FLOODPLAIN MINING IMPACT STUDY
QUALITY ASSURANCE PROJECT PLAN

Date of Plan: Revised January 16, 2002

Project: The Floodplain Mining Impact Study is a cooperative effort between the Washington State Department of Natural Resources, Washington State Department of Fish & Wildlife, Washington State Department of Ecology, Yakima County Planning Department, and Yakama Nation. The study will investigate potential impacts of flood plain mines along the Yakima River from Cle Elum to Richland. The study is funded by the contributing agencies as well as grants from the Centennial Clean Water Act grant # G0100193, the Salmon Recovery Fund Board (IAC #00-1713N) and the United States Bureau of Reclamation (Yakima River Basin Water Enhancement Project).

Approvals:

Yakima County: Steve Erickson_____Date_____

WADNR: David Norman _____Date_____

WDFW: John Easterbrooks_____Date_____

WSDOE: Chad Wiseman _____Date_____

Yakama Nation: David Fast _____Date_____

Grant Administrator: Chris Hall _____Date_____

QAPP Review: Will Kendra_____Date_____

Table of Contents

Project Organization and Schedule……. 3

Background and Key Questions…..…… 5

Project Description…….. 5

Data Quality Objectives…….. 7

Sampling Design……. 9

Field Procedures…….. 11

Laboratory Procedures……. 12

Quality Control…… 12

Data Management Procedures……. 13

Audits and Reports…….. 13

Data Review, Verification, and Validation…….. 14

Data Quality Assessment/Data Analysis…….. 14

Interim and Final Reports……... ……. 16

References…… 18

Appendices

A. Site Distribution Map……. 19

B. Site Information……. 20

Project Organization and Schedule

Project Planning Team:

Kelly Clark, Yakima County Planning Department
Steve Croci, USFWS/USBOR
Jim Cummins, Department of Fish & Wildlife
Randall Doneen, Department of Ecology
Marc Duboiski, Salmon Recovery Funding Board
Steven Erickson, Yakima County Planning Department
Dave Fast, Yakama Nation Fisheries
Anne Knapp, Yakima County Planning Department
Patrick Monk, Fish Biologist/Consultant
Scott Nicolai, Yakama Nation Fisheries
Dave Norman, Department of Natural Resources
Todd Pearsons, Department of Fish & Wildlife
Rob Plotnicoff, Department of Ecology
Robert Raforth, Department of Ecology
Tom Ring, Yakama Nation
Chad Wiseman, Department of Ecology
Wayne Kalbfleisch, Central Pre-Mix
Jason Alvord, Central Pre-Mix

List of Tasks:

Department of Natural Resources: Pit bathymetry, sediment sampling, and cooperation with other study partners in the identification of benthic macroinvertebrate and temperature sampling locations.

Department of Fish & Wildlife: Fish assemblage and analysis.

Yakama Nation: Assist WDFW in data collection for fish assemblage.

Department of Ecology: Benthic macroinvertebrate sampling and analysis.

Yakima County Planning Department: Temperature data collection and analysis, GIS analysis (creation of channel complexity coverages from new and existing data sources), database management (incorporate formatted data tables supplied by other study partners into floodplain mining study database, submit to Environmental Information Management system, and supplement GIS layers), and contract management.

All Study Partners: Data preparation, analysis, and incorporation into an interim and final report.

Project Schedule:

Yakima County Planning Department:

- GIS analysis and database management, October 2001 through December 2002
- Temperature monitoring, (after Spring freshet 2002 through early winter 2002)

Washington State Department of Fish and Wildlife and Yakama Nation:

- Fish assemblage, between May-October, 2002

Washington State Department of Ecology:

- Benthic macroinvertebrates, Fall of 2002

Washington State Department of Natural Resources:

- Pit bathymetry and sediment sampling to begin after temperature data loggers are in place (Spring 2002). Coordination between macroinvertebrate, fish and sediment data collection events is needed to avoid interference.

Collaborative Efforts:

- Finalized data will be submitted to Yakima County Planning Department for incorporation into the project database and GIS point attribute tables.

- Finalized field data in Excel spreadsheets and GIS coverages are to be completed by November 15, 2002.

- Interim draft report completed for review by January 10, 2003.

- Signoff on interim report by February 14, 2003

- Final draft report to be completed by November 14, 2003.

- Signoff on draft final report December 31, 2003

- Final report to be submitted to funding agencies (WSDOE, USBOR, and SRFB) by March 31, 2004.

Background and Key Questions

The Yakima River Basin is one of the most heavily mined basins in Washington State and contains the single largest flood plain mine. Higher temperature water in the Yakima River has raised concerns about the flood plain mines contributing to warmer temperatures in various aquatic habitats. Flood plain function and river ecology are extremely altered in the Yakima River Basin and flood plain mines contribute to this alteration. The extent of this contribution is uncertain, and there is a need for a robust investigation into how flood plain mines individually and cumulatively impact the Yakima River ecosystem.

Habitat biologists have considered reconnecting the stream channel to abandoned flood plain gravel pits as fish habitat restoration efforts. Uncertainties about how fish use these sites have raised questions about this type of management, especially in eastern Washington. The study will determine what type of management is best for specific pits, as well as pits with similar geomorphic and ecologic characteristics. In addition, a list of sites will be provided along with recommends of fish habitat restoration efforts that could be undertaken.

Managers are also concerned about several new large mines that have recently been proposed. Thus, the focus of the study is to gain a better understanding of how these mines affect the Yakima River ecosystem, and to identify how to mitigate for impacts of existing and future mining activities. Physical characteristics (connection/isolation to river, depth, distance from river, and placement in river reach) will be investigated for evaluation of impacts to the river ecosystem. Areas of investigation will focus on water temperature, geomorphology and biological indicators, including fish and benthic macroinvertebrates, to determine what impacts are occurring from these sites. Moreover, identifying and quantifying factors that contribute to specific impacts will better enable the mitigation of existing and future sites for such impacts.

Key Questions:

- What impacts do gravel pits located adjacent to the Yakima River have on benthic communities, fish assemblages, temperature, and geomorphology?
- What are the impacts, design factors and criteria associated with implementing connection or continued isolation of existing pits?
- What factors should be considered in siting, designing, permitting and future use of new flood plain gravel pits?

Project Description

The goal of the Yakima River Floodplain Mining Impact Study is to identify impacts and degree of impacts that sand and gravel mines have on geomorphic flood plain ecosystems throughout the Yakima River continuum. Physical characteristics of the mine sites (i.e. connected/not connected to the river, deep/shallow, far/near to river) will be compared using the data that is collected. The study includes the following areas of investigation:

Fish assemblage study inside the gravel pits and in the river adjacent to the pits; the control and downstream analysis and pit usage of benthic macroinvertebrates; water temperature analysis upstream, downstream and in gravel pits; geomorphic analysis and bathymetry of gravel pits, including sediment sampling; and, historic location and use of gravel pits.

Ten flood plain mines were selected for complete investigations of fish assemblage, benthic macroinvertebrates, water temperature, bathymetry, sediment sampling and geomorphic analysis. Appendix A contains a list and map of ten sites that were selected. Additional sites may be added or substituted if time and money allows, or if complications occur at a given site.

The data from these investigations will be used to create a database that all study partners can use for further investigations and GIS mapping. Sites have been selected to demonstrate a variety of characteristics in flood plain mines so that impacts can be identified with specific mine characteristics. Such characteristics include depth, distance to river, river connection, avulsion and location in river reach. These investigations will be used to develop risk assessment approaches of future gravel mining operations and to develop a decision framework to identify management tools for existing pits.

Water temperature investigations- Water temperature data will be collected upstream, down stream, and in flood plain mines. Correlating temperature measurements and plotting the measurements over time will determine if the mine is contributing to warming of river water. Other factors will need to be considered such as shade and flow.

Existing and on-going temperature data collected from the East Selah and Newland sites by Central Pre-Mix personnel, as part of their independent “Thermal Transport Investigation,” will be used to supplement the temperature investigation. Thus, the Flood Plain Mining Study’s investigation will correspond with the monitoring and data analysis methodologies utilized by the Central Pre-Mix study.

Fish assemblage investigations- Fish will be sampled using standard Department of Fish & Wildlife techniques, which include backpack and boat electrofishing, experimental gill netting, snorkeling and trapping. All fish that are encountered will be identified to species and age class (adult, juvenile, and age 0+). Assemblage composition will be used to assess localized influences of flood plain mines.

Benthic macroinvertebrate- Four replicate benthic macroinvertebrate samples will be collected from a reach upstream and downstream of each gravel pit and may be collected from the reach adjacent to the gravel pit. Three replicate benthic macroinvertebrate samples will be collected in the gravel pit sublittoral zone. Macrophytes, trophic state, and water quality will also be assessed in each (EPA 841-B-98-007). Data analysis will identify how physical and chemical gradients established by gravel pit characteristics influence the benthic macroinvertebrate community characteristics in both riverine and gravel pit environments, respectively.

Bathymetry, geomorphology and sediment sampling- Global Positioning System and depth finder techniques will be used to map current morphology of the mine. Particle size measurement will determine substrate of mines and adjacent river channel. Historic photos and maps will be used to create channel complexity coverage in the area of the flood plain mine.

GIS layers and integration of investigations- Individual data from investigations will be provided to Yakima County GIS in acceptable database format. GIS layers will be created and provided to all study partners for analysis. In addition to analysis of specific investigations, integration between investigations will allow correlation between fish, water temperature, benthic macroinvertebrates and morphology.

Data Quality Objectives

Numeric data that will be collected as part of the study include temperature (ambient and water), sediment particle size, benthic macroinvertebrates and fish assemblages. Each of these individual data collection efforts has a specific purpose and varying data quality objectives.

Temperature (ambient and water): Small increments of temperature change can have profound impacts to biological and chemical systems. Because increasing river temperature from flood plain mines is a central question of the study, these measurements have the highest data quality objective.

Bias will mainly be reduced by the collection of many measurements using data loggers with capacity of over 30,000 measurements before needing to download the measurements. Each data logger placed in the water will take 12 temperature measurements each day (2-hour intervals). Air temperature data will be collected at select sites using data loggers to allow for comparison of atmospheric and surface water temperature trends. Measurements will also be done at 2-hour intervals. Where air temperature loggers are not used, local weather data may be used. In addition to numerically reducing bias, placement and monitoring of data loggers will be used to reduce bias.

Shading from riparian vegetation will be considered for final data logger placement. Monitoring stations will have built in shade to protect them from direct exposure to sunlight, regardless of whether or not shade is provided from riparian vegetation. What will be avoided is to have an upstream station located with a high percentage of shade and a downstream location provided with a high percentage of direct sunlight. Similarities of shading patterns will be sought during placement of monitoring stations. Water flow and depth are other factors that will be replicated between monitoring stations at each flood plain mine. These factors will be as close as possible in the field when placing the stations. Any inability to gain uniformity will be noted.

Precision will be maintained by using duplicate data loggers as checks on specific monitoring stations. Five to ten additional data loggers will be available for placement within existing monitoring stations along with dedicated data loggers. These additional replicate loggers will be rotated to all stations over time to ensure dedicated data loggers are within acceptable data quality objectives. Calibration or replacement of equipment will be necessary if data logger checks identify variation of more than 1.0° F. Accuracy of data logger equipment is ±0.4° F.

Particle size measurements: In contrast to temperature data, the sediment sampling does not require a high degree of data quality. The main purpose of the sediment sampling is to determine what type of strata was left in or carried (if avulsed) into the mine and to compare sediment size distribution of the mines to adjacent channel reaches. Comparisons can also be made to biological indicators (fish and benthic macroinvertebrates) that depend on specific substrate for part of their life cycle. Samples will be taken in correlation with the pit benthic macroinvertebrate samples.

Benthic macroinvertebrate: Benthic macroinvertebrate community characterizations will be used to determine the influence gravel pits have on both adjacent stream and interior pit biota. Sampling must capture representative conditions at each sample site. Replicate samples will be collected throughout each gravel pit site. Replicates are intended to measure the precision in field sampling and some of the variability associated with the natural "clumping" of distribution in the macroinvertebrate communities. Replicates will be collected from riffle habitat at the river margin (pool run habitat) and from within the gravel pits. Using sturdy sample storage vessels and adequate labeling of each vessel will minimize sample loss. Standardized sampling methods will be used in the respective habitat types.

Fish assemblage: Most fish sampling methods suffer from some kind of bias. For instance electrofishing is generally biased against sampling very small fish, gillnets are biased against fish that do not move much, and snorkeling could be biased against large fish and fish that live within the substrate (e.g., sculpins). By using a variety of techniques, biases can be identified and addressed. For example, snorkeling counts can be compared to electrofishing (when water visibility is suitable) to determine the amount of small fish that are missed by electrofishing. Electrofishing techniques (e.g., electrofisher type and settings) will be used to maximize the possibility of capturing small fish.

Target sample sizes of 200 individual fish in an area at least 100 m long will be utilized for each sampling unit to minimize random error from small sample sizes and habitat type. Sampling will continue after the first 100 m in 25 m increments until 200 fish are sampled, if 200 fish are not sampled in the first 100 m.

Sampling Design

Temperature: Temperature data loggers will take the temperature measurements. The data loggers will be deployed at monitoring stations. The location of these stations is critical to good measurements. In general, stations will be located upstream, downstream and in the floodplain mine. Depending on the size and shape of the mine, there may need to be more than one station in the mine. These data loggers will be deployed from the spring freshet to early winter, taking measurements every two hours. The data loggers will need to be downloaded and stations checked every month.

Data loggers will be placed in PCV pipes and deployed in the river/pit lake. In the case of the river temperature, data loggers will be tethered to the shore with a cable. In the case of the pit lake temperature sampling, the logger will be suspended by a float device or tethered to the shore. Air temperature loggers will be tethered on shore and located in the shade with no direct sunlight.

The tubes containing the data loggers will have holes or slots to allow water to flow through. The tube will be deployed as close to the thalwag as possible and in water 12 – 24 inches deep. The pipe containing the probe will have chain attached to the cable line above the tube to lower the tube in the water column, but not enough to allow sediment accumulation within the tube that could potentially insulate the data recorders from the water flow. To prevent jarring in the tube each data logger will be held in position within the tube using a piece of foam rubber.

Riparian shading, water depth, and flow will need to be considered for station placement. Each station will be provided with a shield to shade the data logger, but it will still be important to simulate shade and direct sunlight percentages of the stations. The same is true for depth and flow velocity. This is especially true for upstream and downstream stations. Deep mines will have to be evaluated for deployment depth as well.

In addition, surface water connections between the gravel pit lakes and the Yakima River will be mapped and identified. Flow rates into and out of the pits will be estimated and also measured to where feasible using a current meter. The cross section of connections will be measured while determine velocity using the current meter. As the project proceeds the point source locations will be revisited and evaluated for flow when temperature probes are downloaded. Gaging station data where applicable will be reviewed to determine flow rates of the river.

Fish assemblage: Fish assemblages will be sampled in the gravel pit ponds and in the river both above and below the gravel pits. Avulsed pits will be sampled within the former pit site, as well as upstream and downstream. Exact sample sites will be determined after detailed on-site field evaluation, but in general, sampling reaches will be within 100 m upstream and downstream of pit sites. Sample sections may extend upstream and downriver 500 meters or more. Attempts will be made to sample similar habitats in the gravel pit ponds, avulsed pit sites, and river reaches so that valid

comparisons about the influence of the pits can be made. Sampling will occur between May and October.

Fish assemblages will be compared between the pits, avulsed river-pits, and river sites. Parameters that will be compared will be % species composition, % predators (native and exotic), % competitors (native and exotic), and % native salmonids. Assemblage composition will be analyzed using multivariate statistics. Other parameters will be compared using paired t-tests of arcsine transformed percentages.

Fish will be trapped at the outlets of two ponds to determine if fish move between the pits and the river.

Bathymetry and geomorphology - Global Positioning System (GPS) and depth finder techniques will be used to map current morphology of the mine. Location of the depth measurements using the GPS will be recorded. Traverses of the pit lakes at suitable intervals will be done to acquire enough data to contour the pit lake. Boats used to perform the task will consist of either a rubber raft, aluminum boat or canoe depending on lake size and accessibility.

Depth measurements will be taken with a weighted line and sonar measurements. The duplication of measurements will allow for a more accurate picture of the pit lake bottom and determine spacing of traverses.

Sediment sampling: Particle size samples will be taken at several locations in the mine using a clamshell device (Ponar, Van Veen, or Peterson dredge). This is the same device that will be used for the benthic macroinvertebrate pit sampling. Analysis will only be performed on the most representative samples of the pit and will coincide with the samples taken for benthic macroinvertebrates.

Benthic macroinvertebrate: Replicate samples from three locations, respectively, will be collected at each gravel pit location. Four replicates will be collected along the river margin at locations upstream from (or adjacent to) and downstream of each pit. Three replicate samples will also be collected from the each gravel pit using the clamshell device. A total of eleven macroinvertebrate samples will be collected from each gravel pit site. The upstream or adjacent samples will represent control locations. Future monitoring will be able to determine what, if any, changes have occurred at the downstream river reach when the gravel pits are reconnected to the river. Macroinvertebrate communities may indicate the type of pollutants (e.g., adsorbed contaminants, sedimentation) that are input to receiving water and especially along the river margin where settling occurs most rapidly. Macroinvertebrate community composition, along with trophic state and macrophyte assessments, will rate each pit, in terms of productivity and biological integrity. Sampling will occur in September 2002.

Samples will be preserved in alcohol and transported to a contract laboratory for sample identification. Benthic macroinvertebrates in the river and pit samples will be sorted, identified, and enumerated. Community-level expressions can be generated for each

macroinvertebrate sample and compared to others for changes that relate to chemical and physical elements of each setting. The relationship between physical variables and the biotic community will be further analyzed to determine the key variables describing flood plain mines that influence the condition of aquatic life.

Field Procedures

Fish assemblage: Methods of field sampling have been established from many years of sampling in pond and river environments. Electrofishing will be the primary method of sampling because it can be used under the greatest variety of conditions. Other sampling techniques (e.g., snorkeling and gillnetting) will be used to assess the quality of the electrofishing results. Fish assemblages will be sampled by a three person electrofishing crew. One person will operate the backpack or boat electrofisher and the other two will net fish. Fishes will be netted, placed in holding buckets, anesthetized, identified to species and age class (fry, juvenile, adult), and lengths and weights will be measured on a subsample of each species and age class. Data will be recorded on "Rite in the Rain" paper. The Department of Fish and Wildlife is in the process of obtaining permits from the National Marine Fisheries Service for the sampling fish in waters with threatened or endangered fish species.

Temperature: The data loggers will be down loaded approximately once per month using an optical shuttle. Once the download process is completed, the data loggers will be re-deployed. Most sample sites will be accessible from the shoreline and some of the pit lake sites will need to be accessed with a boat. Optical shuttle data will be transferred to a computer at the Yakima County Planning Department, processed and backed up on the network and on cd or zip disks.

Bathymetry: A GPS will be used for location and storage of the data. Bathymetry measurements will be stored in a field book along with a corresponding map, which will be drawn in the field so as to minimize errors.

Particle size: Samples for particle size analysis will be put into sample bags. Sample bag size will be approximately 1-gallon size. If particle sizes are cobble size then a larger sample will be taken. Boulders and larger cobbles are best measured manually with a tape measure or ruler and will be accounted for in the field. Labeling of samples will be put on bags, plotted on location map, and noted in field book. Samples will be transported back to the DNR lab where they will measured.

Digital photos of the site and sediments will be taken while sampling is being conducted. Appropriate scale will be included in photos.

Benthic macroinvertebrate: Field procedures for benthic macroinvertebrates will conform with sampling techniques described in the Washington State Department of Ecology Publication #01-03-028 "Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams: 2001 Revision." Field procedures for gravel pit assessments will

follow EPA document #841-B-98-007 "Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document."

Laboratory Procedures (benthic macroinvertebrate and sediment sampling only)

Particle size: Representative samples will be taken at each location. Sands and gravels are most generally measured by sieving. The basic principle of this technique is as follows. A sand and gravel sample of known weight is passed through a set of sieves of known mesh sizes. The sieves are arranged in downward decreasing mesh diameters. The sieves are mechanically vibrated (we will use a Ro-Tap) for a fixed period of time (10-15 min). The weight of sediment retained on each sieve is measured and converted into a percentage of the total sediment sample. This method is quick and sufficiently accurate for our purposes. Essentially it measures the maximum diameter of a sediment grain.

Benthic macroinvertebrate: Samples will be stored in 70% ethanol and transported to a contract laboratory for identification. All major Orders of freshwater macroinvertebrates will be identified to at least the generic level and to species where existing taxonomic keys are available. Taxa groups normally identified to coarser taxonomic levels include: Chironomidae, Simuliidae, Lumbriculidae, Naididae, select families of Coleoptera, Planariidae, and Hydracarina (suborder). Additional taxonomic levels may be requested if sampling determines benefits in data analysis due to the additional taxonomic identification.

Quality Control

Fish assemblage: Fish that cannot be identified in the field will be preserved in formalin and identified in the laboratory using standardized taxonomic keys.

Temperature: Immersing instrument in an ice water bath of a known temperature will test calibration of instruments. The calibration of the data loggers may also be conducted at Central Washington University's Wet Lab, where the loggers can be calibrated in a thermal bath at higher temperature (~20º C) to compare the range of temperatures observed.

Data loggers not indicating correct temperature will be rejected. Precision will be determined by using duplicate data loggers as checks on specific monitoring stations. Five to ten additional data loggers will be available for placement within existing monitoring stations with dedicated data loggers. These additional loggers will be rotated to all stations over time to ensure dedicated data loggers are within acceptable data quality objectives.

Particle size: Sample splits will be taken on select samples and analyzed. These splits will allow for precision to be determined.

Benthic macroinvertebrate: Precision of the sub-sampling process is evaluated by resorting a sub-sample of the original samples. Ten percent of the benthic

macroinvertebrate samples will be resorted by a second investigator. Discrepancies between sorting results (< 95% similarity) will indicate the need for:

1. More thorough distribution of sample materials in the sub-sampling tray,
2. Special attention given to easily missed taxa when sorting (i.e. use of a magnifier).

Data Management Procedures

Particle size: Samples will be brought back to the DNR-Geology lab and dried. Particle size analysis will be conducted either at the DNR-Geology lab or sent to a contract lab. After sieving we will make (using the weight percent data from our data table) a histogram, frequency curve, and (using the cumulative percent data from your data table) the cumulative arithmetic curve for data.

For each sample, DNR-Geology will plot (using the cumulative percent data from your data table) the cumulative probability curve on probability graph paper. The cumulative probability graph will be used to compute the mean, standard deviation, skewness, and kurtosis using the graphic formulae of Folk and Ward (1957). Data from particle sizes will be kept in an MS Excel spreadsheet program.

Temperature: Temperature data in the field will be downloaded in the field using the optic shuttle. The data will then be transported back to the office computer and viewed with Onset software (Boxcar Pro 4.0®). Once all data has been downloaded and saved on the hard drive, it will be imported into MS Excel for data and statistical analysis and graphing. Data will then be subject to further analysis and incorporated into the cumulative data set.

Bathymetry: Data will be plotted and a map will be generated while in the field. Data will be stored in an MS Excel spreadsheet on the hard drive and a disk. Data will also be stored in field books where necessary. GPS waypoints and continuous traverse data along with weighted line and sonar depth measurements will be converted into Arc View shape-files for data analysis and graphical output.

Fish assemblage: Field notes and data parameters will be written on data sheets during sampling and identification of fish. Data sheets will be copied and retained. Data will be transferred into MS Excel spreadsheet for further analysis.

Benthic macroinvertebrate: Field data sheets and taxonomic data from the laboratory will be input into an MS Excel spreadsheet for further analysis

Audits and Reports

Fish assemblage: A fish collection report will be written for NMFS as part of the threatened and endangered fish permit process.

Data Review, Verification and Validation

Temperature: Data will be retrieved in the field and later viewed with Onset software (Boxcar Pro 4.0®). Once all data has been downloaded and saved on the hard drive of the office computer it will be imported into MS Excel for data and statistical analysis and graphing. Data will then be subject to further analysis and incorporated into the cumulative dataset. Data will be reviewed for quality, consistency, and completeness. Data of the replicate logger will be evaluated to determine if instruments are working correctly and the precision of the measurements.

Statistical analyses will be performed on the thermal gradients calculated within the immediate pit lake area and for the overall gradient of the river. All data will be saved to the network and backed up on zip disks at Yakima County.

Particle size: Estimates of particle size will be made in the field. Both graphic and statistical methods of data presentation will be developed for the interpretation of sieve data. The percentage of the samples in each class can be shown graphically in bar charts or histogram. Another method of graphic display is the cumulative curve or cumulative arithmetic curve. Cumulative curves are extremely useful because many sample curves can be plotted on the same graph and differences in sorting are at once apparent.

Fish assemblage: Data will be reviewed in the field and incorporated into a database. Initial review and analysis of this dataset will identify any errors or omissions.

Benthic macroinvertebrate: Field data sheets and laboratory data will be reviewed after input into database. Initial review and analysis of this dataset will identify any errors or omissions.

General: All finalized data from individual investigations will be provided to Yakima County GIS for creation of point coverages for GIS layers. Review of GIS layer data will provide an opportunity for cumulative review for errors and omissions.

Data Quality Assessment/Data Analysis

Temperature: Temperature data in the field will be downloaded to the optic shuttle. The data will then be downloaded to the office computer through the base station and viewed with Onset software (Boxcar Pro 4.0®). Once all data has been downloaded and saved on the hard drive it will be imported into MS Excel for data and statistical analysis and graphing. Data will then be subjected to further analysis and incorporated into the cumulative dataset. Data will be reviewed for quality, consistency, and completeness. Data of the replicate logger will be evaluated to determine if instruments are working correctly and the precision of the measurements.

Statistical analyses will be performed on the thermal gradients calculated within the immediate pit lake area and for the overall gradient of the river.

Particle size: Both graphic and statistical methods of data presentation will be developed for the interpretation of sieve data. The percentage of the samples in each class can be shown graphically in bar charts or a histogram. Another method of graphic display is the cumulative curve or cumulative arithmetic curve. Cumulative curves are extremely useful because many sample curves can be plotted on the same graph and differences in sorting are at once apparent.

Sorting can be expressed by various statistical methods. The simplest of these is the measurement of the central tendency of which there are three commonly used parameters: the median, the mode, and the mean. The median grain size is that which separates 50% of the sample from the other; the median is the 50 percentile. The mode is the largest class interval. The mean is variously defined, but a common formula is the average of the 25 and 75 percentile.

A second aspect of sieve analysis is its sorting or the measure of degree of scatter. Sorting is the tendency for the grains to all is of one class of grain size. Several formulae have been used to define this parameter for a sample.

A third property of a grain size frequency curve is termed "kurtosis" or the degree of "peakedness."

The fourth property of a sieve analysis is its skewness, or degree of lop-sidedness. Samples weighted towards the coarse end-member are said to be positively skewed (lop-sided toward the negative phi values), samples weighted towards the fine end are said to be negatively skewed (lop-sided toward the positive phi values).

In summary the four statistical measurements for sieved samples consist of a measure of central tendency (including median, mode, and mean); a measure of the degree of scatter or sorting; kurtosis, the degree of peakedness; and skewness, the lop-sidedness of the curve. Various formulae have been defined for these parameters and the set of formulae used will be Folk and Ward's (1957). All will likely be used in the data analysis.

Fish assemblage: Sampling design and data quality objectives will be reviewed along with a preliminary data review before data is sent to Yakima County for creation of GIS layers. Assemblage composition will be analyzed using multivariate statistics. Other parameters will be compared using paired t-tests of arcsine transformed percentages.

Benthic macroinvertebrate: Sampling design and data quality objectives will be reviewed along with a preliminary data review before the finalized data is sent to Yakima County for creation of GIS layers. Many biological endpoints will be generated, including Species Richness, EPT (Ephemeroptera, Plecoptera, and Trichoptera) richness, number of long lived taxa, number of intolerant taxa, number of predators, % intolerant taxa, and % dominant taxa. Other endpoints or analytical methods may be used if justified by preliminary data review. Environmental variables (pit morphology, temperature, etc.) will be correlated with biological condition.

Interim and Final Reports

Interim and final reports will be supplied to the Department of Ecology describing the investigations. Subsequent papers will be written and submitted to industry and peer review professional journals for publishing. Papers will not be published before the termination of the contract. The results will be readily available for industry and decision-makers. Recommendations and areas of identified impacts will be discussed in detail so that the document can guide future decisions and address additional investigation needs.

Deliverables and Timelines:

The project partners shall prepare an interim report and a final project completion report in conjunction with Yakima County in accordance with the dates listed below. The interim project report shall document the results from data collection and interpretation efforts and provide preliminary recommendations noted below. A final draft project completion report collaboratively developed by the County and other study partners shall include interim report results updated by any further data collection and interpretation efforts in 2003 and a revised set of recommendations. The final draft shall be released for review and comment by peers in the science community, permitting authorities and industry. The study partners will determine whether and how to incorporate comments from peers, permitting authorities and the industry in the final completion report submitted to DOE, BOR and SRFB.

Recommendations

The final project completion report collaboratively developed by the County, and other study partners should include the following:

- A decision framework to identify beneficial overall management strategies for existing pits;
- A review of existing practices, regulatory and policy tools used to evaluate the suitability or risk of specific floodplain gravel pit proposals and related fisheries/habitat enhancement projects;
- Suggested changes to improve effectiveness of practice, regulatory and policy tools in eliminating or further reducing impacts to the river;
- Risk assessment approaches for evaluating future gravel mining operations (e.g., permits), and related fisheries enhancement proposals; and,
- A list of potential reclamation, restoration and fisheries enhancement projects for future funding.

Data Analysis and Reporting Overview

Yakima County will supply hard copy and electronic Geographic Information System (GIS) mapping coverages (e.g., historic aerial photography documenting channel changes/complexity, sampling data, analysis, and reporting) for the presentation of results, and for modeling predictions. Other formatted data tables developed by/for study

partners will be incorporated into a common flood plain study database by Yakima County. This data will be used to generate additional GIS layers for further analysis by the study partners and incorporation into interim and final reports.

The study partners will collaboratively produce interim and final reports. Investigation of existing flood plain gravel mining impacts by the study partners will help determine/assess the risks associated with various mining operations, site reclamation, and related habitat restoration/fisheries enhancement projects. Peer review of the scientific basis for findings in the study will also provide critical information for industry and permitting authorities in evaluating, the effectiveness of existing practices, policies and regulatory tools and those changes recommended to minimize or eliminate impacts to the river.

Interim Report Deliverables:

1. Finalized field data in *MS EXCEL* spreadsheets & markup GIS maps by Nov. 15, 2002
2. Interim draft report for study partners' review by January 10, 2003
3. Signoff on study partners' interim report to DOE by February 14, 2003

Final Project Completion Report Deliverables:

1. Final draft report for study partners' review by November 14, 2003
2. Signoff on study partners' final project review/comment draft by December 31, 2003
3. Collaborate with study partners in editing/revising final project report using comments received; submit final project completion report to funding entities (DOE, USBOR and SRFB) by March 31, 2004

Acceptance Criteria for Deliverables**:**

Text. Contractor shall deliver interim and final reports in Microsoft Word using a format agreed upon by the study partners.

GIS data. GIS data shall be in ArcView shape file format using state plane south, NAD 83, units feet projection or other acceptable format. Mapping shall, at a minimum, meet national mapping accuracy standards as published by the U.S. Geologic Survey. Non GIS mapping or mark-up GIS maps shall be supplied to the County in a mutually acceptable format.

Databases. Data shall be delivered by/to study partners in Microsoft Excel formatted tables and shall include a data dictionary.

Acceptance. Yakima County, and other study partners shall have the right to reject and return deliverables for clarification/correction within ten working days after receipt.

Publication of Additional Reports: If the Contractor (and/or other study partners) deem that the data collected is of value for publication in scholarly journals, the County, while retaining ownership of the data, agrees that the Contractor and/or study partners may

publish in scholarly journals, whether collectively or separately. In the case of failure to agree as to the interpretation of study results, a party to this Agreement may publish after due notice and submission of the proposed manuscript to the other party and study partners. In such instances, the party publishing the data will assume full responsibility for any statements on which there is a difference of opinion. The Contractor, County and study partners may also produce other publications, pamphlets or newsletters for other audiences, subject to the same limitations and credit citations.

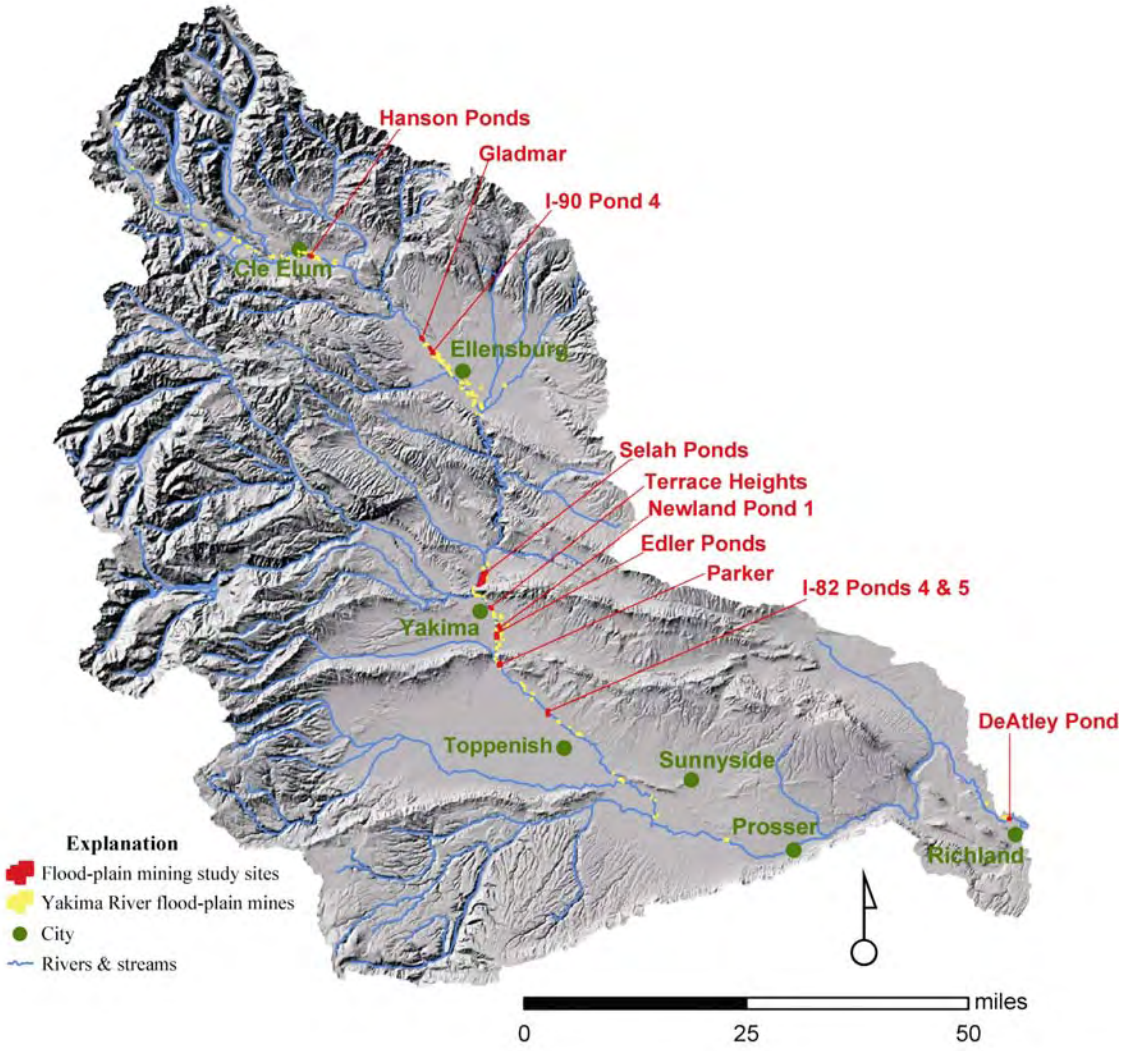
References

Brown, David, and Associates, Inc., 2000, Thermal transport study of the Selah Lakes gravel mine, 1999 annual report: David Brown & Associates [under contract to] Central Pre-Mix Concrete Company, 1 v., 1 CD-ROM disk, 1 plate.

Folk, R. L.; Ward, W. C., 1957, Brazos River bar—A study in the significance of grain size parameters: *Journal of Sedimentary Petrology*, v. 27, p 3-26.

Gerritsen, Jeroen; Carlson, R. E.; Dycus, D. L.; Faulkner, Chris; Gibson, G. R.; Harcum, John; Markowitz, S. A., 2001?, Lake and reservoir bioassessment and biocriteria: Technical Guidance Document: U.S. Environmental Protection Agency Document No. 841-B-98-007. [available online at http://www.epa.gov/owow/monitoring/tech/preface.html]

Washington State Department of Ecology, 2001, Benthic macroinvertebrate biological monitoring protocols for rivers and streams; 2001 revision: Washington State Department of Ecology Publication No. 01-03-028. [available online at http://www.ecy.wa.gov/pubs/0103028.pdf]



Appendix A. Site distribution map

Appendix B. Site Information

Site	Pond Name[a]	River Kilometer	Coordinates	Notes
10	De Atley Pit Pond	4	T9N R28E S23NW	Just upstream of Hwy 240 bridge
9	I-82 Pond #5	155	T11N R20E S20,	Public fishing access
8	Parker Pit	170	T12N R19E S20	Yakama Reservation
7	Edler Ponds	177	T12N R19E S5	North end of Valley Mall Blvd.
6	Newland Pit	180	T13N R19E Sec 33	Adjacent to SR 24 east of river
5	Terrace Heights	183	T13N R19E Sec 17	Avulsed in early 1970's
4	East Selah Pit	192	T14N R19E S31	Large group of pits
3	Freeway Ponds #3 & #4	255-257	T18N R18E S29	I-90 MP103
2	Gladmar Pit	259	T18N R17E S13NE	Avulsed in Feb. 1996
1	Hanson Ponds	291	T20N R15E S36NW	Near town of Cle Elum, proposed for connection to river

[a] Not all names are official.