Plan of Study for
1999 TDG Field Investigations
Chief Joseph Dam

1. **Introduction.** Total dissolved gas (TDG) generated by the dams on the Middle Columbia River contributes to system wide TDG and reduces the ability to provide fish protective spill at downstream dams. The Seattle District Corps of Engineers has given short-term priority to conducting intensive TDG studies at Chief Joseph Dam (CJD). These studies are to be directed at describing spatial and temporal dynamics in TDG both near the structure and downstream in the receiving waters. The information gained can be used in better understanding the gas exchange processes, particularly dissolved gas production from spill and gas dissipation downstream from the project. Results from these studies will enable the determination of benefits associated with gas abatement measures evaluated for CJD such as spillway deflector installation. The planned time for the field-testing is the week of June 6, requiring a total of 5 days of testing to complete.

2. The degree of mixing between powerhouse and spillway releases will be investigated since this is important to the total flux of TDG introduced into the Columbia River. In addition, the study is to characterize transport, mixing, and degassing of dissolved gas that may occur in Lake Pateros, the forebay of the next downstream dam, Wells Dam, located 25 miles below CJD. It is believed that significant degassing may occur in the area know as "Brewster Flats," about halfway between CJD and Wells Dam, where the river is shallow and wide. This portion of the study will aid in evaluating one of the alternatives identified in "Initial Appraisal Report (IAR) of Dissolved Gas Abatement at Chief Joseph Dam." This alternative consists of a structural modification to the river bottom that would enhance dissolved gas dissipation by forcing the river to flow over a shallow, wide sill.

3. **Objectives.** The purpose of the field study is to more clearly define and quantify processes that contribute to dissolved gas transfer during spillway releases at Chief Joseph Dam. In general, the transfer of dissolved gas is thought to be a function of the unit spillway discharge, spill pattern, spillway geometry, stilling basin and tailwater depth and flow conditions, forebay TDG concentration, project head differential, and water temperature. This study will focus on resolving questions regarding accurate source and sink descriptions of mass conservation of dissolved gases from below the dam to an area adjacent to the downstream water quality fixed monitor. TDG time history information as related to specific project operation is of particular interest. The data will be analyzed to provide estimates of the gas transfer throughout the tailwater area that should provide guidance on the relative importance of gas exchange processes within the stilling basin and in the downstream tailrace. The specific objectives of the field investigations are as follows:

- describe dissolved gas exchange processes in the tailwater for various spillway/powerhouse operational scenarios
- describe transport, mixing, and exchange characteristics of the tailrace/tailwater/Lake Pateros area for selected spillway/powerhouse operational scenarios
- characterize and evaluate the functional operation of the present fixed monitoring systems in both the tailwater and forebay of Chief Joseph dam
- provide recommendations for future WQ monitoring as needed for gas abatement
- provide recommendations for minimizing TDG resulting from Chief Joseph project operations

The conclusions drawn from this effort will aid in the identification of operational and structural measures that reduce dissolved gas supersaturation.

4. **Approach.** A single TDG monitoring study will be conducted to address all of the objectives stated above. The work will include near field sampling (immediate tailrace/tailwater often within aerated flow) and far field sampling (downstream of the tailwater and out of the aerated flow). This field study will employ an array of approximately 25 automated remote logging instruments, which are capable of describing the complete water quality time histories. The instruments shall be deployed in a spatial pattern adequate to quantify the water quality and hydrologic processes characteristic of the river/reservoir system. In addition, the instruments will be programmed to measure and log data on a routine time interval of 15 minutes. The variables include total dissolved gas (TDG), dissolved oxygen (DO), temperature (T), and depth (Z). Manual sampling will be used where and when necessary to supplement the automated approaches.

5. The intent of the instrument array is to quantify the TDG flux at various locations in the Columbia River near and downstream of the CJD. The TDG instruments will be deployed on multiple transects, including one above the dam plus several immediately below the dam, and downstream to Wells Dam. This deployment array will provide direct assessment of the lateral and longitudinal gradients and dynamics in TDG concentrations throughout study area. This will then provide descriptions of the gas exchange characteristics of the existing CJD spillway, stilling basin, and tailrace.

6. Near field sampling instruments deployed downstream of the spillway from the stilling basin end sill to the fixed monitoring station (FMS) will be placed along five/six longitudinal profiles forming two lateral transects. The first of these nearfield transects will be located about 400 ft downstream of the spillway but upstream of the powerhouse. A second transect of instruments will be located at the Highway 17 bridge at Bridgeport near the existing tailwater fixed water quality monitor. Auxiliary instruments will be located in the forebay, in the tailwater off the powerhouse deck, and

at two additional transects across the Columbia River between Chief Joseph and Wells Dam (far field).

7. The additional downstream transects in Lake Pateros will allow the characterization of TDG dissipation down to the Wells Dam forebay, located 25 miles below CJD. The first downstream transect will be positioned at the highway 173 bridge downstream of Brewster. The farthest one will be in the Wells Dam forebay.

8. Velocity data describing flow distributions at selected TDG transects will be taken to allow the estimation of TDG flux down the river as well as hydrodynamic interactions between generation and spill water. This will support the rating of operational scenarios in TDG production. It will also provide support in describing transport processes throughout the receiving waters.

9. **Operating Conditions.** Spillway discharge and hydropower discharge will be systematically varied during the field study to achieve a total project discharge of 180 kcfs (or average daily for the week of testing). A second tailwater elevation will be examined during the testing. This will be accomplished by operating at a second total river flow of 80 kcfs for two treatments during the study. The spillway will be operated in a uniform pattern across bays 2-19 for a range of 18.0 to 97.2 kcfs. This will result in individual spillbay releases of 1, 2, 3.1, 4.2 and 5.4 kcfs. Spillway discharges will then be concentrated on the south side of the structure to achieve higher per spillbay discharges of 7.8 and 10.1 kcfs but remain under a total spill of 90.9 kcfs for the project.

10. Powerhouse discharges are expected to range from 42 to about 162 kcfs to allow a total river discharge of approximately 180 kcfs (this may change depending on total river flows for the week of the proposed study) throughout most of the test. Total river discharge and tailwater elevation should remain constant throughout most of the test treatment time periods. Two powerhouse-operating scenarios based on the location of turbines will be tested. One in which all generation is forced to the west or downstream end of the powerhouse and the second using turbines on the east or upstream end of the powerhouse.

11. The testing will require 4 days to complete all requested treatments. For the first 2 days, each spill/powerhouse combination discharge or test treatment will last for 2 hours. A 2-hour spill outage will be required during the middle of the day to allow river conditions to return to ambient before running the afternoon treatments. Treatments required to examine the second powerhouse condition will be run for 2 hours each on the second day of testing.

12. Day 3 of the test will be used to evaluate available real time data collected during the first 2 days of testing and to coordinate this information with all interested parties. It is

expected that decisions will be made at this time regarding modification of the final 2 days of testing as needed to address excessive dissolved gas pressures which may result.

13. The fourth and fifth days will start with 5-hour treatments of 2 and 4.2 kcfs respectively. These long duration treatments will be followed by 4-hour spill outages to allow the river to return to ambient conditions for TSG pressures. This will be followed up with short 2 hour treatments of fairly high bay specific spills of 10.1 and 7.8 kcfs and only 9 of the 18 bays operating. The last treatment on each of these days (2 kcfs per 18 bays for day 4 and 4.2 kcfs per 9 bays for day 5) is to be conducted at a total river flow of approximately 100 kcfs lower than the normal flow treatments. This will give an approximate 5 ft drop in tailwater elevation.

14. **Real Time Monitoring.** Real time TDG monitoring will be conducted throughout the testing at the existing fixed water quality monitoring stations located in the Chief Joseph forebay and tailwater sites and at the Wells Dam forebay site. In addition, a manual sampling boat will be operated as needed to provide additional real time monitoring data. This information will be used to provide guidance regarding TDG concentrations moving down the river and potential water quality compliance violations, which may result from the testing. The data may be used in modifying test conditions to prevent biological impact in the downstream reaches.

15. **Study Criteria Requirements.** The daily highest 12 hours average TDG should not exceed 120 % saturation in the Wells forebay because of the test. If this criterion is exceeded for 3 consecutive days the test will be modified or terminated. Since 'Gas Bubble Disease' impacts organisms at levels above 120 % are unclear at this time, the intent is to avoid generating high dissolved gas pressures, which may extend down the Columbia River. The real time monitoring will provide information as needed to modify the testing. A telephone conference will be coordinated for the third day of the test. This will allow adequate test results review as needed for formulating any recommended modifications to the test procedure.

16. Stage and velocity information collected in these studies will be use to calibrate and verify the general physical model of Chief Joseph Dam.

17. **Test Schedule and Project Operations.**

Date	Hour	SpillBay	KCFS/Bay	QS(KCFS)	QG(KCFS)
June 4	1000-1200	Coordination/Safety Meeting at Chief Joseph Dam, initiate deployment			
June 5	1300-1700	4 hours of No Spill for Instrument Deployment below dam (this may change as river conditions change)			
June 6*	0800-1000	2-19(2hr)	1	18	162
	1000-1200	2-19(2hr)	3.1	55.8	124.2
	1200-1400	(2hr no spill)			
	1400-1600	2-19(2hr)	5.4	97.2	82.8
	1600-1800	11-19(2hr)	5.4	48.6	131.4
June 7**	0800-1000	2-19(2hr)	1	18	162
	1000-1200	2-19(2hr)	3.1	55.8	124.2
	1200-1400	(2hr no spill)			
	1400-1600	2-19(2hr)	5.4	97.2	82.8
	1600-1800	11-19(2hr)	3.1	27.9	152.1
June 8	(No special test conditions required – coordinate with agencies regarding TDG levels)				
June 9*	0500-1000	2-19(5hr)	2	36	144
	1000-1400	(4hr no spill)			
	1400-1600	11-19(2hr)	10.1	90.9	89.1
	1600-2000	(4hr no spill)			
	2000-2200	2-19(2hr)	2	36	44
June 10*	0500-1000	2-19(5hr)	4.2	75.6	104.4
	1000-1400	(4hr no spill)			
	1400-1600	11-19(2hr)	7.8	70.2	109.8
	1600-2000	(4hr no spill)			
	2000-2200	11-19(2hr)	4.2	37.8	42.2
June 11	0800-1200	4 hours of No Spill for Near Field Instrument Retrieval			

* Generation flows from upstream end of powerhouse

** Generation flows from downstream end of powerhouse

18. **Water Quality Instrument Maintenance and Calibration (see Appendix A)**

19. **Velocity Methods and Instrumentation (see Appendix B)**

20. **Field Operations Safety Plan (see Appendix C)**

21. **Personnel and Equipment Information (see Appendix D)**

22. **Points of Contact.** The WES primary points of contact for this work are Joe H. Carroll 541.298.6656 and Mike Schneider 601.634.3424.

Appendix A. Water Quality Instrument Calibration and Maintenance

Two types of gas measurement and logging instruments will be used for the Wanapum Dam TDG Field Studies. The Hydrolab Corp. model DS4® was the preferred instrument for most deployments, with the YSI model 6000® being utilized to a lesser extent. Each instrument is wireless and capable of remotely logging temperature, depth, specific conductance, dissolved oxygen (DO), and TDG for a one to two week deployment period. Programming, calibration, and maintenance procedures of these instruments followed manufacturers' recommendations per instrument manuals. Any changes or modifications in instrument handling were implemented only after consulting with factory technicians. Adjustments and calibrations were performed on all instruments within two days prior to each deployment. Post deployment checks on calibration were completed as soon after retrieval as possible for evaluation of instrument drift and accuracy. An evaluation of instrument performance based on calibration drift was conducted to verify proper equipment operation and define the confidence limits for collected data.

Calibration of Total Dissolved Gas

Both the Hydrolab and YSI tensionometers used for measuring TDG pressures employ semi-permeable membranes connected to pressure transducers with associated electronics to directly measure *in situ* total dissolved gas pressure. Air calibrations for TDG were performed using either a certified mercury column barometer or a portable field barometer that had been calibrated to a certified mercury column barometer. TDG was calibrated by comparing the instrument readings (in mm Hg) to those of the standard barometer at atmospheric conditions. Slope checks were performed by adding known amounts of pressure, usually 100 and 300 mm Hg, directly to the transducer, and then adjusting the instrument reading accordingly. The membrane is bypassed during these calibrations so that the probe itself is calibrated, rather than the probe/membrane combination. The condition of the membrane and any condensation trapped inside it could influence readings and result in a false calibration.

An inspection for leaks was performed on the membrane itself before completing the calibration routine. One of the checks employed involves immersing the membrane in seltzer water. The expected result of a properly functioning membrane is an immediate jump in the TDG reading of at least 300mm Hg. Membranes are also visually inspected for leaks and condensation moisture trapped inside the membrane. The leaks will usually appear as large darker spots in the membrane and indicate that water has entered the silastic tubing through a tear. Defective membranes were replaced before use.

Calibration of Dissolved Oxygen

DO calibration followed procedures developed in the COE DGAS field sampling program. A water bath was employed so that more than one instrument could be rapidly calibrated at a time. The water bath serves as a calibration chamber. After equilibration in this water bath, multiple instruments can then be calibrated to a standardized instrument. By adding a motor-driven propeller sleeved in a ported cylinder to the 50-gallon batch tank, it is possible to achieve a steady state, homogeneous mixture of water approximately 97% saturated with air at a constant temperature. One instrument is designated as the standard for comparison and calibrated for specific conductance, depth, and DO (in air). Once the standard instrument and tank are prepared, several Winkler titration analyses are run to further verify the dissolved oxygen concentration in mg/l of the calibration tank. Adjustments are made to agree with the Winkler titration of DO at this point. The remaining instruments are then adjusted to read the same as the standard instrument for DO, specific conductance, and depth. Several additional Winkler titrations are performed throughout the calibration procedure for the rest of the instruments to ensure consistency.

Water Quality Calibration Data from COE DGAS Field Studies. Calibration checks and necessary adjustments performed on the Hydrolab DS4 instruments have been documented during the 1996, 1997, 1998, and 1999 field sampling for the COE DGAS program on the Lower Columbia and Lower Snake Rivers. The status of each of the parameters before and after each calibration check and adjustment was kept in a calibration log. Data gathered from logs kept on calibration activities were examined as a group, reflecting a pooled data set of all DS4s and all deployments. The data assessed in this evaluation reflect only the calibrations performed on instruments before and after deployments that resulted in readings that were included in the study database. Logs for instruments requiring large-scale adjustments exceeding factory recommendations were not included in the data set. In addition, data logs resulting from instruments determined to be malfunctioning based on normal quality assurance criteria established by the manufacturer were not incorporated into the study database.

An analysis was completed to provide summary statistics defining the variability about the mean of the instrument drift and calibration error (Table 1). The individual data points comprising the population analyzed were the difference between the post-deployment reading of the parameter and it's expected calibration value. DO and TDG were the only parameters evaluated in this assessment because they were the primary parameters in this study.

The mean (±2 standard deviations) post operation calibration shift in DO over all years and instrument types was 0.07 mg/l ±1.07 mg/l. The mean (±2 standard deviations) post deployment calibration shift in TDG pressure over all years and instrument types was 0.43 mm Hg ± 3.8 mm Hg.

Table 1. DGAS Post Deployment Calibration Check for Drift in DO (mg/l) and TDG (mm Hg).

YEAR	Parameter	N	Minimum	Maximum	Mean	Std. Deviation
1996	DO	253	-2.2	2.1	0.13	0.56
1996	DO	253	-2.2	2.1	0.13	0.56
	TDG	235	-21.0	19.0	0.14	5.8
	TDG	235	-21.0	19.0	0.14	5.8
1997	DO	459	-2.4	1.5	0.04	0.42
	TDG	494	-16.0	18.0	0.43	3.5
	TDG	494	-16.0	18.0	0.43	3.5
1998	DO	296	-2.3	2.1	0.06	0.68
	TDG	316	-7.0	8.0	0.67	2.1
	TDG	316	-7.0	8.0	0.67	2.1
1999	DO	25	-0.7	0.9	0.06	0.38
	TDG	24	0.0	6.0	0.67	1.6
	TDG	24	0.0	6.0	0.67	1.6
Combined Years	DO	1033	-2.4	2.1	0.07	0.54
	TDG	1069	-21.00	19.0	0.44	3.7

Of the approximately 1,100 TDG and DO pre-deployment calibrations performed over the four DGAS sampling seasons, only a small percentage have resulted in “out of tolerance” readings or other errors during calibration. Though these numbers do not necessarily reflect the number of times the instruments were serviced by field personnel or by factory technicians, they do suggest that there is a very low frequency of deployments resulting in erroneous measurements. Barring any unforeseen complications or errors associated with deployment and post-calibration handling, the instruments used in DGAS field sampling produced accurate data. Most calibrations revealed that the instruments’ measurement error generally fell within what could be considered an acceptable range of drift. The range we observed was a bit wider than that defined by the manufacturers (± .2 mg/l DO and ± 1 mm Hg TDG pressure). It should be noted, however, that manufacturer-defined expected error is based on optimal lab conditions, not the field conditions and time intervals in which the instruments were required to function. An additional consideration is the fact that calibration conditions and methods were constantly being modified and refined during the DGAS program so that the most accurate and efficient calibrations possible were maintained. It is likely that more experience resulted in the culmination of techniques that could afford tighter calibration data.

Appendix B. VELOCITY INSTRUMENTATION AND METHODS

Acoustic Doppler Current Profiler (ADCP)

A vessel-mounted RD Instruments® acoustic Doppler current profiler (ADCP) was be used to measure water velocity and discharge. The instrument used was a 600 kHz ADCP with 20º convex transducers. The manufacturer's specifications states the instrument's accuracy to be within ±3 cms^{-1}, as configured.

The ADCP utilizes four ceramic transducers capable of emitting and receiving sound signals to measure the change in frequency (Doppler shift) of reflected sound energy. Energy is reflected by *scatterers* (suspended particles, e.g. phytoplankton) that are assumed to be moving in the same direction and at the same velocity as the water in that layer. The ADCP measures its own movement, via boat movement, and subtracts its motion from the water velocity measurements to track the distance traveled by the ADCP for discharge calculations.

Every signal set emitted by the ADCP consists of four water and four bottom *pings* (individual sound bursts). *Water pings* are signals reflected from scatterers and *bottom pings* are signals reflected from the river bottom. The ADCP differentiates between water and bottom pings based on the relative intensity of the return signals since return signals from the bottom are of greater intensity owing to the hardness of the bottom relative to that of the scatterers. A set of four pings of each type constitutes an *ensemble*.

The ADCP is moved across the river channel from shore-to-shore as slowly as possible, thus allowing many ensembles to be averaged for flow measurements. The river cross-section is referred to as a *transect* with each movement across referred to as a *pass*. The cross-sections are subdivided into one meter by ten-meter cells called *bins*. The upper portion of the profile is unmeasured because of the submergence of the transducers and the mechanics of the sound transmission. The unmeasured upper layer is approximately 1m thick. Velocity measurements for the bottom 6% of the profile are excluded due to interference between the four sound cones. The ADCP estimates discharge for the upper and lower unmeasured sections by extrapolating from the nearest good measurements.

Further discussion of the technical workings of the ADCP is beyond the scope of this work. Interested readers are directed to the "Direct Reading and Self-contained Broadband Acoustic Doppler Current Profiler Technical Manual" (RD Instruments 1995).

Global Positioning System (GPS)

A Trimble Navigation global positioning system (GPS) model AGGPS will be used to geo-reference the ADCP data and water quality data. The manufacturer's specifications stated the instrument's position accuracy to be within 16 m. Geo-referencing of the velocity data allowed them to be projected onto real-world maps. Although the ADCP generates detailed records of its movements over the river bottom, it had no means of referencing its starting location in earth coordinates. Position data will be collected independently of, and coincident with the velocity data. The position data will be merged with the incoming ADCP data such that the final data set contained both.

ADCP Sampling Protocol

ADCP data collection is designed to coincide with the water quality sampling. While it is desirable to have multiple passes for all transects, time limitations may preclude intensive sampling.

ADCP Data Processing

The ADCP reports the water velocity components in the north/south, east/west, and vertical directions for each bin in a pass. From these, the ADCP calculates the discharge for each bin in the measured section of the profile, and extrapolates the discharge for the unmeasured top and bottom layers. The component discharges are summed across a transect to yield the total discharge. To compute an accurate total discharge, it is necessary for the ADCP to consider the direction of the flow with respect to the ADCP's movement. This is important so that upstream flow, resulting from eddies or other phenomena are subtracted from the total discharge estimate. A more thorough discussion of discharge extrapolation and measurement may be found in the

“Direct Reading and Self-contained Broadband Acoustic Doppler Current Profiler Technical Manual” (RD Instruments 1995).

ADCP Data Analysis

The ADCP data acquisition software will produce the following three files for each pass:

1. A *raw* data file consisting of every ensemble collected during a pass,
2. A *navigation* file consisting of all of the GPS data collected during a pass,
3. A *processed* data file consisting of ADCP and GPS data that had been averaged to the operator specified interval (in units of time or space).

To perform meaningful analyses, it was necessary to translate the ADCP text files into a format that was usable by data management software.

APPENDIX C: FIELD OPERATIONS SAFETY PLAN

This section defines safety plan items specific to this data collection program. General health and safety procedures for this project site, including personnel responsibilities, evaluation of potential hazards, required personal and boat safety equipment and the use of this equipment, general safe work practices, safe boat operation practices, and emergency procedures are described in detail in the COE EM 385-1-1, 1996, "Safety and Health Requirements manual".

A coordination/safety meeting will be held at the Chief Joseph Dam Powerhouse on May 18, 1999, at 0800 hours to review safety issues regarding the testing program. This meeting will cover radio communication, project access, contact names, contact information, and coordination of testing activities.

It is anticipated that two sampling boats will be used for the field-sampling program. Both vessels will comply with the following general requirements:

- Each boat will have bow and stern lines (at least 50 feet in length) prepared and ready at all times.
- All personnel in the boats will wear life jackets at all times.
- Each boat will be equipped with a back-up motor.
- No boat will operate any closer than 200 feet from an operating spillway bay, unless in an emergency.
- All boats will be under power at all times (There will be no free drifting during sampling).

<u>Communications and Coordination</u>. There will be a two way radio tuned to the COE project control room frequency on each boat operating within the tailrace area. In addition, a shore based field studies team member will also have a radio (plus a cell phone if available) for constant communication with the control room. This individual should maintain constant contact both visually and by radio with the sampling boats and will insure notification of all parties for any emergency actions. These radios will be turned on at all times. The COE project radios will be used only for communications with the control room or other District personnel. The District radios will be the responsibility of the field program leader. The field program leader will delegate responsibility for the radios to the team leaders on each boat. There will also be a team radio on each boat and with the field program leader. The team radios will be used for all inter-team communications. All team radios will be operating on the same frequency. These radios will also be turned on at all times. The control room will be notified:

- when boats are launched onto or retrieved from the tailrace
- before boats enter any restricted areas
- whenever boats prepare to change position inside any restricted areas
- if there is any kind of emergency experienced by any member of the field crew
- before boats leave any restricted area

- communications will be maintained with the control room throughout sampling or survey work to check on stability of flow conditions and to inform the District of progress of the survey

Environmental Conditions. No field operations will be undertaken or field operations already underway will be stopped, if wind speeds or wave heights exceed normal safe limits. It is intended that all survey operations will be conducted during daylight. If it is necessary to extend field operations after dusk, all boats will be equipped with mandatory operating lights and working lights as necessary to facilitate safe operations. In general, boats will be operated within visual contact of each other at all times.

Restricted Area. For purposes of this field program, the area within 500 feet of the powerhouse and within 1,000 feet of the spillway apron will be considered a restricted area.

Safety Boat. A minimum of two boats will generally be deployed for each of the field studies conducted in the boat-restricted areas. Each boat will serve as a safety boat for the other boat for all operations in the general tailrace area (outside of the restricted area). One of the survey boats will act as a designated safety boat for operations inside the restricted area. The boats will be in regular radio communication.

Operations outside the Restricted Area. General safe boating procedures will apply for operations outside the restricted area. Regular radio communications will be maintained between the survey boats using the team radios and between the boats and the control room using the District radios, so that the general location and operations of boats are known. This will facilitate boats providing assistance to each other. Although boats will operate in coordination with each other in order to achieve the survey objectives, they may carry on separate activities, i.e. one boat will be used for data collection, while the another is used for moving the equipment, ferrying personnel and supplies, etc.

Operations inside the Restricted Area. During survey operations inside the restricted area, the designated rescue boat will stand by within 500 feet of the survey vessel until they are out of the restricted area. In the case of a failure of the primary motor of any boat there will be one attempt to restart the engine. If this is unsuccessful, the designated radio operator will immediately notify first the rescue boat and then the control room. The operator of the boat in distress will start its auxiliary motor and steer for the nearest safe shoreline. Both boats will haul in any sampling gear that is over the side. (In the case of the boat in distress, the gear may have to be hauled in by hand by the team leader and the instrument technician). The rescue boat will immediately proceed alongside the boat in distress to pass over the towline and take the boat in distress in tow to the nearest safe shoreline point. The boat in distress shall leave the auxiliary motor on to assist the towboat in control and power. If it is not possible for the rescue boat to maintain headway against the current drawing the boat towards the stilling basin with the boat-in-distress in tow, the control room will be requested to close the spillway gates. If the boat-in-distress is drawn any closer than 200 feet to the stilling basin, the rescue boat will abandon towing efforts, come alongside the boat in distress, and evacuate all personnel, taking them aboard the rescue boat and transporting them to the nearest safe shoreline. No attempt will be made to recover the boat-in-distress, until spillway gates are closed.

Job Hazard Analysis:

HAZARD	PREVENTATIVE MEASURES
man overboard	wear type III approved PFDs, do not stand on gunnels in restricted zone
Drowning	have PFDs fastened and have life rings or throwable devices at reach
Capsizing	vessels will meet Coast Guard safety standards for day and night operation; all operators will be certified; boat will have sufficient room, freeboard, and stability to safely carry cargo and crew with consideration given to weather and water conditions; a safety boat will remain close at hand during deployment and retrieval of equipment
Fire	no open flame at refueling, no operation if fuel leak occurs, all bilge vents will be operated, coast guard approved fire extinguishers will be carried
Collision	one boat length distance minimal and moderate speeds will be observed
Hypothermia	proper PPE will be worn and extra clothes will be kept on hand
sliding on ramp	4 wheel drives and chains will be inspected and used if necessary, personnel will keep clear of vehicles
slips/trips	no skid shoes will be worn
Strains	2-man lift techniques on anchors and when necessary for deployment of heavy equipment
pinch points	gloves will be worn when working with cable
Operation of hoists	hoists will be operated in safe manner as prescribed in Corps safety requirements manual
electrocution	tag out high voltage areas that coincide with deployment work sites; ensure that electrical equipment is in proper working order, ground fault protected, and properly insulated

Clearances/coordination	project clearance procedures will be strictly adhered to, communication while deploying and retrieving equipment will be via radio channel used for navigation so that communication between boat crews and the control room will be constant while operating near the projects
working in elevated areas and/or over deep water	wear work vests and safety vests when applicable, have spotters and safety ropes present when working from ladders

Activity Hazard Analysis:

Though the following addresses potential hazards for particular activities, the most important preventative measure that can be taken is to remain alert and aware of immediate surroundings and conditions. Personnel will avoid distractions that can divert attention from the tasks at hand and use judgments in conjunction with safety and boat operation training. To ensure that communication between project personnel and field team members remains constant, the control room will be contacted upon arrival and departure from the work area, and field personnel will check in as required by project policy.

ACTIVITY	HAZARD	PREVENTATIVE MEASURES
Deployment from draft tube deck and from the dam into the forebay near dissolved gas Fixed Monitor	pinch points, abrasions	Gloves will be worn when working with cable; long pants and sleeved shirts will be worn while on project grounds
	Strains	Lifting and pulling will be accomplished with proper technique: using the legs rather than the back
	working in elevated areas and/or over deep water	work vests or PFDs will be worn when working above water
	head and foot injuries	hard hats will be worn while on the project and overhead hazards exist; safety footwear will be worn while on the project

	Electrocution	tag out high voltage areas that coincide with deployment work sites; ensure that electrical equipment is in proper working order, ground fault protected, and properly insulated
Deployment/retrieval of instruments by boat	general safety concerns	all crew members will be licensed operators; all personnel will wear PFDs at all times while on the boat; contact will be made with control room regarding expected activities, emergency numbers will be posted on all boats
	Strains	Lifting and pulling employing proper back-saving technique; two-man deployment/retrieval of heavy equipment and anchors
	operation of hoists	lift and swing path will be kept clear of personnel and other obstructions
	pinch points, abrasions	Gloves and proper-coverage attire will be worn
	Entanglements	Cables and ropes will be kept clear of feet; decks will provide adequate workspace and be kept tidy, number of personnel on work crew will be within weight and space limits
	man overboard	Personnel will wear PFDs at all times; entanglements with cable will be avoided;

		personnel will not stand above gunners
	Slips	Traction will be provided by proper footwear
boat operation	Fire	no open flame while refueling; operation will cease if fuel leak; bilge vents will be operated: proper fire extinguishers will be on board
	sliding on ramp	Proper tires, 4 wheel drive units and braking capabilities will be observed; personnel will keep clear of vehicles when launching
	power loss	Designated safety boat will be available
	Collision	Excessive speeds will not be incurred; safe distances will be kept of other boats and structures
	Capsizing	Weight limit will not be exceeded per requirements of each boat; work will not be carried out in water and weather conditions that exceed capabilities of the boat

APPENDIX D: PERSONNEL AND EQUIPMENT INFORMATION

Personnel/ Vehicles:

The following list includes personnel involved in field data collection. This list may be modified to include additional manpower as deemed necessary throughout the study. Any updates will be reported and forward as received.

Joe H. Carroll
Ron Wierenga
Larry Mark Gunter
Michael Schneider
Calvin Buie Jr.

Dodge Pickup	white	1997	G63-28913
Chevrolet Pickup (stake bed)	black	1998	G63-00158

Monark	24 ft
Buoy Tender	26 ft

Pertinent Phone Numbers:

Field crew cellular numbers:

Joe Carroll	(cell)	541-490-0300
WES research	(ofc)	541-298-6656

Field crew pager numbers: 541-298-7655

WES research (general)	1320
Joe Carroll	1321
Mark Gunter	1324

Chief Joseph Project numbers:

Radio call numbers:

Chief Joseph Dam	
Joe Carroll	WES442
Ron Wierenga	WES444
Mark Gunter	WES445
Buoy Tender	WES RV-1
Monark	WES RV-2

Personnel Boat Experience and Resumes:

Name	Date last certified	Years prof. Experience	Water types		Related Training
Joe Carroll	9/29/94	26	Coastal & Great Lakes, 100 hrs	Gulf of Mexico, Atlantic Coast, Lake Erie, Puget Sound, Long Island Sound, Houston Ship Channel	first aid 1982
			Rivers 400 hrs	Mississippi, Savannah, White (AR), Arkansas, Columbia, Snake	CPR/First Aid, 1998
			lakes/ reservoirs 1000 hrs	De Gray, Bull Shoals, Table Rock, Beaver, Hamilton, Keystone, Lake Carl Blackwell, Red Rock, Eau Galle, Sardis, Granada, Richard B Russell, Thurmond, Hartwell, West Point, Oconee, Sinclair	
Ron Wierenga	2/7/97	4	Rivers >200 hrs	Snake, Columbia, Clearwater	CPR/First Aid, 1998
			lakes/ reservoirs >? hrs	Lake Roosevelt, other mainstem pools on the Columbia and Snake Rivers	
Mark Gunter	2/7/97	4	Rivers >200 hrs	Snake, Columbia, Clearwater, Savannah, Broad	CPR/First Aid, 1998
			lakes/ reservoirs >500 hrs	Hartwell, Russell, Strom Thurmond	

Calvin Buie	9/12/94	20	lakes/ reservoirs 200 hrs	Chicago Lakes
			Rivers 224 hrs	Mississippi, Columbia, Snake