderwood STP. Minor pollution sources were observed at only three locations.

Becker Creek had an enriched appearance for the entire 1/2-mile distance between the Ryderwood STP outfall and its confluence with Stillwater Creek. Aquatic enrichment was most evident for about 1/4 mile below Ryderwood STP where some sewage sludge had settled and dense vegetation bordered the stream. This was especially true for the first 150 feet below the outfall. The enrichment appeared to clear up somewhat near Stillwater Creek however algae growth was still evident on the Stillwater Creek stream bed for some distance below the mouth of Becker Creek.

Stream flow in Becker Creek near Ryderwood averaged about 0.64 cfs at the time of the investigation documented herein. Ryderwood STP was discharging about .025 cfs into the creek during the day but dropped to a trickle (about .005 cfs) at night. These figures provided effluent/ stream water dilution ratios of 1:26 and 1:128 for these two periods, respectively.

WATER QUALITY ANALYSIS

The 20-hour monitoring results for the two key chemical parameters measured, total residual chlorine and unionized ammonia, are given below:

	TOTAL RESIDUAL CHLORINE (ppm)			UNIONIZED AMMONIA (ppm)		
TIME	Becker Creek above STP	STP effluent	Becker Creek below STP	Becker Creek above STP	STP effluent	Becker Creek below STP
2000	ND[1/]	.10	ND	T[2/]	.04	.001
2200	"	.10	"	"	.04	.001
2400	"	.45	"	"	.04	.001
0200	"	.60	"	"	.06	.001
0400	"	.60	"	"	.02	.002
0600	"	.40	"	"	.04	.001
0800	"	.20	"	"	.02	.001
1000	"	.30	"	"	.02	.001
1200	"	.70	"	"	.04	.002
1400	-	-	-	"	.04	.002
Average	ND	.36	ND	T	.04	.001

1/ ND = None Detected
2/ Trace amounts of less than .001 ppm.

These data indicate total residual chlorine content in Ryderwood STP effluent ranged from less than .10 to .70 ppm with a .36 ppm average during the 20-hour sampling period. Total residual chlorine levels in receiving waters below the Ryderwood STP remained below the 0.1 ppm lower detection limit throughout the monitoring period. Based on the effluent/stream water dilution ratios (1:26 and 1:128) the residual chlorine levels in the receiving waters could have ranged from less than .002 ppm to about .02 ppm during the 20-hour period. EPA recommends that total residual chlorine levels in receiving waters not exceed .002 ppm (EPA Quality Criteria for Water, 1976).

Unionized ammonia content in Ryderwood STP effluent ranged from .02 to .06 ppm with a .03 ppm average during the 20-hour monitoring period. After dilution in Becker Creek, these levels declined to approximately .001 ppm average. This is well below EPA's recommended maximum of 0.02 ppm for unionized ammonia content in receiving waters. (EPA Quality Criteria for water, 1976).

For the remaining ten water quality parameters measured, concentrations did not vary significantly by time of day; therefore, the 20-hour average values are given.

PARAMETER	LOCATION		
	Becker Creek above STP	STP effluent	Becker Creek below STP
Temperature (°C)	13.3	13.9	13.3
pH	6.8	6.9	6.9
Spec. Conductance (μhmos/cm)	63	257	74
Dissolved oxygen (ppm)	9.2	2.5	9.0
Nitrates (ppm)	0.15	12.40	0.66
Nitrites (ppm)	0.16	0.02	0.16
Ortho-phosphates (ppm)	0.01	3.53	0.19
Total phosphates (ppm)	0.04	3.97	0.24
T. Kjeldahl nitrogen (ppm)	0.18	15.5	0.96
Total ammonia (ppm)	0.01	12.0	0.66

These data indicate Ryderwood STP was having little effect on the temperature, pH, nitrites, specific conductance, or dissolved oxygen content in Becker Creek receiving waters. Significant increase was noted in the nutrient compounds: nitrates increased about four-fold; ortho-phosphates, nineteen-fold; total phosphates, six-fold; and total Kjeldahl nitrogen, five-fold. Total ammonia content in Becker Creek below Ryderwood STP was 66 times higher than above the facility.

BIOLOGICAL ASSESSMENT

The biological assessment included quantitative benthic sampling, fish densities, and 96-hour *in situ* bioassays.

Quantitative Benthic Sampling

The quantitative benthic sampling results, expressed in terms of organisms per 100 inches^2 surface area, are given below:

Location	Ephemeroptera (Mayflies)	Plecoptera (Stoneflies)	Trichoptera (Caddis flies)	Diptera (True flies)	Coleoptera (Beetles)	Total
Above STP	10	1	<1	3	3	18
250 feet below STP	0	<1	<1	2	19	23
500 feet below STP	12	3	5	4	6	30

The diversity of aquatic insect communities inhabiting Becker Creek was significantly altered for over 250 feet below the Ryderwood STP outfall. A fairly balanced distribution of the five insect Orders existed above Ryderwood STP, with Ephemeroptera accounting for about 50 percent of the total. However, no Ephemeroptera (pollution-sensitive) were counted at the station located 250 feet below the outfall, and the Plecoptera, Trichoptera, and Diptera declined in numbers at this station. Conversely, the pollution-resistant Coleoptera increased accounting for nearly 90 percent of the total organisms counted.

Aquatic insect diversity at the station sampled 500 feet below Ryderwood STP was about the same as above the facility.

There appeared to be a greater number of aquatic insects below Ryderwood STP than above the facility. This was due to the increase in Coleoptera beetles. All five orders appeared to increase in numbers at the station 500 feet downstream.

Fish Densities

The electrofishing results indicated fewer fish were inhabiting Becker Creek below Ryderwood STP than above. A total of 23 juvenile coho salmon and cutthroat trout plus 10 dace were captured in a 750-foot section of stream sampled above the sewer treatment facility. However, no salmonids and only 5 dace were captured in a comparable section of creek sampled below the outfall. From all appearances the two stream areas sampled were similar habitat.

96-Hour *in situ* Bioassay

Liveboxes each containing 20 juvenile coho salmon were placed at the locations shown on the following table:

	NUMBER FISH MORTALITIES		
Test	Becker Creek above STP	Becker Creek 100 feet below STP	Becker Creek 300 feet below STP
Chlorinator Off	0	0	0
Chlorinator On	0	20	20

All 20 juvenile coho placed at both downstream stations survived the 96-hour *in situ* bioassay without chlorination, and all livebox fish survived above Ryderwood STP during both tests.

However, during chlorination a 100 percent mortality occurred in the live-boxes at the two downstream stations. The first signs of stress were evident after about 10 hours exposure and total mortality occurred within 48 hours. Chlorine appeared to be the critical factor in these mortalities.

RECOMMENDATIONS

Wastewater discharged from Ryderwood sewage treatment plant is adversely affecting water quality in Becker Creek receiving waters below the outfall. The low-volume flow makes the creek extremely vulnerable to to water quality alterations, especially during the summer months.

Total residual chlorine removal is recommended for the new facility. Chlorine concentrations in the receiving waters exceeded by considerable margin the maximum allowable levels recommended by EPA. This condition would probably continue to be a problem unless chlorine removal is included in the facility upgrading program.

Unionized ammonia concentrations in Becker Creek below the Ryderwood STP were well below EPA's maximum allowable levels; therefore, provisions for ammonia removal are not recommended.

VADER EVALUATION

GENERAL SURVEYS

Vader is a rural community of about 420 people located about 7 miles south of Winlock, Cowlitz County (Figure 1). Like nearby Ryderwood but slightly larger, there are no industries and very little commercial development except for a cafe, laundromat, post office, etc. Many of the residents are retired. Most of the employed people work in some phase of agriculture or the wood products industry such as Weyerhaeuser Company or International Paper Company.

Sewage generated by Vader is collected by a network of sewer culverts connected to a main line that carries the material to a 4-acre sewage lagoon located on the south side of town. Solids settle out and organic decomposition occurs in the pond, while the surface liquids drift to the south end and enter a small (about 3x10 feet) wood enclosure. Chlorine is added to the liquids that enter this structure, then the chlorinated waste water is discharged into Olequa Creek. It was noted during the study that much of the liquids in the lagoon were being lost by evaporation, seepage through the dike or entering the discharge pipe below the standpipe level, rendering the chlorination mechanism nearly ineffective.

Olequa Creek near Vader measures 20 to 50 feet wide by one to seven feet deep. Stream flow averages 20-40 cfs during the dry summer months, but may increase more than 10-fold during periods of heavy rainfall.

STREAM SURVEYS

There were no significant discharges of water pollutants observed entering Olequa Creek near Vader other than from the Vader sewage treatment plant. The sections of Olequa Creek and Stillwater Creek surveyed are shown in Figure 1.

There was a prominent plume near the Vader STP discharge pipe. A sewage odor was apparent, the water was discolored and gray-colored sediments covered the stream bed in this area.

An effluent/stream water dilution ratio could not be calculated because virtually all wastewaters being discharged into Olequa Creek were seeping through the diking around the pond, and not through the discharge culvert.

WATER QUALITY ANALYSIS

The 20-hour water quality monitoring results for the two key chemical parameters measured, total residual chlorine and unionized ammonia, are given in the following table:

TIME	Total Residual Chlorine (ppm)			Unionized Ammonia (ppm)		
	Olequa Creek above STP	STP effluent	Olequa Creek below STP	Olequa Creek above STP	STP effluent	Olequa Creek below STP
2000	ND[1/]	0.25	ND[1/]	T[2/]	.07	T
2200	"	1.30	"	"	.04	"
2400	"	0.31	"	"	.04	"
0200	"	1.20	"	"	.06	"
0400	"	0.22	"	"	.06	"
0600	"	0.70	"	"	.06	"
0800	"	0.70	"	"	.06	"
1000	"	0.10	"	"	.06	"
1200	"	0.70	"	"	.06	"
1400	"	1.30	"	"	.04	"
Average	ND	0.68	ND	T	.06	T

1/ ND = None detected.
2/ Trace amounts of less than .001 ppm.

As shown above, total residual chlorine concentrations within the chlorine contact chamber ranged from 0.10 to 1.30 ppm during the 20-hour monitoring period. Residual chlorine content in Olequa Creek below the Vader sewage lagoon remained below the 0.10 ppm lower detection limit of the DPD Colormetric Test Kit throughout this period. An estimate of these values could not be obtained because the effluent/stream water dilution ratio was not calculated.

Unionized ammonia concentrations in the Vader sewage lagoon effluent ranged from .04 to .07 ppm with a .06 ppm average during monitoring. Only trace amounts (less than .001 ppm) of unionized ammonia were detected in the receiving waters Olequa Creek during this period, which is significantly below the EPA recommendations (EPA Quality Criteria for Water, 1976).

Concentrations of the remaining ten water quality parameters did not fluctuate significantly by time during the 20-hour monitoring period; therefore, only the average values are given:

Parameter	LOCATION		
	Olequa Creek above STP	STP Effluent	Olequa Creek below STP
Temperature (°C)	15.2	17.1	15.2
pH	7.4	7.1	7.4
Specific Conductance (μhmos/cm)	106	1084	107
Dissolved Oxygen (ppm)	9.2	1.9	9.1
Nitrates (ppm)	.22	.02	.22
Nitrites (ppm)	.02	.02	.02
Ortho-phosphates (ppm)	.08	5.0	.08
Total phosphates (ppm)	.10	5.0	.11
T. Kjeldahl Nitrogen (ppm)	.33	10.08	.21
Total Ammonia (ppm)	.02	9.90	.03

Wastewaters discharged from Vader sewage lagoon did not appear to significantly alter any of the parameters measured in Olequa Creek.

BIOLOGICAL ASSESSMENT

The biological assessment included quantitative benthic samplings, fish densities, and 96-hour *in situ* bioassays.

Quantitative Benthic Sampling

The quantitative benthic sampling results, expressed as numbers of organisms per 100 inches^2 surface area are given below:

LOCATION	Ephemeroptera (Mayflies)	Plecoptera (Stoneflies)	Trichoptera (Caddis flies)	Diptera (True flies)	Coleoptera (beetles)	Total
Olequa Creek above STP	40	2	26	9	2	79
Olequa Creek 250 feet below STP	35	2	9	8	1	55
Olequa Creek 500 feet below STP	44	6	6	4	1	61
Olequa Creek 750 feet below STP	37	1	6	2	0	46

There were no clear data trends indicating sewage discharge emanating from Vader sewage lagoon was significantly altering diversity or abundance of benthic insects in Olequa Creek. This minimal impact probably stemmed from the fact that there was very little discharge from the sewage lagoon entering the receiving waters.

Fish Densitites

It was not possible to obtain comparable electrofishing data for above and below Vader sewage lagoon because stream habitat characteristics were distinctly different in these two areas. The upstream area was best adapted for salmonid production, being fairly rocky with a good pool/riffle ratio. However, Olequa Creek below Vader sewage lagoon became a generally shallow, slow water-velocity area, with several large pools. Nongame species such as sculpins, dace, etc. would best utilize this habitat.

However, fair numbers of coho and cutthoat trout were captured in all suitable habitat areas, both above and below the Vader sewage lagoon.

96-Hour *In situ* Bioassay

No fish mortalities occurred in any of the liveboxes (20 coho salmon juveniles per box) whether or not the Vader sewage lagoon chlorinator was in operation.

RECOMMENDATIONS

Wastewater discharged from Vader Sewage treatment lagoon did not appear to significantly alter water quality or impose an impact on aquatic life in Olequa Creek receiving waters. This was probably because very little effluent was being discharged during the evaluation. It appeared that most liquid wastes that entered the lagoon were evaporating or seeping through the dike.

It is recommended that facility upgrading or new construction at Vader sewage lagoon include provisions for chlorine removal, however, based on the EPA standards and foregoing data (including Winlock and Ryderwood) unionized ammonia removal is not recommended.

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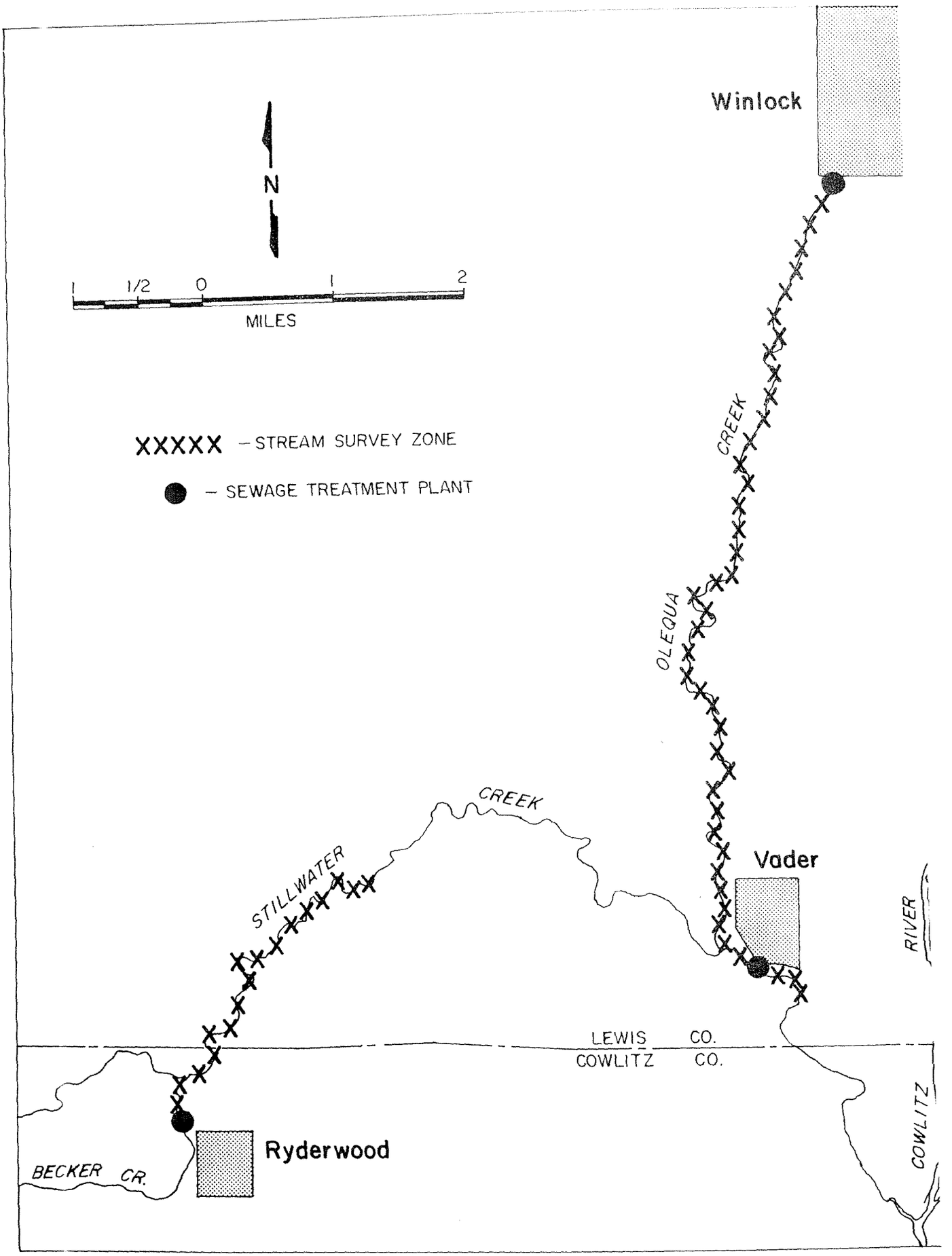

Figure 1. MAP DEPICTING SECTION OF OLEQUA CREEK SYSTEM SAMPLED BY DOE DURING 1976, WINLOCK, RYDERWOOD, VADER SEWAGE TREATMENT FACILITY EVALUATION