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LOWER CACHE CREEK
OFF-CHANNEL PITS MERCURY MONITORING PROTOCOLS

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Introduction and Background

Cache Creek is known to be a mercury-impacted watershed, dating from extensive mercury mining activities in the upper watershed from the mid 1800s through the mid 1900s. In the course of mining and refining mercury in the upper watershed throughout that period, some mercury was also lost into the downstream watershed. Additional mercury continues to discharge from the historic mercury mining areas. The historic and ongoing mercury movement downstream has created an elevated mercury environment in lower Cache Creek.

Since the 1800s, the lower creek has also been the source of aggregate rock and gravel material for a range of construction activities in the region and beyond. In 1996/1997, Yolo County partnered with the aggregate industry to move mining of aggregate rock material out of the Cache Creek channel, to adjacent floodplain areas.

As these off-channel mining operations proceed, consistent with permits granted by the County, they will extract the feasibly accessible aggregate material available within each mining area. As mining is completed, reclamation will occur. In many cases, reclamation will be to a lake or pond with surrounding habitat, adjacent to Cache Creek. These monitoring protocols address the issue of potential mercury contamination in de-commissioned aggregate mining ponds adjacent to Cache Creek.

A large amount of research and monitoring has been directed toward Cache Creek in relation to its mercury legacy. A baseline study was conducted in the lower creek adjacent to the off-channel aggregate-mining zone (Slotton and Ayers 2013). In that work, a series of large fish, small fish, and aquatic invertebrates were collected and analyzed for mercury. The most prevalent species were sampled, with a particular focus on species most likely to inhabit or move into the off-channel ponds. The 2013 study was completed pursuant to Section 10-5.517 of the County's Reclamation Ordinance which regulates mercury bioaccumulation in wildlife. A major purpose of that baseline in-creek work was to provide updated ambient mercury concentration

information for the County that could be used to compare to future testing of mercury conditions in off-channel mining ponds (also called "wet pits") following their initial creation and subsequent reclamation. The 2013 report also compiled other existing data from this region of Cache Creek, from four earlier studies:

- A 1996 report entitled "Off-Channel Gravel Pit Lakes – Mercury Considerations, Lower Cache Creek, Yolo County, California" (Slotton et al. 1996, study and report)
- The original lower Cache Creek baseline study (Slotton et al. 1997, study and report)
- A pilot study in and around the Cache Creek Nature Preserve (conducted 2000-2004, reported in Slotton and Ayers 2004)
- A watershed-wide study for the State's CalFed program (conducted in 1998-2000, reported in Slotton et al. 2004).

These other data are useful as reference levels for similar data that may be collected in off-channel gravel-mining ponds. However, the earlier collections were parts of other projects, with incomplete, disconnected, and old data in relation to current off-channel pond monitoring. The extensive 2011-2012 updated creek baseline study (reported in Slotton and Ayers 2013) provides the most comprehensive and relevant comparison data base.

The subject mercury monitoring protocols are a companion to the 2013 baseline study report and provide recommended and updated protocols for mercury testing in the off-channel wet pits as specified in the County's regulations.

Proposed Modifications and Protocols

Section 10-5.517 of the County's Reclamation Ordinance identifies two tiers of monitoring that are required for purposes of satisfying the local regulatory requirements:

1) Five years of annual monitoring once excavation has reached depths that cause the pit to fill with water ("lake creation"); and

2) Ten years of biennial monitoring once reclamation has been completed.

The County's regulations (Section 10-5.517) specify that the monitoring shall be performed by a qualified aquatic biologist or limnologist acceptable to the County and shall include specified steps.

The requirements from the 1996 ordinance are provided verbatim below in bold italic type. Relevant background information, discussion, and proposed modifications and protocols follow each ordinance excerpt. Following this explanatory/rationale/discussion section, the proposed revised Ordinance is presented on pages 11-13.

Yolo County Surface Mining Reclamation Ordinance
Sec. 10-5.517. Mercury bioaccumulation in wildlife.

Prior to the approval of reclamation of aggregate mining areas to permanent lakes, the County shall commission a sampling and analysis program, to be implemented in one existing wet pit mining area within the OCMP planning area, to evaluate the potential for increased methylmercury production associated with wet pit mining and reclamation of mining areas to permanent lakes. The program shall include the sampling of water and sediments from the bottom of the existing pit and analysis of the samples for organic content; pH; dissolved oxygen content; dissolved carbon content; and total mercury. In addition, samples of predatory fish (preferably largemouth bass) shall be collected and analyzed for mercury and methylmercury content.

The requirement above was satisfied by a May 1996 report included as Appendix C in the 1996 OCMP FEIR. The name of that report is "Off-Channel Gravel Pit Lakes – Mercury Considerations, Lower Cache Creek, Yolo County, California. Preliminary Study, April 1996", with a document date of May 2, 1996. The 1996 mercury assessment was conducted at the time the Reclamation Ordinance was developed (1996) at two active off-channel mining ponds. These ponds were located just east of Highway 505, on the current CEMEX property, formerly owned by Solano Concrete. The ponds were moderately deep (approximately 40 feet) and representative of the then-proposed future off-channel gravel mining ponds. Water, sediment, fish, and aquatic invertebrates were analyzed for mercury and methylmercury as listed in the ordinance. Related analyses included water column profiling of the specified parameters and analysis of associated water and sediment components.

This assessment reached the following conclusions:

- "Water concentrations of mercury at the time of this April 1996 sampling (<2-4 ng/L) were lower and less variable than corresponding levels from adjacent Cache Creek, and were well below the water quality criterion for mercury (12 ng/L). "
- "Bottom sediments were somewhat elevated at 0.2-1.0 ppm, though this is typical for this region and is far lower than levels seen in highly contaminated sites."
- "Fish collected from the existing gravel pit lakes were of some concern, in that they approached and in several cases surpassed the 0.5 ppm consumption guideline for fish mercury. However, these fish muscle mercury concentrations were very similar to concentrations found in corresponding samples from adjacent Cache Creek."

If the initial sampling indicates either of the following conditions, the County shall perform verification sampling:

(a) Average concentrations of total mercury in excess of 0.000012 milligrams per liter (mg/l) in the water; and

(b) Average mercury levels in fish samples in excess of 0.5 milligrams per kilogram (mg/kg).

The sampling did not exceed either threshold, so verification sampling was not required. The above listed water threshold level of 0.000012 milligrams per liter corresponds to 12 nanograms per liter (the aqueous units most relevant to current mercury research and monitoring). The 1996 assessment of the representative off-channel mining ponds found water mercury concentrations of <2-4 nanograms per liter from all depths, and found them to be lower and less variable than corresponding water mercury in adjacent Cache Creek.

The fish collections included 24 angling-sized fish of several species found to be present in the ponds. Average mercury concentration for these fish was 0.39 mg/kg, lower than the 0.5 mg/kg threshold level listed for average fish mercury levels in the ordinance. A set of comparison fish from lower Cache Creek averaged a very similar, and statistically indistinguishable 0.36 mg/kg.

If verification sampling indicates exceedance of these mercury criteria, the County shall approve the reclamation of mining areas to permanent lakes only if the average level of mercury in fish collected from the existing mining pits is shown to be equal to or less than ambient (background) mercury levels determined from a representative sample of similar species of fish (of similar size) collected in the Cache Creek channel within the planning area.

Verification sampling was not required because the listed thresholds were not exceeded. The County proceeded at the time to approve reclamation of various mining areas to permanent lakes. The 1996 study also found fish mercury levels in the ponds to be very similar to fish mercury in lower Cache Creek. The two ponds assessed in 1996 were later filled and converted to farmland.

The determination of the ambient mercury level shall be performed by the County prior to the excavation of any new wet pit mine and at years ten (10), twenty (20) and thirty (30) in the permit time period, and shall be paid for by the mining permit operators on a fair-share basis. The County shall evaluate available data to determine any significant change in ambient concentrations of mercury in fish within the Cache Creek channel.

This ambient (baseline) testing was conducted for fish and water mercury in 1996 and more extensively for fish in 1997. The 10-year reassessment was inadvertently missed in 2007 and was conducted in 2011-2012 (reported in 2013) when the oversight was discovered by County staff. Fish mercury was found to be at similar levels as seen in 1996-1997, with the highest concentrations in bass, pikeminnows, and green sunfish, as before.

An extensive mercury monitoring program was also conducted at the Cache Creek Nature Preserve pond and adjacent Cache Creek and Gordon Slough, beginning in 2000 (reported in

2004). The Nature Preserve reclamation was studied as an additional representative gravel mining pond reclamation case.

> ***In the event of approval of reclamation of mined areas to permanent lakes, each mining area to be reclaimed to a permanent lake as part of each approved long-range mining plan shall be evaluated annually by the operator for five (5) years after creation of the lake for conditions that could result in significant methylmercury production. An additional ten (10) years of biennial monitoring shall be performed after reclamation of each lake has been completed.***

The County approved five applications in 1996 that all included reclamation to at least one permanent lake, and there have been additional approvals since that time. The phrase "after creation of the lake" in the first sentence of the excerpt above is distinguished from the last sentence which refers to "after" reclamation has been "completed". This suggests that five years of monitoring is required once a lake is created (e.g. fills with groundwater) and another ten years of monitoring is required after reclamation is completed. The County has confirmed this interpretation. Once each pit is identified by the County as becoming subject to this regulation, five years of evaluation must occur in order to satisfy the requirement. Once mining and reclamation are complete, mercury monitoring on these lakes is required every two years, for a ten-year period.

In 2011, which was the first year lake monitoring pursuant to this regulation was undertaken, the County identified six pits which met this criterion: Syar Pit B1, Cemex Phase I Pit, Cemex Phase III/IV Pit, Teichert-Esparto Reiff Pit; Teichert Esparto Mast Pit, Teichert Woodland – Storz Pit.

The purpose of this report is to provide technical protocols for subsequent evaluations that will ensure comparable data and feasible implementation in light of the requirements of the ordinance and other applicable regulations, historic reporting under the County's program, modern technical capabilities, and current understanding of mercury issues.

> ***The evaluations shall be conducted by a qualified aquatic biologist or limnologist acceptable to the County and shall include the following analyses:***
>
> ***(c) Lake condition profiling during the period of June through September, including measurements of pH; eH (or redox potential); temperature; dissolved oxygen; and total dissolved carbon.***

This requirement should first be modified to occur later in the monitoring process, as described below. Lake condition profiling can be useful in sorting out the possible sources of high methylmercury exposure—if significantly elevated exposure is found with fish collections in multiple years. Therefore, it is recommended that lake condition profiling be conducted if a problem is found, but not necessarily in conjunction with every routine set of fish collections. Some of the parameters requested are redundant and/or unnecessary. Total dissolved carbon and

pH can be important parameters in clearwater and humic lakes in other parts of the country, but in this region of California there is little meaningful variation. Also, eH (or redox potential) varies in parallel with dissolved oxygen.

The key parameters to profile from surface to bottom are temperature and dissolved oxygen. This is because one of the most important potential issues with ponds and lakes is the phenomenon of warm season thermal stratification. This is the physical separation, like oil and water, of sun-warmed upper waters from cool deep waters. It can lead to the depletion of oxygen, through normal microbial metabolism, in the deep, now-isolated water, and the movement of methylmercury into that anoxic water, and then easily into the food web. It is recommended that lake profiling of temperature and dissolved oxygen be conducted in lakes found to contain significantly elevated fish mercury over three or more consecutive years. In that event, lake condition profiling should be undertaken throughout the period extending from mid-May through mid-November in order to follow lake condition across the typical warm season cycle for this region (this is longer than the June-September period listed in the ordinance). During this period, the recommended schedule is: five water column profiling events per year, distributed approximately every 6 weeks between mid-May and mid-November. Maximum water depth should be determined. The bottom area and volume potentially effected by seasonal anoxia should be calculated. Additional analyses may include characterization of water quality and bottom sediment parameters most relevant to mercury bioaccumulation (the choice of specific analyses may change as mercury biogeochemistry science continues to develop, but may include: sediment organic percentage, total mercury, methylmercury, and/or 'reactive' mercury; and aqueous suspended solids and organic carbon). Again, it is recommended that this section be moved to follow item (f) of the ordinance.

> ***(d) Collection of a representative sample of fish specimens (including a minimum of five (5) predator fish if available) and analysis of the specimens for mercury content. Sampling and analysis shall be conducted using methodologies which are consistent with the California State Water Resources Control Board Toxic Substances Monitoring Program procedures, or more stringent procedures.***

Fish samples are the core of most mercury monitoring. They represent the direct potential exposure to human and wildlife fish-consumers. They also provide an ideal measure of mercury exposure, for comparison between ponds and between ponds and adjacent Cache Creek. Based on this understanding, developed after the Ordinance was written in the 1990s, this core component should be expanded in order to provide useful feedback information. In particular, the target number of samples of each monitored large fish species should be 10, and small, young-of-year fish should be included in the monitoring.

As reflected in the excerpt above, the 1996 ordinance states that "a representative sample of fish specimens (including a minimum of five (5) predator fish if available)" should be taken and analyzed for mercury. "Representative" is interpreted to mean collection of a statistically useful number of each general type of fish that is found to be present in the lake. For example, if there are one or two predatory species like bass, several midwater panfish like bluegill or green sunfish, and one or two bottom species like catfish, it is recommended that collections target 10

individuals of the same species for each of these three fish groups (for example, 10 largemouth bass, 10 green sunfish, and 10 channel catfish). This will result in up to 30 large (adult, angling sized, > app. 6") fish samples which should be analyzed for fillet muscle mercury (the part eaten by people and that contains most of the mercury). If fewer species are available, more than 10 individuals should be sampled from the most relevant species, particularly a predator like bass, with the total count remaining at up to 30 large fish samples, to provide statistical strength.

It is likely that these lakes will also be colonized by a variety of small fish species, like red shiner, mosquitofish, fathead minnow, and young bluegill and green sunfish. Good comparative information has been collected from Cache Creek for small fish species like these. It is recommended, if small fish species are present in the lake, that samples should be taken. Small fish are the most relevant samples in relation to wildlife consumption, because they are what most fish-eating birds and other animals eat. Additionally, because small, young-of-year fish, by definition, track methylmercury exposure conditions specifically of the year sampled, they will show an immediate change from year to year if exposure conditions change. As wildlife consume fish whole, mercury analyses of these samples should be done on a whole-fish basis, consistent with the baseline collections in the creek.

Small fish sampling should target 3 prevalent species, as available. These should be characterized either with 15 individual whole fish samples or 4 multi-individual whole fish composites (≥5 fish per composite) for each species. Each composite should ideally include ≥5 similar-sized individuals, with the 4 composites spanning the range of typical sizes present, but with the individuals within each composite being closely matched in size (for example, for red shiners: 5-10 at 35-40 mm, 5-10 at 40-45 mm, 5-10 at 45-50 mm, and 5-10 at 50-55 mm). With 3 species, this will result in up to 12 multi-individual small fish composite samples or 45 individual small fish samples for each monitored lake.

Use of fish of different species and sizes provides different information as part of the assessments. Large fish muscle mercury provides a direct measure of human health risk. Small, young-of-year fish provide a measure of methylmercury exposure conditions specifically for that year sampled and can be compared from year to year to discern changes in exposure conditions. They also reflect risk for fish-eating wildlife.

Invertebrates were collected, analyzed, and reported on in both the 1996 and 2013 reports. Invertebrates can provide useful information under certain circumstances, but are generally not ideal for interpretation of methylmercury exposure levels because they typically contain significant and variable proportions of inorganic (non-methyl) mercury, and can change concentrations quickly. However, they can provide useful data if fish are not available.

Fish samples may be collected with a variety of methods, including electro-fishing, seining, trapping, gill netting, and angling. Extra fish not needed for analysis should be quickly released, to avoid unnecessary mortality. For samples chosen for mercury analysis, it is critical that they be weighed and measured, and held on ice for transport to the laboratory, where they may be stored in a freezer. It is also critical that the samples be protected from freezer desiccation ("freezer burn"), as this is one of the largest potential sources of analytical error. For large fish intended for muscle mercury analyses, the fish should be carefully sealed in freezer weight zip-

close bags with all air removed before storing in a laboratory freezer. Alternatively, a piece of fillet muscle may be stored. In that case, the piece should be taken from the thickest part of the fillet, the skin should be left on, and the sample should be sealed in plastic wrap and then in a freezer weight bag with all air removed. At the laboratory, after thawing for analysis, the analytical portion should be dissected out of the center of the fillet piece. For fish delivered to the laboratory whole (frozen or on ice), after thawing, the analytical portion should be dissected from the thickest part of the fillet, sometimes called the "shoulder" area above the lateral line and behind the gills. In either case, the objective is to obtain a clean sample of fillet muscle tissue (no skin etc.). Another good approach, developed at UC Davis, is to field-collect small biopsy samples of fillet muscle, allowing the live release of sampled fish. This, however, requires careful sealing of biopsy samples into pre-weighed vials to be used throughout the succeeding analytical process without further sample transfer.

For the small fish samples, protection from potential freezer burn is even more important than for the large fish, because the small fish can become desiccated more rapidly. To keep this from occurring, small fish samples should be stored frozen, but with water surrounding them. This can be done by placing groups of small fish in doubled, freezer weight zip-close bags, adding enough water to surround the fish, and removing all air while sealing, then placing in the freezer (or temporarily on dry ice if this is done directly in the field). Preparation for analysis will involve thawing the samples and removing surface moisture, and carefully homogenizing each composite. If done directly with the fresh samples, great care must be taken to avoid desiccation. Alternatively, the safest approach is to first dry and then uniformly homogenize (powder) the samples. In this case, the samples will be analyzed dry, so it will be necessary to calculate the fresh sample moisture percentage, so that the dry weight mercury concentration can be converted to the corresponding natural, wet/fresh mercury concentration. Sample moisture percentage should be determined through sequential weighings of the sample container, the container with fresh sample, and finally the container with stabilized dry sample following 48 hours in a laboratory oven at 50-60 °C.

Since 1996 when the ordinance was written, mercury analytical technology has become widespread and more reliable. Most of the currently available techniques would be adequate for this work. It will be important, though, to have a sufficient amount of quality assurance / quality control (QA/QC) samples to assure the data interpreters that the data are reliable. This QA/QC should include method blanks, replicate analyses of some of the fish samples, spiked samples, and samples of reference materials containing certified levels of mercury. Results from the QA/QC samples must fall within acceptable ranges before the fish sample data can be treated as reliable. For the most consistent results and for inter-comparison, ideally a single laboratory with a strong track record should be used for the monitoring, including baseline creek analyses.

(e) The results of the evaluation shall be summarized in a report and submitted to the County. The report shall include a comparison of the site-specific data to available data on the background concentrations of mercury in fish within the Cache Creek watershed. The County shall be responsible for submitting the data on mercury levels in fish to the California Department of Fish and Game and the Office of Environmental Health Hazard Assessment for a determination of whether a fish

advisory should be issued.

(f) If a fish advisory is issued, the owner/operator shall be required to post warnings on fences surrounding the mining pit lakes which prohibit fishing in the lakes and describe the fish advisory.

If the average fish specimen mercury content exceeds the statistically verified ambient mercury concentrations for comparable fish species (of similar size) collected within the CCRMP planning area for two (2) consecutive years, wet pit mining on property controlled by the mining operator/owner shall be suspended and the owner/operator shall either:

Fish mercury is often quite variable from year to year and place to place. Since many water bodies, including the baseline creek, can experience shifts of up to ±50% or more in fish mercury levels based solely on natural changes in factors that influence mercury cycling, it is recommended that this requirement be clarified to be triggered if lake mean fish mercury levels are found to be, statistically, ≥30% higher than "comparable levels in Cache Creek" for three or more consecutive years.

(g) Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material; or

(h) Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible and reliable method or reducing methylmercury production or exposure to elevated mercury levels. Potential mitigation could include permanent aeration of the bottom levels of the lake, alteration of the water chemistry (increasing pH or dissolved organic carbon levels), control of anaerobic bacteria populations, or removal and replacement of affected fish populations. The mitigation plan would require review by the Regional Water Quality Control Board, California Department of Fish and Game, and the Yolo County Department of Environmental Health. (The removal and replacement of fish is not intended to be a long-term solution.)

Since the time this ordinance was written, methods for controlling unacceptable mercury levels have emerged and it is anticipated that new technologies will become available over time. It is recommended to retain flexibility in addressing mercury concerns. At this time, one of the most straightforward options, particularly for deep basins where the bottom waters become anoxic in the summer/fall, is to physically mix the bottom waters up into the oxygenated surface waters, so that there is no anoxia in the lake's bottom water (and the associated movement of methylmercury into that anoxic water). The simplest way to accomplish this is with a well-placed bubbler in the deepest point of the lake. Rather than "aerating the water" directly, the rising column of bubbles forms a strong upward current that pulls the cool, low-oxygen bottom water up into the warm, oxygenated surface layer, effectively mixing the lake. The ordinance

language states that ***removal and replacement of fish is not intended to be a long-term solution***. However, if removal of a high-bioaccumulating species like bass is accompanied by replacement with a lower bioaccumulating species like sunfish, the net effect could be positive and long-lasting. Additional potential site-specific remediation approaches will likely be developed in the field of mercury biogeochemistry over time.

> ***The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)***

It is now well known that every aquatic system may have its own unique mercury cycle. So, it is not reasonable to apply one mitigation, like a deep lake thermal destratification technique, to other lakes that have no anoxic bottom waters, etc. Similar water bodies *may* benefit from the same mitigation approach, but each should be assessed, and remediated, individually.

Incorporating these updates and recommendations, proposed modifications to the Yolo County Surface Mining Reclamation Ordinance Sec. 10-5.517 on mercury bioaccumulation in wildlife are presented below on pages 11-13.

References Cited

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Slotton, D.G., and S.M. Ayers. 2013. Lower Cache Creek 2011-2012 Baseline Mercury Monitoring. *Report for Yolo County*. 66 pp.

Yolo County Code, Chapter 5, Title 10: 'Yolo County Surface Mining and Reclamation Ordinance'.

Proposed Modifications to the Yolo County Surface Mining Reclamation Ordinance Sec. 10-5.517 on Mercury Bioaccumulation in Wildlife

May 2017

Existing Ordinance language is denoted with ***bold, italic type***.
Proposed additions/modifications are shown unbold, un-italicized, and underlined.
Proposed text removal/replacement is shown in ~~***strike-through bold italic***~~.

Yolo County Surface Mining Reclamation Ordinance
Sec. 10-5.517 on Mercury Bioaccumulation in Wildlife

Prior to the approval of reclamation of aggregate mining areas to permanent lakes, the County shall commission a sampling and analysis program, to be implemented in one existing wet pit mining area within the OCMP planning area, to evaluate the potential for increased methylmercury production associated with wet pit mining and reclamation of mining areas to permanent lakes. The program shall include the sampling of water and sediments from the bottom of the existing pit and analysis of the samples for organic content; pH; dissolved oxygen content; dissolved carbon content; and total mercury. In addition, samples of predatory fish (preferably largemouth bass) shall be collected and analyzed for mercury and methylmercury content.

If the initial sampling indicates either of the following conditions, the County shall perform verification sampling:

(a) Average concentrations of total mercury in excess of 0.000012 milligrams per liter (mg/l) in the water; and
(b) Average mercury levels in fish samples in excess of 0.5 milligrams per kilogram (mg/kg).

If verification sampling indicates exceedance of these mercury criteria, the County shall approve the reclamation of mining areas to permanent lakes only if the average level of mercury in fish collected from the existing mining pits is shown to be equal to or less than ambient (background) mercury levels determined from a representative sample of similar species of fish (of similar size) collected in the Cache Creek channel within the planning area.

The determination of the ambient mercury level shall be performed by the County prior to the excavation of any new wet pit mine and at years ten (10), twenty (20) and thirty

(30) in the permit time period, and shall be paid for by the mining permit operators on a fair-share basis. The County shall evaluate available data to determine any significant change in ambient concentrations of mercury in fish within the Cache Creek channel.

In the event of approval of reclamation of mined areas to permanent lakes, each mining area to be reclaimed to a permanent lake as part of each approved long-range mining plan shall be evaluated annually by the operator for five (5) years after creation of the lake ~~for conditions that could result in significant methylmercury production~~ with an intensive fish mercury monitoring program, as outlined below.

An additional ten (10) years of biennial monitoring shall be performed after reclamation of each lake has been completed.

The evaluations shall be conducted by a qualified aquatic biologist or limnologist acceptable to the County and shall include the following ~~analyses~~:

~~(c) Lake condition profiling during the period of June through September, including measurements of pH; eH (or redox potential); temperature; dissolved oxygen; and total dissolved carbon~~.

(c) ***Collection of a representative sample of fish specimens and analysis of the specimens for mercury content ~~(including a minimum of five (5) predator fish if available)~~***, including 30 adult (angling size) fish muscle samples and multi-individual whole fish samples of 3 species of young-of-year small fish, as available. Adult fish sampling should target 10 individuals from each of 3 species, distributed across the prevailing size ranges. Priority shall go to a predatory species like bass, with additional species including a midwater planktivore such as sunfish and a bottom feeder such as catfish, if present. If less than 3 species are present, sample up to 20 of the predatory species, if present. Small fish sampling should target 3 prevalent species, as available. These should be characterized either with 15 individual whole fish samples or 4 multi-individual whole fish composites (≥5 fish per composite) for each species. Composites should span the range of typical sizes present, but with the individuals within each composite being closely matched in size. ***Sampling and analysis shall be conducted using methodologies which are consistent with the California State Water Resources Control Board Toxic Substances Monitoring Program procedures, or more stringent procedures.***

(d) ***The results of the evaluation shall be summarized in a report and submitted to the County. The report shall include a comparison of the site-specific data to available data on the background concentrations of mercury in fish within the Cache Creek watershed. The County shall be responsible for submitting the data on mercury levels in fish to the California Department of Fish and Game and the Office of Environmental Health Hazard Assessment for a determination of whether a fish advisory should be issued.***

(e) ***If a fish advisory is issued, the owner/operator shall be required to post warnings on fences surrounding the mining pit lakes which prohibit fishing in the lakes and describe the fish advisory.***

(f) ***If the average fish specimen mercury content exceeds the statistically verified ambient mercury concentrations for comparable fish species (of similar size) collected within the CCRMP planning area*** (defined as average fish mercury ≥30% above corresponding baseline creek samples in the majority of pond samples) ***for ~~two (2)~~*** three (3) ***consecutive years, ~~wet pit mining on property controlled by the mining operator/owner shall be suspended and~~ the owner/operator shall ~~either:~~*** initiate monitoring to try to identify lake condition factors linked to elevated methylmercury production and/or exposure in the pond. This shall include (1) water column profiling of temperature and dissolved oxygen (determined at ≤1 m intervals, surface to bottom) approximately every 6 weeks between mid-May and mid-November (5 events/year); (2) determination of maximum depth; (3) estimation of pond bottom area and volume affected by seasonal anoxia. Additional analyses may include (4) characterization of water quality and bottom sediment parameters most relevant to mercury bioaccumulation (the choice of specific analyses may change as mercury biogeochemistry science continues to develop, but may include: sediment organic percentage, total mercury, methylmercury, and/or 'reactive' mercury; and aqueous suspended solids and organic carbon).

Following 2-3 years of factor-identification monitoring and continued fish sampling, the owner/operator shall either:

(g) ***Present a revised reclamation plan to the Yolo County Community Development Agency which provides for filling the reclaimed lake to a level five (5') feet above the average seasonal high groundwater level with a suitable backfill material; or***

(h) ***Present a mitigation plan to the Yolo County Community Development Agency which provides a feasible ~~and reliable~~ method for reducing methylmercury production or exposure to elevated mercury levels. Potential mitigation could include permanent aeration of the bottom levels of the lake, alteration of the water chemistry ~~(increasing pH or dissolved organic carbon levels)~~, control of anaerobic bacteria populations, or removal and replacement of affected fish populations. (The removal and replacement of fish*** , if with the same species, ***is not intended to be a long-term solution*** , though replacement with species that alter the existing food web may be effective) ***. The mitigation plan would require review by the Regional Water Quality Control Board, California Department of Fish and Game, and the Yolo County Department of Environmental Health.***

~~The reclamation plan shall be modified such that the mitigation approved for methylmercury reduction shall be applied to all mining areas proposed for reclamation to permanent lakes within the reclamation plan. (§ 1, Ord. 1191, eff. September 5, 1996)~~