COUNTY OF HUMBOLDT EXTRACTION REVIEW TEAM (CHERT)
FINAL 2000 POST-EXTRACTION REPORT

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For the

Humboldt County Board of Supervisors

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EXECUTIVE SUMMARY

This report represents the compilation and analysis of information on gravel extractions in the 2000 mining season in Humboldt County. Site-specific recommendations by CHERT to extraction designs submitted by the operators' consultants as well as operator performance in achieving approved designs and specifications are summarized. In 2000, CHERT reviewed 47 extraction areas distributed among 25 mining sites in Humboldt County (many sites had more than one extraction area). The total volume of gravel approved for extraction in 2000 was about 962,826 cubic yards (cy). The total volume actually extracted was about 680,426 or 71% of that approved for extraction. Primary conclusions drawn from this report are:

- Both the quality of extraction designs and monitoring information have steadily improved since 1992. With few exceptions, pre- and post-extraction submittals provided clear, complete information for evaluating mining proposals and performance in meeting approved plans. This, combined with preliminary field reviews that are conducted before initial mining plans are developed, has made the review process quicker, less expensive.

- Extraction operations significantly deviated from their approved extraction plans at 6 of the 25 sites reviewed in a manner potentially harmful to river habitat (extraction transgressed approved designs in elevation or horizontal position or created depressions impeding drainage). While approved volumes were not exceeded in all these cases, it is important for operators to follow approved plans and specifications in order to minimize adverse effects on local habitat.

- As was mentioned last year, biological monitoring requirements in the Corps of Engineers Letter of Permission (LOP) and the County's Interim Monitoring and Adaptive Management Program for the Lower Eel and Van Duzen Rivers, while providing a limited basis for evaluating gravel mining effects over the long term, do not provide guidance for identifying potential impacts to aquatic resources in the near term or for improving mining practices. Consequently, results of biological monitoring to date should not be considered assessments of potential impacts of gravel mining on aquatic and riparian resources. Biological monitoring requirements are presently being reviewed by regulatory agencies and other individuals volunteering their time and will likely be revised to better ensure data useful for adaptive management are collected cost-effectively.

In addition, this year's post-extraction report expands on the concept of sustained yield extraction relative to MAR (an estimate of the long term average annual supply of gravel to a specific reach of a river). Also discussed are site-specific measures recommended by CHERT to reduce local effects of mining on riparian and aquatic habitat. These were included to assist the reader in understanding the complexities of managing gravel mining to minimize both localized and cumulative effects arising from instream mining and how CHERT uses these criteria on an annual and multi-year basis to meet management objectives.

I. INTRODUCTION

Following is the 2000 annual report of the County of Humboldt Extraction Review Team (CHERT) as authorized under the US Army Corps of Engineers (COE) Letter of Permission (LOP) adopted on August 19, 1996, and the Interim Monitoring Program for the Lower Eel and Van Duzen Rivers adopted by the Humboldt County Board of Supervisors on July 2, 1996. The adoption of these two programs enlarged the geographical extent of scientific overview of gravel extraction operations over that described in the 1992 Memorandum of Agreement (MOA) and Programmatic Environmental Impact Report on Gravel Removal from the Lower Mad River (certified by the Humboldt County Board of Supervisors on May 31, 1994). The MOA authorized the formation of a Mad River Scientific Committee, and the Mad River PEIR authorized continuation of the scientific review process and changed the name of the committee to the Mad River Scientific Design and Review Committee (SDRC).

While the two County programs cover both the Lower Mad River and the Lower Eel and Van Duzen Rivers (representing most operations in the County), the LOP covers all instream gravel mining operations extracting more than 5,000 cubic yards of gravel annually in Humboldt County, including parts of the Trinity River near Willow Creek, Mattole River and all other rivers in the County except for Redwood Creek near Orick. The County, California Department of Fish and Game (CDFG), and US Army Corps of Engineers (Corps) require scientific review of mining operations by CHERT. For a description of the county and federal programs in general, and the role and function of the CHERT in particular, the reader is referred to the Interim Monitoring Program for the Lower Eel and Van Duzen Rivers, the PEIR on Gravel Removal from the Lower Mad River and the LOP.

This report summarizes CHERT recommendations and agency approvals for volumes and design specifications of gravel extraction operations for the 2000 season, as well as evaluations of how well operators and their consultants met the recommendations.

Substantial monitoring at mine operations on the Eel and other rivers began in 1995. A report on historical channel changes in the Lower Eel and Van Duzen rivers was completed by the Corps of Engineers in May, 1999 (COE, 1999). Riverbed elevation changes from 1968 to 1998 were quantified at several cross sections on the South Fork and lower main channel Eel River as well as two on the lower Van Duzen River.

II. SUSTAINED YIELD MANAGEMENT

Management strategies for gravel extraction on the lower Mad River and the lower Eel and Van Duzen rivers are guided by environmental impact reports (EIRs) specific to each area. Both EIRs require, among other things, that gravel mining volumes be constrained so that channel bed degradation (net lowering) does not result from gravel mining. Channel bed degradation is but one of many negative effects linked to gravel mining in environmental documents (EIRs, EISs, etc.) and published scientific literature from case studies from many areas across the globe. Other effects include channel widening through increased bank erosion, braiding (establishment of multiple flow channels across a bar), loss of confinement of flows within the low flow channel, and loss of channel habitat “infrastructure” (low flow channel and bar morphology, riparian vegetation). They increase in geographical extent and severity as the volume of gravel mined in a river reach approaches (or exceeds) the volume of gravel supplied to the reach by fluvial (streamflow) transport during winter storms.

The concept of “sustained yield”, simply stated, requires that mining methods and volumes be constrained to allow river processes and conditions (and by extension, habitat) to continue relatively unaffected by gravel extraction. Infrastructure protection and habitat maintenance and recovery require a sustainable aggregate extraction strategy; one that only harvests less than recruitment when averaged over several years or longer. A sustainable extraction strategy limits average annual extraction to a volume less than mean annual recruitment in such a manner as to maintain or recover a complex channel morphology and aquatic habitat within the immediate area of mining, as well as to prevent or reverse mining-induced cumulative effects upstream and downstream.

III. MEAN ANNUAL RECRUITMENT

While the volume of gravel transported ("recruited") to a mining reach can vary tremendously from year-to-year, the long-term annual average volume provides an essential tool for managing cumulative effects from gravel extraction. We call this value the "mean annual recruitment", or MAR. It is the cornerstone of sustained yield management and can be estimated by several techniques that vary in accuracy. Generalized methods are briefly described below in order of increasing accuracy:

1. <u>Regional sediment yield</u>: this method applies an estimate of regional sediment yield (usually expressed in tons per unit area per year) to a local area within the region. Unless the regional value is expressed in terms of bedload (as opposed to total or suspended load), the method requires conversion (by using an assumed ratio of bedload to total or suspended load). In addition, within-region geologic variability can confound the estimate for the subject area, as can scale differences (the ratio of suspended to bedload typically increases with basin size).

2. <u>Within-basin sediment yield</u>: this method transposes unit sediment yields from an area within the subject basin (where it has been established from detailed sediment budget studies) to another point within the basin, usually by simply scaling to basin size. As with regional estimates, conversions may be necessary depending on the nature of the yield estimate used, although geologic variability may be lower. Scale differences may also apply, but probably to a lesser degree than with regional yields.

3. <u>Reach-level conversions</u>: this method uses measured suspended sediment transport for a certain reach and applies a conversion factor (the ratio of bedload to suspended load) to estimate bedload yield for that reach, provided a long term gaging record is available. A common assumption is that bedload is between 5 and 10% of suspended load, with 20% an upper limit. Accuracy of the estimate depends on the accuracy of the conversion factor used, with the most accurate results derived at locations that actually have overlapping bedload and suspended load measurements.

4. <u>Sediment budget</u>: a sediment budget relies on both sediment yield estimates (discussed above) and long term historical topographic and other information (e.g., topographic maps, cross sections, bridge construction drawings, historical photos, etc.). Where available, sediment accumulation rates behind dams and/or actual measurements of sediment transport substantially improve accuracy. This is the most comprehensive method and it allows cross-checking of results to evaluate accuracy. It is the method of choice, assuming sufficient data are available.

Using MAR as a basis for determining sustainable extraction volumes is a robust method for ensuring or evaluating sustainability. Although different terms are used to describe this recruitment-based approach, it has been used to develop sustainable extraction strategies in a number of locations in the western US (Collins and Dunne, 1990; Collins, 1992; Lehre, 1993). It applies the basic concept of the river continuum in avoiding cumulative effects by ensuring that extraction volumes remain low enough to leave sufficient gravel in the river to maintain channel alluvial structure (gravel bars, channel bends, floodplains, riparian tree stands). Risk (to bridges, salmonid habitat, and other issues dependent on alluvial structure) will generally increase with an increasing percentage of MAR extracted.

In Humboldt County at present, MAR has only been estimated with reasonable confidence for the Mad and Van Duzen Rivers. Table 1 compares bedload sediment yield per square mile of basin area, MAR for the two rivers calculated by multiplying yield per square mile by basin area, and permitted volume ceilings (as set by conditional use permits (CUPs) or vested rights determinations; note that effective volume for the Van Duzen River is the total permitted volume for the river minus the volume typically extracted from the delta at the Eel River confluence, which could be considered extraction from the Eel River). The estimate for the Mad River is considered to be scientifically superior than that for the Van Duzen River because of the sediment budgeting approach that relied on bedload transport measurements, sediment accumulation behind Sweasey Dam upstream of the mined reach, air photo analysis of channel changes, and historical river cross section measurements. In contrast, the estimate of MAR for the Van Duzen River derived for the Addendum to the SEIR for the Van Duzen River Ranch was based on transposing sediment yield estimates by Kelsey (1977) at the USGS stream gaging station at Bridgeville (station no. 11478500), located in the middle of the basin, to the mining reach near the mouth of the river about 23 miles downstream.

Table 1. Comparisons of mean annual recruitment (MAR) estimates and permitted mining volumes for the lower Van Duzen and lower Mad rivers.

Average annual bedload sediment yield at Bridgeville (adapted from Kelsey, 1977)		Mean annual recruitment (MAR) for the lower Van Duzen River (from scaling to total basin area of 430 mi^2)			Total effective annual permitted mining volume for the lower Van Duzen River
Low estimate	High estimate	Low	High	Median	193,000 cy (96% of high MAR)
315 $cy/mi^2/yr$	469 $cy/mi^2/yr$	135,000 cy	202,000 cy	168,500 cy	
Average annual bedload sediment yield for lower Mad River (Lehre, 1993)		Mean annual recruitment (MAR) for the lower Mad River (Lehre, 1993)			Total annual permitted mining volume for the lower Mad River
Low estimate	High estimate	"Reasonable"	High	Median	917,000 cy (459% of high MAR)
309 $cy/mi^2/yr$	412 $cy/mi^2/yr$	150,000 cy	200,000 cy	175,000 cy	

Since 1993, the recommended volume of gravel extraction on the Mad River has been approximately 100% of the upper estimate of MAR (200,000 cy/yr), while actual extraction has been about 90% of this value and about 120% of the 'reasonable' estimate given in the 1993 PEIR (150,000 cy/yr, see Table 1). Mining volumes on other rivers (primarily the Eel and Van Duzen rivers) are, at present, only limited by site-specific conditions and/or by permitted volume ceilings (vested rights and CUPs). While this may be sufficient to avoid adverse impacts in areas with few mining operations, there is a potential to exceed sustained yield in river reaches where numerous mining sites are concentrated. The COE report mentioned above could contribute substantially to development of sustained yield mining programs on these river systems if it was incorporated into a gravel budgeting analysis similar to that performed on the Mad River, but no such analysis is scheduled. There will undoubtedly be increasing demand for aggregate when or if the rail line connecting Humboldt County to markets to the south is once again functional. We believe an MAR analysis, especially one that includes contemporary bedload transport data, is critically needed and should be performed at the earliest possible time.

IV. Mining Design Criteria for Minimizing Localized Impacts

There exists a large body of scientific literature on gravel mining that describes the spectrum of observed effects on channel geomorphology, aquatic and riparian plant and animal communities, and infrastructure. While some of the literature provides general recommendations for impact reversal or avoidance, it stops short of providing specific mining plan design criteria for minimizing localized impacts. In Humboldt County's mining program, several criteria are employed to minimize geomorphic and/or habitat impacts at mining sites. They are described below.

1) Skim boundaries are typically laid out as curvilinear benches along the outside of point bars as this usually provides a good replenishment configuration without preventing riparian colonization or encouraging braiding;
2) Skim widths are constrained to avoid braiding (divided flow) by being no wider than about half the unvegetated bar width;
3) Skim floors are sloped to provide for drainage following inundation (either directly toward the low flow channel, in a downstream direction, or somewhere in between) to reduce salmonid stranding potential;
4) A vertical offset of the skim floor above the low water surface (typically 1-2 feet) is provided to retain sufficient low flow channel confinement;
5) The upper one-third of a bar is usually left undisturbed to preserve sufficient high flow confinement of flows entering the bend and discourage braiding.
6) In low recruitment years, bar skimming may be forgone in favor of wetland pits outside the active channel, but on surfaces no higher than the 5-year floodplain;
7) Gentle (10:1) side slopes are provided around the outer edges of wetland pits, with deeper areas in the interior to increase volumes;
8) Wetland pit boundaries are laid out to limit disturbance to existing riparian vegetation by conforming to existing openings in perennial riparian vegetation;
9) Wetland pits are avoided near the upstream ends of bars to prevent elevating the risk of meander cutoff;
10) Total pit area on a bar should not exceed about 10% of the bar's surface area to avoid elevating the risk of meander cutoff.

These criteria are intended to be flexible (i.e., adaptive) and are recommended by CHERT as needed during mining plan review in an effort to avoid localized geomorphic and/or habitat impacts (avoidance is always preferable to attempting to reverse observed impacts). They are based largely on professional judgement and appear to be reasonably successful in avoiding impacts associated with historical mining methods.
To the extent that operators' consultants incorporate these criteria in mining plan preparation, the need for CHERT to make recommendations for modifying initial plan submittals can be minimized.

V. Monitoring and Adaptive Management Program

Detailed descriptions of methods and standards for instream gravel extraction monitoring data collection and presentation for the project area can be found in: 1) the California Department of Fish and Game's (CDFG) Humboldt County monitoring guidelines (contained in a May 9, 1995, memo from Richard Elliot, Regional Manager, Region 1), 2) the 1996 Letter of Permission (LOP 96-1) issued by the Army Corps, and 3) the 1996 Interim Monitoring and Adaptive Management Program issued by the Humboldt County Department of Public Works. These documents either require or recommend physical and/or biological monitoring methods to be implemented by all gravel operators within their geographic scope.

By their very nature, rivers are dynamic and their behavior cannot be predicted with a high degree of accuracy or specificity. For example, while long-term weather forecasts can often predict regional climate conditions with reasonable certainty, specific flood magnitudes, timing, and duration, all of which determine the volume of gravel supplied to a mining reach over the winter, cannot be predicted. Consequently, impact avoidance must rely on scientific knowledge of river behavior and mining effects to anticipate 'potential' impacts and 'frontload' management with criteria drawn from the available data, experience, and professional judgement. In the event impact avoidance is unsuccessful, 'realized' impacts will hopefully be detected by monitoring early enough so they can be mitigated for by altering (adapting) management.

As with potential effects of instream gravel mining, adaptive management strategies can be divided into two general categories: 1) those that are aimed at avoiding or reducing cumulative effects, and 2) those that are geared towards localized, site-specific effects. In reality, the distinction is somewhat arbitrary: pervasive localized effects of mining (for example, excessively low bar skimming on a concentration of mined bars within a mining reach) may also precipitate cumulative effects (reach-wide depletion of gravel, braiding, and loss of low flow channel confinement). Adaptive management for localized effects is a goal of the Mad River and lower Eel and Van Duzen rivers EIRs, the IMP, and the LOP and is reasonably well-accommodated by annual CHERT review and comment on mining plans. Managing cumulative effects is accomplished by conducting long term assessments and a 'hardwiring' adaptive management responses into the system.

Management of local mining effects is accomplished by reviewing pre-extraction mining plans and supporting documentation (air photos, cross sections, replenishment estimates, etc.) and recommending alterations to mining plans to reduce effects. Spring field reviews are conducted at each mining operation with mining plans, air photos and cross sections in hand to assist in the evaluation process. Mining plans are evaluated within the context of the channel's response to previous years' mining and high flows that occurred over the previous winter and the generalized criteria described above in Section IV. Occasionally, mining plans must go through several iterations before CHERT can recommend their approval by regulatory agencies. This can be an expensive and time-consuming process. In recent years, however, early-season field reviews have been conducted at many sites prior to the preparation of mining plans by the operators' consultants. Conceptual mining plans are discussed and usually agreed to by all parties involved, resulting in submittal of initial mining plans that require little or no modification for agency approval. This has greatly improved the annual mining plan review/approval process, saving both time and money for operators, and can be considered a management adaptation that has benefited the mining community.

Management of cumulative effects is attempted through the sustained yield strategy described above, and adaptations to management for cumulative effects would be largely based on adjusting mining volumes for a river reach. For example, if approved mining volumes appear to be too high to prevent channel bed lowering or rebuilding lost terraces and floodplains, reducing the volume of mining would be the appropriate adaptation. However, quantitative cumulative effects assessment requires assembling and processing a large amount of information (cross sections, etc.) from a period of several or more years from all relevant sources for a mined river reach as well for the length of river upstream and downstream where offsite effects are anticipated or have been previously observed. This represents a fairly intensive analysis that is neither practical nor particularly valuable on an annual basis (single-year changes do not necessarily indicate longer-term trends).

Alternatively, reach-wide trends are better evaluated once every five years on average (with additional evaluations following a 5-year or greater flood) for assessing the need for adaptive management from cumulative effects. Cumulative effects evaluation should be proactive with a specific schedule for comprehensive periodic reach-wide evaluations In a proactive approach, periodic evaluations would provide early warning signals for taking preventative measures.

To summarize:

- Annual monitoring informs management of the need for and nature of adaptations necessary in site-specific mining criteria and builds a data set for periodic quantitative evaluation of reach-wide effects.

- Periodic (once every five years or so) quantitative, reach-wide assessments would allow evaluations of longer-term, broader scale cumulative effects and proactive management adaptations (e.g., adjusting reach-scale mining volumes).

A reach-wide assessment was anticipated with a five-year planned update of the Mad River PEIR. This update has not yet been performed, but with the larger data set and results from a recent study (by Kondolf and Lutrick (2000), discussed later) now available, and the impetus to collect critical new data (additional cross section surveys and bedload measurements as recommended in the Kondolf and Lutrick study), we feel it is an opportune time to update the PEIR and supporting technical analyses. Periodic reach-wide assessments of other County rivers are not presently an established part of the County mining program.

VI. REACH-SCALE PROBLEM IDENTIFICATION AND ADAPTIVE MANAGEMENT RESPONSES

This section describes reach-scale geomorphic impacts that may be initiated by gravel mining and adaptive management responses intended to mitigate the impacts. The primary focus is on channel geomorphology since other issues (aquatic and riparian habitat, infrastructure integrity) are largely dependent on appropriate channel geomorphic conditions and processes.

For the geomorphic setting of most mining operations in the County, a single-threaded, sinuous main channel with alternating bars of sufficient height above the low water surface benefits most river uses. It provides alluvial structure important for maintaining aquatic habitat, coarse sediment transport (throughput to downstream reaches), and infrastructure (bridges, etc.). Over time, channel migration is to be expected in a properly functioning alluvial river: management should neither excessively restrict this process (beyond that required to protect existing infrastructure or developed areas) nor accelerate it beyond natural rates. Frequently, multiple types of impacts to channel geomorphology coincide and management adaptations overlap. Channel geomorphic indicators for adaptations to management and adaptive management responses are:

<u>Channel bed degradation</u> (lowering) is well documented in the literature as a result of gravel mining. It poses risks to infrastructure, accelerates bank erosion, and deprives downstream areas of necessary gravel supply. It is assessed by reviewing channel cross sections and making field observations. When channel bed degradation is observed, mining volumes will be curtailed by limiting the number of bars mined annually and/or by applying mining design criteria (increasing vertical offset, skim floor cross-channel slope, and horizontal setbacks from the low flow channel edge and/or the head of bar) that are incrementally more conservative and/or by alternating between bar skimming and wetland pit excavations.

<u>Channel widening</u> is caused by bank erosion or lateral channel migration without attendant bar building and is well documented as a result of gravel mining in the literature. It is assessed by reviewing channel cross sections and making field observations. When channel widening is observed, mining volumes will

be curtailed by limiting the number of bars mined annually and/or by applying mining design criteria (increasing vertical offset, skim floor cross-channel slope, and horizontal setbacks from the low flow channel edge and/or riparian vegetation and/or the head of bar) that are incrementally more conservative and/or by alternating between bar skimming and wetland pit excavations. Biotechnical bank protection projects may also be recommended where they might provide cost-efficient controls on bank erosion.

Loss of low flow channel confinement is indicated by excessively low relief between the low flow channel and adjacent bar surfaces. It is assessed by reviewing channel cross sections and/or by field observations during recession of stormflows. When insufficient low flow channel confinement is observed, mining criteria on vertical offset, skim floor cross-channel slope, and horizontal setbacks from the low flow channel edge and/or the head of bar that are applied during pre-mining (spring) reviews will be made incrementally more conservative.

Braiding (also called "divided flow") is indicated when the main channel splits into two or more channels across a bar surface. It is assessed by reviewing channel cross sections, air photos, and/or by field observations. Conditions conducive to braiding are similar to those conducive to loss of low flow channel confinement. When braiding is observed, mining criteria on vertical offset, skim floor cross-channel slope, and horizontal setbacks from the low flow channel edge and/or the head of bar that are applied during pre-mining (spring) reviews will be made incrementally more conservative

Channel migration is commonly expressed as shifting of the channel by erosion of banks at the outside of river bends or by diversion of the primary flow channel to a location across the inside of a meander. Channel migration is a natural process necessary for rejuvenating habitat and is part of the "natural disturbance regime" essential for healthy riparian and aquatic ecosystems. However, land uses including gravel mining can alter the natural disturbance regime such that impacts to river processes occur and dependent biota are adversely affected. Gravel mining is typically associated with increases in channel migration rates and magnitudes over and above the natural regime, sometimes resulting in chronic channel instability. Instability generally takes one of two possible forms: 1) meander cutoff, which creates a discontinuity in the pattern of sinuosity and may set off planform adjustments (a 'shock wave' of lateral channel movements) upstream and downstream, or 2) channel incision (bed degradation) which confines abnormally high stormflows (and their erosive power) within the active channel rather than allowing dissipation of stream energy across the floodplain, thus elevating erosive stresses on exposed banks and accelerating bank erosion. Mitigations for channel bed degradation and bank erosion are described above. When early signs of cutoff channel formation or enlargement and/or excessive channel migration are observed, mining criteria on skim floor elevations and horizontal setbacks from the head of bar that are applied during pre-mining (spring) reviews will be made incrementally more conservative. Also, areas considered for wetland pit excavations may be either eliminated or relocated and their footprint area and/or depth reduced.

VII. 2000 GRAVEL MINING RECOMMENDATIONS AND OPERATOR PERFORMANCE

In the 2000 extraction season, a total of 962,826 cubic yards (cy) was approved for Class A (annual extraction greater than 5,000 cy) operations in Humboldt County. Of this, 680,426 cy (or 71% of the approved volume) was actually extracted, as documented in post-extraction submittals from the operators. The following sections provide information specific to each operation in the County, segregated by river reach.

CHERT recommendations and other communications from the operators, their consultants, and agencies were compiled in numerous electronic mailings generated throughout the mining season. While this expedited the process of information exchange and approval of mining plans, no single report containing all recommendations was compiled. Consequently, this post-extraction report is the only document summarizing all CHERT recommendations for the 2000 extraction season. In addition to comparing the recommended/approved and extracted volumes, compliance is also evaluated by comparing the configuration of our recommendations on individual cross sections with the post-extraction bar surface configurations. We note specific operations where the actual extraction deviated significantly from approved extraction volumes and post-extraction bar configurations.

With few exceptions, 2000 gravel extractions in Humboldt County were designed as skims on unvegetated or sparsely vegetated bar areas. Skim configurations were of two general forms: a bench located near the edge of the low flow channel (most common) and a planar skim of the crown of a bar. Horizontal limits of skims were laid out to conform to the overall shape of the bar, typically in a crescent shape. On large-amplitude meander bends, the upstream end of the bar was left undisturbed to discourage meander cutoff and bar destabilization.

Where significant clumps of vegetation (mostly willows) occurred near the edge of a proposed skim, the boundaries of the skim were realigned to avoid them. Where such vegetation was located in the interior of a skim, these clumps were left as undisturbed "islands" within the skim boundaries. In most extraction areas, designs included a vertical offset of 1-2 feet above the low water surface to confine the low flow channel. Commonly, this offset was tied to a light colored "silt band" found along the edge of the channel. This silt band provided a reliable means to allow consistency in vertical offset for individual bars and between the numerous bars extracted along the river. Drainage of receding river flows was provided by designing extraction surfaces which slope either directly toward (perpendicular to) the low flow channel or in a downstream direction and avoiding closed depressions that could strand salmon.

An encouraging trend continued in the 2000 gravel extraction season whereby the vast majority of initial extraction plans submitted were recommended by CHERT for approval by regulatory agencies with little or no modification. This is the beneficial result of both conducting field reviews before plan preparation and of operators and their consultants submitting initial plans that incorporate design specifications, including proposed volumes, that minimize impacts to aquatic and riparian habitat and channel geomorphology. Further, extraction at nearly all sites reviewed in 2000, as indicated during post-extraction reviews, was carried out in good conformance with approved plans.

A. Mad River Gravel Extraction

1. Gravel Extraction Volumes

In the 2000 extraction season, eleven extraction areas distributed among five operators on the Mad River were mined. The preceding winter high flow season was not a particularly large one. Consequently, gravel recruitment (supply) to the mined reach, as estimated by applying a bedload rating curves (from Brown, 1975) to the winter flows recorded at the USGS stream gaging station (No. 11481000), was only about 114,000 cy. Although this rating curve was developed some time ago (the 1970s), it is still the best predictor of gravel recruitment we have available. Replenishment (gravel deposition on bars over the winter period) varied between sites, but was generally low.

The sum of all initial proposals received from operators in 2000 totaled 252,890 cubic yards (cy), or about 103,000 cy (69%) above the best estimate of MAR (150,000 cy/year, as determined in the Technical Supplement to the Mad River PEIR). Table 2 shows the volumes recommended by CHERT, the actual extraction volumes (calculated by the operators' consultants from cross sections), and the deviations between recommended and actual volumes, expressed as a percentage. As indicated in Table 2, total extraction recommended by CHERT on the Mad River for the 2000 season was approximately 204,748 cy, while the total gravel volume actually extracted was approximately 146,554 cy, or about 72% of that recommended by CHERT.

Table 2. Recommended and extracted volumes for Mad River sites (in downstream order), 2000.

Operator; bar	Recommended	Extracted	Percent Extracted
Mad River S&G; Guynup Upper Bar	27,185	19,585	72%
Redwood Empire Agg; Emmerson Bar Area 1	5,608	6,377	114%
Redwood Empire Agg; Emmerson Bar Area 2	9,424	8,327	88%
Redwood Empire Agg; Emmerson Bar Area 3	2,000	1,497	75%
Redwood Empire Agg; Blue Lake Bar	29,671	32,163	108%
Eureka Ready Mix; Christie Bar Area 1	52,435	46,925	89%
Eureka Ready Mix; Christie Bar Area 2	13,175	12,471	95%
Redwood Empire Agg; Johnson Bar	10,250	10,946	107%
Mercer Fraser Co; Essex Bar	5,000	4,663	93%
Arcata Readimix; John-Spini Right Bank Bar	40,000*	0	0%
Arcata Readimix; John-Spini Left Bank Bar	10,000*	3,580	36%
Total for Mad River	**204,748**	**146,534**	**72%**

* Figures are approximate, as no documentation of mining plans incorporating CHERT recommendations and ultimately approved by the agencies was provided by the operator.

2. Summaries of Site-specific CHERT Recommendations and Post-Extraction Observations

Guynup Bars (Mad River Sand and Gravel, MRS&G): The mining proposal for this site was for skimming about 50,000 cy from two areas: the upper bar (Area 1) and the lower bar (Area 2). CHERT recommendations included deleting Area 2 due to the low gravel replenishment experienced by the site as a whole and the fact that the operator preferred to extract off the upper bar. The CHERT recommendation for Area 1 was to provide a greater horizontal setback from the low flow channel to protect shoreline habitat and better preserve low flow channel confinement. The bar was significantly under-extracted (see Table 2), but was done so in a manner that left the skimmed surface in good condition (no significant depressions or other impediments to drainage following inundation).

Emmerson Bar (Redwood Empire Aggregates, REA): The initial proposal was to skim two areas (1 and 2) on either side of the low flow channel. CHERT recommendations at this site consisted of accepting the proposal as designed, but adding an optional ‘alcove’ skim at the downstream end of the lower bar for an estimated 2,000 cy additional gravel (Area 3). This option was for creating potential holding habitat for salmonids, and the operator opted do the extraction. While extraction exceeded that approved on Area 1 by 14% (see Table 2), the volume over-extracted was relatively small (about 800 cy) and did not appear to create unfavorable conditions on the specific area. Under-extraction for the other areas (2 and 3) made the site total less than that approved.

Blue Lake Bar (Redwood Empire Aggregates, REA): The proposal for this site was to skim an unvegetated bar surface adjacent to the right side of the low flow channel along the lower two-thirds of the bar with a downstream slope and a vertical offset of about 1-2 feet above the low water surface. The CHERT recommendation was to approve the proposal as submitted. Extraction was carried out fairly close to approved designs, but was slightly over-extracted and minor undulation in final grades was noted in the upper half of the area. Some ponding is expected following inundation, but it is not anticipated to present significant stranding potential to fish.

Christie Bar (Eureka Ready Mix, ERM): The initial proposal for this site was to skim two areas (Area 1 (52,435 cy) to the east of the low flow channel and Area 2 (13,140 cy) to the west) on either side of the low flow channel. Recommendations at this site consisted of accepting the operator's proposal for Area 1 as initially submitted, but to hold off on Area 2 until other sites on the Mad River had been reviewed. Later in the season, Area 2 was recommended for extraction with only a minor modification to raise the skim floor elevation by one foot and increase the width to achieve a similar volume. The approved plans were generally well-met at this site, with the exception that the extraction went landward (by about 75 feet on monitoring cross section 3+33) of the approved horizontal limits at the upper end of Area 1.

<u>Johnson Bar (Redwood Empire Aggregates, REA):</u> The initial proposal for this site was to skim the unvegetated bar surface adjacent to the left side of the low flow channel near the apex of this bar. The extraction plans included a vertical offset of about 1-2 feet above the low water surface, exclusion of vegetation clumps from the extraction area, and avoidance of backwater habitat (an alcove feature) near the downstream end of the site, as in 1997-99. CHERT recommendations were for approval of plans as initially submitted. The approved designs were well met at this bar.

<u>Essex Bar (Mercer Fraser Company, MFC):</u> The initial proposal was for 6,282 cy, although the permitted volume is only 5,000 cy. CHERT recommendations at this site consisted of raising the skim floor elevation to reduce the volume to the 5,000 cy limit and to improve drainage conditions. The approved designs were well met at this site.

<u>Johnson-Spini Bar (Arcata Readimix, ARM)</u>: The initial proposal for this site was to skim 77,290 cy from two areas on either side of the low flow channel: Johnson-Spini Right Bank Bar and Johnson-Spini Left Bank Bar. CHERT recommendations at this site consisted of raising skim floor elevations on both areas proposed for extraction. This was recommended to: 1) better preserve low flow channel confinement, and 2) limit extraction to 50,000 cy to keep the total extraction for the Mad River closer to the high estimate of MAR (200,000 cy). A second proposal for 66,040 cy was not recommended because too little low flow channel confinement and too great a volume were proposed. This site was under-extracted by a large volume; only about 3,600 cy was removed from the upstream portion of the Johnson-Spini Left Bank Bar, while the Johnson-Spini Right Bank Bar was left un-extracted. Field review following extraction indicated the extraction appeared to have been done in a manner that would facilitate drainage following inundation.

The following is a brief summary of events that occurred during the ARM mining plan review period in 2000 that is provided to help explain the low volume of extraction. CHERT received a mining plan from ARM on August 23, 2000. We reviewed the plan after being reimbursed for our services rendered over the previous year (payment was made on Sept. 1, 2000). The initial proposal was for 77,290 cy. During the field review on Sept. 7 we communicated our recommendations verbally. The operator then submitted a revised plan later that same day for 66,040 cy, above the volume discussed during the field review. CHERT maintained its initial recommendations for lower volume and increased low flow channel confinement. The operator appealed the recommendation to the County Board of Supervisors and the Department of Fish and Game. The US Army Corps of Engineers, however, approved the higher volume (66,040 cy) despite the CHERT recommendation. The appeals were later dropped (on or about Oct. 19), and the operator began extracting gravel, but was soon shut down for failing to secure Corps permission to extract after the regular extraction season had ended (Sept. 30). Only about 3,600 cy of gravel were removed from the Left Bank Johnson-Spini Bar before cessation of extraction; the Right Bank Johnson-Spini Bar was not extracted from in 2000. As of this writing, CHERT had not yet received post-extraction materials from the operator, but we were supplied a copy by the Corps in January 2001.

B. Main Stem Eel River Gravel Extraction

1. Gravel Extraction Volumes

As shown in Table 3, the total volume actually extracted on the main stem Eel River in 2000 was approximately 339,675 cy distributed among 13 areas at 10 sites. This volume is about 69% of that recommended by CHERT (496,047 cy).

Table 3. Recommended and extracted volumes for the Main Stem Eel River sites (in downstream order), 2000.

Operator; site/bar	**Recommended Volume (cy)**	**Extracted Volume (cy)**	**Percentage Extracted**
Fort Seward Ranch; Satterlee Bar	43,200	22,908	53%
PALCO; Bowlby Bar	29,359	20,781	71%
PALCO; South Fork (Dyerville) Bar	29,979	26,138	87%
PALCO; Elinor Bar	29,900	24,080	81%
PALCO; Three Mile Bridge Bar	29,200	28,149	96%
PALCO; Truck Shop Bar	18,000	17,015	95%
PALCO; Vroman Bar	23,551	14,900	63%
Eureka Ready Mix; Hauck Bar Area 1	40,288	39,608	98%
Eureka Ready Mix; Hauck Bar Area 2	23,200	0	0%
Hansen Site; Hansen Bar	48,741	39,631	81%
Mercer Fraser Co; Sandy Prairie Area 1 (A)	70,513	57,358	81%
Mercer Fraser Co; Sandy Prairie Area 2 (B)	43,156	24,142	56%
Mercer Fraser Co; Sandy Prairie Area 3 (B)	21,007	19,874	95%
Mercer Fraser Co; Sandy Prairie Area 4 (B)	18,912	7,858	42%
Mercer Fraser Co; Sandy Prairie Area 5 (B)	3,122	2,842	91%
Humboldt County PWD; Worswick Bar	22,919	17,299	75%
Mallard Pond; Drake Bar	0	0	0%
Total for Main Stem Eel River	**495,047**	**339,675**	**69%**

2. Summaries of Site-specific CHERT Recommendations and Post-Extraction Observations

Fort Seward Ranch (Satterlee): The operator's proposal was to skim the crown of a large, tall, unvegetated gravel bar in an area on the main channel Eel River at a location far upstream from other operations and only occasionally mined. The site was proposed to be mined by both the applicant and the Humboldt County Public Works Department. CHERT recommendations were to minimize disturbance to an area of the bar surface armored by coarse cobbles because of their contribution to local habitat and geomorphic stability. The site was significantly under-extracted (see Table 3), for the most in an environmentally benign manner. However, extraction went deeper than that approved at cross section 2E by about 2.5 feet. Because this was located in an area well above the low flow channel, no negative effects are anticipated.

Bowlby Bar (PALCO): CHERT recommendations at this site consisted of accepting the operator's proposal as originally submitted, which was to skim the inner (riverward) edge of a large, unvegetated, and frequently mobile point bar. Although the site was under-extracted (see Table 3), the extraction area went too far landward on cross section 'BOL-C' by about 25 feet. Other than that, approved plans were well met at this site.

South Fork Bar (PALCO): CHERT recommended approval of the operator's proposal as submitted, which was to skim the inner (riverward) edge of a large, unvegetated, and frequently mobile point bar. The approved plans were well met at this site.

Elinor Bar (PALCO): The operator's proposal for this site was to skim the riverward edge of a large, unvegetated, and frequently mobile point bar. CHERT recommended approval of the operator's proposal as submitted. The approved plans were well met at this site.

Three Mile Bridge Bar (PALCO): The operator's proposal was to skim the riverward edge of a large, unvegetated, and frequently mobile lateral bar. CHERT recommended approval of the operator's proposal as submitted. The approved plans were well met at this site.

Dinner Creek bar (PALCO): The operator did not propose extraction at this site for 2000.

Lower Truck Shop Bar (PALCO): The operator's proposal was to skim the crown of a large, unvegetated, and frequently mobile lateral bar. CHERT recommended approval of the operator's proposal as submitted. The approved plans were well met at this site.

Vroman Bar (PALCO): The operator's proposal for this site was to skim a relatively small area along the riverward edge of a large, unvegetated, and frequently mobile bar. CHERT recommended approval of the operator's proposal as submitted. Extraction was higher than approved at the landward margin on the upstream part of the skim and lower than approved in the central part, but the slight depression was well away from the water's edge and should not pose a significant stranding potential.

Hauck Bar (Eureka Ready Mix): CHERT recommendations at this site consisted of accepting the operator's proposal as submitted, which was to skim the inner (riverward edge) of bar on the right side of the channel (Area 1, part of the downstream edge of the Van Duzen River delta) and another area near the upstream end of a mid-channel bar downstream (Area 2). Approved designs included about 1.5 to 2 feet of vertical offset from the low water surface and leaving a clump of willows within the extraction area boundaries of Area 1 undisturbed with a 25 foot buffer. Area 2 was not extracted, and approved plans for Area 1were well met at this site.

Hansen Bar (Charles Hansen, Sr.): CHERT recommendations at this site consisted of accepting without modification the operator's proposal, which was to skim the upper portions of a large, unvegetated, and frequently mobile mid-channel bar. The proposal left about 2 feet of vertical offset from the low flow water surface. The volume extracted was less than that approved, mainly because the extraction did not go as far downstream as planned and approved. Post-extraction surveys indicated that extraction went deeper than approved on several cross sections by up to 2 feet, leaving little vertical offset above the low water surface (less than about 1 foot) at the downstream end of the area. Because the extraction was narrower than approved at the downstream end of the area, the loss of low flow channel confinement resulting from the deeper extraction is not anticipated to cause significant problems for fish migration. However, future extractions should be carried out using more care to follow approved plans.

Sandy Prairie Bar (Mercer Fraser Co.): This bar feature is fairly complex, consisting of several high flow channels and intervening dissected bars. The extraction proposal consisted of skimming five areas on unvegetated bar surfaces. CHERT recommended the proposal be approved without modification. Although significant under-extraction occurred in Areas 2 and 4, under-extraction was accomplished in an appropriate manner (no drainage impediments). Approved extraction plans were well met by the operator at this site.

Worswick Bar (Humboldt County Public Works Dept.): The operator's mining proposal at this site consisted of skimming a relatively small area on a large, unvegetated, frequently mobile bar surface. A wide

(50 feet or more) horizontal buffer from the water's edge was proposed along with a cross-bar slope of 1% to facilitate drainage. CHERT recommended approval of the operator's proposal as submitted. Although the site was significantly under-extracted, approved plans were well met.

Mallard Pond (Drake Bar): No mining proposal was made for this bar in 2000.

C. South Fork Eel River Gravel Extraction

1. Gravel Extraction Volumes

As shown in Table 4, the total volume actually extracted on the South Fork Eel River in 2000 was approximately 53,812 cubic yards (cy). This volume is about 71% of that recommended by CHERT and approved by agencies (75,756 cy). Note that the Cook's Valley site (MFC) straddles the Humboldt and Mendocino County line, and Area 1 (the upstream most area) was located in Mendocino County. Consequently, the Humboldt County recommended and extracted volume totals for the South Fork Eel River were 51,106 cy and 43,887 cy, respectively.

Table 4. Recommended and extracted volumes for the South Fork Eel River sites (in downstream order), 2000.

Operator; site/bar	**Recommended Volume (cy)**	**Extracted Volume (cy)**	**Percentage Extracted**
Mercer Fraser Co.; Cooks Valley, Area 1 (Men .Co)*	19,650	9,925	51%
Mercer Fraser Co; Cooks Valley, Area 2	2,362	2,234	95%
Mercer Fraser Co; Cooks Valley, Area 3	8,518	7,229	85%
Mercer Fraser Co; Cooks Valley, Area 4	0	0	0%
Mercer Fraser Co; Cooks Valley, Area 5	8,916	8,651	97%
Randall Sand and Gravel; County Bar	4,471	4024	90%
Randall Sand and Gravel; Home Bar	4,228	0	0%
Randall Sand and Gravel; Tooby Park Bar	18,311	16,037	88%
Wallan and Johnson; Wallan & Johnson Bar	9,300	5,712	61%
Total for South Fork Eel River	**75,756**	**53,812**	**71%**

* Located in Mendocino County

2. Summaries of Site-specific CHERT Recommendations and Post-Extraction Observations

Cooks Valley Site (Mercer Fraser Co.): This site straddles the line between Humboldt and Mendocino Counties on a large forced meander bend. Five areas were proposed for mining in 2000. Area 1 (Mendocino County) was proposed as a trench excavation along the outside of a forced meander bend. Areas 2, 3, and 5 were proposed as more conventional bench skims on unvegetated gravel bars, and area 4 was proposed as wedge-shaped excavation on the active delta gravels of a tributary entering the South Fork Eel from the northeast, all of which were in the Humboldt County portions of the site. CHERT recommended deepening of the trench and widening of its upstream end for fish migration purposes, and deleting Area 4 from the mining plan. Post-extraction cross sections indicated the trench had not been excavated as deep as approved, but this will not worsen migration conditions beyond the pre-mining condition. Under-extraction at Area 3 (skim) resulted in a residual berm along the low flow channel, but this was contiguous with a natural berm and thus is not expected to worsen pre-mining conditions. Other than these observations, approved mining plans were well met at this site.

Randall Site (Randall Sand and Gravel): The operator's initial proposal was to skim three areas at the site: 1) a lateral bar, called 'County Bar', near the upstream end of the site, consisting of a skim which avoided a strand of willows along the low flow channel margin, similar to previous years, 2) a skim on 'Tooby Park Bar', adjacent to Tooby Park on the south (right) bank, and 3) a skim on the downstream half of 'Tooby Bar' (a.k.a., 'Home Bar') on the inside of the meander bend adjacent to the processing facilities. This is a forced meander exhibiting very consistent replenishment and morphology from year to year. CHERT recommendations for this site consisted of lowering the skim floor on part of the Tooby Bar to facilitate drainage following inundation. Tooby Park Bar was left un-extracted. Approved plans were reasonably well met at the other two areas.

Wallan and Johnson Bar (Wallan and Johnson): This site is located on a large, unvegetated, frequently mobile lateral bar along the right side of the channel. CHERT recommendations consisted of accepting the operator's proposal without modification, which was to skim the top of the bar well above the low water surface. Post extraction cross sections revealed that significant gravel extraction occurred within the upstream end of the area and farther upstream "by others as part of bridge construction activities", resulting in far greater bar disturbance than described in the operator's approved mining plans. At one cross section (8E, about 300 feet downstream of the bridge), the gravel extraction for bridge construction lowered the bar and adjacent wetted channel margin significantly. Apparently, gravel extraction for bridge construction took place within the approved mining area for this site, but the operator (Wallan and Johnson) did not harvest this gravel. As for the area that was reportedly extracted by the operator, actual extraction deviated significantly from the approved mining plans by extending much farther toward the river's edge than approved. While the site appears to have been significantly under-extracted based on the reported volume (see Table 5), the actual volume extracted between the two contiguous operations was likely much greater. Although CHERT was not asked to review this additional gravel extraction, we feel the entire area should have been reviewed as a single contiguous extraction area.

D. Van Duzen River Gravel Extraction

1. Gravel Extraction Volumes

As shown in Table 5, the total volume actually extracted on the Van Duzen River in 2000 was approximately 121,384 cubic yards (cy). This volume is about 62% of that recommended by CHERT and approved by agencies (194,794 cy).

Table 5. Recommended and extracted volumes for the Van Duzen River sites (in downstream order), 2000.

Operator; site/bar	**Recommended Volume (cy)**	**Extracted Volume (cy)**	**Percentage Extracted**
Bess Site; East Area	25,794	21,549	84%
Bess Site; West Area	0	0	0%
Noble Site; Area 4	27,000	0	0%
Noble Site; Area 5	18,000	0	0%
Noble Site; Area 6	24,000	0	0%
Leland Rock; East Area ("A")	10,500	13,248	126%
Leland Rock; Middle Area ("B")	43,000	46,043	107%
Leland Rock; West Area ("C", Dwelley Bar)	46,500	40,544	87%
Total for Van Duzen River	**194,794**	**121,384**	**62%**

2. Summaries of Site-specific CHERT Recommendations and Post-Extraction Observations

Bess Site (Tom Bess): One extraction area, a skim on an active, unvegetated bar on the south side of the channel, was proposed for this site in 2000. CHERT recommended approval of the operator's initial plans as submitted. Approved plans were well met at this site, however, it was realized later that the proposed and approved extraction volume was mis-calculated. The true proposed/approved volume was 25,794cy, nearly 6,000 cy over that permitted for the site (20,000 cy). Had this error been known, the proposal would have been modified to keep extraction within the approved limit. Actual extraction was about 1,500 cy above the permitted volume due to the errors in the proposal. Table 5 now contains corrected volumes.

Noble Site (Jack and Mary Noble): The operator proposed three extraction areas in 2000. Two were to be bench skims on unvegetated bars (areas 4 and 5), and the other a shallow 'dry trench' to the across a sparsely vegetated bar to the north (right) of the low flow channel near the downstream end of the site (an area of frequent overflow during winter stormflows). CHERT recommendations consisted of accepting proposed design for Area 4, reducing the horizontal limits of Area 5 to avoid young riparian vegetation, and substituting the dry trench with a more conventional bench skim along the riverward edge of the point bar. These changes were approved by the agencies, but the operator chose not to conduct any gravel extraction in 2000. This is the reason why the actual volume extracted from the Van Duzen River fell far short of that approved by agencies.

Leland Rock Site (Leland Rock); The operator's initial proposal was to skim three areas: Area A at the downstream end of a mid-channel bar at the upstream end of the site, Area B north (right) of the low flow channel on a lateral bar just upstream from the US Highway 101 and railroad bridges over the mouth of the Van Duzen River, and Area C to the south (left) of the low flow channel on the Van Duzen River's delta at the confluence with the Eel River downstream of the bridges. CHERT recommendations for this site consisted of accepting the operator's proposal as submitted for Area B, but providing a horizontal buffer between the skim area and the low flow channel in Areas A and C to better preserve the minimal low flow channel confinement that existed prior to mining.

As indicated in Table 5, Area A was over-extracted by about 2,750 cy, presumably by extracting slightly deeper than approved at the upper end of the area (near cross section 6). In Area B, cross sections indicated that the landward edge of extraction went beyond that approved along the upstream half of the area, cutting into a natural berm feature forming the boundary between the extraction area and a sparsely vegetated upper bar surface. This accounted for the over-extraction of about 3,000 cy for this area (see Table 5). Area C, on the delta, was under-extracted because it did not extend downstream as far as planned. This area was under-extracted by about the same volume as the sum of over-extractions at the two other areas, resulting in a site total consistent with that approved. Although the total site extraction volume was within that approved, area-specific design specifications must be adhered to minimize local effects on habitat. Excess extraction at areas A and B resulted in minor loss of low flow channel confinement at Area A and a greater extent of bar disturbance at Area B.

E. Miscellaneous Humboldt County Sites Gravel Extraction

1. Gravel Extraction Volumes

As shown in Table 6, the total volume actually extracted on miscellaneous sites in 2000 was approximately 22,181 cubic yards (cy). This volume is about 123% of that recommended by CHERT and approved by agencies (18,000 cy).

Table 6. Recommended and extracted volumes for miscellaneous sites in Humboldt County (Trinity River), 2000.

Operator; site/bar	Recommended Volume (cy)	Extracted Volume (cy)	Percentage Extracted
Mercer Fraser Co; Trinity River, Area 1	4,300	7,321	170%
Mercer Fraser Co; Trinity River, Area 2	4,500	3,926	87%
Mercer Fraser Co; Trinity River, Area 3	9,200	10,934	119%
Total for miscellaneous sites	**18,000**	**22,181**	**123%**

2. Summaries of Site-specific CHERT Recommendations and Post-Extraction Observations

<u>Willow Creek Site, Trinity River (Mercer Fraser Co.):</u> The operator's proposal for this site consisted of extracting at three areas: Area 1 was a skim on a right lateral bar near the upstream end of the site, Area 2 was a trench along the left bank of the Trinity River, separated from the river flow by a residual berm, and Area 3 was a bench cut into the terrace inside a large forced meander at the downstream end of the site. CHERT recommendations included extracting Area 1 as proposed while preserving willows on either side of the extraction area, providing a buffer alongside the trench at Area 2 to protect an adjacent overflow channel, and avoiding disturbance to willows along the margins of the Area 3 extraction. Areas 1and 3 were over-extracted according to the post-extraction volume calculations provided, however, the post-extraction cross section plots do not indicate over-extraction. Rather, they indicate approved plans were reasonably well met at this site. The operator should provide an explanation for this discrepancy.

VIII. SUMMARY OF RIVER CONDITIONS AND TRENDS

River conditions vary from year-to-year and are primarily dictated by the magnitude of winter stormflows, amount of gravel bedload transported by winter stormflows, and by human influences. Gravel supply (recruitment) is determined primarily by the magnitude (peak discharge rate) and duration of the largest one to several flow events produced by winter rains. Numerous smaller events may also be large enough to move bedload, but their influence is overshadowed by the effects of larger floods. Annual or seasonal rainfall is a relatively poor predictor of river changes, as in 1998 when rainfall was above normal, but was distributed over the rainy season in numerous rainstorms of only small or moderate size. Such storms do not produce the large, long duration river flows required to transport large volumes of gravel, even though turbidity (caused by fine sediment in suspension) may be high for extended periods. It is also the larger flow events that re-supply mined bars with new gravel (replenishment) and allow mining on a recurring basis on an individual bar.

Humboldt County rivers underwent more rapid geomorphic changes in 1995-99 than either in the early years of the scientific review program (1992-94), when winter flows were relatively low, or in the recent past (the winter of 1999-2000), when rainfall was about normal, but peak river flows were either relatively small and/or of short duration. Recruitment in the winter of 1999-2000 was low despite above or near normal rainfall. Recruitment for the present winter runoff season (2000-01) is shaping up to be low as well and below normal recruitment is expected unless unusually large flow events, uncharacteristic of the remaining winter high flow period (primarily February and March), occur.

In previous post-extraction reports (1997 and 1998), we developed quantitative information on changes in river conditions for the Mad River from compilation and comparison of large amounts of data. This is an important task for tracking river channel changes through time in all areas where mining is concentrated within Humboldt County. However, as discussed earlier, this is a time consuming task and is expensive for the operators who reimburse us for our time. We feel such an analysis is important, but would be more appropriately performed in the context of a larger effort conducted at approximately five-year intervals following a 5-year or greater flood. At present, the County mining program (with the possible exception of the Mad River PEIR) does not mandate this type of analysis. Consequently, this report includes only a brief narrative describing river conditions and trends for each of the major locations of instream mining in Humboldt County based on observations made during the course of field reviews, looking at air photos of mining sites, and summarizing observations made by others.

A. Mad River

As discussed in earlier post-extraction reports, the predominant changes since 1992 have been in the river's planform (configuration of the river viewed from above, as in maps or air photos). Several meanders have tightened their radii and migrated downstream over the last decade (e.g., Blue Lake, Leavey, and Christie meander bends). This is a natural process in alluvial rivers and has resulted in large volumes of bank erosion in high flow years at several locations in the river reach near the City of Blue Lake. The main flow channel at Christie Bar has cut across the middle part of the bar. Minor planform change or bank erosion was observed in the river reach downstream from the Annie and Mary Railroad Bridge since 1992. Over the winter of 1999-2000, the lack of high stormflows limited channel changes to minor movement of the low flow channel and small to moderate replenishment within the mining reach. The Humboldt Bay Municipal Water District reports continued bed lowering in the reach above Highway 299, but we do not have documentation to support this at this time.

As discussed earlier in this report, recruitment was estimated to be about 114,000 cy at the upper end of the mining reach for the 1999-2000 winter season using Brown's (1975) bedload transport rating curves. Replenishment estimates at the mining sites provided by the operator's consultants indicated deposition of about 60,000 cy and scour of about 48,000 cy, giving a net volume of deposition of about 12,000 cy at the mining sites over the 1999-2000 winter. The recruitment estimate may be subject to error because of the age of the data (nearly 30 years) used to develop the bedload transport curve. Renewal of bedload sampling at the USGS stream gage would provide much needed contemporary data for quantifying recruitment. In addition, we lack of information for assessing replenishment in between mined sites or upstream and downstream of the mining reach. However, we can say with confidence that considering the estimates of replenishment and recruitment, the mining volumes seen in recent years cannot be recommended in 2001 unless the remainder of the present winter season is much wetter than it has been thus far. Should a second consecutive low recruitment year occur, we will likely see a return to lower reach-wide mining volumes and the use of wetland pits as alternate aggregate source areas in the 2001 mining season.

During preparation of this report, we were provided with a draft report Changes in Bed Elevation and Sediment Storage in the Mad River, 1970-1999 by Dr. Matt Kondolf and Erin Lutrick of UC Berkeley. The report, prepared for Eureka Ready Mix, analyzes changes in the lower Mad River based on a number of cross sections surveyed initially in 1970 by the Corps of Engineers and again in 1999 by local consultants to the gravel mining industry. The authors compare their estimates of channel bed degradation (incision) and mean annual recruitment with those in the Mad River PEIR technical appendix. Based on the Corps' cross sections, they found the degree of bed degradation to be lower than that reported in the PEIR, but note that some of the discrepancy could be the result of differing time periods examined, differences in computational methods and assumptions, and gaps in the network of cross sections used to assess changes. The authors recommend surveying the remainder of Corps' cross sections that were not surveyed in 1999, as well a compiling other cross sections from the Humboldt Bay Municipal Water District reach.

They also estimated a mean annual recruitment of about 270,000 cy, 70,000 cy higher than the upper limit estimated in the PEIR (200,000 cy) and about 90,000 cy higher than average annual extraction from 1993 to 2000 (180,000 cy). Their estimate was computed as the residual term in a simple sediment budget (not independently measured, but deduced by subtracting the change in sediment storage in the channel from the amount of gravel extracted), and the authors note the potential for substantial errors in this approach. We believe the analysis is scientifically credible and provides important new information that could be used in combination with other data in a re-analysis similar to that done in the PEIR. However, we don't feel this report alone is sufficiently comprehensive in scope to justify changing the existing management approach or limits on mining volumes for the lower Mad River.

The report concludes with six recommendations, including surveying the remainder of the Corps' cross sections, resolving the timing of channel changes using photogrammetric methods, and resuming suspended and bedload sampling at the USGS stream gage, among others. We agree with these recommendations and feel that a comprehensive analysis that uses data generated from these activities along with that already collected would go a long way toward resolving the outstanding technical questions on gravel mining in the lower Mad River.

B. Eel, South Fork Eel, and Van Duzen Rivers and Miscellaneous Humboldt County Rivers

At this time, no quantitative assessment has been made of river conditions and trends in the South Fork Eel, Lower Eel and Van Duzen rivers except for the relatively brief 1999 report on these rivers by the COE (1999). As mentioned earlier, the COE has completed an analysis of several cross sections surveyed in 1968 and again in 1998 on the South Fork Eel, lower Eel, and Van Duzen rivers. While it is difficult to generalize broad channel changes over many miles of river with just a few cross sections, results of this analysis suggest the following: the South Fork Eel experienced significant net aggradation over the 30-year period, while the lower Eel degraded and the lower Van Duzen aggraded slightly. More recent changes in river conditions are likely relatively small, owing to the mild winters of 1999-2000. Insufficient information precludes summarizing changes in river conditions and trends near miscellaneous County mining sites because data (cross section surveys) usually collected only for the mine site and only sporadically, when mining is planned. Consistent monitoring at sites that are repeatedly mined, but not necessarily on an annual basis, would be needed for evaluating long term trends at such sites, and operators of several such sites in the County are performing monitoring during years when no extraction takes place.

IX. EVALUATION OF BIOLOGICAL MONITORING PROTOCOLS AND 2000 RESULTS

At this time, we have reviewed the only report available on biological monitoring required of gravel mining operations in Humboldt County. This is the Final Report: 2000 Fisheries Monitoring Program for Gravel Extraction Operations on the Mad, Eel, Van Duzen, and Trinity Rivers prepared by Dennis Halligan of NRM Corporation. Other reports on riparian vegetation monitoring results have not yet been provided to CHERT. A report prepared for Arcata Readimix is reportedly completed, but CHERT was not provided with a copy. Another report covering numerous sites is still being prepared by NRM.

In the fisheries monitoring report prepared by Mr. Halligan, summer steelhead surveys were the only fish data collected in 2000, as required under the LOP. Our concerns for the rationale of sampling adult summer steelhead, as stated in the 1999 CHERT Post-Extraction Report, remain unchanged. Dennis Halligan of NRM does a good job of summarizing adult counts in the report, and satisfies the LOP requirements for fish monitoring. The following operators contributed to this monitoring effort: Mad River Sand and Gravel, Eureka Sand and Gravel, Redwood Empire Aggregates, Arcata Readimix, Hansen Trucking, Mercer-Fraser Company, Drake Materials, County of Humboldt, Tom Bess, Jack Noble, Leland Rock, Fort Seward Ranch, Randall Sand and Gravel, and Wallan and Johnson.

Given that an effort to develop of new monitoring protocols is presently being led by the National Marine Fisheries Service (NMFS), the following observations and questions may be helpful and timely:

1) Mr. Halligan notes that the adult steelhead in the Kadle Hole on the lower Mad River below Highway 299 may have been early winter run steelhead, rather than summer steelhead. We agree. This would mean only 5 summer steelhead were observed below the CDFG Mad River Hatchery (see Table 1 of the fisheries report). Summer steelhead tend to move upstream during the summer if the channel morphology and summer flows permit. The sample date was August 25, 2000. The chances that more summer steelhead are present below the Mad River Hatchery earlier in the summer are very high. This should be examined by multiple sample periods beginning late-May (depending on flow conditions) with the objective of determining appropriate sampling dates. Figure 2 of the fisheries report needs additional information to make the inter-annual comparisons. For example, a list of sample date(s) and subdivided counts by date and sample reach should be included.

2) Summer steelhead habitat needs to be mapped on the aerial photos first, then followed by the adult counts. This would show where the habitat is located relative to mining and potential control (unmined) reaches. A new sampling protocol should rely on a habitat classification specific for summer adult steelhead and possibly for older steelhead (2+ juveniles). This protocol would not use the standard CDFG protocol, but be based on a smaller spatial scale sensitive to the microhabitat selected by adult fish.

3) Cutthroat trout should be noted. In dives of the Mad River this summer by Dr. Trush, a surprising number of cutthroat was observed. Also, notes (indicated by an outlined area on the aerial photo) should be made for Pacific lamprey juvenile habitat (the backwater silt/sand deposits).

4) The low flow elevation ("silt line") for mining should be examined relative to riffle confinement and safe fish passage depths in case of low flow years (as this year).

X. RECOMMENDATIONS

We offer the following recommendations to improve the quality of information required in the review process and keep program costs to a minimum. Most operators already follow the recommendations listed below. Several of these recommendations were included in last year's report, but bear repeating:

- ♦ All spring monitoring and extraction cross section surveys should include: 1) the current water surface, 2) the top of the silt band, if present, and 3) points in the wetted channel as far as is safely wadable. These will facilitate pre-extraction reviews and save time and money. Post-extractions submittals should include both the spring and fall water surface elevations at the time of survey to document the decline over the low flow season as well as high water marks from the previous high flow season.

- ♦ Consider a discussion of mining plans, on site if feasible, with CHERT prior to preparing a mining proposal in the spring. This will help minimize changes recommended to the proposal by CHERT and save money and time.

- ♦ CHERT should be provided with final approved mining plans as soon as possible in the mining season. Although CHERT sometimes recommends approval of mining plans given prior to receiving final plans, we need to know the final approved configurations and volumes for post-extraction field reviews, which are frequently conducted before post-extraction submittals, are received.

- ♦ Post-extraction cross sections should include the final approved mining configuration overlaid onto the pre- and post-extraction survey data. This was also recommended in last year's report, but not all operators included this information, which expedites post-extraction reviews and preparation of this report, saving time and money.

- A brief narrative should be included with the post-extraction submittal. This should note such things as post-extraction grading, stockpile areas, and any other observations relevant to explanations of what took place before, during or after extraction.

- When making pre- and post-extraction submittals, operators should make it clear as to where the materials should go (whether or not they are copies for the files or are to be used by the technical members for review purposes).

XI. LITERATURE CITED

US Army Corps of Engineers (COE). 1999. Eel and Van Duzen Rivers: General assessment of historical change in channel morphology. San Francisco District. 15 p., with appendices, maps, and photos.

Brown, W.M. III. 1975. Sediment transport, turbidity, channel configuration, and possible effects of impoundment of the Mad River, Humboldt County, California. US Geological Survey Water Resource Investigations 26-75. 63 p.

Kondolf, G.M., and E. Lutrick. 2000. Changes in bed elevation and sediment storage in the Mad River, 1970-1999. Draft report to Eureka Ready Mix. 23 p.

APPENDIX A: Response to Comments on 1999 CHERT Post-extraction Report

A total of 12 comment letters on the 1999 post-extraction report were received, 11 from the two major consultants for the gravel mining companies (Paul Krause of Pacific Affiliates and Bob Brown of Streamline Planning Consultants) and one from Richard Stein of the Humboldt County Department of Public Works, a local agency that conducts gravel mining subject to the County's program. This response to comments was supposed to have been completed as a supplement to the post-extraction report by April 30, 2000. For various reasons, it was not. We apologize for the tardiness of this response to comments and hope it has not inconvenienced anyone. We also note that where applicable, comments were incorporated during the 2000 extraction review season. Comments received and our responses are briefly summarized below.

Comments from Bob Brown, Streamline Planning Consultants

Mr. Brown provided 10 comment letters, nine of which were related to specific gravel operators for whom he provides services and one of which was of a general nature. The operator-specific comments primarily: 1) provide explanations for observations and criticisms made by CHERT in the post-extraction report, 2) give recommendations for ways to avoid encountering problems with compliance in the future, and 3) report on over-winter observations made at the sites. He does not dispute observations noted in the post-extraction report. Rather than digress into a lengthy discussion of all Mr. Brown's operator-specific comments, we hope it suffices to say that the comments have been noted and will be considered during future reviews.

Regarding Mr. Brown's general comment letter, we discuss his several main points here. He correctly states that there are no quantitative standards for evaluating compliance in terms of, for example, the depth of actual extraction on a cross section below an approved skim floor elevation or the number of feet outside the approved horizontal limits that actual mining might be done that would be considered non-compliance. In the strictest sense, any transgression outside the approved limits would constitute a violation. However, minor transgressions (say, one foot in skim floor elevation or 10 feet in width) are typically not pursued as violations by the regulatory agencies. In our reports, we simply note these transgressions and make qualitative evaluations of their relative severity. We believe it is one of our responsibilities to note these observations in the post-extraction report. It is up to the regulatory agencies to choose to pursue violations or not and to set quantitative standards or not. We suggest that Mr. Brown make his case before the regulatory agencies if he feels such standards are needed.

Mr. Brown also objects to our criticism of biological monitoring programs established by the regulatory agencies, stating that we had the opportunity to provide input when the programs were being developed. In fact, we did provide input at that stage, but the program ultimately adopted was not what we had suggested or envisioned. His claim that we criticized without offering alternatives is untrue. We offered several suggestions in our post-extraction reports and elsewhere, in other writings and verbally at meetings. We agree with his closing statement on this subject, "I would like to see the above-mentioned [*regulatory*] agencies defend the program they said would produce the information and was worth requiring the operators to pay for". If he feels the agencies should be called to task to defend their biological monitoring programs, we can only assume that, like us, he has criticisms of the present program.

Later in the letter, Mr. Brown returns to the subject of biological monitoring. He lays the responsibility for developing a more useful monitoring program on CHERT, but this is clearly beyond our scope of work. He also mentions that riparian vegetation monitoring has shown no impact from mining because there has been no loss of existing stands. This statement fails recognize the dynamic nature of riparian vegetation and the fact that recurring mining prevents establishment and succession of vegetation: you can't monitor or quantify the loss of something you've prevented from coming into being. That said, it is not surprising that there has been no loss of *existing* riparian vegetation attributable to mining since vegetated areas are avoided when mining areas are delineated each year.

Mr. Brown's third area of comment was about the development and use of mean annual recruitment (MAR) as a management tool. The estimation of MAR and its use as a management tool are discussed at length earlier in this report. Simply stated, it is imperative to have some idea of how much gravel is supplied to a mining reach to be able to set appropriate limits on the volume mined. This is a basic element of informed management. We have difficulty in understanding Mr. Brown's criticism of using MAR on the Mad River or any other river.

Finally, Mr. Brown criticizes both the overall approach and the assumptions used to develop MAR for the Mad River. He also criticizes CHERT for not re-assessing the Mad River using data that were not available when the Mad River PEIR was prepared in 1993. As discussed earlier, any new analysis that is not comprehensive in scope (i.e., does not use the entire set of available data, such as the recent Kondolf and Lutrick (2000) study discussed earlier) should not supplant the existing technical analysis and management strategy in the PEIR. We agree that the analysis done for the PEIR would benefit from updating with inclusion of newer data, but County authorization and a funding source are needed to carry this out. We hope a comprehensive analysis of the technical issues along with a review of the management program can be conducted in the near future, but some elements of this effort (e.g., bedload sampling, etc.) probably cannot be done without financial support from agencies.

Comments from Paul Krause, Pacific Affiliates

Mr. Krause submitted a single comment letter. He concludes that, after a decade of monitoring, "there have been no identified significant impacts relative to any extraction operation or group of operations known to either our firm or to our clients [*mine operators*] through the annual feedback loop". We agree, but feel this is attributable to either: 1) the true absence of significant effects, 2) the masking of mining effects by effects from other land use activities or natural processes, 3) the failure to collect meaningful information (e.g., biological monitoring conducted within the context of hypothesis testing), or 4) the lack of comprehensive analysis of existing multi-year data sets covering an entire river reach (i.e., the five-year periodic assessments that were discussed earlier in this report). Until biological monitoring programs are geared toward cause-and-effect type hypothesis testing and periodic comprehensive analyses of geomorphic trends are incorporated into the program, it will be impossible to find that there have or have not been significant effects.

He also questions the use of Brown's (1975) bedload transport curves for estimation of recruitment on the Mad River. We agree that there is uncertainty from using these old curves (as discussed earlier in this report), but they are nonetheless the most reliable estimators presently available for this purpose. As mentioned earlier, resuming bedload sampling on the Mad and other rivers would provide much needed data for estimating contemporary MAR volumes.

Mr. Krause also discusses the results of 1999 re-survey of Corps of Engineers cross sections first surveyed in 1970 in terms of bed lowering, arguing that a lack of bed lowering is evidence for a large error in the present MAR estimate for the Mad River. We have not yet examined these cross sections in detail, but would point out that MAR is a measure of volume, whereas bed elevation is not. Only considering the cross sectional changes in terms of bed elevation does not account for channel width (bank erosion) or stored sediment changes that would be necessary for comparison with MAR in a sediment budgeting-type analysis, a position we have expressed repeatedly and one that is echoed in the Kondolf and Lutrick (2000) report discussed earlier.

Mr. Krause goes on to ask whether or not MAR has been refined for the Mad River since the PEIR estimate was made in 1993. We refer him to the CHERT 1997 post-extraction report, which includes a brief sediment re-balancing using recent data (1993-97 data from cross sections, air photos, bedload transport, and mining volumes). This analysis validates the reasonableness of the original estimate of MAR in the Mad River PEIR. Mr. Krause suggests that the time has come to comprehensively re-evaluate geomorphic conditions and trends in the Mad River. We support this suggestion, as discussed earlier in this report.

Later in his letter, Mr. Krause challenges the PEIR finding of 'severe' bed degradation in the Mad River, citing analyses by operators' consultants (including himself). We maintain that the conclusions in the PEIR were valid based on the data then available. His and Mr. Brown's analysis of more recent data (mainly the Corps cross sections surveyed in 1970 and 1999, data not available during the PEIR analysis) showed less degradation in some reaches and aggradation in others than found in the PEIR. However, using these same data, Kondolf and Lutrick (2000; discussed earlier) found substantially more degradation than did Mr. Krause and Mr. Brown in the reach near Blue Lake, but less than the PEIR. Moreover, as discussed above, the volume loss of gravel in the riverbed is a better indicator of mining effects. Kondolf and Lutrick found a net loss of about 1.85 million cubic yards in that reach between 1970 and 1999. We think this could be considered severe.

Regarding development of a gravel management plan and MAR estimates the lower Eel and Van Duzen rivers, Mr. Krause poses several questions revolving around the scope of such a study, funding source(s), quality control, and peer review. We believe these to be valid questions that must be addressed by all stakeholders in an open forum before proceeding.

On the related subject of shipping aggregate to markets south of Humboldt County via the railroad, Mr. Krause notes that re-establishing the rail line is questionable for economic reasons. He further notes that even were the rail line to be successfully re-established, shipping costs would add substantially to the cost to end-users and may not be competitive with other sources closer to southern markets. We don't disagree with his points, but maintain that there would be increased pressure for greater mining volumes if the rail line were re-established. What might not seem economically viable today could become so tomorrow. When limited only by market demand, whether originating locally or elsewhere, gravel mining volumes can easily exceed the limits of sustainability, and already have in many California rivers. For the lower Eel and Van Duzen rivers, we are recommending "an ounce of prevention" (defining MAR and sustainable mining management protocols to avoid mining-related cumulative effects) in order to avoid a ton of "cure" (correcting a problem, such as bridge pier undermining, at great expense once the problem has been detected).

Comments from Richard Stein, Humboldt County Department of Public Works

Mr. Stein's letter clarifies several points regarding biological monitoring performed for the County's mining operations. First, he notes that coho surveys conducted in October 1999 probably did not find presence of coho because the surveys were done prior to the fall/winter run. We agree with this statement.

Second, he corrects a statement made in the post-extraction report that mentions vegetation surveys were done downstream of Moody Bridge on the South Fork Eel River. They were in fact done upstream of the bridge, initially in 1996 and repeated in 1999, as clarified by Mr. Stein.