Response to the Independent Science Review Panel's Preliminary Review
Analysis of ground-water and surface-water interactions in
the Methow River and its major tributaries, Project ID 29018

1. Many other species are listed in the basin.

The proposed project would use the life-history of stream-type, spring chinook to guide the analysis of ground-water and surface-water interactions in the Methow, Twisp, and Chewuch Rivers. The project would locate and quantify 1) downwelling and upwelling flow in the late summer to assess spawning habitat availability and quality primarily for spring chinook, 2) the spatial extent of surface flow (i.e., reaches with perennial flow and reaches with intermittent flow) and maximum (weekly) temperatures in the late summer to assess incubation and stream-type rearing habitat; and 3) minimum (weekly) temperatures and the location of flow during winter to assess rearing habitat. The results, including maps showing the spatial distribution of these conditions, generally will be relevant to other aquatic species and stocks including summer chinook, steelhead, and bull trout. We do not anticipate being able to assess hydrologic/thermal conditions, however, for more than one type of life history (e.g., late summer spawning, fall incubation, and winter rearing) within the proposed project. Our concern is that we would need to expand the study area and monitor ground-water and surface-water interactions throughout the year to address species/stocks other than spring chinook, particularly for opportunistic species such as steelhead, which modify their behavior according to environmental conditions or species with more extensive ranges such as bull trout.

In response to this comment, we will discuss the significance of the hydrologic, thermal, and hydraulic conditions for other aquatic species/stocks in the Methow basin besides spring chinook including summer chinook, steelhead, and bull trout. Given the proposed scope of the project, however, we would not be able to address these conditions comprehensively over the range of territories and times of year pertinent to all listed species in the basin.

2. Describe procedures for selection of study sites, use probabilistic sampling procedures and a formal design that samples the whole study area.

The objective of the proposed project is a comprehensive evaluation of river conditions throughout the Methow basin. Thus, we agree with the ISRP that the study requires a robust design, which will include probabilistic sampling for site selection within reaches. We propose to divide river network into reaches based on major tributaries junctions, changes in basin geomorphology, and known patterns of gains and losses. A preliminary list of reaches are provided below.

Reach	Approximate limits (river kilometer)
Methow River from Lost River to Goat Creek	100-115
Methow River from Goat Creek to Chewuch River	80 - 100
Methow River from Chewuch River to Twisp River	64 - 80
Methow River from Twisp River to Gold Creek	37 - 64
Methow River from Gold Creek to backwater from Wells	0 - 37

Chewuch from Twentymile Creek to Eightmile Creek	13 - 32
Chewuch from Eightmile Creek to Methow River	0 - 13
Twisp River from South Creek to War Creek	23 - 35
Twisp River from War Creek to Buttermilk Creek	17 - 23
Twisp River from Buttermilk Creek to Newby Creek	10 – 17
Twisp River from Newby Creek to Methow River	0 - 10

Discharge will be measured under low flow conditions in the fall, winter, early spring, and late summer at the junction of each of these reaches and for any major tributaries or diversions (i.e., those expected to change river flow by 5%). For the Methow, major tributaries include Lost River (gaged) Early Winters Creek (gaged), Goat Creek, Wolf Creek (gaged), Chewuch River (gaged), Twisp River (gaged), Beaver Creek, and Gold Creek. Major diversions include the Foghorn Canal (operated by the Winthrop National Hatchery) and MVID East Canal. For the Chewuch River, major tributaries include Boulder Creek and Eightmile Creek and major diversion include the Chewuch and Eightmile Canals. For the Twisp River, major tributaries include War Creek, Buttermilk Creek and major diversions include the Twisp Valley Power and Irrigation Canal and MVID West Canal. Additional discharge measurements will be made within each reach found to have large exchanges between ground-water and surface-water (for example, Methow River from Goat Creek to Chewuch River and Methow River) to resolve the location and magnitude of these exchanges.

At the junction between each of the reaches (above), we will measure temperature continuously (15 minute intervals) using thermistors/loggers during WY 2003. Manual temperature measurements will be made within each reach over the course of 1 week in the summer and 1 week in the winter. We will measure surface and near-bed temperature at 10 locations in each reach. These locations will be selected at random by river kilometer. The temperature data will be used to compare the spatial variation within the reach to the temperatures recorded at the upstream and downstream ends of the reach. The sampling design may have to be modified for the winter because of the potential difficulty in making temperature measurements. In particular, selected sampling locations may be buried by snow, particularly for Methow River above Wolf Creek, the Chewuch River, and the Twisp River. In this case, the sampling sites will be moved to accommodate accessibility.

We believe that 12 temperature measurements (10 synoptic, 2 continuous) in each reach should adequately characterize the reach-average value and spatial variation in temperature based on temperature data collected in the Twisp River. During Water Year 2001, the maximum difference in daily maximum temperatures between the Twisp River above Newby Creek and the Twisp River at the gage near Twisp (a distance of 15 km) was 3.3 degrees. The difference corresponds to an average rate of change of 0.22 degrees per km. If the change in water temperature was steady between these two points, then a thermometer with an accuracy of 0.5 degrees would be able to resolve differences in temperature every 2 km. The 11 reaches for the whole study area have a mean length of approximately 22 km and, thus, we would expect to be sampling temperature at an average interval of slightly less than 2 km.

We are proposing to use in-stream piezometers to compare the hydraulic conditions of one preferred spawning reach in each of the Methow, Chewuch, and Twisp River to the conditions of reaches that are not commonly used by spring chinook but otherwise meet criteria for suitable habitat in the basin based on channel slope, size of bed material, temperature, flow availability, and wetted width (see 4. below for a discussion of habitat suitability). The initial proposal provided for using in-stream piezometers at three sites in the six reaches because of the time required for their installation. We do not suggest that the reaches be selected at random since the primary purpose of measuring hydraulic gradients between ground water and surface water is to determine whether there are differences that account for preferred spawning locations. We would rely on redd count data to select the preferred spawning reaches and then would attempt to find comparable non-spawning reaches. While we would only want to sample pool tails, we could randomly select the sample site from pool tails within each reach.

Although not originally stated in the proposal, we will measure dissolved oxygen and specific conductance in river and interstitial water at the in-stream piezometer sites. These data will be used to help identify the source of the interstitial water (river flow or ground-water flow) and to provide additional site characteristics for analyzing spawning preferences.

3. Give specific references to methods.

Discharge will be measured in accordance with Rantz and others (1982). Briefly, stream gaging is done where flow is straight and well distributed across the channel. A tag line, or tape measure, is secured across the channel and perpendicular to flow. A vertical axis, cup-type current meter (either a Pygmy or AA depending on flow depth) is used to measure current velocity. The meter is subjected to a spin test prior to the measurement and must spin freely for at least 45 sec (Pygmy) or 90 sec (AA). The channel is divided into a minimum of 20 sections. Current velocity is measured at the center of each section and at either 0.6 of the flow depth at that point or at 0.2 and 0.8 of the flow depth depending on the flow depth and type of meter used. Discharge through each section is calculated as the product of current velocity and the cross-sectional area of the section. If flow is not perpendicular to the section, then a coefficient is applied to the discharge calculation to account for the flow angle. No more than 5 percent of the total discharge may pass through any cross-section or else additional velocity measurements should be made. Discharge measurements and calculations are recorded on a standard form (9-275-G) and checked by another hydrologist or hydrologic technician. Check measurements (a repeat measurement at a different section with a different current meter) are made on an ad hoc basis (e.g., when measurement accuracy is questionable).

There are many additional procedures for the development of continuous discharge records, which will be used by the proposed project (see table under 5. for a list of gages) but are funded through other projects. Continuous discharge records are based on a relation between river stage and discharge measurements and a continuous record of river stage. River stage is measured continuously using a non-submersible pressure transducer and is checked to the nearest 3 mm (0.01 ft) using a staff gage mounted in the river. Orifice elevation is surveyed twice a year and the survey must close to within +/- 3 mm. Discharge measurements are made over the range of flows in the river to develop a stage-discharge curve. Measured values of discharge must be within 5% of the curve for the record to be rated “good”. The record is checked and entered into USGS National Water Information System (NWIS) where it is available to the public.

Temperature will be measured in accordance with Wilde and Radtke (1998), which is summarized here. Temperature will be collected using continuous recording thermistors with an accuracy of +/- 0.5° C. At each site where temperature data are collected continuously, the cross-channel variation in stream temperature (if any) will be checked at six different flow levels. Water temperature will be measured at five locations across the channel using a handheld thermistor to verify that the sensor is representing the mean water temperature for the section. The handheld thermistor will have an accuracy of +/- 0.2° and passed an annual 5-point calibration test by the Washington District

During January (expected minimum temperature) and August (expected maximum temperature), water temperature will be measured at 10 sites selected at random within each reach using a handheld thermistor subject to the calibration described above. Two measurements will be made near the center of the channel at each of the 10 sites: one near the water surface and one near the bed.

During September, vertical hydraulic gradients (the difference between static ground-water level and river stage) will be measured using in-stream piezometer (Geist et al., 1998) with a manometer board. Each piezometer consists of a 2.5 cm diameter, steel pipe that is pounded manually with a post-driver into the stream bed, typically to a depth of 1 m. The water surface level in the pipe is measured along with the stage (water-surface level) of the river at the same point. If river stage is higher than the water level in the pipe, then downwelling flow (from the river into the bed) expected. If river stage is lower than the water level in the pipe, then upwelling flow (from the bed into the river) is expected. Specific conductance and dissolved oxygen will be measured with meters that are calibrated daily in the field using standard solutions.

4. Clarify criteria for salmonid habitat suitability.

The proposed project will both evaluate criteria for salmonid habitat suitability (e.g., hydraulic gradients between surface and ground water) and assess the distribution of habitat as defined by other established habitat suitability criteria. With regard to evaluating criteria, fish/redd distribution data will be compared to flow, water temperature, and in-stream hydraulic conditions. Thus, these variables will be tested as criteria for identifying suitable habitat. When we evaluate hydraulic criteria for habitat suitability (with in-stream piezometers) we will measure and control for factors know to influence salmonid spawning preference including channel gradient, width, depth, velocity, substrate size, and distance to rearing habitat (Bovee, 1978; Bjornn and Reiser, 1991; G. Pess, National Marine Fisheries Service, personal comm., 7 March 2002). We will limit the variation of these conditions at non-spawning sample sites to the observed range for known spawning reaches in the Methow (J. Molesworth, U.S. Forest Service, personal comm., 12 March 2002). This approach accounts directly or indirectly for a broad range of habitat characteristics affecting redd site selection listed by Geist and Dauble (1998) for fall chinook salmon in the mainstem of the Columbia River.

With regard to assessing the distribution of habitat, we will measure/map hydrologic, thermal, and hydraulic conditions influencing habitat suitability in each of the 13 reaches including: upwelling flow; downwelling flow; maximum and minimum weekly temperatures, minimum (riffle) depths during spawning and incubation periods; mean (riffle) velocity; median particle size of riffles; and mean channel and minimum wetted widths. The distribution of these conditions will be discussed with respect to established criteria for spring chinook salmon (Bovee, 1978; Raleigh and others, 1986; Armour, 1991), although we would not provide a comprehensive assessment of fish response to these conditions. The data would directly support such efforts as the Washington State Department of Fish and Wildlife's Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) and Ecosystem Diagnosis and Treatment (EDT) (D. Johnson, Washington State Department of Fish and Wildlife, personal comm., 8 March, 2002). For examples of how the data would be used to in salmonid habitat/population assessments in the Methow, refer to Columbia Cascade FY 2003 Projects 29037 and 29043.

5. Identify data/gages outside of the proposal that will be used.

USGS currently operates 16 gages in the Methow River Basin, listed in the table below. All of the gages, with the exception of the three gages on irrigation canals, are expected to operate in WY/FY 2003. Measurements will be made at the irrigation canals during the seepage runs if these gages are not operating in WY 2003.

Station_name	Station_ID	Funding_agency
Lost River	12447370	Okanogan Co./USGS
Early Winters Creek	12447382	Okanogan Co./USGS
Methow River above Goat Creek	12447383	Washington DOE/USGS
Wolf Creek	12447387	Okanogan Co./USGS
Andrews Creek	12447390	USGS
Chewuch River above Cub Creek	12447600	Okanogan Co./USGS
Chewuch River nr Winthrop	12448000	Washington DOE/USGS
Methow River at Winthrop	12448500	Washington DOE/USGS
Twisp River above Newby Creek	12448990	Okanogan Co./USGS
Twisp River nr Twisp	12448998	Washington DOE/USGS
Methow River at Twisp	12449500	Washington DOE/USGS
Methow River nr Carlton	NA	Okanogan Co./USGS
Methow River nr Pateros	12449950	Douglas County PUD, WA DOE
Twisp Valley Power and Irrigation Canal	12448992	USGS
Methow Valley Irrigation District East Canal	12448620	Bonneville Power Administration
Methow Valley Irrigation District West Canal	12448996	Bonneville Power Administration

A variety of temperature data will be available as well from sources outside of the proposed project. Aerial thermal infrared imagery collected for the Okanogan - Wenatchee National Forest in August 2001 will be used to evaluate the preliminary reach divisions and temperature sites for the Twisp and Chewuch Rivers. Continuous temperature data collected by the U.S. Forest Service and U.S. Fish and Wildlife Service in the study area will be incorporated in the temperature analysis.

6. Discuss diversion/recharge importance seasonally.

Surface-water diversions and recharge from unlined irrigation canals are of great interest in the Methow valley, particularly during late summer when 50% or more of the flow may be diverted from some rivers. The proposed project will collect data that could be used to evaluate the effect of surface-water diversions, but this is not a focal point for the project because USGS is examining the effects of surface-water diversions on streamflow in the basin and on ground-water recharge as part of current projects. Current projects include a surface-water model designed to simulate river flows if there were no surface water diversions and an investigation of ground-water recharge from irrigation canals and the ground-water discharge to the Twisp River. A report on the surface-water model is available online (*http://wa.water.usgs.gov/methow/PDF/wa44201.pdf*) with additional reports due in FY 2003.

7. Why are salmon spawning in upwelling region, is this a matter of scale?

This is a primary issue to be addressed by the proposed project and, indeed, it may be a matter of scale. Salmon spawning has been associated with both downwelling flow (Bjornn and Reiser, 1991) and upwelling flow, provided that flow is oxygen-rich (e.g., hyporheic flow that traveled only a short distance through the subsurface) (Geist, 2000). Salmon are known to spawn in the Methow River along the Big Valley Wildlife Area where ground water discharges to the river. The project will evaluate hydraulic conditions in the reach to determine if flow is indeed upwelling in the vicinity of salmonid redds or if flow is downwelling in the vicinity of the redds despite the pattern of upwelling flow at a reach scale.

References cited

Armour, C.L., 1991, Guidance for evaluating and recommending temperature regimes to protect fish, U.S. Fish and Wildlife Service Instream Flow Information Paper 28, 13 p.

Bovee, K.D., 1978, Probability-of-use criteria for the family Salmonidae, U.S. Fish and Wildlife Service Instream Flow Information Paper 7, 81 p.

Geist, D.R. and D. D. Dauble, 1998, Redd site selection and spawning habitat use by fall chinook salmon: the importance of geomorphic features in large rivers: Environmental Management, v. 22, no. 5, p. 655-669.

Geist, D.R., M.C. Joy, D.R. Lee, and T. Gosner, 1998, A method for installing piezometers in large cobble-bed rivers: Ground Water Monitoring and Remediation, v. 18, p. 78-82..

Geist, D.R., 2000, Hyporheic discharge of river water into fall chinook salmon (*Oncorhynchus tshawytscha*) spawning areas in the Hanford Reach, Columbia River: Canadian Journal of Fisheries and Aquatic Sciences, v. 57, p. 1647 – 1656.

Rantz, S.E. and others, 1982, Measurement and computation of streamflow: Volume 1 – Measurement of stage and discharge; Volume 2 – Computation of discharge, U.S. Geological Survey Water-Supply Paper 2175, 631 p.

Raleigh, R.F and others, 1986, Habitat suitability index models and instream flow suitability curves: chinook salmon, U.S. Fish and Wildlife Service, Biological Report 82(10.122), 64 p.

Wilde, F.D. and Radtke, D.B., eds., 1998, Field measurements, in National field manual for the collection of water –quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A6.