# TECHNICAL MEMORANDUM 3-1

## Aquatic Macroinvertebrates
## Upstream of Englebright Reservoir

Yuba River Development Project
FERC Project No. 2246

April 2013

**TECHNICAL MEMORANDUM 3-1**

# EXECUTIVE SUMMARY

In 2012, Yuba County Water Agency (YCWA) conducted an aquatic macroinvertebrates study in stream reaches upstream of the United States Army Corps of Engineers' Englebright Reservoir that are potentially affected by YCWA's Yuba River Development Project.

Field data collection was performed in July 2012. Eight sites, all selected in collaboration with Relicensing Participants, were sampled. Sampling and analysis conformed to the reach-wide benthos protocol for documenting and describing benthic macroinvertebrate assemblages and physical habitat adopted by the State Water Resources Control Board's *Surface Water Ambient Monitoring Program* (SWAMP) in February 2007. Identification of collected aquatic macroinvertebrates began in July 2012 and continued as sampling proceeded. Laboratory identification of specimens was completed in August 2012.

A total of 3,481 organisms representing 96 distinct taxa (i.e., 89 insect and 7 non-insect taxa) was identified from sub-samples of the benthic macroinvertebrates (BMI) collected from the eight BMI sites. This equated to an estimated total of 4,277 collected organisms. Represented BMI phylogenetic Orders included: Diptera (i.e., 32 taxa); Trichoptera (18); Ephemeroptera (10); Hemiptera (2); Homoptera (1); Coleoptera (8); Plecoptera (10); Odonata (4); Megaloptera (3); and Lepidoptera (1). In addition, aquatic crustaceans, arachnids, oligochaetes, gastropods, and mollusks were identified.

Index of biotic integrity (IBI) scores ranged from 21 at the site in the North Yuba River upstream of the Middle Yuba River, to 69 at the site in the Middle Yuba River downstream of Oregon Creek. Multi-metric index (MMI) scores ranged from 16 at the site in the North Yuba River upstream of the Middle Yuba River, to 64 at the site in the Middle Yuba River downstream of Oregon Creek (with higher scores being better). Overall, the highest scores were observed consistently on the Middle Yuba River. Lower scores were found on the North Yuba River and Yuba River. Abundance was generally low, and five sites were evaluated with an abundance of less than 500 organisms. The lower abundance reduced the reliability of IBI and MMI scoring at those sites; at least 500 organisms is the standard count to calculate IBI and MMI.

Site scores from both indices found that higher quality sites (as ranked) were found further downstream. This is similar to findings by Rehn (2009). Rehn (2009) stated that sites below diversions tend to have similar composition to above-dam or above-diversion sites. Sites below reservoirs generally show a significant difference in reduced quality. Rehn suggests that reduced quality may include lower diversity, EPT (i.e., ephemoptera, plecoptera, trichoptera) richness, and reduced intolerant taxa and that studies showed that these issues may lessen with distance downstream. Generally, results from current sampling followed these trends.

Comparison of the current studies findings with historic work generally showed similar results for each available site. Only limited data was allowed for direct comparison, such as species richness and composition. This limitation was due to differences in data collection methodologies; regardless, the findings indicate similar results over time.

The study was conducted according to the Federal Energy Regulatory Commission (FERC)-approved Study 3.1, *Aquatic Macroinvertebrates Upstream of Englebright Reservoir*, with three variances. First, during the site selection process, YCWA and Relicensing Participants agreed to not sample two locations that were indentified in the FERC-approved study: 1) the Middle Yuba River downstream of Our House Dam; and 2) the North Yuba River downstream of New Bullards Bar Reservoir. The sites were not sampled due to poor site conditions to implement the approved protocol. The remaining eight sampling sites provided adequate distribution throughout the Project and included at least one site further downstream from each of the two sites that were not sampled.

Second, the FERC-approved study stated the SWAMP targeted riffle composite methodology would be followed. However, this methodology would not have been feasible for the selected sites due to a lack of available riffle habitats and, therefore, the SWAMP reach-wide benthos (RWB) – multi-habitat protocol for documenting and describing BMI assemblages and physical habitat was utilized (Ode 2007). The RWB methodology included substrate classification for each transect which negated the need for additional substrate collection methods described from the FERC-approved study plan. Use of the RWB collection methodology resulted in improved representation of available habitat and BMI assemblages in the study area and did not result in a substantial change to the data collection methods or prevent the study from meeting its objectives.

Third, the FERC-approved study specified the study be completed by the end of September 2012. The quality assurance/quality control review of study results took longer than anticipated resulting in a slight delay of study completion.

The study is complete.

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**TECHNICAL MEMORANDUM 3-1**

# AQUATIC MACROINVERTEBRATES UPSTREAM OF ENGLEBRIGHT RESERVOIR[1]

Yuba County Water Agency's (YCWA) continued operation and maintenance (O&M) of the Yuba River Development Project, Federal Energy Regulatory Commission (FERC or Commission) Project Number 2246 (Project) may potentially have an adverse effect on benthic macroinvertebrate (BMI) assemblages in the Yuba River upstream of the United States Army Corps of Engineers' (USACE's) Englebright Reservoir.[2]

The United States Department of Agriculture, Forest Service lists aquatic macroinvertebrates as a Management Indicator Species (MIS) for lakes, rivers and streams that are located on National Forest System (NFS) land, including within the Plumas National Forest (PNF) and Tahoe National Forest (TNF) because the Forest Service believes changes in BMI assemblages could indicate the effects of management activities on non-fish or wildlife species and on water quality (USDA 2007).

## 1.0 Goals and Objectives

The goal of the study was to characterize BMI assemblages within Project-affected reaches upstream of Englebright Reservoir using the State Water Resources Control Board's (SWRCB) *Surface Water Ambient Monitoring Program* (SWAMP) protocol. The objective of the study was to collect BMIs and physical data to meet the study goal.

## 2.0 Methods and Analysis

The study was conducted in four steps: 1) study area and site selection; 2) collect SWAMP data; 3) BMI sample processing; and 4) data analysis. Each of these steps is described below. Surveys followed the methods adopted for the SWAMP described in *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessment in California* (Ode 2007).

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[1] This technical memorandum presents the results for Study 3.1, *Aquatic Macroinvertebrates Upstream of Englebright Dam*, which was included in YCWA's August 17, 2011 Revised Study Plan for Relicensing of the Yuba River Development Project, and approved by FERC in its September 30, 2011 Study Plan Determination. There were no modifications to Study 3.1 subsequent to FERC's September 30, 2011 Study Determination.

[2] Englebright Reservoir is formed by Englebright Dam. The dam is about 260 feet high, was constructed by the California Debris Commission in 1941, and is owned by the United States, and the dam and reservoir is not included as a Project facility in FERC's License for the Yuba River Development Project. When the California Debris Commission was decommissioned in 1986, administration of Englebright Dam and Reservoir was passed to the USACE. The primary purpose of the dam is to trap and contain sediment derived from extensive historic hydraulic mining operations in the Yuba River watershed. Englebright Reservoir is about 9 miles long with a surface area of 815 acres. When the dam was first constructed in 1941, it had a gross storage capacity of 70,000 ac-ft; however, due to sediment capture, the gross storage capacity today is approximately 50,000 ac-ft (United States Geological Survey 2003).

## 2.1 Study Area and Site Selection

The study area included six Project-affected stream reaches in the North Yuba, Middle Yuba, and Yuba rivers, as well as Oregon Creek, a tributary to the Middle Yuba River. Potential sampling sites were evaluated based on proximity to potential Project influence (e.g., downstream from Project dams and powerhouses), co-location with other Relicensing study sites (e.g., Study 3.8, *Stream Fish Populations Upstream of Englebright Reservoir*), and availability of sufficient habitat to comply with SWAMP protocols for collecting BMI samples.

Sites were selected in consultation with Relicensing Participants. Table 2.1-1 lists the eight sample sites including reach names and locations. Figures 2.1-1 through 2.1-4 show the site locations. Representative photographs of the study sites are presented in Attachment 3-1A.

**Table 2.1-1. Benthic macroinvertebrate sampling locations in 2012.**

| Reach Name | Site Description | River Mile[1] | Elevation (ft) | UTM Coordinates[2] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Upstream Transect | | Downstream Transect | |
| | | | | Easting | Northing | Easting | Northing |
| New Bullard's Bar Dam Reach | North Yuba upstream of Middle Yuba Confluence | 0.3 | 1,160 | 660048 | 4359501 | 660285 | 4359441 |
| Log Cabin Diversion Dam Reach | Oregon Creek downstream of Log Cabin Diversion | 4.0 | 1,980 | 667042 | 4367183 | 667038 | 4367055 |
| Log Cabin Diversion Dam Reach | Oregon Creek upstream of Middle Yuba Confluence[3] | 0.2 | 1,470 | 665345 | 4362773 | 665218 | 4362699 |
| Our House Diversion Dam Reach | Middle Yuba upstream of Oregon Creek Confluence[3] | 5.1 | 1,460 | 665664 | 4362241 | 665429 | 4362184 |
| Oregon Creek Reach | Middle Yuba downstream of Oregon Creek Confluence[3] | 4.4 | 1,430 | 664924 | 4362239 | 664891 | 4361993 |
| Oregon Creek Reach | Middle Yuba upstream of North Yuba Confluence | 0.1 | 1,200 | 660719 | 4359466 | 660574 | 4359341 |
| MYR/NYR Reach | Yuba upstream of New Colgate Powerhouse | 34.88 | 550 | 656541 | 4355628 | 656559 | 4355374 |
| New Colgate Powerhouse Reach | Yuba downstream of New Colgate Powerhouse | 33.76 | 530 | 655396 | 4354600 | 655346 | 4354358 |

1 River Mile = As designated from the downstream end of the river (e.g., RM 0.0 in the Middle Yuba River occurs at the confluence of the Middle Yuba and North Yuba rivers where the Middle Yuba River terminates).
2 UTM = Universal Transverse Mercator
3 Sites on NFS land.

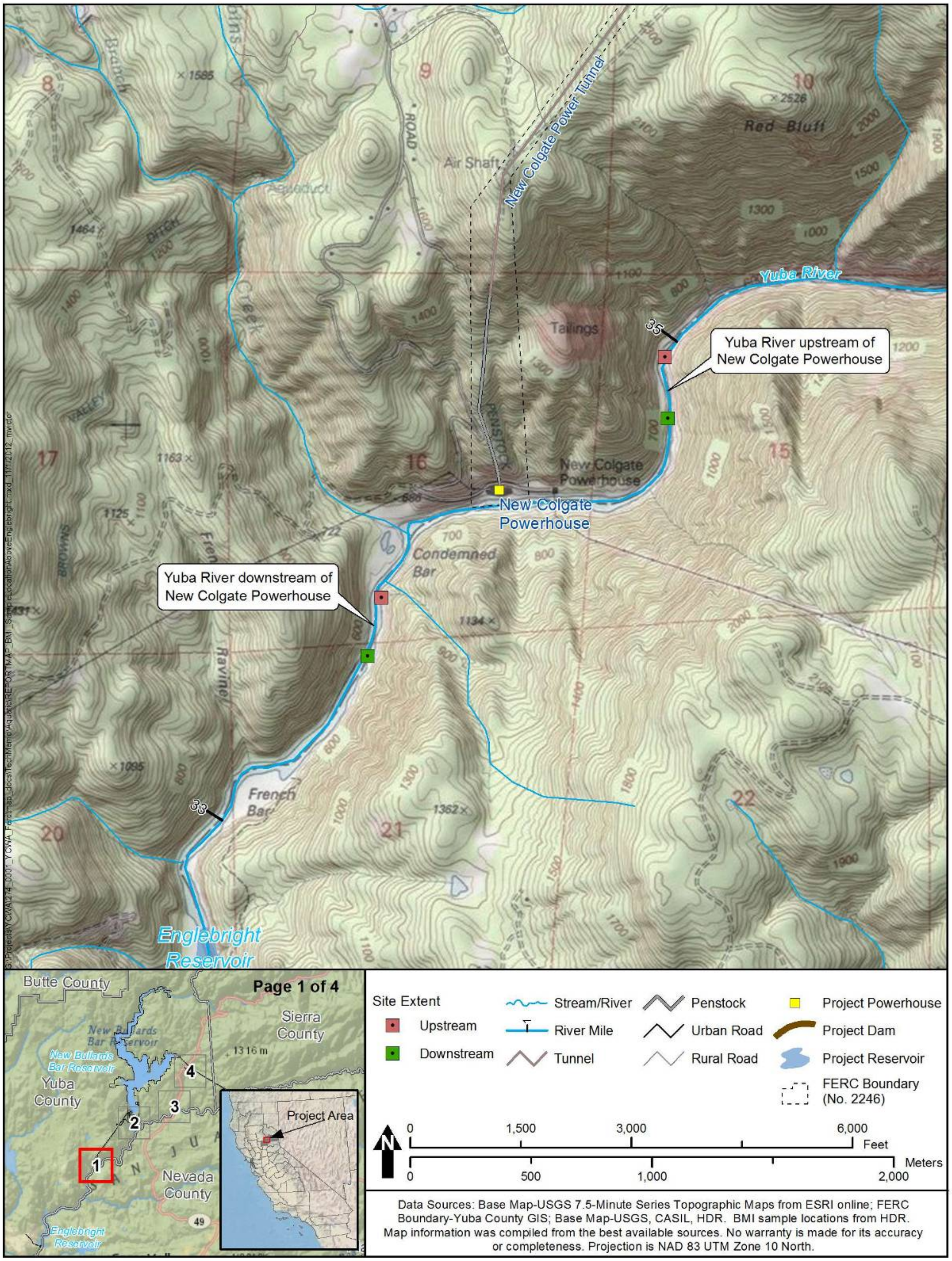


**Figure 2.1-1. Map of two aquatic macroinvertebrate sampling locations on the Yuba River in 2012.**

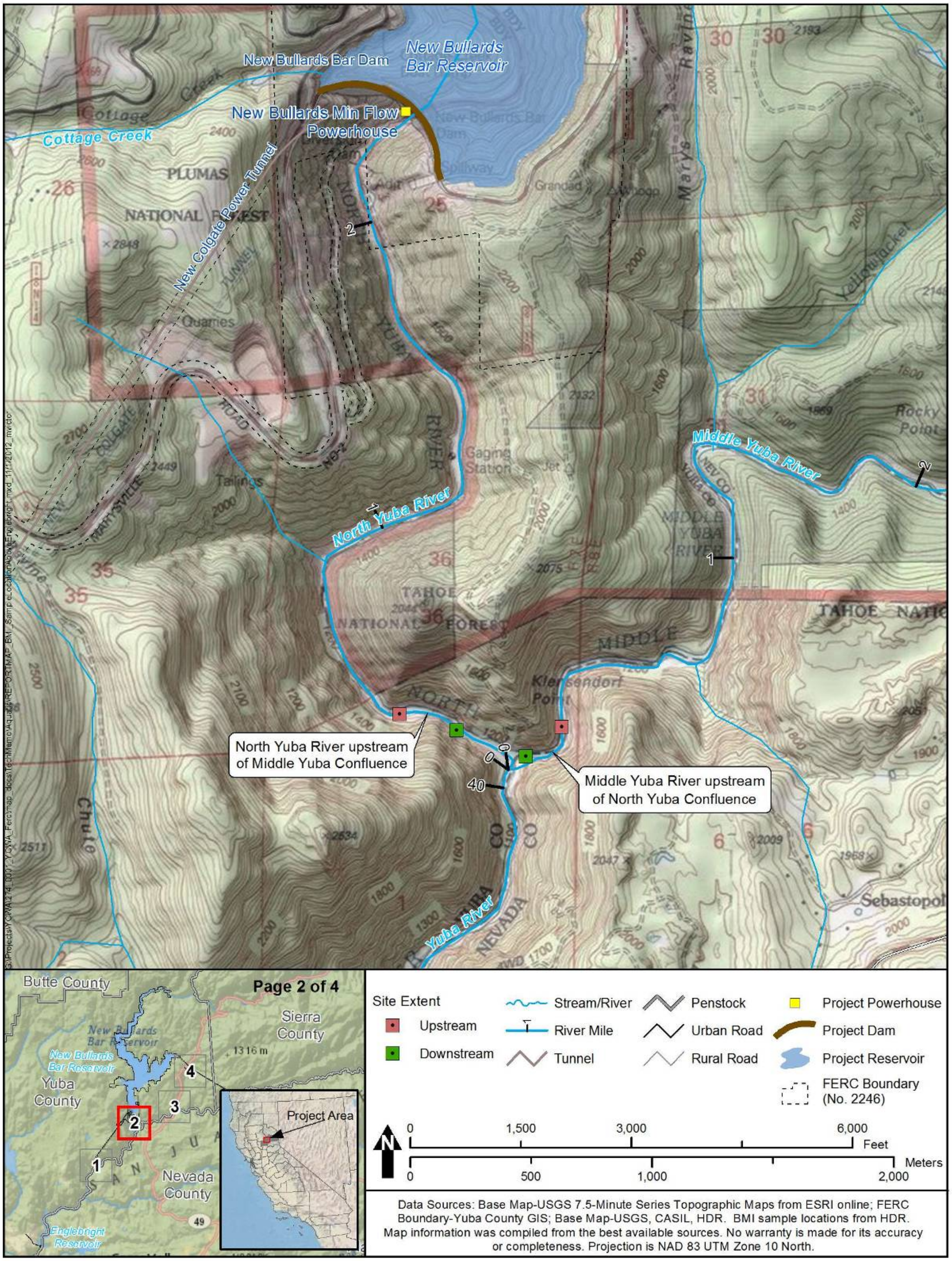


**Figure 2.1-2. Map of two aquatic macroinvertebrate sampling locations, one each on the North and Middle Yuba rivers in 2012.**

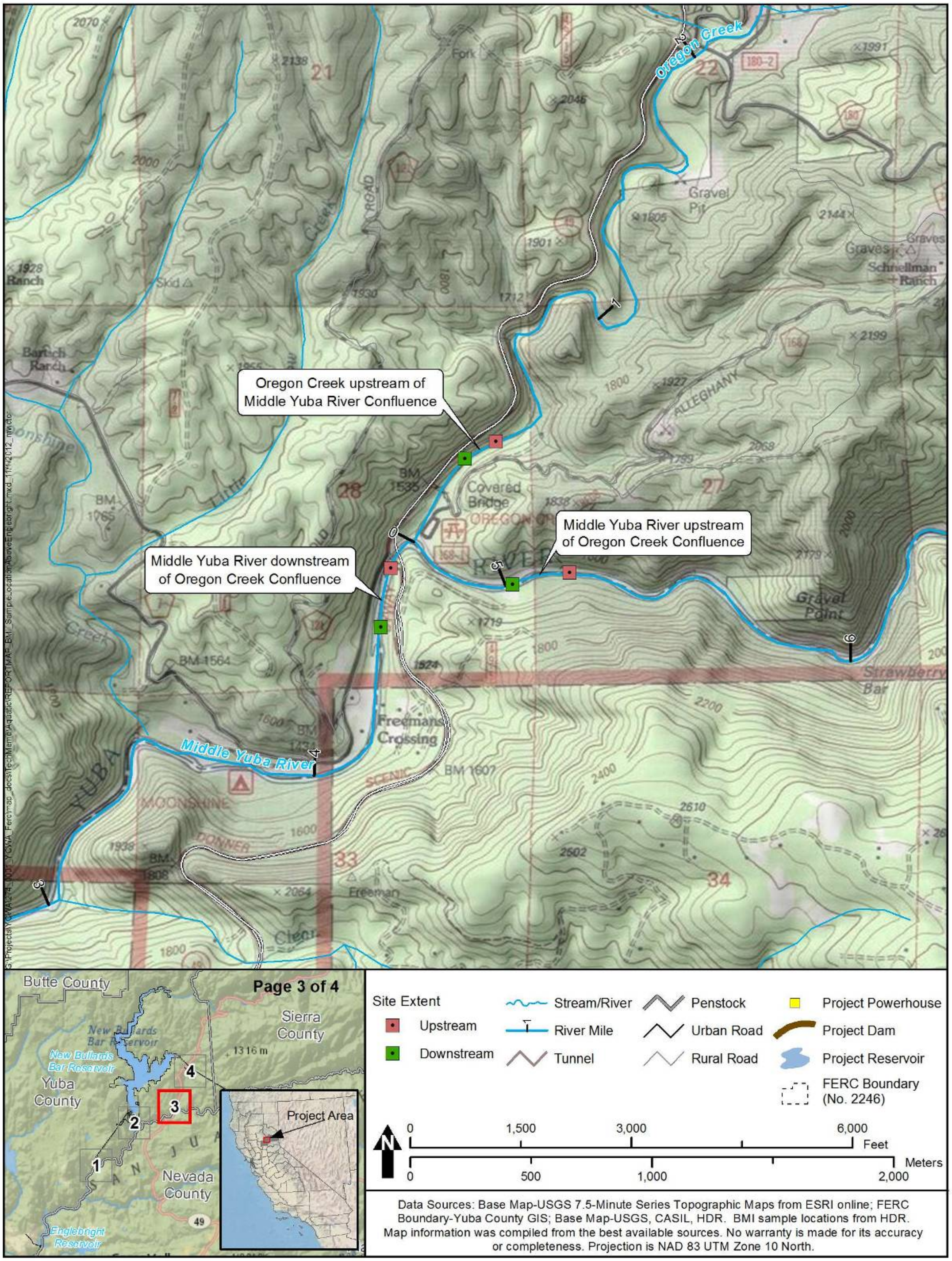


**Figure 2.1-3. Map of three aquatic macroinvertebrate sampling locations, two on the Middle Yuba River and one on Oregon Creek in 2012.**

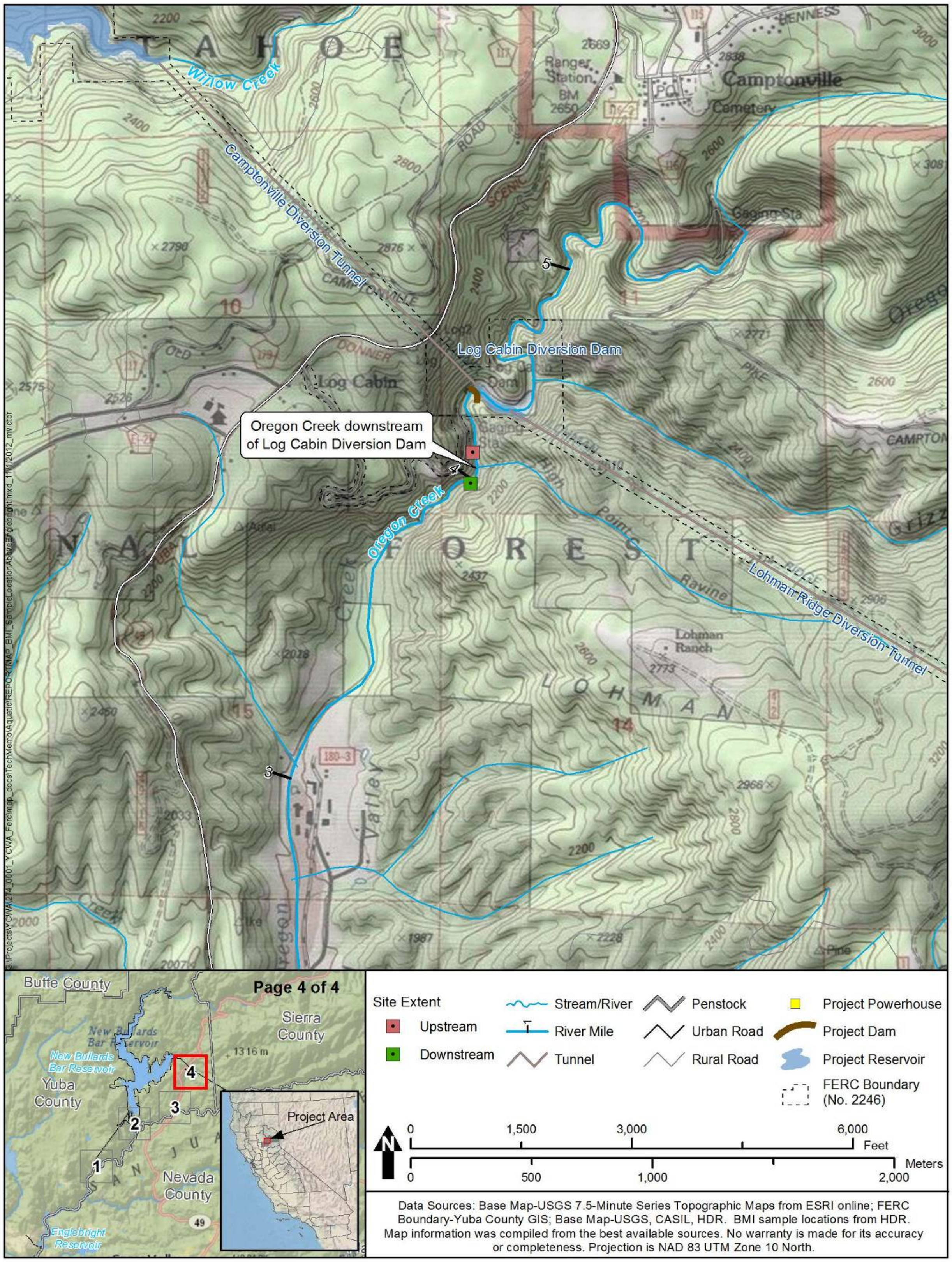


**Figure 2.1-4. Map of one aquatic macroinvertebrate sampling locations on Oregon Creek in 2012.**

## 2.2 General Site Setup and Water Quality

Surveys conformed to the SWAMP reach-wide benthos (RWB) data collection methods, which is a multi-habitat protocol for documenting and describing BMI assemblages and physical habitat (Ode 2007). Surveys were performed by a three-person crew. Generally, sites with an average wetted width equal to or less than 10 meters (m) were set to 150 m in length, and sites with an average wetted width of more than 10 m were set to 250 m in length.

General site characteristics and water quality were characterized at each site according to the SWAMP protocol (Ode 2007). Cartographic coordinates were obtained using a Garmin® eTrex global positioning system for the upstream and downstream boundaries of each site. Water quality measurements were taken using a factory calibrated Hydrolab® Quanta to measure water temperature (± 0.1°C), specific conductance (± 0.5% of reading + 0.001 mS/cm), pH (±0.2 pH units), and dissolved oxygen (DO) ( ±0/1 mg/L at < 8 mg/L and ±0.2 mg/L at > 8 mg/L). Water velocities were measured at 20 equidistant points across a single transect, using a Swoffer® 2100 current velocity meter (average ft/second over a 30 second window). As described in the SWAMP protocol (Ode 2007), velocity transects were placed in a stream section with uniform flow to maximize the consistency of the measurements. Site gradient was assessed using a clinometer to measure the percent slope between transects.

At each site, 11 primary transects were identified at even intervals (i.e., every 25 m for a 250 m long site) and labeled "A" through "K." In addition, 10 inter-transects were identified at the mid points between each of the primary transects and labeled "AB" though "JK." Digital photographs were taken looking upstream and downstream from each of transect labeled A, F, and K, and are available in Attachment 3-1A. Figure 2.2-1 provides a schematic of a typical SWAMP site setup.

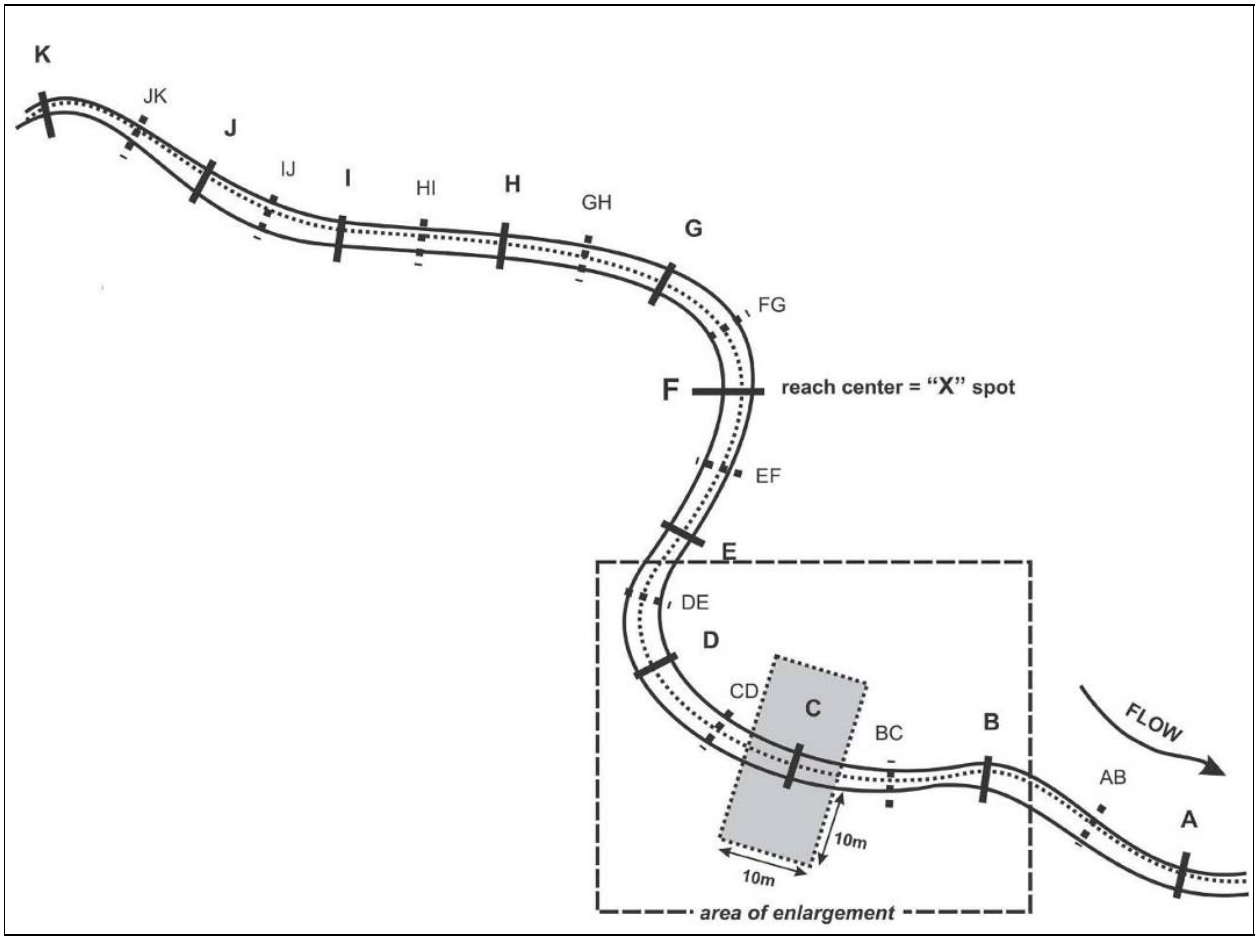


**Figure 2.2-1. A schematic of a typical SWAMP site setup (SOURCE: Ode 2007).**

The sampling for benthic macroinvertebrates at the primary transects and physical habitat measurements at both primary transects and inter-transects are described below.

## 2.3 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate (BMI) sampling occurred at each of the primary transects (A-K) described above for a total of 11 subsamples at each site

The specific sampling location along each transect was alternated between the left, center and right positions or approximately 25 percent, 50 percent and 75 percent of the wetted width. In instances where the sample location would be located in an area too deep or otherwise unfit to complete a sample, the location was moved to a new point as close as possible along the transect.

Samples were collected by rubbing cobble and boulder substrates and disturbing finer substrate upstream of a D-frame kick-net fitted with a 0.02-inch-diameter mesh net. To minimize instream disturbance during sampling which might otherwise affect results, samples were taken by moving upstream from the most downstream transect. Each of the 11 subsamples collected invertebrates from 1 square-foot (sq-ft) of the stream bottom. All 11 subsamples were combined to form a single composite sample for that study site, and the sample was placed into a polypropylene jar, preserved with 95 percent ethanol, sealed and labeled.

## 2.4 Physical Habitat Measurements

At each of the 11 primary transects, surveyors measured wetted width at the time of sampling, bankfull width and bankfull height. Wetted width was measured using a laser rangefinder or tape, and both bankfull width and height were estimated based on the characteristics present at each transect (e.g., vegetation size and type, evidence of erosion and discoloring on rocks). Canopy cover was measured in four directions - upstream, downstream, and facing the left and right banks from the center of each transect - using a convex spherical densitometer modified to correct for overestimation of canopy density, as described by the SWAMP protocol (Ode 2007). The surveyor held the densitometer in each of the four directions and counted the number of intersections covered by the canopy. Human influence, riparian vegetative cover, and instream habitat complexity were estimated visually, following the SWAMP protocol (Ode 2007).

At each of the 10 inter-transects, surveyors measured wetted width, and visually estimated channel type (i.e., percent cascade/falls, rapid, riffle, run, glide, pool, and dry habitat) within each inter-transect interval.

At five equally spaced points along both the primary transects and inter-transects, water depth (centimeters, or cm) and substrate size class were recorded. Size classes were identified using a gravelometer or ruler to measure the intermediate axis of the substrate at each point and compared to the table provided in the SWAMP protocol (Ode 2007). Cobble embeddedness was estimated to the nearest 5 percent by visually inspecting the cobble to determine the percent that was buried by fine particles.

## 2.5 Aquatic Macroinvertebrate Sample Processing

In the laboratory, samples were emptied from the polypropylene jars into a 500-micrometer (μm) sieve, rinsed, and transferred to plastic trays labeled with numbered grids. The sample was evenly distributed over the tray, and a randomly selected grid or portion of a grid was removed and placed in a Petri dish. Using a dissecting microscope, the grid sample was examined for BMIs. All BMIs from the grid or portion of the grid were enumerated. Additional grids or grid portions were selected from each sample until approximately 500 organisms had been obtained or the entire sample had been processed.

BMIs were identified to the lowest possible taxonomic level (i.e., usually species or genus) in accordance with Standard Taxonomic Level II, outlined in the Southwestern Association of *Freshwater Invertebrates Taxonomists Rules for the Development and Maintenance of the Standard Level of Taxonomic Effort* (Rogers and Richards 2006). The taxonomic keys used for BMI identification included: Arnett and Thomas (2001); Arnett et al (2002); Burch (1972); Cook (1974); Epler (2001); Kathman and Brinkhurst (1998); McAlpine et al. (1981); McAlpine

(1987); Merritt and Cummins (1996); Papp and Darvas (2000); Pennak (1978); Stewart and Starke (1993); Thorpe and Covich (1991); Usinger (1956); and Wiggins (1977).

## 2.6 Data Analysis

### 2.6.1 Aquatic Macroinvertebrates

Data were entered into a Microsoft® Excel spreadsheet template for macroinvertebrates in order to calculate the required BMI community structure metrics. The types of metrics included abundance, richness, composition, tolerance/intolerance, feeding, and multi-metric.

Richness metrics count the number of unique taxa in a group (e.g., number of Plecoptera taxa) that is expected to decrease in richness with disturbance. Composition metrics account for the number of individuals in a taxon or group of sensitive taxa (e.g., Ephemeroptera) relative to the total number of individuals in a sample. The Shannon diversity index (SDI) is a measure of both taxa richness and the evenness of taxa composition. Tolerance/Intolerance metrics measure the richness and composition of a sample, in terms of published values of tolerance to disturbance. The California Tolerance Value (CTV) is a weighted average with a scale from 1 to 10, based on taxonomic composition and each taxon's assigned tolerance value. Feeding metrics indicate the presence of certain food resources and the complexity of the overall BMI community. The BMI abundance metric was calculated by multiplying the number of organisms per grid (or grid portion, if the count is extremely high) by the total number of grids (e.g., 500 BMIs counted from one grid times 10 grids in the sample equals an abundance of 5,000 BMIs).

The multi-metric index (MMI) scores were calculated following the *Assessment of Ecological Impacts of Hydropower Projects on Benthic Macroinvertebrate Assemblages: A Review of Existing Data Collected for the Federal Energy Regulatory Commission (FERC) Relicensing Studies* (Rehn et al. 2007). This MMI was developed as an ad hoc measure that is sensitive to the cumulative effects of hydropower operations on streams. The suite of metrics used to calculate the MMI includes number of Ephemeroptera, Plectoptera, and Trichoptera (EPT) taxa, percent Coleoptera, percent total collectors (i.e., collector-filterers + collector-gatherers), percent non-gastropod scraper individuals, and percent tolerant taxa. The MMI score is the sum of the five metric values times a multiplier of 2.0 to provide a 100-point scale: MMI scores of 0 to 32 are considered poor, 33 to 66 are fair, and 67 to 100 are good.

The index of biotic integrity (IBI) scores were calculated with guidance from *Benthic Macroinvertebrates as Indicators of Biological Condition below Hydropower Dams on West Slope Sierra Nevada Streams, California, USA* (Rehn 2009). This multi-metric IBI was developed to assess biological condition below hydropower diversion dams on the west slope of the Sierra Nevada streams based on BMIs. Reference conditions used to validate this metric were defined by screening upstream study sites and 77 other regional streams with quantitative Geographic Information System (GIS) land use analysis, reach-scale physical habitat data, and water chemistry data. Three criteria were used to evaluate 82 metrics: sufficient range for scoring; good discrimination between reference and first downstream sites with indication for recovery with distance sampled; and minimal correlation with other discriminating metrics. The

IBI score is based on ET Taxa Richness, Percent Intolerant Individuals, Percent Non-Insect Taxa, Percent Predator Individuals, Percent Scraper Individuals, Percent Tolerant Individuals, and Shannon diversity index. Each metric is scored on a 10-point scale. The IBI score is a sum of the metric scores times a multiplier of 1.43 to adjust to 100-point scale. Condition categories were not assigned to IBI scores.

BMI data for each site were initially analyzed using the 18 selected metrics identified in the FERC-approved study. Four other metrics were added in order to calculate IBI and MMI scores. Additionally, total estimated abundance was calculated. Table 2.6-1 describes each of the 23 metrics calculated and indicates which ones were used to calculate IBI and MMI scores.

**Table 2.6-1. Metrics used to analyze BMI data and calculate IBI and MMI scores.**

| Metric | IBI | MMI | Description | Predicted Response to Impairment |
|---|---|---|---|---|
| **ABUNDANCE** | | | | |
| Total Estimated Abundance | | | Extrapolated value of all the individual taxa in a sample | Decrease |
| **RICHNESS** | | | | |
| Taxonomic richness | | | Total number of individual taxa | Decrease |
| Number of EPT taxa | | X | Number of taxa in the insect orders Ephemeroptera, Plecoptera, and Trichoptera | Decrease |
| ET Taxa richness[1] | X | | Total number of individual taxa from the orders Ephemeroptera and Trichoptera | Decrease |
| Number of Ephemeroptera taxa | | | Number of mayfly taxa | Decrease |
| Number of Plecoptera taxa | | | Number of stonefly taxa | Decrease |
| Number of Trichoptera taxa | | | Number of caddisfly taxa | Decrease |
| Number of Coleoptera taxa | | X | Number of beetle taxa | Decrease |
| **COMPOSITION** | | | | |
| Shannon diversity Index | X | | General measure of sample diversity that incorporates richness and evenness | Decrease |
| Percent Ephemeroptera | | | Percent of mayfly nymphs | Decrease |
| Percent EPT | | | Percent of the composite of mayfly, stonefly, and caddisfly larvae | Decrease |
| Percent non-insect taxa[1] | X | | Percent of taxa not in the class insectivora. | Decrease |
| **TOLERANCE/INTOLERANCE** | | | | |
| California tolerance value (CTV) | | | CTVs between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values) | Increase |
| Percent tolerant organisms | X | | Percent of individuals considered to be tolerant of various types of perturbation | Increase |
| Percent tolerant taxa[1] | | X | Percent of taxa considered to be tolerant of various types of perturbation | Increase |
| Number of intolerant taxa | | | Taxa richness of those organisms considered to be sensitive to perturbation | Decrease |
| Percent intolerant individuals[1] | X | | Number of organisms considered to be sensitive to perturbation | Decrease |
| Percent dominant taxa | | | Measures the dominance of the single most abundant taxon. Can be calculated as dominant 2, 3, 4, or 5 taxa | Increase |
| **FEEDING** | | | | |
| Percent collector individuals (CF + CG) | | X | Percentage of BMIs within the collector-filterer and collector gatherer functional feeding groups | Increase |
| Percent scraper individuals | X | | Percent of BMIs that graze upon periphyton | Variable |
| Percent non-gastropod scraper individuals | | X | Percentage of BMIs within the scraper functional feeding group excluding gastropod scrapers | Decrease |
| Percent predator individuals | X | | Percent of BMIs that prey on living organisms | Decrease |
| Percent shredder individuals | | | Percentage of BMIs within the scraper functional feeding group excluding gastropod scrapers | Decrease |

[1] Metric added in order to calculate IBI or MMI scores.

### 2.6.2 Physical Habitat

Data from the SWAMP physical habitat transects and BMI sample points were entered into a Microsoft® Excel spreadsheet, and average values were calculated for channel slope, water depth, bankfull and wetted widths, canopy cover, substrate particle size distribution, and cobble embeddedness for each site. The percent of each channel type (cascade/falls, rapid, riffle, run, glide, pool, and dry habitat) was estimated within each inter-transect interval, and the average percent of each type was calculated for each site.

Three SWAMP habitat characteristics (i.e., epifaunal substrate/cover, sediment deposition, and channel alteration) were also scored from 1-20 for each reach sampled, with a score of 19-20 considered optimal.

# 3.0 Results

## 3.1 Physical Habitat

Physical habitat characteristics for each study site are organized by their respective sub-basins and summarized in the following sections. Detailed habitat data for all sites are provided in tabular form in Attachment 3-1B.

### 3.1.1 North Yuba River

#### 3.1.1.1 North Yuba River above Middle Yuba River

There was one sampling site in the North Yuba River sub-basin. The North Yuba River above Middle Yuba River sampling site was approximately 2.0 mile (mi) downstream of New Bullards Bar Dam on the North Yuba River at an elevation of 1,160 feet (ft). Tables 3.1-1 to 3.1-3 provide a summary of water quality, physical habitat parameters and channel type, and substrate composition respectively.

**Table 3.1-1. Summary of water quality parameters in the North Yuba River above Middle Yuba River Site.**

| Parameter | North Yuba River above Middle Yuba River |
|---|---|
| Water temperature (°C) | 19.3 |
| Specific conductivity (µS/cm) | 70 |
| pH (units) | 7.4 |
| Dissolved oxygen (mg/L) | 8.3 |

**Table 3.1-2. Summary of physical habitat parameters and characterization in the North Yuba River above Middle Yuba River Site.**

| Parameter | North Yuba River above Middle Yuba River |
|---|---|
| **PHYSICAL HABITAT** | |
| Reach length (m) | 250 |
| Average wetted width (m) | 10.3 |
| Average depth (cm) | 46.2 |
| Discharge (cfs) | 5.4 |
| Average gradient (%) | 2.4 |

 

**Table 3.1-2. (continued)**

| Parameter | North Yuba River above Middle Yuba River |
|---|---|
| **PHYSICAL HABITAT (continued)** | |
| Average canopy cover (%) | 7 |
| **ADDITIONAL HABITAT CHARACTERIZATION (Scored 0 – 20)** | |
| Epifaunal Substrate/Cover | 15 |
| Sediment Deposition | 14 |
| Channel Alteration | 16 |

**Table 3.1-3. Summary of channel type and substrate characterization in the North Yuba River above Middle Yuba River Site.**

| Parameter | North Yuba River above Middle Yuba River |
|---|---|
| **CHANNEL TYPE (%)** | |
| Cascade/falls | 5 |
| Rapid | 0 |
| Riffle | 14 |
| Run | 0 |
| Glide | 2 |
| Pool | 79 |
| Dry | 0 |
| **SUBSTRATE CHARACTERIZATION (%)** | |
| Sand (0.06–2 mm) | 1 |
| Fine gravel (2–16 mm) | 6 |
| Coarse gravel (16–64 mm) | 5 |
| Cobble (64–250 mm) | 30 |
| Boulder (25 cm – 4m) | 49 |
| Bedrock (>4 m) | 10 |
| Average % cobble embeddedness | 21 |

This site received suboptimal scores for all three SWAMP habitat characteristics (i.e., epifaunal substrate/cover, sediment deposition, and channel alteration). The 250-m-long site was generally dominated by pool habitat and boulder substrate. There was little canopy (7%), relatively low flow (5.4 cfs), and water temperature on the day of sampling approached 20°C. Forestry was the primary land use observed.

### 3.1.2 Oregon Creek

There were two sampling sites in the Oregon Creek sub-basin: one downstream of the Log Cabin Diversion Dam and one upstream of the confluence with the Middle Yuba River. Tables 3.1-4 to 3.1-6 provide a comparison of water quality, physical habitat parameters and channel type and substrate composition respectively.

**Table 3.1-4. Summary of water quality parameters in the Oregon Creek Sub-basin.**

| Parameter | Below Log Cabin Diversion Dam | Above Middle Yuba River Confluence |
|---|---|---|
| Water temperature (°C) | 19.6 | 20.4 |
| Specific conductivity (µS/cm) | 128 | 132 |
| pH (units) | 7.7 | 8.1 |
| Dissolved oxygen (mg/L) | 7.9 | 8.3 |

**Table 3.1-5. Summary of physical habitat parameters in the Oregon Creek Sub-basin.**

| Parameter | Below Log Cabin Diversion Dam | Above Middle Yuba River Confluence |
|---|---|---|
| **PHYSICAL HABITAT** | | |
| Reach length (m) | 150 | 150 |
| Average wetted width (m) | 6.4 | 6.0 |
| Average depth (cm) | 38.4 | 35.8 |
| Discharge (cfs) | 6.8 | 8.2 |
| Average gradient (%) | 3.4 | 2.7 |
| Average canopy cover (%) | 74 | 74 |
| **ADDITIONAL HABITAT CHARACTERIZATION (Scored 0 – 20)** | | |
| Epifaunal Substrate/Cover | 16 | 15 |
| Sediment Deposition | 14 | 10 |
| Channel Alteration | 19 | 19 |

**Table 3.1-6. Summary of channel type and substrate characterization in the Oregon Creek Sub-basin.**

| Parameter | Below Log Cabin Diversion Dam | Above Middle Yuba River Confluence |
|---|---|---|
| **CHANNEL TYPE (%)** | | |
| Cascade/falls | 4 | 0 |
| Rapid | 0 | 0 |
| Riffle | 17 | 25 |
| Run | 28 | 13 |
| Glide | 8 | 12 |
| Pool | 23 | 50 |
| Dry | 0 | 0 |
| **SUBSTRATE CHARACTERIZATION (%)** | | |
| Sand (0.06–2 mm) | 2 | 13 |
| Fine gravel (2–16 mm) | 0 | 7 |
| Coarse gravel (16–64 mm) | 13 | 11 |
| Cobble (64–250 mm) | 34 | 25 |
| Boulder (25 cm – 4m) | 23 | 30 |
| Bedrock (>4 m) | 28 | 13 |
| Average % cobble embeddedness | 17 | 33 |

#### 3.1.2.1 Oregon Creek below Log Cabin Diversion Dam

The Oregon Creek below Log Cabin Diversion Dam sampling site was approximately 0.2 mi downstream of Log Cabin Diversion Dam on Oregon Creek at an elevation of 1,980 ft. The site received suboptimal scores for two of the SWAMP habitat characteristics - epifaunal substrate/cover and sediment deposition - and an optimal score for channel alteration. The 150-meter-long site had good canopy (74%), but substrate was generally larger sized material overall. Water temperatures approached 20°C. Habitat was distributed primarily within run (28%) and pool (23%). Forestry was the primary land use observed.

#### 3.1.2.2 Oregon Creek above Middle Yuba River Confluence

The Oregon Creek above Middle Yuba River Confluence sampling site was approximately 4.0 mi downstream of Log Cabin Diversion Dam at an elevation of 1,470 ft. The site received suboptimal scores for two of the SWAMP habitat characteristics - epifaunal substrate/cover and sediment deposition - and an optimal score for channel alteration. The 150-meter-long site was similar in many aspects to the site below Log Cabin. Water temperature was slightly over 20°C, but canopy remained at 74 percent. Relative to the upstream site (i.e. site below Log Cabin

Diversion Dam), substrate was more embedded (33%) and channel type was primarily composed of pool habitat (50%). Forestry was the primary land use observed.

### 3.1.3 Middle Yuba River

There were three sampling sites in the Middle Yuba River sub-basin: 1) upstream of the Oregon Creek confluence; 2) downstream of the Oregon Creek confluence; and 3) upstream of the North Yuba River confluence. Tables 3.1-7 to 3.1-9 provide a comparison of water quality, physical habitat parameters and channel type and substrate composition, respectively.

**Table 3.1-7. Summary of water quality parameters in the Middle Yuba River Sub-basin.**

| Parameter | Above Oregon Creek Confluence | Below Oregon Creek Confluence | Above North Yuba River Confluence |
|---|---|---|---|
| Water temperature (°C) | 21.0 | 20.6 | 21.8 |
| Specific conductivity (μS/cm) | 121 | 124 | 131 |
| pH (units) | 7.6 | 6.3 | 7.1 |
| Dissolved oxygen (mg/L) | 7.6 | 7.7 | 8.1 |

**Table 3.1-8. Summary of physical habitat parameters in the Middle Yuba River Sub-basin.**

| Parameter | Above Oregon Creek Confluence | Below Oregon Creek Confluence | Above North Yuba River Confluence |
|---|---|---|---|
| **PHYSICAL HABITAT** | | | |
| Reach length (m) | 250 | 250 | 250 |
| Average wetted width (m) | 15.2 | 29.4 | 16.8 |
| Average depth (cm) | 49.6 | 31.6 | 81.9 |
| Discharge (cfs) | 35 | 44.2 | 49.1 |
| Average gradient (%) | 0.7 | 0.6 | 2.6 |
| Average canopy cover (%) | 30 | 15 | 33 |
| **ADDITIONAL HABITAT CHARACTERIZATION (Scored 0 – 20)** | | | |
| Epifaunal Substrate/Cover | 15 | 15 | 16 |
| Sediment Deposition | 10 | 9 | 14 |
| Channel Alteration | 18 | 12 | 19 |

**Table 3.1-9. Summary of channel type and substrate characterization in the Middle Yuba River Sub-basin.**

| Parameter | Above Oregon Creek Confluence | Below Oregon Creek Confluence | Above North Yuba River Confluence |
|---|---|---|---|
| **CHANNEL TYPE (%)** | | | |
| Cascade/falls | 0 | 0 | 16 |
| Rapid | 0 | 0 | 0 |
| Riffle | 21 | 42 | 4 |
| Run | 19 | 24 | 4 |
| Glide | 3 | 23 | 11 |
| Pool | 57 | 13 | 65 |
| Dry | 0 | 0 | 0 |
| **SUBSTRATE CHARACTERIZATION (%)** | | | |
| Sand (0.06–2 mm) | 14 | 9 | 2 |
| Fine gravel (2–16 mm) | 2 | 2 | 2 |
| Coarse gravel (16–64 mm) | 9 | 16 | 7 |
| Cobble (64–250 mm) | 37 | 45 | 24 |
| Boulder (25 cm - 4 m) | 36 | 27 | 35 |
| Bedrock (>4 m) | 2 | 0 | 30 |
| Average % cobble embeddedness | 26 | 35 | 37 |

#### 3.1.3.1 Middle Yuba River above Oregon Creek Confluence

The Middle Yuba River above Oregon Creek Confluence sampling site was approximately 7.5 mi downstream of Our House Diversion Dam on the Middle Yuba River at an elevation of 1,460 ft. The site received suboptimal scores for two of the SWAMP habitat characteristics - epifaunal substrate/cover and sediment deposition - and an optimal score for channel alteration. The site was primarily composed of pool habitat (57 percent) and had 30 percent canopy. Water temperature on the time of measurement was 21.0°C. Substrate was large and composed of cobble and boulder. Forestry was the primary land use observed.

#### 3.1.3.2 Middle Yuba River below Oregon Creek Confluence

The Middle Yuba River below Oregon Creek Confluence sampling site was approximately 0.2 mi downstream of the Oregon Creek confluence on the Middle Yuba River at an elevation of 1,430 ft. The site received suboptimal scores for all three SWAMP habitat characteristics - epifaunal substrate/cover, sediment deposition and channel alteration. The site had a relatively wider channel (29.4 m) compared to other Middle Yuba locations with a shallower depth (31.6 cm). Water temperature was coolest amongst the two other locations and canopy provided 15 percent coverage. Substrate was relatively larger and composed cobble and boulder. Habitat was distributed within riffle, run, glide, but lacked pool. Forestry was the primary land use observed.

#### 3.1.3.3 Middle Yuba River above North Yuba River Confluence

The Middle Yuba River above North Yuba River Confluence sampling site was approximately 4.5 mi downstream of the Oregon Creek confluence on the Middle Yuba River at an elevation of 1,200 ft. The site received suboptimal scores for two of the SWAMP habitat characteristics - epifaunal substrate/cover and sediment deposition - and an optimal score for channel alteration. The site had the highest proportion of pool habitat (65%) and the warmest water temperature at the time of the survey (21.8°C). Similar to other Middle Yuba River sites, the substrate was large. The site also had a relatively narrow channel (16.8 m), but the highest flow (49.1 cfs). Forestry was the primary land use observed.

### 3.1.4 Yuba River

There were two sampling sites in the Yuba River sub-basin; one above Colgate Powerhouse and one below Colgate Powerhouse. Tables 3.1-10 to 3.1-12 provide a comparison of water quality, physical habitat parameters and channel type and substrate composition respectively.

**Table 3.1-10. Summary of water quality parameters in the Yuba River Sub-basin.**

| Parameter | Above Colgate Powerhouse | Below Colgate Powerhouse |
|---|---|---|
| Water temperature (°C) | 23.6 | 12.4 |
| Specific conductivity (µS/cm) | 129 | 82 |
| pH (units) | 8.2 | 7.7 |
| Dissolved oxygen (mg/L) | 7.7 | 9.7 |

**Table 3.1-11. Summary of physical habitat parameters in the Yuba River Sub-basin.**

| Parameter | Above Colgate Powerhouse | Below Colgate Powerhouse |
|---|---|---|
| **PHYSICAL HABITAT** | | |
| Reach length (m) | 250 | 250 |
| Average wetted width (m) | 16.2 | 25.1 |
| Average depth (cm) | 67.8 | 60.8 |
| Discharge (cfs) | 75 | 173.5 |
| Average gradient (%) | 3 | 1.4 |
| Average canopy cover (%) | 20 | 22 |
| **ADDITIONAL HABITAT CHARACTERIZATION (Scored 0 – 20)** | | |
| Epifaunal Substrate/Cover | 15 | 13 |
| Sediment Deposition | 17 | 14 |
| Channel Alteration | 19 | 11 |

**Table 3.1-12. Summary of channel type and substrate characterization in the Yuba River Sub-basin.**

| Parameter | Above Colgate Powerhouse | Below Colgate Powerhouse |
|---|---|---|
| **CHANNEL TYPE (%)** | | |
| Cascade/falls | 25 | 2 |
| Rapid | 0 | 0 |
| Riffle | 0 | 50 |
| Run | 24 | 5 |
| Glide | 0 | 0 |
| Pool | 51 | 43 |
| Dry | 0 | 0 |
| **SUBSTRATE CHARACTERIZATION (%)** | | |
| Sand (0.06–2 mm) | 0 | 3 |
| Fine gravel (2–16 mm) | 1 | 1 |
| Coarse gravel (16–64 mm) | 7 | 10 |
| Cobble (64–250 mm) | 28 | 35 |
| Boulder (25 cm – 4m) | 22 | 48 |
| Bedrock (>4 m) | 42 | 3 |
| Average % cobble embeddedness | 18 | 26 |

#### 3.1.4.1 Yuba River above Colgate Powerhouse

The Yuba River above Colgate Powerhouse sampling site was approximately 0.6 mi upstream of New Colgate Powerhouse on the Yuba River at an elevation of 550 ft. The site was the only monitored location that received optimal scores for all three SWAMP habitat characteristics - epifaunal substrate/cover, sediment deposition and channel alteration. The site had larger substrate composed of bedrock, cobble and boulder, but substrate embeddedness was relatively low (18%). Moderate canopy was present (20%), but water temperature was warm and exceeded 23°C. Forestry was the primary land use observed.

#### 3.1.4.2 Yuba River below Colgate Powerhouse

The Yuba River below Colgate Powerhouse sampling site was approximately 0.6 mi downstream of New Colgate Powerhouse on the Yuba River at an elevation of 530 ft. The site received suboptimal scores for all three SWAMP habitat characteristics - epifaunal substrate/cover, sediment deposition and channel alteration. The site had relatively moderate canopy (22%) and was composed of riffle and pool habitat. Discharge was relatively high (175 cfs) along with substrate embeddedness (26%). Water temperature was significantly cooler (12.4°C) relative to other sites. Forestry was the primary land use observed.

## 3.2 Aquatic Macroinvertebrates

A total of 3,481 organisms representing 96 distinct taxa (i.e., 89 insect and 7 non-insect taxa) was randomly sorted from the BMI samples collected from the eight BMI sites and identified. This equated to an estimated total of 4,277 collected organisms. The distinct insect taxa included the following phylogenetic Orders: Diptera (n=32 taxa); Trichoptera (18); Ephemeroptera (10); Hemiptera (2); Homoptera (1); Coleoptera (8); Plecoptera (10); Odonata (4); Megaloptera (3); and Lepidoptera (1). In addition, aquatic crustaceans, arachnids, oligochaetes, gastropods, and mollusks were identified.

IBI scores ranged from 21 at the site in the North Yuba River upstream of the Middle Yuba River, to 69 at the site in the Middle Yuba River downstream of Oregon Creek. MMI scores ranged from 16 at the site in the North Yuba River upstream of the Middle Yuba River, to 64 at the site in the Middle Yuba River upstream of Oregon Creek and the site in the Middle Yuba River downstream of Oregon Creek. Calculated metrics and BMI taxonomy and enumeration are presented in Attachment 3-1C.

BMI data for each site were analyzed for abundance and IBI and MMI scores were calculated using the 18 selected metrics identified in the FERC-approved study plus four additional metrics. Values for the selected metrics, including those used to calculate the IBI and MMI scores, as well as total estimated abundance are shown in Table 3.2-1.

**Table 3.2-1. BMI abundance and 22 metrics from samples collected at eight sites in Oregon Creek, and the North Yuba, Middle Yuba, and Yuba rivers in July 2012.**

| BMI Metric | North Yuba River Above Middle Yuba River | Oregon Creek Below Log Cabin Diversion Dam | Oregon Creek Above Middle Yuba | Middle Yuba River Above Oregon Creek | Middle Yuba River Below Oregon Creek | Middle Yuba Above North Yuba River | Yuba River Above New Colgate PH | Yuba River Below New Colgate PH |
|---|---|---|---|---|---|---|---|---|
| **ABUNDANCE** | | | | | | | | |
| Total Estimated Abundance | 325 | 243 | 942 | 486 | 476 | 834 | 198 | 676 |
| **RICHNESS METRICS** | | | | | | | | |
| Taxonomic Richness | 23 | 31 | 35 | 37 | 36 | 30 | 28 | 23 |
| No. ET Taxa | 6 | 8 | 7 | 12 | 11 | 11 | 10 | 11 |
| No. EPT Taxa | 8 | 12 | 12 | 16 | 15 | 14 | 11 | 14 |
| No. Ephemeroptera Taxa | 2 | 3 | 3 | 5 | 4 | 4 | 3 | 5 |
| No. Plecoptera Taxa | 2 | 4 | 5 | 4 | 4 | 3 | 1 | 3 |
| No. Trichoptera Taxa | 4 | 5 | 4 | 7 | 7 | 7 | 7 | 6 |
| No. Coleoptera Taxa | 0 | 4 | 4 | 6 | 4 | 4 | 3 | 0 |

 

**Table 3.2-1. (continued)**

| BMI Metric | North Yuba River Above Middle Yuba River | Oregon Creek Below Log Cabin Diversion Dam | Oregon Creek Above Middle Yuba | Middle Yuba River Above Oregon Creek | Middle Yuba River Below Oregon Creek | Middle Yuba Above North Yuba River | Yuba River Above New Colgate PH | Yuba River Below New Colgate PH |
|---|---|---|---|---|---|---|---|---|
| **COMPOSITION METRICS** | | | | | | | | |
| % EPT | 50.2 | 57.6 | 39.0 | 55.3 | 51.5 | 57.8 | 58.1 | 41.3 |
| % Ephemeroptera | 15.7 | 33.3 | 19.3 | 13.6 | 21.6 | 26.1 | 44.4 | 30.0 |
| Shannon Diversity Index (SDI) | 2.2 | 2.4 | 2.9 | 2.6 | 2.8 | 2.8 | 2.6 | 2.0 |
| % Non-insect taxa | 19.1 | 22.6 | 2.9 | 0.6 | 3.2 | 0.4 | 3.5 | 0.7 |
| **TOLERANCE/INTOLERANCE METRICS** | | | | | | | | |
| California Tolerance Value (CTV) | 4.6 | 4.4 | 3.4 | 3.9 | 3.4 | 4.2 | 5.0 | 5.2 |
| No. of Intolerant taxa | 4 | 9 | 8 | 13 | 12 | 11 | 4 | 12 |
| % Tolerant Taxa | 8.7 | 3.2 | 2.9 | 2.7 | 0.0 | 3.3 | 14.3 | 0.0 |
| % Intolerant Organisms | 2.2 | 14.0 | 27.0 | 24.9 | 32.4 | 24.3 | 5.6 | 18.3 |
| % Tolerant Organisms | 2.2 | 2.9 | 1.2 | 0.2 | 0.0 | 0.4 | 11.1 | 0.0 |
| % Dominant Taxon | 30.2 | 28.4 | 21.6 | 25.3 | 20.8 | 20.0 | 25.8 | 30.3 |
| **FEEDING METRICS** | | | | | | | | |
| % Collector-filterer+ Collector-gatherer Individuals | 87.7 | 74.9 | 58.5 | 67.1 | 57.1 | 77.3 | 84.8 | 81.6 |
| % Scrapers | 2.2 | 6.2 | 4.6 | 11.1 | 15.1 | 7.5 | 2.5 | 5.9 |
| % Non-gastropoda Scrapers | 1.2 | 6.2 | 4.6 | 11.1 | 15.1 | 7.2 | 2.5 | 5.8 |
| % Predators | 6.2 | 11.1 | 18.7 | 17.5 | 23.5 | 12.2 | 8.6 | 10.2 |
| % Shredders | 0.0 | 2.1 | 2.7 | 0.6 | 0.2 | 0.4 | 0.5 | 0.0 |

In general, the IBI and MMI scores provided similar rankings of sites. Table 3.2-2 and Figure 3.2-1 provide an overview of calculated IBI and MMI scores for each site by sub-basin with elevation and distance from upstream Project feature. In the Oregon Creek and Yuba River sub-basins, IBI and MMI scores had higher values in sites further downstream of Project features. However, in the Middle Yuba sub-basin, IBI and MMI scores remained relatively similar in the two upper sites, with the lowest scores calculated at the furthest downstream site. Other parameters, such as substrate composition, habitat type, and the effects of mining and recreational activities, may have a substantial influence on IBI and MMI scores.

**Table 3.2-2. Overview of IBI and MMI scores for each site along with elevation and location from nearest project features. Shaded cells represent locations where insufficient organisms were collected to make the resultant IBI and MMI scores reliable.**

| Site | Elevation | IBI Score | MMI Score | Distance From Project Feature | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reservoir | Diversion Dam | Powerhouse | Name of Facility |
| **NORTH YUBA RIVER SUB-BASIN** | | | | | | | |
| North Yuba River Above Middle Yuba River | 1,160 | 21 | 16 | 2.0 | -- | -- | New Bullards Bar Dam |
| **OREGON CREEK SUB-BASIN** | | | | | | | |
| Oregon Creek Below Log Cabin | 1,980 | 34 | 50 | -- | 0.2 | -- | Log Cabin Diversion Dam |
| Oregon Creek Above Middle Yuba | 1,470 | 61 | 56 | -- | 3.7 | -- | Log Cabin Diversion Dam |
| **MIDDLE YUBA RIVER SUB-BASIN** | | | | | | | |
| Middle Yuba River Above Oregon Creek | 1,460 | 64 | 62 | 7.0 | -- | -- | Our House Diversion Dam |
| Middle Yuba Creek Below Oregon Creek | 1,430 | 69 | 64 | 7.6 | -- | -- | Our House Diversion Dam |
| Middle Yuba Above North Yuba | 1,200 | 59 | 52 | 11.9 | -- | -- | Our House Diversion Dam |
| **YUBA RIVER SUB-BASIN** | | | | | | | |
| Yuba River Above Colgate Powerhouse | 530 | 30 | 26 | 7.0 | -- | -- | New Bullards Bar Dam |
| Yuba River Below Colgate | 500 | 47 | 34 | 7.9 | -- | 0.3 | New Bullards Bar Dam and New Colgate Powerhouse |

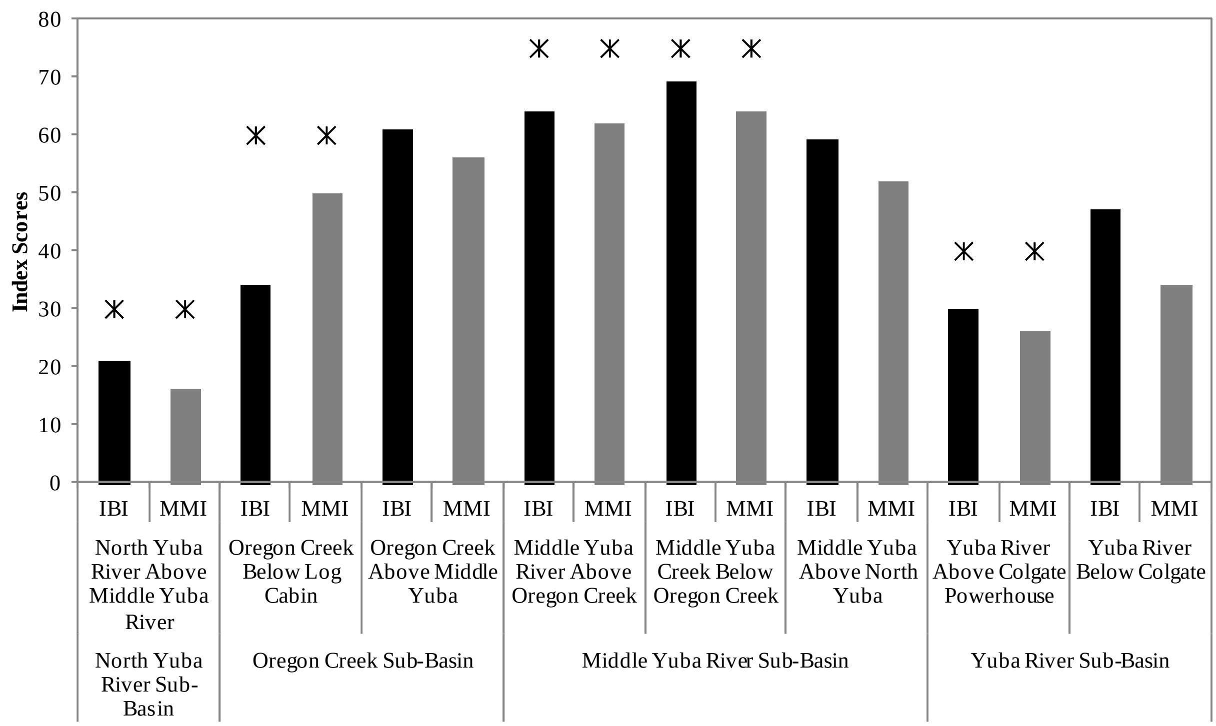


**Figure 3.2-1. Overview of scores by basin, stream, and indices. Sites with starred symbols represent locations where insufficient organisms were collected to make the resultant IBI and MMI scores reliable.**

### 3.2.1 North Yuba River

BMI samples were taken at a single site in the North Yuba River at a location approximately 2.0 RM downstream of New Bullards Bar Dam near the confluence with the Middle Yuba River. Sampling at the location provided 325 total organisms per grid, which is below the standard minimum of 500 organisms per grid used for IBI and MMI scoring. Therefore, the reliability of the calculated indices scores are low. Nonetheless, the IBI score was 21 and MMI was 16 and classified per MMI standards as in poor condition.

### 3.2.2 Oregon Creek

BMI were collected at two locations in the Oregon Creek Sub-Basin, 0.2 and 4.0 RM downstream of Log Cabin Diversion Dam. At the site downstream of Log Cabin Diversion Dam, 243 individuals per grid were collected. This count is insufficient to provide reliable IBI and MMI scores and should be viewed under that consideration. IBI scores were 34 at the site downstream of Log Cabin Diversion Dam site and 61 at the site upstream of the Middle Yuba River. MMI scores were 50 below Log Cabin Diversion Dam and 56 above the Middle Yuba River confluence. MMI scores for both locations were rated as fair.

### 3.2.3 Middle Yuba River

The Middle Yuba River was sampled for BMI in three locations, 7.5, 8.2 and 12.5 RM downstream of Our House Diversion Dam. At the site upstream of Oregon Creek site and the downstream of Oregon Creek, low abundance limited the collection of organisms to 486 and 476 individuals per grid, respectively. These counts are just under the standard 500 organisms per grid used for IBI and MMI scoring and therefore the reliability of the calculated indices scores are considered low. IBI scores were 64, 69, and 59 from upstream to downstream, respectively. MMI scores were 62, 64, and 52 from upstream to downstream, respectively. All MMI scores were rated as ‘fair’ and approached a rating of ‘good’ which is greater than 67.

### 3.2.4 Yuba River Sub-Basin

Samples of BMI were collected in two locations on the Yuba River 7.6 and 8.8 RM. The lower site is 0.56 RM below New Colgate Powerhouse does not have an impoundment, but releases water from deep within the upstream impoundment. Sampling at the upstream location only provided 198 total organisms per grid, which is below the standard 500 organisms per grid used for IBI and MMI scoring and also represented the lowest number collected for all samples. Therefore, the reliability of the calculated indices scores are considered low. Nonetheless, IBI scores were 30 and 47 from upstream to downstream, respectively. MMI scores were 26 and 34 from upstream to downstream with subsequent ratings of ‘poor’ and ‘fair’ respectively.

## 3.3 Aquatic Macroinvertebrate Sample QA/QC

The California Department of Fish and Wildlife (CDFW) Aquatic Bioassessment Laboratory (CDFW ABL) QA/QC and laboratory taxonomic determinations for the Yuba River

Development Project found minor differences in taxonomic ID that did not result in a change to the IBI quality rating at the site randomly selected for taxonomic QA/QC (Oregon Creek above Middle Yuba River Confluence). Most taxonomic discrepancies occurred with Chironomidae, elmid beetles, and ephemeroptera taxa as well as differences in taxonomic resolution, and general count (see Attachment 3.1-E).

Based on the results of the CDFW QA/QC taxonomic verification, the IBI score of the QA/QC site was recalculated to evaluate potential changes to the score. The taxonomic discrepancies between CDFW ABL and laboratory determinations resulted in an increase of the IBI value from a score of 61 to 73. Both of these scores are in the Fair condition range, however, the later score is on the higher end of the 'Fair' condition classification. This means that the CDFW results suggest that the site is in better condition than the results found from the Licensee's laboratory findings.

The original results and discussion remain unchanged for each QA/QC'd site, as the CDFW QA/QC did not address every site. This QA/QC's primary purpose was to assess the accuracy and precision of the laboratory analyses, with an independent reviewer (i.e., CDFW), and to describe the potential variance that may be present. The CDFW review indicates that despite the variances from the original taxonomic determinations, condition classification at the site remained unchanged.

# 4.0 Discussion

BMI communities in streams can be highly influenced by a variety of naturally occurring and human-induced factors, including annual hydrologic cycles, timing and magnitude of spring outflows, water temperatures, streambed substrate composition, channel gradient, bank erosion and sediment deposition, pollution, riparian habitat degradation, instream-mining, hydropower development and recreational activities. The presence of dams and diversions on streams can substantially affect the supply and mobility of streambed sediment by retention in storage reservoirs and alteration of the magnitude and timing of stream flows, which can significantly affect the abundance and distribution of BMI communities. Rehn (2009) found that BMI-based IBI metrics tend to be lowest immediately downstream of dams and diversions but normally increase with distance below these structures. However, stream characteristics such as substrate type and riparian vegetation composition, which affect primary stream productivity, can affect BMI community metrics, regardless of distance from dams or diversion structures (Bahuguna et al. 2004). Section 4.1 provides a review of existing historical data and how previous information may highlight any potential changes over time. Then following the historical review, Section 4.2 offers additional discussion of current findings based on habitat, water quality, and other influential factors.

## 4.1 Comparison with Historical Data

Available historical BMI data for comparison with the sites evaluated in this study were limited to surveys conducted by the South Yuba River Citizen's League (SYRCL) in the Middle Yuba River above the confluence with Oregon Creek from 2004 through 2006 and in 2008; in the

Middle Yuba River below the Oregon Creek confluence in 2009; and in Oregon Creek above the Middle Yuba River confluence in 2007 and 2009 (G. Reedy, pers. comm., 2012). The historical BMI sampling sites occurred near the study sites. Stream habitat characteristics, which influence BMI community structure, may have changed between these historic sampling events and 2012. Physical habitat data were not available for the historical sites; therefore, only a limited discussion is provided of the factors potentially influencing differences between Project and historical sites.

IBI and MMI scores could not be calculated from historical data because taxonomic resolution was not consistent with requirements for the IBI and MMI. However, many of the FERC-approved study-specific metrics were extracted from the historical data and could be directly compared to this study's data. Therefore, a limited and qualitative comparison of available metrics was conducted for each location (Tables 4.1-1 to 4.1-3).

### 4.1.1 Middle Yuba River Above Oregon Creek Confluence

SYRCL collected BMI samples near the Study 3-1 site locations in the Middle Yuba above the Oregon Creek confluence in 2004, 2005, 2006 and 2008. Taxonomic richness was similar in 2012 compared to the results of historical surveys with the highest value occurring in 2005. The EPT richness metrics varied across years with no temporal trend. The difference in overall taxonomic richness could be due to various environmental factors such as water temperature and flow, time of year the sample was collected, sampling effort, and sample identification effort. The percent composition of EPT taxa and the SDI values were similar to the various historical sampling years. The relative abundance of collector-filterer and collector-gatherer BMI's varied between 50 percent and 80 percent, but showed no obvious pattern from year to year. The 2012 sample saw an increase in predator abundance and a decrease in scraper abundance, compared to historical samples, which could be due to sampling various habitat types in 2012 versus targeted riffles in the historical samples. (Table 4.1-1.)

**Table 4.1-1. BMI metrics from samples collected for Study 3-1 at the Middle Yuba River Above Oregon Creek Confluence Site and historical data at the same location from SYRCL.**

| BMI Metrics | Study 3-1 Site, 2012 | SYRCL Site, 2004 | SYRCL Site, 2005 | SYRCL Site, 2006 | SYRCL Site, 2008 |
|---|---|---|---|---|---|
| **RICHNESS** | | | | | |
| Taxonomic Richness | 37 | 33 | 42 | 37 | 37 |
| No. EPT Taxa | 16 | 18 | 20 | 23 | 17 |
| No. Ephemeroptera Taxa | 5 | 10 | 9 | 10 | 7 |
| No. Plecoptera Taxa | 4 | 1 | 1 | 2 | 3 |
| No. Trichoptera Taxa | 7 | 7 | 10 | 11 | 7 |
| No. Coleoptera Taxa | 6 | 4 | 7 | 4 | 6 |
| **COMPOSITION** | | | | | |
| % EPT | 55.3 | 54.5 | 47.6 | 62.2 | 51.7 |
| Shannon Diversity Index (SDI) | 2.6 | 2.7 | 2.9 | 2.8 | 3.1 |
| **FEEDING** | | | | | |
| % Collector-filterer+Collector-gatherer Individuals | 67.1 | 58.9 | 78.6 | 62.9 | 50.1 |
| % Scrapers | 11.1 | 33.3 | 16.4 | 32.0 | 14.6 |
| % Predators | 17.5 | 6.1 | 3.2 | 2.7 | 16.4 |
| % Shredders | 0.6 | 0.0 | 0.0 | 0.6 | 0.0 |

### 4.1.2 Middle Yuba River Below Oregon Creek Confluence

SYRCL collected BMI samples from a similar location to that of the sampling location identified in Study 3-1 for the Middle Yuba below the Oregon Creek confluence in 2009. Taxonomic richness was similar in 2012 compared to the results of historical surveys with the highest value occurring in 2009. The EPT richness values were lower in 2012 which is likely due to the sampling of non-riffle habitats. The percent composition of EPT taxa and the SDI values were similar to the various historical sampling years. The relative abundance of collector-filterer and collector-gatherer BMI's varied between 57 percent and 64 percent, but showed no obvious pattern from year to year. The 2012 sample saw an increase in predator abundance and a decrease in scraper abundance, compared to the 2009 sample, which could be due to sampling various habitat types in 2012 versus targeted riffles in the historical sample (Table 4.1-2).

**Table 4.1-2. BMI metrics from samples collected for Study 3-1 at the Middle Yuba River below Oregon Creek Confluence Site and historical data at the same location from SYRCL.**

| BMI Metrics | Study 3-1 Site, 2012 | SYRCL Site, 2009 |
|---|---|---|
| **RICHNESS** | | |
| Taxonomic Richness | 36 | 42 |
| No. EPT Taxa | 15 | 18 |
| No. Ephemeroptera Taxa | 4 | 5 |
| No. Plecoptera Taxa | 4 | 5 |
| No. Trichoptera Taxa | 7 | 8 |
| No. Coleoptera Taxa | 4 | 6 |
| **COMPOSITION** | | |
| % EPT | 51.5 | 52.4 |
| Shannon Diversity Index (SDI) | 2.8 | 3.2 |
| **FEEDING** | | |
| % Collector-filterer+Collector-gatherer Individuals | 57.1 | 63.9 |
| % Scrapers | 15.1 | 16.5 |
| % Predators | 23.5 | 10.6 |
| % Shredders | 0.2 | 1.2 |

### 4.1.3 Oregon Creek above Middle Yuba River Confluence

SYRCL collected BMI samples from a similar location to that of the sampling location identified in Study 3-1 for the Middle Yuba above the Oregon Creek confluence in 2007 and 2009. Taxonomic richness was lower than that observed in 2007 but slightly higher than in 2009. The EPT richness values were significantly lower in 2012 than in 2007 and 2009. The difference in overall taxonomic richness could be due to various environmental factors such as water temperature and flow, time of year the sample was collected, sampling effort and sample identification effort. Specifically, in 2012 samples were collected from various habitat types while in 2007 and 2009 samples were collected from targeted riffle habitats. Despite these sampling differences, the SDI values were similar over the various sampling years and % EPT was highest in 2009. The relative abundance of collector-filterer and collector-gatherer BMI's was highest (59%) in 2012, again likely due to the variety of sampling habitats. The 2012 sample saw an increase in shredder abundance and a decrease in scraper abundance, compared to historical samples, which could be due to sampling various habitat types in 2012 versus targeted riffles in the historical samples (Table 4.1-3).

 

**Table 4.1-3. BMI metrics from samples collected for Study 3-1 at the Oregon Creek Above Middle Yuba River Confluence Site and historical data at the same location from SYRCL.**

| BMI Metrics | Study 3-1 Site, 2012 | SYRCL Site, 2007 | SYRCL Site, 2009 |
|---|---|---|---|
| **RICHNESS** | | | |
| Taxonomic Richness | 35 | 48 | 41 |
| No. EPT Taxa | 12 | 21 | 21 |
| No. Ephemeroptera Taxa | 3 | 7 | 6 |
| No. Plecoptera Taxa | 5 | 6 | 6 |
| No. Trichoptera Taxa | 4 | 8 | 9 |
| No. Coleoptera Taxa | 4 | 6 | 7 |
| **COMPOSITION** | | | |
| % EPT | 39 | 39.1 | 62.4 |
| Shannon Diversity Index (SDI) | 2.9 | 3.1 | 3.1 |
| **FEEDING** | | | |
| % Collector-filterer+Collector-gatherer Individuals | 58.5 | 39.8 | 35.2 |
| % Scrapers | 4.6 | 22.1 | 16.7 |
| % Predators | 18.7 | 20.2 | 16.1 |
| % Shredders | 2.7 | 0.3 | 15.6 |

## 4.2 Comparison within Sub-Basins

The following section describes the trends in BMI index site scores and potential interrelated factors leading to those scores. Overall site scores from both indices found that higher quality sites (as ranked) were found further downstream. This is similar to findings by Rehn (2009). Rehn (2009) stated that sites below diversions tend to have similar composition to above-dam or above-diversion sites. Sites below reservoirs generally show a significant difference in reduced quality. Rehn suggests that reduced quality may include lower diversity, EPT (i.e., ephemoptera, plecoptera, and trichoptera) richness, and reduced intolerant taxa and that studies showed that these issues may lessen with distance downstream. Generally, results from current sampling followed these trends.

### 4.2.1 North Yuba River

A single sample location was located in the North Yuba River Sub-basin near the confluence with the Middle Yuba River and only 2.0 mi downstream of New Bullards Bar Dam. This location had the lowest IBI and MMI scores of all the study sites. Additionally, an insufficient number of BMI were collected at the site, making the calculated IBI and MMI scores less reliable.

It is likely that the low abundance of BMI and low IBI and MMI scores at this site are partially related to available habitat. Habitat at this site was dominated by pool (79%) with boulder substrates (49%). The dominance of these parameters are not ideal for high abundance and diversity of BMI populations. Another factor possibly contributing to the overall low scores was the lack of riparian vegetation. Water quality parameters were within expected ranges and did not appear to be a limiting factor to BMI.

### 4.2.2 Oregon Creek

There were two sampling locations on Oregon creek, both located downstream of Log Cabin Diversion Dam. IBI and MMI scores were both higher at the furthest downstream site. However, it is important to note that an insufficient number of BMI were collected at the upstream site, making the calculated IBI and MMI scores less reliable for that sampling location.

Run and pool were the dominant habitat types at the upstream site while the lower site was composed primarily by pool followed by riffle. Riffle habitats tend to support greater abundance and diversity of BMI and may partially explain the higher scores observed at the lower site. A broad variety of substrates were observed at the two sites and for the most part were proportionately similar. However, the upstream site had a significantly higher proportion of bedrock (28%) compared to the downstream site (13%). This higher proportion of bedrock may have contributed to lower metric scores at the upstream site. Canopy cover, water quality, and other habitat attributes among the sites were similar.

### 4.2.3 Middle Yuba River Sub-Basin

The three sampling locations in the Middle Yuba River were all located downstream of the Our House Diversion Dam. There was not an apparent trend in IBI or MMI scores as distance downstream of the diversion dam increased.

The highest IBI and MMI scores were calculated for the site located below the Oregon Creek confluence (i.e., 69 and 64, respectively). This site had the greatest amount of riffle habitat with the least amount of pool habitat and a cobble dominated substrate. While the other two sites in the Middle Yuba River had IBI and MMI scores above 50, there was a substantial increase in pool habitat and boulder substrate. Riparian vegetation was similar throughout the three sampling sites as were basic water quality parameters and other site characteristics.

These riffle dominated habitats, which often include a large percentage of cobble, provide more surface area and interstitial space for BMI communities to be successful and may have contributed to higher metric scores. In addition, cobble dominated substrates provide more flow refugia for BMI, especially those with limited mobility.

### 4.2.4 Yuba River Sub-Basin

There were two sampling locations in the Yuba River, one upstream and one downstream of New Colgate Powerhouse. IBI and MMI scores were higher below New Colgate Powerhouse than those observed at the upstream location. An insufficient number of BMI were collected at the upstream site, making the calculated IBI and MMI scores less reliable.

It appears that IBI and MMI scores were positively related to habitat type and substrate. The sampling location downstream of New Colgate Powerhouse was primarily composed of riffle (50%), with Boulder (49%) and Cobble (35%) as the most prominent substrates. Riparian vegetation was similar throughout the two sampling sites as were other general site characteristics. Water quality measurements varied due to the nature of water being released from the powerhouse. Significantly cooler water temperature and increased DO was measured downstream of the powerhouse.

# 5.0 Study-Specific Consultation

The FERC-approved study required one study-specific consultation, which is described below.

## 5.1 Selection of Sampling Sites

The FERC-approved study required:

> YCWA will select sampling sites, and then invite interested and available Relicensing Participants into the field to comment on selected sites (Step 1).

YCWA invited Relicensing Participants into the field during site selection on November 7 and 8, 2011. Participants in the field agreed to all sampling sites.

# 6.0 Variances from FERC-Approved Study

There were three variances from the FERC-approved study related to sampling sites and collection methods. First, the FERC-approved study plan included 10 sampling locations. During the site selection process, YCWA and Relicensing Participants agreed to not sample at two of the locations; the Middle Yuba River below Our House Dam and the North Yuba River below New Bullards Bar Reservoir. These sites were not sampled due to poor site conditions for implementing the approved protocol. If samples were collected at these locations it would have been difficult to compare the results with historical data and other locations included in the study. The remaining eight sampling sites provided adequate distribution throughout the Project and included at least one site further downstream from each of the two sites that were not sampled.

Second, the FERC-approved study plan specified that the SWAMP targeted riffle composite methodology would be followed. However, this methodology would not have been feasible for the selected sites due to a lack of available riffle habitats and therefore the SWAMP RWB – multi-habitat protocol for documenting and describing BMI assemblages and physical habitat was utilized (Ode 2007). The RWB methodology included substrate classification for each transect which negated the need for additional substrate collection methods described from the FERC-approved study plan. Use of the RWB collection methodology resulted in improved representation of available habitat and BMI assemblages in the study area and did not result in a substantial change to the data collection methods or prevent the study from meeting its objectives.

Third, the FERC-approved study specified the study be completed by the end of September 2012. The quality assurance/quality control review of study results took longer than anticipated resulting in a slight delay of study completion.

# 7.0 Attachments to This Technical Memorandum

This technical memorandum includes four attachments:

- Attachment 3-1A — Representative Photographs [1 Adobe pdf file: 5 MB; 31 pages formatted to print double sided on 8 ½ by 11 paper]
- Attachment 3-1B — Water Quality and Physical Habitat Summaries [1 Adobe pdf file: 122 kB; 9 pages; formatted to print double sided on 11 by 17 paper]
- Attachment 3-1C — Aquatic Macroinvertebrate Taxonomy and Enumeration [1 Adobe pdf file: 195 kB; 18 pages; 4 pages formatted to print double sided on 8 ½ by 11 paper and 14 pages formatted to print double sided on 11 by 17 paper]
- Attachment 3-1D — Scanned Field Datasheets [1 Adobe pdf file: 25 MB; 210 pages formatted to print double sided on 8 ½ by 11 paper]
- Attachment 3-1E — QA/QC Report [1 Adobe pdf file: 72 kB; 18 pages formatted to print double sided on 8 ½ by 11 paper]

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