Rogue River Point Source Phase I Study

Prepared for

Rogue Flyfishers

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Summary of Findings

Seven point sources and 16 sites along the mainstem Rogue River were sampled from October 10-13, 2023. A field assessment was made at each site for habitat, water quality, and biological condition. Information from these assessments was collected to answer three main objectives of this reconnaissance survey. Each objective is addressed below:

Objective 1: Is there suitable habitat for assessing the aquatic macroinvertebrate community above and below each point source?

For biological assessments to accurately assess water quality impairment from point sources it is important that habitat suitable for sampling is available at appropriate locations above and below the point source. For macroinvertebrate assessments in large rivers like the Rogue River, this means wadeable reaches with rocky substrate located outside any mixing zones, but close enough to the point source to determine that any impairment downstream is due to the point source. In addition, the type of substrate (type and size of rocky material) should be similar at the sites sampled upstream and downstream of the point source so if any biological impairment exists it is due to changes in water quality and not the result of different substrate conditions.

Field assessments from this survey found that suitable sites for macroinvertebrate assessments were present above and below each of the seven point sources evaluated. As described in the results section, substrate material was very similar above and below each point source and wadeable reaches for sampling were present at relatively close proximity to each point source (typically less than 0.5 miles). Based on this information it should be possible to carry out, if needed, in-depth water quality and biological studies above and below any of the seven point sources evaluated for this study.

Objective 2: Do the results of the field data show impaired water quality and/or biological condition below any of the point sources indicating a release of harmful nutrient loads to the Rogue River?

As described in the results of this report, one or more parameters generally showed some level of impairment below each of the seven point sources studied. Changes downstream compared to upstream were typically small and no violations of water quality standards were observed. Each of the different parameters are discussed below.

Water quality parameters:

Conductivity and Turbidity - Measurements of these two parameters were often higher (worse) downstream of each point source. These parameters of themselves, don't directly harm aquatic life (unless much higher than observed), but rather indicates that the effluent released from the point source into the river hasn't completely mixed or been completely diluted by the receiving stream. The purpose of a regulatory mixing zone is to provide a short distance for mixing to occur so the effluent is diluted and conditions in the river are back to levels present above the point source once below the mixing zone. The increases in conductivity and turbidity were typically small, but do indicate that mixing was not complete by the end of the mixing zone and a potential indication of permit noncompliance. The source showing the highest increase was Little Butte Creek (Table 11, page 24). Because Little Butte Creek is not a permitted discharge source there is no mixing zone when it meets the Rogue River. Agricultural and urban runoff (non-point source pollution) into Little Butte Creek are the most likely cause of this increase. The first site below the Grants Pass outfall had the second highest increase in conductivity compared to upstream as well as a small increase in turbidity. Shady Cove actually showed a slight decrease in conductivity and turbidity below its outfall (Table 7, page 18).

Water Temperature - Water temperature showed very little change downstream from any of the point sources. However, mid-October is not the best time of year to identify point source impacts on water temperature given the cool weather. Even so, Little Butte Creek and the Applegate River increased water temperature in the Rogue River by more than 0.5˚C. Little Butte Creek increased water temperature by 0.8˚C compared to upstream, while the Applegate River increased temperature in the Rogue River by 1.3˚C, and indicates that the 2003 Total Maximum Daily Load (TMDL) for temperature has not achieved its goal.

Dissolved Oxygen - Dissolved oxygen (DO), besides being necessary for aquatic life to survive, is a useful measure of increased algal and plant biomass that are often driven by excess nutrients. This is because greater biomass of aquatic plants means greater photosynthesis and thus higher DO concentrations. Therefore, if higher algae and plant biomass occurs below a point source one would expect to see higher DO concentrations downstream.

Differences in DO from above to below point sources in this reconnaissance survey were quite small - generally less than 0.2 mg/L - and did not indicate an increase in algae or aquatic plants.

pH - Like DO, pH can be a useful indicator of increased algae or aquatic plant biomass because photosynthesis decreases CO_2 concentrations, which causes pH to increase. In this survey there were no measurable increases in pH below the point sources that indicated a significant increase in aquatic plant biomass downstream.

It’s important to note, however, that the time of year (late fall) and the cool and cloudy weather limited the available sunlight, and thus would have limited photosynthesis of the algae and plants present in the river. This may have prevented larger changes in pH and DO from occurring even if higher algal and plant biomass were present downstream. Collecting hourly pH and DO measurements over a one or two day period is much more sensitive at detecting changes in pH or DO due to increases in algae and aquatic plants, but that level of sampling was not possible for this reconnaissance survey.

Biological Parameters:

Plant community - Even though pH and DO did not increase significantly below any of the point sources, visual assessments of algae and aquatic plants indicated some increase in density downstream from each point source. There were a few exceptions however. For example, while all sites above and below the Cole Rivers Hatchery had an apparent high biomass of algae on the substrate, the most upstream site (site closest to the dam) had the highest. The site upstream of Bear Creek also appeared to have a slightly higher biomass of aquatic plants than the site downstream. There was also a slight smell of effluent in the air at the upstream Bear Creek site and it appeared that the effluent from the Medford wastewater treatment plant was possibly affecting conditions at this site. The Medford treatment plant is approximately 1.0 mile upstream from this sample site. The site with the greatest increase in aquatic plant biomass was the site below Little Butte Creek compared to the site just upstream.

Macroinvertebrates - Samples of macroinvertebrates were collected and assessed in the field. While not quantitative, or as sensitive as sending samples to a lab for analysis, it did provide a consistent assessment method for identifying potential negative changes in the aquatic macroinvertebrate community below the point sources.

Results of the macroinvertebrates were similar to the observed changes in aquatic plants. In most cases, the community downstream of the point sources showed a slight decline in abundance and/or diversity of taxa sensitive to organic enrichment when compared to the site just above the point source. The site with the largest observed decline was the site below Little Butte Creek compared to the site just upstream.

When all the data are considered together, there was no point source that demonstrated a major increase in nutrients downstream that caused significant changes in water quality or macroinvertebrates. The site downstream from Little Butte Creek showed the most notable decline compared to its upstream site. In addition, the nutrient samples collected below Little Butte Creek, as well as in it, showed high nutrient concentrations in Little Butte Creek that also raised nutrient levels in the Rogue River just downstream from its mouth.

Finally, based on observations of the aquatic plants and macroinvertebrates, it appeared that all sites sampled, whether upstream or downstream of each point source, had somewhat limited abundance and diversity of aquatic macroinvertebrates and moderately high biomass of aquatic plants indicating some level of nutrient pollution in the Rogue River overall. There was no biological change observed below any of the permitted point sources that clearly indicated a biocriteria violation. However, more pronounced changes below the point sources may have been limited by the poor level of biological condition seen throughout the river indicated by a general scarcity of sensitive taxa and higher abundance of tolerant taxa.

<u>Objective 3:</u> Are there any point sources with impaired conditions downstream that warrant in-depth followup studies in 2024? If so, are they causing significant water quality and/or biological impairment that violate state water quality standards?

The data and observations from this survey did not find any of the permitted point sources to clearly be causing a biocriteria violation below their regulatory mixing zones. However, because the entire river appeared to be affected by some level of nutrient pollution, further studies at a few sites might be warranted. In other words, it is possible that one or more of these sources is *contributing* to biocriteria violations, even though they are not the only *cause* of them.

First, a better understanding of nutrient loads released from William S. Jess Dam (also called Lost Creek Dam) would be useful. The three sites directly below the dam (above and below Cole Rivers Hatchery) had the highest overall algal density observed during the survey. It would be helpful to understand nutrient levels and their impacts in this area of the river and how far downstream it may be affecting the river.

Second, Little Butte Creek appears to be a problem source of nutrients to the Rogue River. Because it is not a permitted point source there is no mixing zone or specific point source that can be directly linked to the high nutrient levels. Non-point runoff from agriculture and development is the most likely source.

Third, Bear Creek is a known source of nutrients to the Rogue River. Stream conditions upstream of Bear Creek, however, appeared to be impacted by the City of Medford's wastewater treatment plant such that possible impacts from Bear Creek were not apparent.

Fourth, changes were observed in the Rogue River below the Applegate River with an increase in temperature and conductivity. This indicates that runoff from non-point sources into the Applegate River could be affecting the Rogue River. Significant changes caused by increased nutrient loads to the Rogue River were not apparent, however, and there were no changes in the macroinvertebrate community indicating a biocriteria violation. For a better understanding of possible impacts from the Applegate River, a more in-depth assessment would be needed.

Finally, while the two sites below the Grants Pass outfall did not show significant changes from the site just upstream, because of its size, regional importance, and its potential to effect the river, the Grants Pass outfall could be considered for further study and assessment. Changes observed downstream of the outfall included higher conductivity and turbidity measurements indicating that the effluent had not mixed completely below its allowed mixing zone, plus a slightly higher abundance of algae and aquatic plants, and a slightly lower condition of the macroinvertebrate community was observed downstream. Changes in the macroinvertebrate community were small and did not indicate a biocriteria violation given the poor background conditions. More in-depth studies would confirm if the Grants Pass outfall causes any significant impacts to the Rogue River.

Rogue River Point Source Phase 1 Study

Objective

Previous bioassessment studies on the Rogue River found that the City of Medford's Wastewater Treatment Plant caused significant impairment to aquatic life below its sewage treatment outfall (Hafele 2013, DEQ 2014, Brown & Caldwell 2014). As a result of this work, the City of Medford will be upgrading its wastewater treatment plant in order to remove excess nutrients. However, there are several other city treatment plants discharging to the Rogue River that may have similar problems and also need to remove nutrients from their wastewater. In addition several major tributaries contribute excess nutrients to the river. Funding was provided in 2023 to complete a reconnaissance survey (Phase 1) above and below important point sources and tributaries to the Rogue River in order to evaluate potential nutrient pollution and determine if and where more in-depth studies (Phase 2) should be completed. This report describes the methods and results of the Phase 1 reconnaissance survey that was completed October 10-13, 2023.

Rogue River Watershed

The Rogue River flows 215 miles from its source at Boundary Springs at an elevation of 5,200 feet near Crater Lake, to its mouth at the Pacific Ocean by the town of Gold Beach, OR (Figure 1). The river is typically divided into three sections based on geology, slope, and land use (LaLande 2022). The upper section runs approximately 70 miles from Boundary Springs to Shady Cove, OR. The Middle and South Fork join the mainstem (called Upper Rogue or North Fork) at the town of Prospect. This section is heavily forested. All three forks have relatively steep gradients and flow through steep-walled canyons of old lava flows. Other main tributaries in this section include Big Butte Creek and Elk Creek. Also in this section is Lost Creek Dam (renamed William L. Jess Dam) built for flood control in 1977, and located 10 miles above Shady Cove.

The middle section of the river extends from Shady Cove downstream roughly 64 miles to Hellgate Canyon below the city of Grants Pass. This section is characterized by moderate, more gentle slopes with land use dominated by agriculture and urban development. The highest density of population in the watershed (≈260,000) occurs in this section of the basin. Bear Creek , a major tributary in this section, drains an area that includes most of the the major cities and urban areas in the watershed including Medford, Ashland, Phoenix, Talent, and Central Point. Little Butte Creek, and the Applegate River are other major tributaries in this section. Little Butte Creek enters the Rogue upstream of Bear Creek, and the Applegate River enters the Rogue just downstream from Grants Pass. Nearly all the important point sources of nutrient inputs occur in this section of the watershed.

The lower section of the river flows roughly 82 miles from Hellgate to the Pacific Ocean at Gold Beach. This section cuts through the rugged forested terrain of the Siskiyou Mountains creating a steep roadless section that is one of the most sought after whitewater river trips in the Northwest. The Illinois River, another major tributary, joins the lower Rogue River near the town of Agnes.

The Rogue River has two segments designated as Wild & Scenic. The first area, from the mouth of the Applegate River downstream 84.5 miles to the Lobster Creek bridge (≈15 miles upstream from Gold Beach), was designated in 1968. In 1986, the Upper Rogue from Boundary Springs to Lost Creek Lake Reservoir (41 miles) was designated as Wild & Scenic.

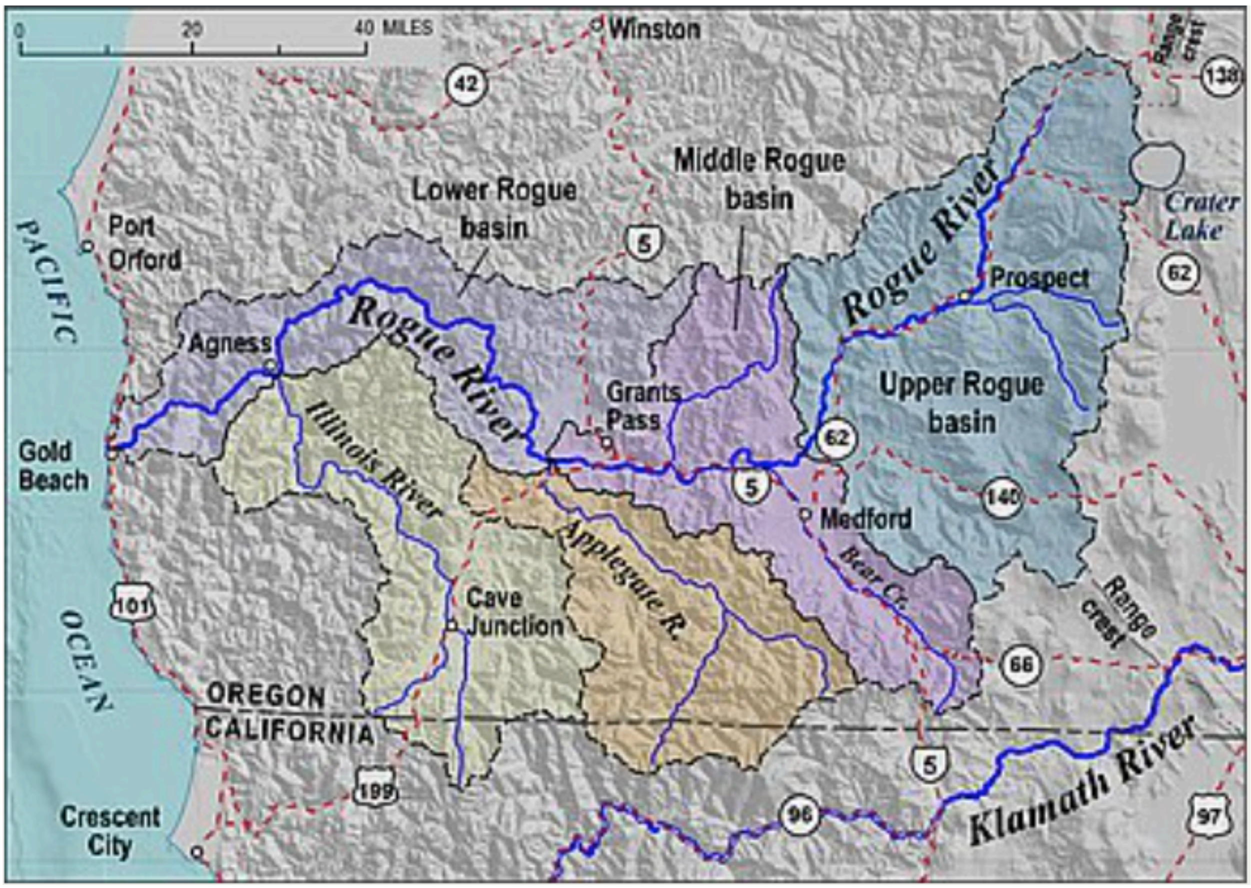

Figure 1. Rogue Watershed (from Oregon Encyclopedia)

Phase 1 Reconnaissance Survey Overview

This report summarizes the results of stream field sampling above and below major point sources on the Rogue River. Funding for this study was provided from the Rogue Flyfishers in Medford, Oregon. The purpose of the field work was threefold:

1. Determine if suitable habitat for in-depth biological assessments of aquatic macroinvertebrates and aquatic plants and algae exists at appropriate locations above and below major point sources on the Rogue River.
2. Collect water quality and biological field data above and below the major point sources to determine if the sources are releasing high nutrient levels and impairing water quality or aquatic life.
3. Determine which, if any, of the point sources require in-depth follow-up studies in 2024 in order to quantify impairment caused by the point source, and then use this information to justify improved water treatment and removal of excess nutrients from entering the river.

For this reconnaissance survey seven point sources were assessed: one fish hatchery discharge, three city wastewater treatment plants, and three tributary discharges (Table 1).

Table 1. Point sources and major tributaries to the Rogue River sampled in October 2023.

Source	Number of samples	Discharge Location (River Mile)	NPDES Permit (Y/N)	Nutrient Limits (Y/N)	Current Permit Expired (Y/N)	Proposed date for new permit
Cole Rivers Fish Hatchery	2 - upstream 1 - downstream	154	Y	N	?	?
Shady Cove	1 - upstream 1 - downstream	143.1	Y	N	Y	2026
City of Rogue River	1 - upstream 1 - downstream	110	Y	N	Y	2023
Grants Pass	1 - upstream 2 - downstream	100.5	Y	N	Y	2025
Little Butte Creek	1 - upstream 1 - downstream	≈132.6	-	-	-	-
Bear Creek	1 - upstream 1- downstream	≈127	-	-	-	-
Applegate River	1 - upstream 1 - downstream	≈96	-	-	-	-

Note: The Gold Hill treatment plant discharge was not sampled since the city plans to close the treatment plant and send its wastewater to the Medford Regional wastewater treatment plant.

Data Collection Methods

Sites were sampled during the week of October 9-13, 2023. River discharge was stable and ranged from 1200 cfs at Dodge Bridge to 1340 cfs at Grants Pass during the week. Weather for the week was initially cloudy with two hours of light rain on the morning of October 10th, followed by clearing in the afternoon and mostly clear weather the rest of the week.

Field data were collected within wadeable riffles above and below each point source listed on Table 1. In total 16 sites were sampled. An assessment of water quality, habitat, and aquatic biology was made at each of the 16 sites. Below is a list of the data collected at each site.

Habitat:

- Estimated length and width of wadeable portion of the sampled riffle.
- Estimated average depth and velocity of the sampled area.
- General bank stability and riparian vegetation within and near the sample site.
- Estimated percent of major substrate size classes within the sampled area.
- An estimate of the percent embeddedness (% of substrate covered by fine sediment) within the sampled area.

Water Quality:

- Time of day
- Air temperature
- Water temperature
- pH
- Dissolved Oxygen (mg/L and % saturation)
- Conductivity
- Turbidity

Biological condition:

- A visual assessment was made of the amount of algae and aquatic plant growth covering the substrate within the sample area. Underwater photos were also taken to document algae and plant growth. The visual assessment was given a score of 1 to 5, with 1 indicating highly impaired due to excessive growth of of algae and aquatic plants and 5 indicating no impairment.
- Aquatic macroinvertebrates were sampled by taking four kick samples of approximately three square feet each (total ≈12 sq. ft.) randomly located within the sample area using a D-frame kick net with 500μ mesh. A composite of the sampled material was placed in a white tub and a visual assessment of the number and types

of aquatic macroinvertebrates present was recorded. The overall invertebrate community was then given a score of 1 to 5, with 1 indicating a high level of impairment and 5 no impairment.

- Based on the above evaluation of aquatic plants, macroinvertebrates, and water quality measurements, the site was scored from 1 to 5 as a subjective indicator of nutrient enrichment, with 1 indicating highly enriched and 5 indicating low enrichment.

All of the above information was recorded on a standardized field data sheet, a copy of which is provided in Appendix A

Field Sampling Procedure:

All sites were accessed via boat. Because of low water levels, the upper three sites (above and below Cole Rivers Hatchery) were accessed with a drift boat. All other sites could be reached with a jet boat.

Upon arriving at a site, water quality measurements taken with water quality meters were taken first and recorded on the data sheet. Next the macroinvertebrate samples were collected and the community visually assessed by recording all invertebrate taxa observed and their relative abundance by giving each taxon an abundance score of 1 to 3 (1 = low; 2 = moderate; 3 = high). Finally, the relative percent of overall abundance of each of the major orders was estimated. All data were recorded on the field data sheets.

After completing the macroinvertebrate assessment, the percent substrate composition was assessed and recorded, and then the plant community was visually evaluated and underwater photos taken. The final estimate of the overall impact from nutrient enrichment was then recorded.

In addition to the above assessments, water samples for lab analysis of nutrients (nitrogen and phosphorus) were collected above and below and inside the mouth of Little Butte Creek and Bear Creek.

The data collected at each site, with the exception of water quality measurements, were qualitative in nature. This was intentional given that the goal of this reconnaissance survey was to determine if suitable sampling habitat for biological assessments was present above and below each point source, and provide enough general information above and below point sources to determine which, if any, point sources impaired water quality and/or biological communities downstream and should be selected for future in-depth quantitative studies.

Results

Results for data collected at sites above and below each point source are described below beginning with the uppermost point source (Cole Rivers Fish Hatchery) and proceeding down to the lowest source, the Applegate River.

Cole Rivers Fish Hatchery

Two sites above and one site below the Cole Rivers Fish Hatchery were sampled on the morning of October 10th. A drift boat was needed to access the sites due to the low water level in the river at this location. As a result sampling started upstream of the hatchery. Two sites were sampled above the hatchery (sites 1 & 2) and one site sampled downstream (site 3) (Figure 2). Distance from the hatchery discharge are approximately: Site 1 - 1700' upstream; Site 2 - 650' upstream; and Site 3 - 1350' downstream.

The discharge for the hatchery enters a small side channel that then flows for about 100-200' before entering the main channel of the Rogue River (Figure 2, Figure 3). There was no visible color or smell observed from the hatchery discharge.

Figure 2. Cole Rivers Fish Hatchery sample sites: #1-first upstream site; #2-second upstream site; #3-downstream site; ⬭= hatchery discharge location.

Figure 3. Cole Rivers Fish Hatchery discharge entering side channel before merging with mainstem of the Rogue River.

One important factor when comparing biological communities between sites is how similar the habitat - primarily substrate composition - is between sites (Davis & Simon 1995). Sites with significantly different substrate composition will have different biological communities despite no changes in water quality. Therefore, to evaluate sites above and below point sources for nutrient impacts, it is important that habitat and substrate conditions between sites are similar.

Substrate conditions at the three sites sampled above and below are shown in Table 2 and instream water quality measurements in Table 3. The substrate matrix was very similar between the three sites with cobble (2.5-10”) followed by gravel (0.08-2.5”) comprising the majority of substrate within the sampled riffle areas (Table 2). Overall water quality between the three sites was also very similar. The pH, dissolved oxygen, conductivity, and turbidity all showed little to no change between the sites and all were within acceptable ranges (Table 3). Figures 4, 5 and 6 show the riffles sampled at Site #1, Site #2, and downstream Site #3, respectively.

Table 2. Bank condition and percent substrate classes at sites above and below Cole Rivers Fish Hatchery.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embedded
#1	Rip Rap left bank	Right bank okay	5	10	30	50	0	0	0	<5
#2	Good	Good	0	5	15	60	20	0	0	<5
#3	Good	Good	5	10	30	50	5	0	0	<5

Table 3. General sample site information and instream water quality results for sites above and below Cole Rivers Fish Hatchery.

Sample Site	Sample date/time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Conductivity	Turbidity	Effluent Visible/ Effluent Smell
#1	Oct. 10 9:30	Cloudy with light rain	120'x120'	1' - 3 f/s	10.8/7.3	7.28	11.6 - 96.4%	53.8	1.4	N.A.
#2	Oct. 10 10:45	Cloudy	450'x150'	1' - 4 f/s	11/7.4	7.3	11.7/97%	51.2	1.4	N.A.
#3	Oct. 10 11:45	Cloudy	90'x150'	1' - 4 f/s	11.06/7.8	7.42	11.7/98.1%	55	1.7	N/N

Figure 4. Upper Site #1.

Figure 5. Upper Site #2.

Figure 6. Downstream Site #3.

While water quality measurements were within normal ranges, the condition of the algal and macroinvertebrate communities showed signs of impairment from nutrient enrichment (Table 4). This was indicated by the visual assessment of algal growth on the substrate that showed extensive algal growth covering the rocks at all three sites. The two sites above the hatchery outfall had the highest apparent density of algal growth. Figures 7, 8, and 9 show underwater views of the algae covering the substrate at Site #1, Site #2, and Site #3, respectively.

Table 4. Biological condition of sites above and below Cole Rivers Fish Hatchery.

	Cole River Hatchery Above - Site #1	Cole River Hatchery Above - Site #2	Cole River Hatchery Below - Site #3
Possible Nutrient Enrichment *1=highly likely; 5=not enriched*	1	1.5	1.5
Algal/Plant community *1=highly impaired; 5=not imp.*	1	1.5	1.5
Macroinvertebrate community *1=highly impaired; 5=not imp.*	2	2	1.5

Figure 7. Upper Site #1 - Underwater photo of algal growth on substrate.

Figure 8. Upper Site #2 - Underwater photo of algal growth on substrate.

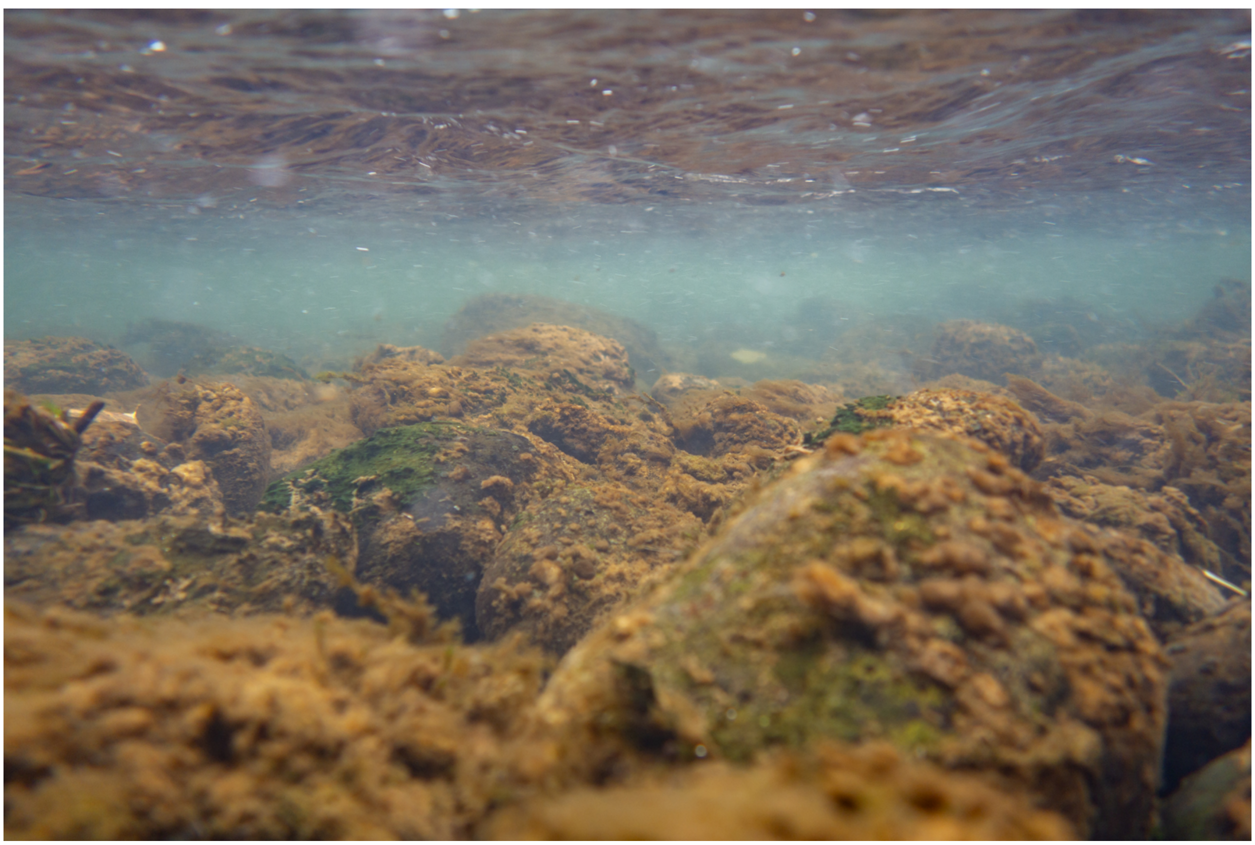

Figure 9. Downstream Site #3 - Underwater photo of algal growth on substrate.

In addition to heavy algal growth, the macroinvertebrate community at the three sties also indicated impaired conditions with low diversity at all three sites. Mayflies and stoneflies dominated the abundance at the two upper sites Table 5). The taxa present, however, are known to be moderately tolerant. For example, the mayfly genus *Baetis* is found across a wide range of habit types, water quality conditions, and thermal regimes. The three stoneflies present are also relatively tolerant stoneflies. Most notable was the lack of caddisflies found at the three sites. It is likely that the close proximity to the dam, and its effects on water quality, is affecting the macroinvertebrate and algal communities at all three of these sites. Water temperature directly below the dam is unnaturally cold and stable throughout the year. Some hydropsychid caddisflies, for example, are known to be to absent in areas with little to no diel temperature fluctuation (Ross and Wallace 1982).

The macroinvertebrate community at the downstream site showed a marked increase in the abundance of Diptera and non-insect taxa: 40% and 15% of total invertebrates, respectively (Table 4). Both groups are tolerant invertebrates.

Because of the high algal biomass and limited macroinvertebrate community, the overall condition assessment of the three sites was scored as relatively high impairment due to possible nutrient enrichment (Table 3), though other factors, such as water temperature effects, may also be controlling factors affecting the algal and macroinvertebrate communities.

Table 5. Macroinvertebrate results for sites by Cole Rivers Fish Hatchery. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Cole River Hatchery Upstream- Site 1	Cole River Hatchery Upstream - Site 2	Cole River Hatchery Downstream Site 3
Mayflies (% of total invert. comm.)	**35**	**30**	**40**
Baetis sp.	3	3	3
Ephemerella sp.	2	2	1.5
Drunella sp.			1
Stoneflies (% of total invert. comm.)	**30**	**50**	**5**
Pteronarcys californica	3	3	1
Hesperoperla pacifica	2	2	2
Skwala sp.		1	1
Caddisflies (% of total invert. comm.)	**0**	**2**	**<1**
Glossosoma sp.		1.5	
Brachycentrus sp.			1
Diptera (% of total invert. comm.)	**35**	**28**	**40**
Chironomidae	3	3	3
Simuliidae	1		1
Tipulidae	1		
Non-insects (% of total invert. comm.)			**15**
Snails			1
Limpets			2

Based on all the factors evaluated at the three sites - habitat, water quality, algae and macroinvertebrates - there was no indication that the hatchery outfall alone impacted stream conditions, though it is possible the close proximity to the dam, and its effects on water quality, overshadowed any effects of the hatchery effluent. Also, the quality and amount of hatchery effluent discharged changes depending on hatchery operations (e.g. cleaning) and number of fish in the hatchery. As a result, it is not known how hatchery effluent may effect downstream water quality under different hatchery conditions.

Shady Cove Sewage Treatment Plant Outfall

Shady Cove has a population of roughly 3,000 people and sits 10 miles below William L. Jess Dam at an elevation of 1400 feet. The town is located at approximately river mile 144, and the wastewater treatment plant outfall location is listed in the NPDES permit as RM 142.5.

The current NPDES permit for Shady Cove was issued in April 2011, and expired end of March 2016. According to online information from DEQ's permit issuance plan (DEQ 2022), a new NPDES permit for Shady Cove is scheduled to be issued sometime in 2026. In the meantime, the permit issued in 2011 is still applicable.

The current permit lists effluent limits for BOD5, TSS, pH, total residual chlorine, and a maximum thermal load for temperature adjusted by season. There are no nutrient limits in the existing permit, however, samples for nutrient analysis (TKN, NH3-N, NO2+NOW3-N, and Total Phosphorus) are to be taken and reported once every two weeks from May-October. No permit violations have been reported over the last three years (EPA data records at: https://echo.epa.gov/detailed-facility-report?fid=110039735169).

The mixing zone for this discharge is described as 40 feet out from the west bank, 10 feet upstream, and 100 feet downstream from the point of discharge.

Two sites were sampled on the afternoon of October 10, under cloudy skies (Figure 10). The upstream site (Site #1) (Figure 11) was approximately 1900' above the outfall, while the downstream site (Site #2) (Figure 12) was approximately 2100' below the outfall (Figure 10). While there was a closer riffle about 550' below the outfall, this site had currents and substrate too fast and large to sample successfully.

A jet boat, launched at the boat ramp at Takelma County Park, was used to access these sites. The actual outfall location was described by the treatment plant operator, but it was not clearly visible from the water. An approximate location was identified by taking conductivity measurements in the water column and locating where the highest reading occurred. The red circle on Figure 9 is as close as we could determine it to be.

Bank condition and the substrate matrix between the two sites were very similar with cobble the dominate substrate size followed by gravel (Table 6). Water quality data were also very similar between the two sites (Table 7). Water temperature, pH, dissolved oxygen, conductivity and turbidity were quite similar between the two sites and there was no noticeable smell or visible effluent plume below the treatment plant's outfall. Based on the instream water quality results, there was no measurable effect from the sewage treatment plant's discharge.

Table 6. Bank condition and percent substrate classes at sites above and below Shady Cover sewage treatment plant.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embeded
Site #1 above	Good	Good	0	3	30	65	2	0	0	10
Site #2 below	Good	Good	<1	5	25	65	1	0	0	0

Table 7. General site information and instream water quality measurements at sites sampled above and below Shady Cover sewage treatment plant.

Sample Site	Sample date/time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Conductivity	Turbidity	Effluent Visible/ Effluent Smell
Site #1 above	Oct. 10 14:50	Cloudy	200'x90'	0.75' - 3 f/s	12.4/8.7	8.26	12.83/111.4%	56	3.37	N.A.
Site #2 below	Oct. 10 13:40	Cloudy	75'x150'	0.5' - 3.5 f/s	12.72/8.9	8.13	12.8/108.6%	54.4	3.1	N/N

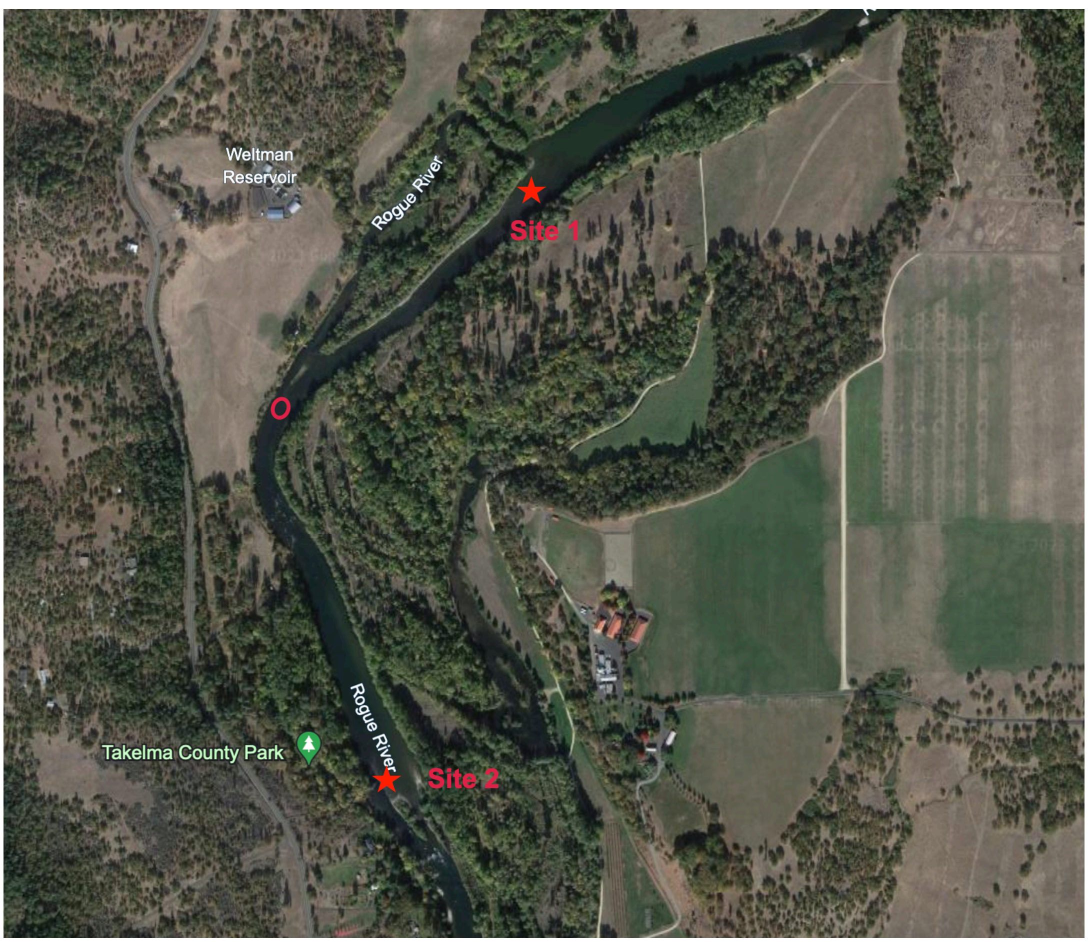

Figure 10. Shady Cover sample sites: Site#1-upstream site; Site #2- downstream site. ⬭ = approximate location of treatment plant outfall.

Figure 11. Shady Cover sample site #1, upstream of the treatment plant outfall.

Figure 12. Shady Cover sample site #2, downstream of the treatment plant outfall.

The biological condition improved at these two sites compared to the sites above and below Cole Rivers Hatchery located about 10 miles upstream, though some impairment from nutrient enrichment was still observed (Table 8). Comparing sites above and below the Shady Cove outfall, there appeared to be some decline in overall biological condition below the outfall, though it was not large. The upstream site was scored a 3.5 for the condition of the algal community, macroinvertebrate community and level of nutrient enrichment, while the site below the outfall scored 2.5 for the same three components, indicating a slight decline in biological condition downstream was observed (Table 8). Figures 13 and 14 show underwater views of the substrate at the upstream and downstream site respectively. Compared to the sites near Cole Rivers Hatchery, there was noticeably less biomass of algae on the substrate.

Table 8. Biological condition of sites above and below Shady Cover sewage treatment plant.

	Shady Cove - Upstream Site #1	Shady Cove - Downstream Site #2
Nutrient Enrichment *1=highly enriched; 5=not enriched*	3.5	2.5
Algal/Plant community *1=highly impaired; 5=not imp.*	3.5	2.5
Macroinvertebrate community *1=highly impaired; 5=not imp.*	3.5	2.5

Figure 13. Upstream Site #1 - Underwater photo of algal growth on substrate.

Figure 14. Downstream Site #2 - Underwater photo of algal growth on substrate.

The macroinvertebrate community scored 3.5 upstream of the outfall and 2.5 downstream indicating a slight decline in community condition downstream. Both sites showed improved conditions compared to the sites above and below Cole Rivers Hatchery. The upstream Shady Cove site was relatively evenly composed of mayflies (25%) stoneflies (25%), caddisflies (15%) and Diptera (20%). Non-insect taxa equaled about 15% of the total invertebrate community (Table 9). Downstream of the Shady Cove outfall mayflies accounted for 35% of the total community, stoneflies 15%, caddisflies 5%, Diptera 30%, and non-insect taxa 15% (Table 9). The reduced percentage of stoneflies and caddisflies and increased percentage of Diptera accounted for the lower overall score of 2.5 compared to 3.5 upstream of the outfall. The overall diversity of mayflies, stoneflies, and caddisflies at both Shady Cove sites was greater than what occurred at the Cole Rivers Hatchery sites. While some decline in biological condition was observed below the Shady Cove outfall, the changes were relatively small and do not show a clear violation of the biocriteria standard, however, the decline downstream does suggest that the discharge may be contributing to the generally poor macroinvertebrate community observed in the Rogue River.

Table 9. Macroinvertebrate results for sites above and below Shady Cove treatment plant. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Shady Cove - Upstream Site #1	Shady Cove - Downstream Site #2
Mayflies (% of total invert. comm.)	**25**	**35**
Baetis sp.	3	3
Ephemerella sp.	1	1
Drunella sp.		1
Heptagenia sp	1.5	1
Stoneflies (% of total invert. comm.)	**25**	**15**
Pteronarcys californica	2	1
Hesperoperla pacifica	2.5	2
Skwala sp.	2	2
Chloroperlidae	1	1
Caddisflies (% of total invert. comm.)	**15**	**5**
Hydropsyche sp.	1	1
Glossosoma sp.	2.5	2
Brachycentrus sp.	1	1
Diptera (% of total invert. comm.)	**20**	**30**
Chironomidae	3	3
Simuliidae		2
Tipulidae		
Non-insects (% of total invert. comm.)	**15**	**15**
Snails	2.5	1
Mites		2
Leeches		1
Worms	1	1
Flat worms (planaria)	1	

Little Butte Creek

Little Butte Creek is a small tributary that flows into the mainstem Rogue River at about river mile 132, roughly 10 miles downstream from Shady Cove. Little Butte Creek (LBC) is a concern because it is known to carry excess nutrients into the Rogue River. For this reason we sampled above and below the mouth of LBC as well as in LBC just before it enters the Rogue (Figure 15). Samples were collected between 1:00 and 3:00pm on October 11. The weather was cloudy with some sun breaks.

Habitat conditions above and below LBC were similar. Bank stability and vegetation were good and the substrate at both sites was primarily composed of cobble (70-75%) followed by gravel (15-20%) (Table 10). Embeddedness was noticeably higher below LBC compared to upstream, indicating that LBC probably transports fine sediment into the Rogue River.

Figure 15. Sample sites above (Site 1) and below (Site 2) and in Little Butte Creek.

Table 10. Substrate matrix at sites above (Site 1) and below (Site 2) the mouth of Little Butte. Creek.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embedded
Rogue River above LBC Site 1	Good	Good	0	5	15	75	5	0	0	10
Rogue River below LBC Site 2	Good	Good	0	5	20	70	5	0	0	30-40

Water quality measurements showed some changes below LBC (Table 11). Water temperature was slightly higher in the mouth of LBC and downstream in the Rogue River (site 2) compared to upstream (site 1), but pH was slightly lower in LBC and at site 2. Both temperature and pH were within acceptable ranges. Most obvious were changes in conductivity and turbidity. Conductivity and turbidity in the mouth of LBC were more than twice the level measured just upstream, while the downstream site was lower than LBC but still above the upstream site (Table 11). This shows that Little Butte Creek is carrying fine sediment and dissolved solids into the Rogue River.

Table 11. Instream water quality measurements in the Rogue River above (Site 1) and below (Site 2) Little Butte Creek (LBC), and from LBC near its confluence with the Rogue River.

Sample Site	Sample date/time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L /% saturation	Condu ctivity	Turbidity	Effluent Visible/ Effluent Smell
Rogue River above LBC Site 1	Oct. 11 14:40	Cloudy with sun breaks	400'x75'	1' - 3.5 f/s	17.9/10.4	8.34	12.85/115%	58.5	1.98	N.A.
Rogue River below LBC Site 2	Oct. 11 13:15	Cloudy with sun breaks	75'x300'	0.6' - 2.5 f/s	18.62/11.2	8.15	12.0/110.6%	88	4.7	N/N
Mouth of LBC	Oct 11 14:15	Cloudy with sun breaks	N.A.	N.A.	17.06/13.7	8.13	11.3/110?	123	7.1	N/N

In addition to the routine instream water quality measurements, water samples for nutrient analyses were collected above, below, and in Little Butte Creek and sent to a local laboratory. Results show that LBC is higher in nutrients and contributes to some increase in nutrients to the Rogue River (Table 12). Nitrogen levels above LBC were below detection, and phosphorus levels were fairly low. Within LBC however, nitrogen and phosphorus levels were considerably higher, and these higher levels apparently increased nutrient levels downstream in the Rogue River at Site 2 (Table 12). The relatively high total Kjeldahl nitrogen (TKN) levels in LBC indicates contamination from animal or human waste my be present. Figures 16-20 show above water and underwater photos of sites 1 and 2, and above water of Little Butte Creek.

Table 12. Nutrient results from samples collected above, below, and within Little Butte Cr.

	Rogue River above LBC -Site 1	Rogue River below LBC-Site 2	Little Butte Creek
Total Nitrogen: Nitrate + Nitrite (mg/L)	ND	0.023	0.027
Total Kjeldahl Nitrogen (mg/L)	ND	ND	0.388
Total Phosphorus (mg/L)	0.06	0.075	0.103
Orhtophosphate (mg/L)	0.028	0.045	0.06

Figure 16. Rogue River sample area above Little Butte Creek (Site 1).

Figure 17. Substrate condition in Rogue River above Little Butte Creek (Site 1).

Figure 18. Rogue River sample area below Little Butte Creek (Site 2).

Figure 19. Substrate condition in Rogue River below Little Butte Creek (Site 2).

Figure 20. Little Butte Creek near confluence with the Rogue River.

The biological condition in the Rogue River above and below Little Butte Creek appears to reflect the effects of nutrients introduced from LBC (Table 13). Above LBC there was relatively low biomass of algae and aquatic plants on the substrate, while downstream there was a notable increase.

Table 13. Biological condition at sites above (Site 1) and below (Site 2) the mouth of Little Butte Creek.

	Rogue River above LBC-Site 1	Rogue River below LBC-Site 2
Possible Nutrient Enrichment *1=highly likely; 5=not enriched*	3.5	1.5
Algal/Plant community *1=highly impaired; 5=not imp.*	4	1.5
Macroinvertebrate community *1=highly impaired; 5=not imp.*	2.5	2

The macroinvertebrate community showed a similar change, with a higher relative percent of pollution tolerant taxa downstream compared to upstream. Above the mouth of LBC, 75% of the community was made up mayflies, stoneflies and caddisflies (Table 14). Downstream mayflies, stoneflies, and caddisflies accounted for approximately 64% of the community. The biggest change was noticeably fewer caddisflies and more Diptera downstream, and the presence of amphipods and aquatic beetles (Dytiscidae and Elmidae) downstream.

Overall, when changes in water quality, algae, and macroinvertebrates are all considered, there appears to be a higher level of nutrient enrichment in the Rogue River below Little Butte Creek. The changes in the macroinvertebrate community show the largest decline seen below any of the point sources.

Table 14. Macroinvertebrate results for sites in the Rogue River above and below Little Butte Creek. 3 = high abundance; 2 = moderate abundance; 1 = low abundance.

	Site 1	Site 2
Mayflies (% of total invert. comm.)	**25**	**30**
Baetis sp.	2.5	2.5
Ephemerella sp.	1	1
Drunella sp.	2	
Drunella grandis/spinifera		1.5
Heptagenia sp	2	2
Stoneflies (% of total invert. comm.)	**15**	**25**
Pteronarcys californica		1.5
Hesperoperla pacifica	1	2
Calineuria californica	1	2
Skwala sp.	2	2
Chloroperlidae	1	
Caddisflies (% of total invert. comm.)	**35**	**9**
Hydropsyche sp.	3	1
Glossosoma sp.	3	2
Brachycentrus sp.	1	1
Diptera (% of total invert. comm.)	**10**	**20**
Chironomidae	2	3
Simuliidae	1.5	1.5
Other Insects (% of total invert. comm.)		**1**
Elmidae		1
Dytiscidae		1
Non-insects (% of total invert. comm.)	**15**	**15**
Snails	2	2.5
Amphidods		1
Mites	3	3
Worms	1	1
Flat worms (planaria)	1	1

Bear Creek

Bear Creek is approximately 29 miles long with a basin size of 361 square miles. It begins downstream from Emigrant Lake where Emigrant Lake Creek and Neil Creek come together, and then flows northwest parallel to Interstate 5 through the major urban centers of Ashland, Talent, Phoenix, Medford, and Central Point. The Bear Creek watershed is heavily impacted by human development as it includes the most densely populated area in the Rogue Basin with a watershed population of ≈150,000 by 2015 (Oregon Encyclopedia). Bear Creek joins the Rogue River at approximately RM 127, about 3.5 miles downstream from Medford's wastewater discharge.

Bear Creek has a history of water quality problems. DEQ determined Bear Creek to be impaired for temperature, bacteria, sediment, aquatic weeds and algae, dissolved oxygen, and phosphorus, and completed TMDL (Total Maximum Daily Load) clean-up plans in 1992 in order for the stream to come into compliance with water quality standards. Based on discussions below, it does not appear that the TMDL has resulted in attainment of its goals.

The City of Ashland's wastewater treatment plant currently discharges to Ashland Creek (tributary to Bear Creek). Its NPDES permit expired in 2008. The newly issued permit has discharge limits on ammonia and phosphorus, but not nitrogen. Monitoring nutrient concentrations in the effluent is required on a quarterly basis. The facility has frequently violated its thermal load limits since 2019 with violations ranging from 114% to 1481% over permit limits (https://echo.epa.gov/detailed-facility-report?fid=110006618160).

Sites above and below Bear Creek were sampled on the morning of October 11th between 10:30 and 11:30am. The weather was cloudy with sun breaks. A jet boat was used to access the sample sites. The first suitable riffle for sampling upstream of Bear Creek (Site 1) was almost a mile upstream (≈4,500 feet). This site was also about 2.5 miles downstream from the Medford STP outfall. The sample site downstream (Site 2) was approximately a half mile downstream (≈2,400 feet) (Figure 21). Besides the routine samples collected at Sites 1 and 2, water samples for nutrient analysis were also collected in the Rogue River just above and below Bear Creek as well as in Bear Creek itself.

Habitat conditions at the two samples sites appeared similar, though both the right and left banks at the downstream site were exposed and eroded. At the upstream site the right bank was eroded while the left bank was stable with good riparian vegetation (Table 15) (Figures 22 and 23).

Figure 21. Sample sites above (Site 1) and below (Site 2) and in Bear Creek.

Figure 22. Rogue River sample area upstream of Bear Creek (Site 1).

Figure 23. Rogue River sample area downstream of Bear Creek (Site 2).

The substrate at both sample sites was predominately composed of cobble (70%) followed by gravel (20%). Substrate at the upstream site appeared more embedded by fines (30-40%) compared to the downstream site (10-15%) (Table 15).

Instream water quality measurements for pH, dissolved oxygen, conductivity, and turbidity were similar at both sites and within normal ranges (Table 16). The differences in these water quality measurements in the Rogue River below Bear Creek compared to upstream were small and did not indicate any decline in water quality downstream from Bear Creek. Results of nutrient samples collected in the Rogue River above and below Bear Creek and in Bear Creek, however, did show high levels of nitrogen and phosphorus in Bear Creek, and slightly higher levels in the Rogue River downstream of Bear Creek compared to upstream (Table 17).

Table 15. Substrate matrix at sites in Rogue River above (Site 1) and below (Site 2) the mouth of Bear Creek.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embed ded
Site 1	Eroded Right Bank/ Left Bank Good	Eroded Right Bank/ Left Bank Good	0	5	20	70	5	0	0	30-40
Site 2	Exposed cut banks both sides	Exposed cut banks both sides	0	5	20	70	5	0	0	10-15

Table 16. Instream water quality at sites above (Site 1) and below (Site 2) the mouth of Bear Creek.

Sample Site	Sample date/ time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Conduc tivity	Turb idity	Effluent Visible/ Effluent Smell
Site 1	Oct. 11 11:20	Cloudy with sun breaks	75'x150'	0.75'/ 3.5 f/s	19.05 9.9	8.06	12.6/111.3%	73.4	2.5	N/Y
Site 2	Oct. 11 10:40	Cloudy with sun breaks	300'x100'	0.75'/ 3 f/s	15.45 9.8	7.75	11.7/102.9%	79.9	2.35	N/Y

Table 17. Nutrient results from samples collected in the Rogue River above (Site 1), below (Site 2) Bear Cr. and within Bear Creek.

	Site 1	Site 2	Bear Creek Mouth
Total Nitrogen: Nitrate + Nitrite (mg/L)	0.135	0.158	0.883
Total Kjeldahl Nitrogen (mg/L)	ND	ND	0.61
Total Phosphorus (mg/L)	0.072	0.08	0.12
Orhtophosphate (mg/L)	0.049	0.055	0.072

Both upstream and downstream sites showed signs of nutrient enrichment based on biological conditions, and the upstream site appeared to be slightly more impacted than the downstream site. Based the density of algae and aquatic plants, the upstream site was scored a 1.5 (highly impacted) compared to 2.0 (high impact) downstream. The macroinvertebrate community was given a score of 2.0 at both sites. Overall, the upstream site appeared slightly more impacted (1.5) from nutrient enrichment than the downstream site (2.0) (Table 18) (Figures 24 and 25). There was also a slight smell of effluent at the upstream site. This site is about 2.5 miles below the Medford STP, which may have been affecting conditions at this site.

Table 18. Biological condition at sites in the Rogue River above (Site 1) and below (Site 2) the mouth of Bear Creek.

	Site 1	Site 2
Nutrient Enrichment *1=highly enriched; 5=not enriched*	1.5	2
Algal/Plant community *1=highly impaired; 5=not imp.*	1.5	2
Macroinvertebrate community *1=highly impaired; 5=not imp.*	2	2

Figure 24. Substrate condition in Rogue River above Bear Creek (Site 1).

Figure 25. Substrate condition in Rogue River below Bear Creek (Site 2).

The macroinvertebrate community at both sites showed a relatively high level of impairment (2.0) with low abundance and diversity of sensitive taxa. A greater abundance of tolerant taxa of caddisflies, Diptera, and non-insects (snails and worms) made up the majority of the community accounting for 65% of the community upstream and 60% downstream (Table 19). The Diptera families Chironomidae and Simuliidae were abundant at both sites, and snails, amphipods, and worms were also prevalent, all of which indicate possible effects of nutrient enrichment.

Table 19. Macroinvertebrate results for sites in the Rogue River above (Site 1) and below (Site 2) Bear Creek. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Site 1	Site 2
Mayflies (% of total invert. comm.)	**25**	**35**
Baetis sp.	2.5	3
Ephemerella sp.	1	1
Drunella sp.		2
Drunella grandis/spinifera	2	
Heptagenia sp	1	1
Stoneflies (% of total invert. comm.)	**10**	**5**
Hesperoperla pacifica	1.5	1
Skwala sp.	2	2
Chloroperlidae		1
Caddisflies (% of total invert. comm.)	**25**	**20**
Hydropsyche sp.	3	2.5
Glossosoma sp.	1	1
Amiocentrus sp.	1	
Diptera (% of total invert. comm.)	**25**	**20**
Chironomidae	3	3
Simuliidae	2.5	2
Other Insects (% of total invert. comm.)		**<1**
Elmidae		1
Non-insects (% of total invert. comm.)	**15**	**20**
Snails	2	2
Amphidods	1	2
Leeches		1
Worms	1	
Flat worms (planaria)	1.5	3

City of Rogue River

The City of Rogue River is located on the banks of the Rogue River between Gold Hill and Grants Pass at approximately RM 110.5, at an elevation of 1004 feet. It has a population of roughly 2400 people (2020 census). Originally named Woodville in 1876, it was renamed Rogue River in 1912.

The wastewater treatment plant is located at RM 110. The current NPDES permit was modified in 2005 and expired in 2007. The permit modification in 2005 eliminated the requirement for monitoring nutrients in the wastewater outfall. Ammonia (NH_3-N) is required to be sampled and reported weekly from May 16-November 15, and monthly from November 16-May 15). DEQ's "Permit Issuance Plan" (DEQ 2022) indicates a new permit is scheduled to be issued in 2023.

The existing permit has discharge limits for BOD_5, TSS, pH, *E. coli*, and thermal loading. Temperature load limits were exceeded in September 2020, 2021, and 2022 (https://echo.epa.gov/effluent-charts#OR0023043/51040). The mixing zone is described as that portion of the Rogue River extending from the bank to the center of the river, and 10 feet upstream and 150 feet downstream from the point of discharge.

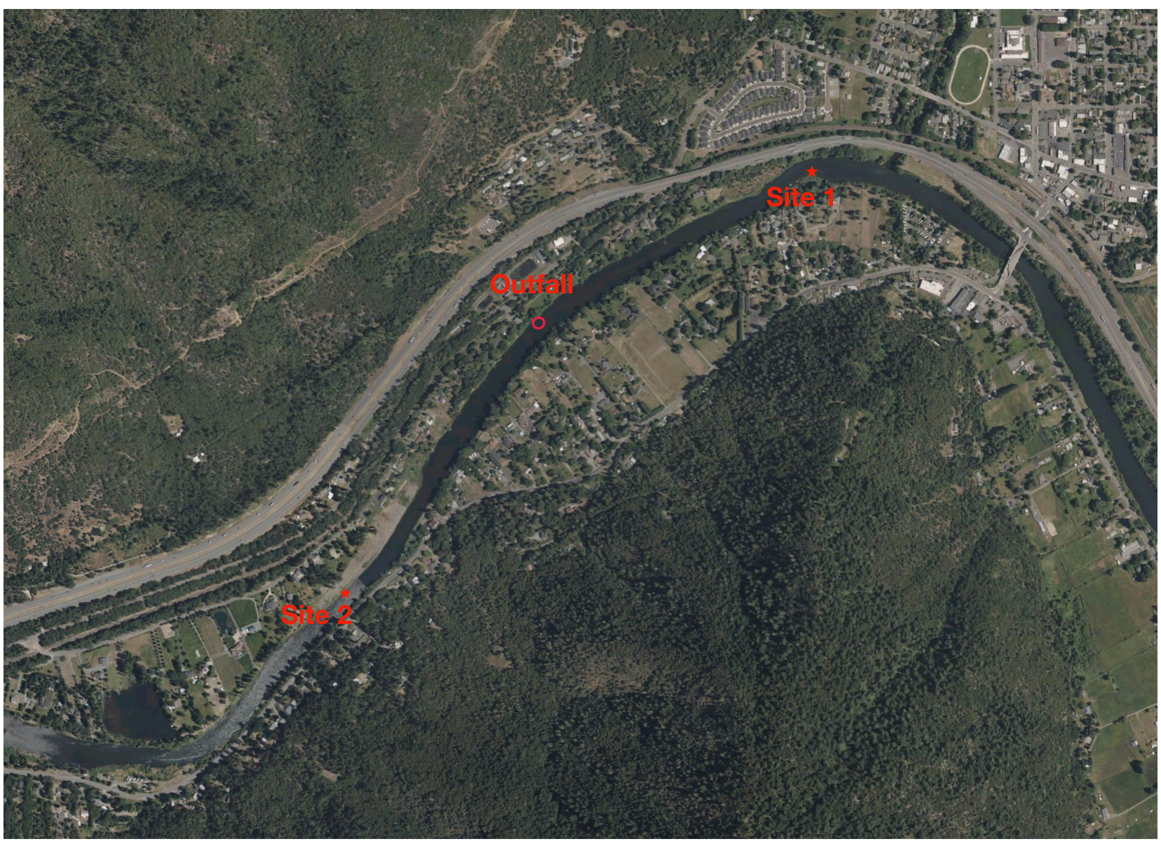

Figure 26. Sample sites above (Site 1) and below (Site 2) the City of Rogue River outfall..

Two sites were sampled, one above (Site 1) and one below (Site 2), from the wastewater treatment plant outfall (Figure 26). Sites were accessed by jet boat using the boat ramp located just above Site 1. Site 1 is approximately 0.5 miles upstream from the outfall and Site 2 is approximately 0.5 miles downstream. These were the closest suitable sample sites available above and below the outfall.

Habitat conditions at the two sites were similar (Table 20). Banks were stable and not eroding at both sites, while riparian vegetation was limited at Site 2 with houses present near the river on both sides of the river. The substrate matrix appeared to be very similar with cobble and gravel comprising the majority of the substrate at both sites. The substrate at the upper site (Site 1) appeared to be more embedded with fine sediment (65%) than the lower site (Site 2)(50%). The overall habitat and substrate conditions at the two sites were similar (Figures 27 & 28) and would not be expected to be the cause of any changes in aquatic plants or macroinvertebrates.

Table 20. Substrate matrix at sites above (Site 1) and below (Site 2) the City of Rogue River's outfall.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embeded
Site 1 - Upstream	Good	River left okay; River right minimal	0	2.5	25	60	10	2.5	0	65
Site 2 - Downstream	Good	Minimal river right; both sides with houses	0	2.5	25	60	10	2.5	0	50

Water quality measurements were taken on October 12, between 1:00 and 2:00pm under clear skies (Table 21). Water quality measurements between the two sites were similar, but slight deviations at the downstream site (Site 2) indicate that the treatment plant's effluent may be causing a small impact downstream. For example, pH, dissolved oxygen, conductivity, and turbidity were all higher downstream (Site 2) compared to the upstream site (Site 1). The increase for all parameters, however, was quite small, but the increase in conductivity and turbidity, as well as a faint but noticeable effluent smell downstream all suggest the effluent may be affecting downstream conditions.

Table 21. Instream water quality at sites above (Site 1) and below (Site 2) the City of Rogue River's outfall.

Sample Site	Sample date/ time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Condu ctivity	Turb idity	Effluent Visible/ Effluent Smell
Site 1 - Upstream	Oct. 12 15:00	Sunny	400'x50'	0.5' - 4 f/s	23.54/11.8	8.17	12.3/113.2%	81.4	3.14	N.A.
Site 2 - Downstream	Oct. 12 14:00	Sunny	500'x40'	0.75' - 4 f/s	26.5/12.1	8.24	12.5/115.8%	85.3	5.08	N/ Slight

Figure 27. Rogue River sample area upstream (Site 1) from City of Rogue River's outfall.

Figure 28. Rogue River sample area downstream (Site 1) from City of Rogue River's outfall.

Like water quality, the biological condition appeared slightly worse downstream than upstream (Table 22), as the density of aquatic plants and algae was visually greater downstream (Figures 29 & 30).

Table 22. Biological condition at sites above (Site 1) and below (Site 2) the City of Rogue River's outfall.

	Site 1 - Upstream	Site 2 - Downstream
Nutrient Enrichment *1=highly enriched; 5=not enriched*	3	2
Algal/Plant community *1=highly impaired; 5=not imp.*	4	3
Macroinvertebrate community *1=highly impaired; 5=not imp.*	2	2

Both sites appeared to have impaired macroinvertebrate communities (Table 23). Tolerant non-insect taxa were abundant both upstream and downstream, while more sensitive taxa of mayflies and stoneflies were relatively sparse. An interesting change in one stonefly taxon was also observed. This was the first site on the Rogue River where the stonefly *Claassenia sabulosa* was collected. It is closely related to *Hesperoperla pacifica* that had been collected at study sites farther upstream. *C. sabulosa* appears to be more tolerant of warmer water and thus replaced *H. pacifica*. Very few stoneflies, however, were collected at either site above or below the City or Rogue River's outfall. The most abundant caddisfly was *Hydropsyche* sp., a group known to be common in larger streams with abundant suspended organic matter (DeShon 1995).

Overall, based on water quality, algal density, and macroinvertebrates, the level of nutrient enrichment appeared slightly higher downstream compared to upstream. The difference in the macroinvertebrate communities however was small, such that the City of Rogue River's discharge did not appear to cause a potential violation of the biocriteria standard.

Table 23. Macroinvertebrate results for sites above and below City of Rogue River. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Site 1 - Upstream	Site 2 - Downstream
Mayflies (% of total invert. comm.)	**15**	**20**
Baetis sp.	2.5	2
Ephemerella sp.	1	1
Heptagenia sp	1	1.5
Stoneflies (% of total invert. comm.)	**15**	**10**
Claassenia sabulosa	1	1
Skwala sp.	1	1.5
Caddisflies (% of total invert. comm.)	**20**	**30**
Hydropsyche sp.	3	3
Glossosoma sp.		1.5
Dicosmoecus sp.	1.5	1
Rhyacophila sp.	1	1
Diptera (% of total invert. comm.)	**15**	**10**
Chironomidae	2	3
Simuliidae	1	1.5
Other Insects (% of total invert. comm.)	**<1**	**<1**
Elmidae	1	1
Non-insects (% of total invert. comm.)	**35**	**30**
Snails	2	2
Limpets	1.5	2
Amphidods	3	3
Mites	2	3
Leeches	1	
Worms	3	3
Flat worms (planaria)	3	3
Crayfish	1	
FW Mussels	0.5	

Figure 29. Substrate condition in Rogue River above the City of Rogue River's outfall (Site 1).

Figure 30. Substrate condition in Rogue River below the City of Rogue River's outfall (Site 2).

Grants Pass

The City of Grants Pass sits on the banks of the Rogue River at roughly RM 101 at an elevation of 960 feet. With a population of 39,189 (2020 census) it is the second largest city along the Rogue River before the river enters the Wild & Scenic segment downstream. Though its population is much larger than the small towns along the river, it has less than half the population of Medford (≈85,000).

The wastewater treatment plant is located at RM 100.5 . The current NPDES permit expired September 30, 2014. According to DEQ's "Permit Issuance Plan," (DEQ 2022) a new permit is scheduled for 2025. The existing permit includes discharge limits for BOD_5, TSS (total suspended solids), pH, and *E. coli* bacteria. There are discharge limits for Ammonia-N from June 1 - September 30, and thermal load maximums from April 1 - October 31. The permit includes no discharge limits on nutrients, but does require that nutrients (TKN, NO2+NO3-N, and Total Phosphorus) be sampled and reported weekly from May-October. Exceedance of the *E. coli* permit limit occurred in February and August of 2022 (https://echo.epa.gov/detailed-facility-report?fid=110045420157).

The mixing zone is described as that portion of the Rogue River extending 10 feet on either side of the diffuser, and 300 downstream from the diffuser.

Three sites were sampled near the Grants Pass treatment plant outfall; one upstream (Site 1) and two downstream (Sites 2 & 3) (Figure 31). The upstream site (Site 1) was approximately 1400 feet (0.27 miles) upstream from the sewage treatment plant (STP) outfall. Site 2 was located approximately 680 feet (0.13 miles) below the outfall, while Site 3

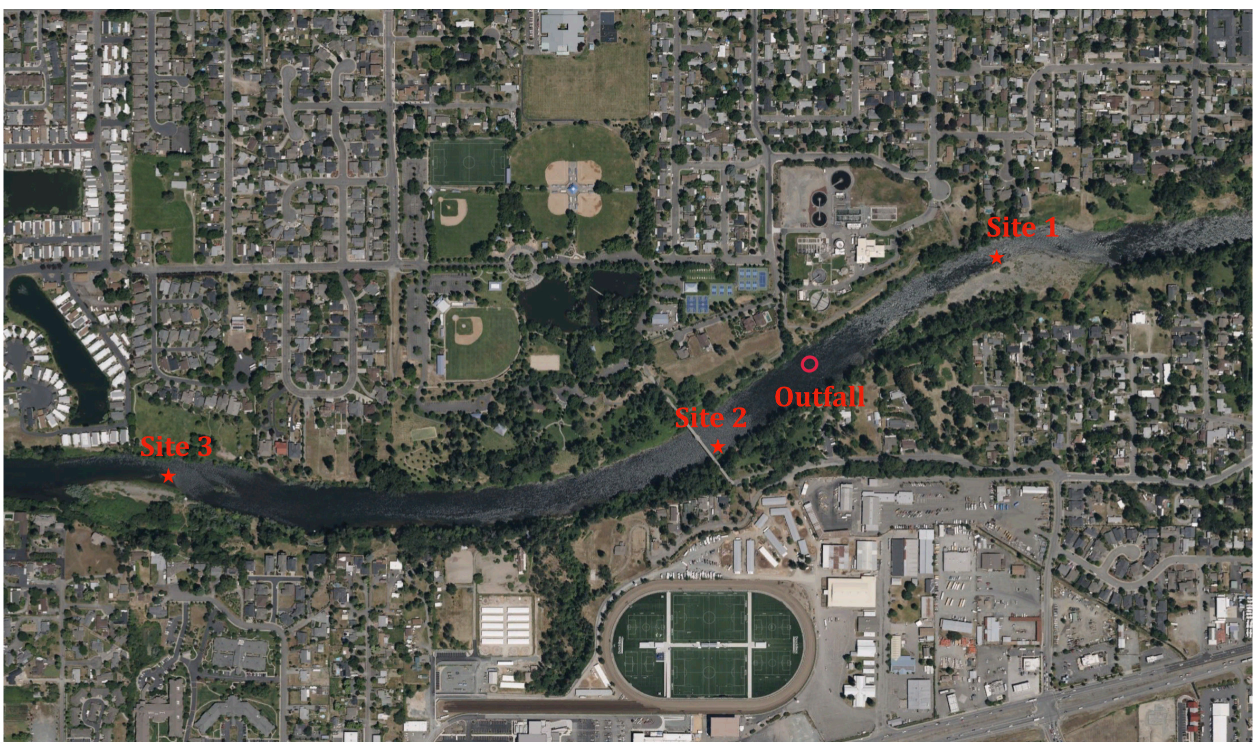

Figure 31. Sample sites above (Site 1) and below (Sites 2 & 3) the city of Grants Pass outfall.

was roughly 3460 feet (0.66 miles) downstream. A jet boat was used to access the sites, however, the riffle a short distance above Site 1 was not passable with the jet boat, so access from the boat ramp upstream of the outfall could not be used. Instead the boat ramp at Schroeder Park, about two miles downstream from the STP, was used.

Samples at the three sites were collected on October 13, between 9:30-11:00am. Habitat conditions at all three sites were similar (Table 24) (Figures 32, 33, & 34). Banks were stable at all sites, but riparian vegetation was minimal on both sides of the river at the upstream site due to lawns from houses that came down to the river's edge. Substrate at all three sites was mostly composed of cobble and gravel. The upstream site (Site 1) appeared to have slightly more small and large boulders compared to the two downstream sites. The two downstream sites (Sites 2 & 3) also appeared to have higher emdeddedness than the upstream site (Table 24).

Table 24. Substrate matrix at sites above (Site 1) and below (Sites 2 & 3) the Grants Pass outfall.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embeded
Grants Pass - Site 1 Upstream	Okay	Poor: Houses both sides of river	0	5	15	40	30	10	0	10
Grants Pass - Site 2	Good	Good	0	5	15	60	15	5	0	30-40
Grants Pass - Site 3	Good	Good	0	5	15	60	15	5	0	25

Figure 32. Rogue River sample area upstream (Site 1) from the Grants Pass outfall.

Figure 33. Rogue River sample area at the first site downstream (Site 2) from the Grants Pass outfall.

Figure 34. Rogue River sample area at the second site downstream (Site 3) from the Grants Pass outfall.

Instream water quality measurements showed no significant changes at the two downstream sites compared to above the outfall (Table 25). The first site below the outfall (Site 2) did show an increase in conductivity and turbidity compared to Site 1 upstream. This increase was likely due to the effluent discharge from the treatment plant. No increase in pH or dissolved oxygen was detected, however, indicating that under the conditions during this field work the effluent was not causing water quality impacts due to increases in biomass of algae or aquatic plants downstream.

Table 25. Instream water quality at sites above (Site 1) and below (Site 2 & 3) the Grants Pass outfall.

Sample Site	Sample date/ time	Weather	Reach length/ width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Conductivity	Turbidity	Effluent Visible/ Effluent Smell
Grants Pass Site 1 Upstream	Oct. 13 09:35	Partly cloudy	50x20'	1'-1.5f/s	10.9/10.7	7.71	11.1/100.5%	87.7	3.26	N.A.
Grants Pass Site 2	Oct. 13 10:25	Partly cloudy	500x50'	0.6'-3.5f/s	11.2/11.0	7.69	11.2/101.3%	96.3	4.76	N/N
Grants Pass Site 3	Oct. 13 11:05	Partly cloudy	75x100'	0.5'-3f/s	12.95/11.0	7.91	11.35/102.9 %	89.2	3.12	N/N

Visually, the two downstream sites appeared to have a slightly higher density of algae and aquatic plants on the substrate (Table 26) (Figures 35, 36, & 37).

Table 26. Biological condition at sites above (Site 1) and below (Sites 2 & 3) the Grants Pass outfall.

	Grants Pass Site 1	Grants Pass Site 2	Grants Pass Site 3
Nutrient Enrichment *1=highly enriched; 5=not enriched*	4	3	3
Algal/Plant community *1=highly impaired; 5=not imp.*	4	3	3
Macroinvertebrate community *1=highly impaired; 5=not imp.*	3	3	3

The macroinvertebrate community showed no apparent change between the three sample sites (Table 27). Caddisflies were the dominant invertebrate group at all sites (35%) followed by non-insect taxa (25-20%). The Diptera family Chironomidae - a relatively tolerant group of invertebrates (Ward 1992) - was common at all three sites. Sensitive taxa accounted for about 25% of the invertebrate community (mayflies - 20%; stoneflies 5-7%). Few stoneflies were found at any of the sites. These results indicate some impairment to the macroinvertebrate community at all three sites.

Based on the conditions of habitat, water quality and biology, the two downstream sites were ranked with a slightly higher impact from nutrient enrichment (score of 3) compared to the upstream site (score 4) (Table 26). However, none of the changes downstream were large and the macroinvertebrate communities appeared to be very similar among all sites, therefore, the Grants Pass discharge did not appear to cause a biocriteria violation.

Table 27. Macroinvertebrate results for sites above and below Grants Pass outfall. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Grants Pass - Site 1 Upstream	Grants Pass Site 2	Grants Pass Site 3
Mayflies (% of total invert. community.)	**20**	**20**	**20**
Baetis sp.	2.5	2	2
Ephemerella sp.	1	1	1
Heptagenia sp	3	3	3
Stoneflies (% of total invert. comm.)	**5**	**5**	**7**
Pteronarcys californica			1
Claassenia sabulosa	1	1	1.5
Skwala sp.	1	1	1
Caddisflies (% of total invert. comm.)	**35**	**35**	**35**
Hydropsyche sp.	3	3	3
Glossosoma sp.	2.5	2.5	2.5
Brachycentrus sp.		1	1
Dicosmoecus sp.	1		
Rhyacophila sp.	1		
Diptera (% of total invert. comm.)	**15**	**20**	**17**
Chironomidae	3	2.5	2.5
Simuliidae		2	2
Other Insects (% of total invert. comm.)	**0**	**<1**	**1**
Elmidae		1	2
Non-insects (% of total invert. comm.)	**25**	**20**	**20**
Snails	2	2	2.5
Limpets	3	2	2
Amphidods	1.5	1.5	1.5
Mites	1.5	2	2
Leeches			
Worms	2	2.5	2.5
Flat worms (planaria)	3	3	3
Crayfish			2

Figure 35. Substrate condition in Rogue River above the Grants Pass outfall (Site 1).

Figure 36. Substrate condition in Rogue River at the first site below the Grants Pass outfall (Site 2).

Figure 37. Substrate condition in Rogue River at the second site below the Grants Pass outfall (Site 3).

Applegate River

The Applegate River enters the Rogue River six miles downstream from Grants Pass and just above the start of the Wild & Scenic section of the Rogue River. The Applegate River is 51 miles long and its watershed covers 698 square miles. Its headwaters are in the Siskiyou Mountains in California. Applegate Dam, located in Oregon near the California border, was completed in 1980 and forms the 988 acre Applegate Lake. Several small unincorporated towns are located along the river with a population in the watershed of roughly 12,000. Agriculture and logging are the primary land uses in the watershed.

Two sites were sampled in the Rogue river by the mouth of the Applegate River: one approximately 3.5 miles upstream (Site 1) and the other 0.5 miles downstream (Site 2) (Figure 38). Both sites were accessed with a jet boat that was launched at the boat ramp near Schroeder Park located a half mile above Site 1. Samples were collected on October 12, between 10:00 and 11:30.

Figure 38. Sample sites in the Rogue River above (Site 1) and below (Sites 2) the Applegate River.

Table 28. Substrate matrix at sites in the Rogue River above (Site 1) and below (Site 2) the Applegate River.

Sample Site	Bank Stability	Riparian Vegetation	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Small Boulder	% Large Boulder	% Bedrock	% Embedded
Site 1 Upstream	Good	River right okay; River left lawns & houses	0	7	20	60	10	3	0	40-50
Site 2 Downstream	Good	Good	0	7	40	45	5	3	0	40-50


Figure 39. Rogue River sample area upstream (Site 1) of the Applegate River.


Figure 40. Rogue River sample area downstream (Site 2) of the Applegate River.

Habitat conditions between the two sites were similar (Table 28) (Figures 39 & 40). Substrate at both sites was comprised primarily of cobble and gravel, but the upper site appeared to have a greater percentage of cobble (60%) compared to the lower site (45%). While there was little visible sand or silt, the substrate at both sites appeared to be 40-50% embedded by fines. Banks were stable on both sides of the river at both sites, while the riparian vegetation was poor on the left bank of the upper site due to lawns from houses extending down to the river's edge.

Some small changes in water quality were noted in the Rogue River below the Applegate River compared to upstream (Table 29). Conductivity was higher downstream versus upstream (93.1 vs. 84.5), while turbidity was slightly lower downstream (1.59 vs. 5.0). The higher conductivity probably results from agricultural runoff from the Applegate River. However, turbidity in the Applegate River was low, which resulted in the lower turbidity measurement in the Rogue River downstream. The pH increased slightly downstream compared to upstream (8.06 vs. 8.2), but both measurements were within the pH standard for the Rogue River watershed (6.5-8.5).

Table 29. Instream water quality at sites above (Site 1) and below (Site 2) the Applegate River.

Sample Site	Sample date/ time	Weather	Reach length /width	Average Depth/ Velocity	Air Temp/ Water Temp (˚C)	pH	Dissolved Oxygen mg/L - % saturation	Conduc tivity	Turbidity	Effluent Visible/ Effluent Smell
Site 1 Upstream	Oct. 12 10:05	Sunny	75x30'	0.5'-3 f/s	12.93/11.4	8.06	12.7/116.4%	84.5	5	N.A.
Site 2 Downstream	Oct. 12 11:20	Sunny	80x20'	1'-3.5 f/s	15.67/12.7	8.2	11.27/106.3%	93.1	1.59	N/N

The algal and plant communities at the two sites appeared very similar with no discernible difference downstream from the Applegate River compared to the site upstream (Table 30) (Figures 41 & 42). Both sites had high densities of algae and aquatic plants indicating moderately high levels of nutrient enrichment.

Table 30. Biological condition at sites above (Site 1) and below (Site 2) the Applegate River.

	Site 1 Upstream	Site 2 Downstream
Nutrient Enrichment *1=highly enriched; 5=not enriched*	2	1.5
Algal/Plant community *1=highly impaired; 5=not imp.*	2	2
Macroinvertebrate community *1=highly impaired; 5=not imp.*	3	2.5

The macroinvertebrate community also showed some impairment at both sites (Table 30). The downstream site appeared slightly worse, mostly due to a lower abundance of sensitive stoneflies and low diversity of mayflies (Table 31). Both sites were dominated by tolerant taxa of Diptera and non-insect taxa like snails, limpets, and worms.

Considering all factors of water quality, aquatic plants, and macroinvertebrates, both sites appeared to have moderately high nutrient enrichment, with the downstream site appearing slightly worse (Table 30). Given the similarity in the macroinvertebrate communities between the two sites however, the Applegate River did not appear to cause a violation of the biocriteria standard.

Table 31. Macroinvertebrate results for sites above and below the Applegate R. 3 = high abundance; 2 = moderate abundance; 1 = low abundance

	Site 1 Upstream	Site 2 Downstream
Mayflies (% of total invert. comm.)	**20**	**25**
Baetis sp.	2	2.5
Ephemerella sp.	1	
Drunella sp.	1	
Heptagenia sp	2	3
Stoneflies (% of total invert. comm.)	**10**	**5**
Pteronarcys californica	1	
Claassenia sabulosa	1.5	1
Skwala sp.	2	1.5
Caddisflies (% of total invert. comm.)	**30**	**30**
Hydropsyche sp.	3	3
Glossosoma sp.	2.5	2
Brachycentrus sp.	1	1.5
Diptera (% of total invert. comm.)	**20**	**20**
Chironomidae	1.5	2
Simuliidae	1.5	1
Other Insects (% of total invert. comm.)	**<1**	**0**
Elmidae	1	
Non-insects (% of total invert. comm.)	**20**	**20**
Snails	1	1
Limpets	2.5	1
Amphidods	1	1
Mites	2	1.5
Worms	1	1
Flat worms (planaria)	1	2
Crayfish	1	

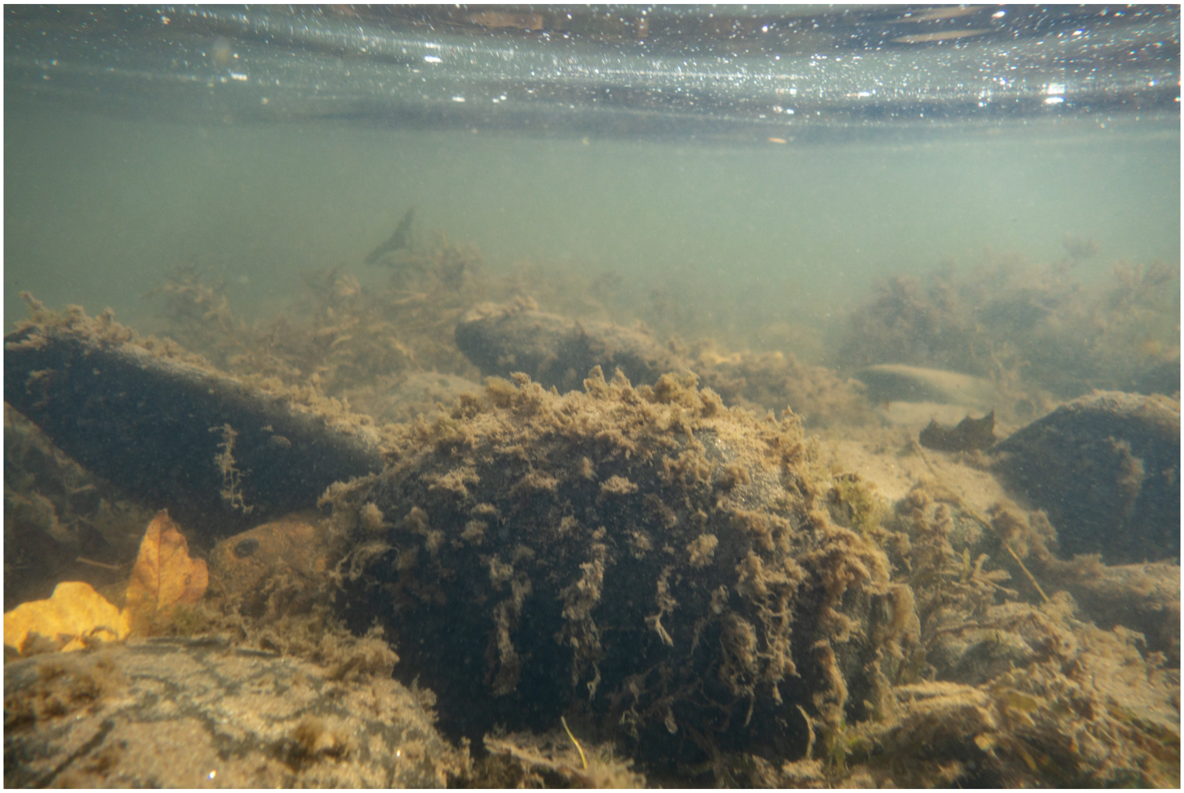

Figure 41. Substrate condition in Rogue River above the Applegate River (Site 1).

Figure 42. Substrate condition in Rogue River below the Applegate River (Site 2).

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Appendix A

Field Data Sheets

Rogue River Recon Survey Site Assessment

Date: __________________ Time: ______________ Air Temp: _______

Point Source: ___________________________________

Site Name: ____________ Lat:_____________ Long:________________

Photo # ______ to ______

Approx. Reach Length (ft) / Width (ft)	
Bank Stability	
Riparian vegetation	
Substrate (% composition)	
Silt/clay	
Sand	
Gravel (0.08-2.5")	
Cobble (2.5-10")	
Small Boulder (10-20")	
Large Boulder (>20")	
Bedrock	
Embeddedness (%)	
Average depth/velocity	
Water Temperature	
pH	
D.O.	
Conductivity	
Turbidity	
Effluent visible (Y/N)	
Effluent smell (Y/N)	
Algal/Plant community (1-5) 1 = Highly impaired: heavy growth of macrophytes and periphyton 5 = Not impaired: limited to no macrophytes, no excess periphyton	
Macroinvertebrate community (1-5) 1 = Highly impaired: diversity low, dominated by tolerant taxa 5 = Not impaired: high diversity of intolerant taxa	
Nutrient Enrichment (1-5) 1 = High enrichment likely 5 = No to little enrichment likely	

Macroinvertebrate Survey Summary

Stoneflies (~% of total): ______________

Hesperoperla/Calineuria - 1 2 3 *Skwala* - 1 2 3

Isoperla - 1 2 3 Chloroperlidae - 1 2 3

Nemourid group - 1 2 3 Peltoperlidae - 1 2 3

Pteronarcys - 1 2 3

Other: ____

Mayflies (~% of total): ______________

Baetis - 1 2 3 *Ephemerella* - 1 2 3

Drunella - 1 2 3 *Ameletus* - 1 2 3

Paraleptophlebia - 1 2 3 *Epeorus* - 1 2 3

Heptagenia - 1 2 3 *Rhithrogena* - 1 2 3

Other: ____

Caddisflies (~% of total): ______________

Hydropsychidae - 1 2 3 Brachycentridae - 1 2 3

Rhyacophila - 1 2 3 *Glossosoma* - 1 2 3

Dicosmoecus - 1 2 3 Limnephilidae - 1 2 3

Other: ____

Diptera (~% of total): ______________

Chironomidae - 1 2 3 Tipulidae - 1 2 3

Other: ____

Other Insect Taxa (~% of total): ______________

____

Non Insect Invertebrate (~% of total): ______________

Snails - 1 2 3 Worms - 1 2 3 Crayfish - 1 2 3

Other: ____