TECHNICAL COMMITTEE

FEDERAL INTERAGENCY SEDIMENTATION PROJECT

Fall Meeting – November 9, 2010 – 0830-1700

Army Corps of Engineers, ERDC, Room 200, Vicksburg, MS

Attendees (all in person):

- Steve Blanchard, USGS, member and chair
- Joe Schubauer-Berigan, EPA, member
- Pat Mckinney, ERDC, COE, member
- Roger Kuhnle, ARS, member
- Rob Hilldale, BR, member
- Mark Landers, USGS, guest
- Johnny Wheat, USGS-HIF, guest
- Frank Henry, USGS-HIF, guest
- Broderick Davis, FISP Chief
- John R. Gray, USGS, guest

Notable Outcomes:

- US P-6 Sampler Approved Unanimously:
  - Comments on the US P-6 draft memorandum are due Nov. 29, 2010.
  - FISP will purchase one ‘legacy’ US P-6 sampler to retain for historical purposes.
  - Include Broderick Davis’ written comments on the paper (submitted to Tech comm in October 2010) as an appendix (2) of these minutes

- Water Temperature and FISP Nozzles: Consider, at the next TC meeting the suggestion for a FISP research topic to be initiated on water temperature effects on isokinetic and sedimentological efficiencies. It was surmised that it could be a future research topic for the FISP Chief or through a funded research project.
- The TC decided that David Rubin’s digital imagery system for bed material size characterization is something the FISP Chief could evaluate through a literature review, and that David Ruben could write-up a summary of the method and its evaluation to date.
- FISP Heirloom Equipment: Urgency was expressed in finding a “new home” of for FISP equipment to retain in perpetuity. Equipment should be distributed by December 31, 2010. At least one of each FISP sampler will be kept as a permanent archive. The USGS will determine internally where those samplers will be kept. USGS will determine location of and permanently archive one of each kind of FISP samplers.
- SEDIMENT SUBCOMMITTEE: A report from the SOS will be included as part of all future TC meetings. A member of the FISP TC who is also a member of the SOS will give the report.

- Sediment-Data Accuracy Criteria: TC members should refer to the suggested criteria presented during the meeting and be prepared to address the topic at the Spring 2011 TC meeting.
- FISP MOU: John Gray, Joe Schubauer-Berigan, and Mark Landers will work on a revised draft of the FISP MOU to reflect the current focus and operation of the FISP and its member Federal Agencies and bring the MOU back to the TC for consideration.
- Notes on Sedimentation Activities: The TC will not pursue compiling and publishing the Notes.
- Shift from Plastic to Brass Nozzles for Sediment Work: This is an internal USGS matter and hence need not be discussed further among the TC.

Next Technical Committee (TC) Meeting: No date was set for the Spring meeting. A decision was made to query Principal Investigators of FISP-supported projects for FY2011 to ascertain if the Spring TC meeting might be held at one of project venues. If so, a meeting date will be resolved in concert with the PI and her/his office.

MINUTES OF THE FALL 2010 TECHNICAL COMMITTEE MEETING

AGENDA, NOV. 9, 2010:

8:30 AM Committee Business

Introduction, announcements, agenda review (Potyondy)
Introduction of new FISP Chief – Mark Landers
Review of 2010 Spring Meeting Minutes (Hilldale)
FY2010 Financial report and FY2011 Proposed budget (Davis)
HIF sales report (Blanchard for Frank Henry)
FISP approval of US P-6 point-integrating sampler (Davis)
Sabol/Topping FISC paper discussion (Davis)
Rubin digital imagery system (Davis)
Heirloom equipment in FISP possession (Gray)
Status/plans for LISST-SL testing (Gray)
Report from the Subcommittee on Sedimentation (Gray)
Suggestion/Need for More Formal Tech Com-SOS link - Gray
MOU and contributions -- ? time? Who? – Gray/Hilldale
Mississippi River Sediment and QW proposal - Gray
Bedload-Surrogate Monitoring Technologies - Gray
Acceptance criteria for suspended sed (bedload, bed material) data - Gray
Notes on Sedimentation Activities -- resurrect? - Gray
Shift from colored nozzles to brass -- Davis (needed?)
FISP Award Series -- 10 minutes - Gray?
Closure of Vicksburg FISP operation - Davis?
USGS Sediment Lab QA program and relevance to FISP - Gray

12:00 Lunch

1 - 5:00 PM FISP funded projects (review and vote)

Update on funded projects (Davis)
- Agency reports
- FISP priority work tasks

5:00 PM Adjourn

Note: In the absence of John Potyondy, Steve Blanchard (USGS) chaired the meeting. The USGS is next in the rotation to have its TC member serve as chair and will chair the TC for FY11. After chairing this meeting, Steve ceded his TC membership and chair status to John Gray.

Spring 2010 Meeting Minutes: Rob Hilldale, BR, will share these minutes later this month for review and approval.

Incoming FISP Chief: Mark N. Landers, Hydrologist, U.S. Geological Survey, Atlanta, Georgia, will succeed Broderick Davis as the next FISP Chief effective January 1, 2011.

FISP Financial Report (presented by Broderick Davis): See appendix 1, FISP financial statements for FY2010 and FY2011 plus HIF FY2010 sales list.

- FY2010: $71,078 Balance (surplus on $289,074 income).
- FY2011: $323,530 total income in proposed budget; includes $57,959 carry over.
- Rob Hilldale/BR reported that BR has yet to identify its means of supporting the FISP in FY2012 (BR pre-paid FY2011 in FY2010). Rob also noted that the BR MOU and Interagency Agreement for the FISP needs to be renewed
- With the FISP moving off the Corps Vicksburg campus, the COE will no longer have the facilities and office support counted as in-kind contribution toward the FISP. Pat McKinney indicated he would seek some cash funding from the Corps for FY2011.

TC Membership:

- USEPA has neither been represented on, nor contributed to FISP "for years" (Joe Schubauer-Berigan represented EPA at this meeting). According to Joe, "Ultimately for the good of FISP it would probably be best to have an EPA Office of Water (OW) HQ/DC representative on the panel (more of a direct channel). However until I/EPA figure out who that is going to be I would be glad to serve as the EPA rep and try to coordinate with those at OW HQ. I have an interest in the research and the subject matter and want to help where I can to keep EPA connected. If EPA's Doug Norton (HQ) has no one to cover this from HQ or thinks it is best for me to serve as the rep, I will agree to continue to serve as the EPA rep
- TC member John Potyondy, FS: John continues to recover from heart attack and quadruple bypass surgery of Nov. 1. The committee wishes him the best for a rapid and complete recovery.

HIF Sales Report: Frank Henry:

- Total sales in FY2010 = $252,426.
- FISP Vendor Purchases in FY2010 = $12,551
- Top selling sampler: D-95
- The US D-99 sampler is now available for purchase, as are bedload traps.

FISP approval of US P-6 Point-Integrating Sampler (Davis): See draft FISP Technical Committee Memorandum 2010.01, Nov. 2010: "US P-6 Point Integrating Suspended-Sediment Sampler."

- This is a replacement for the problematic P-61 sampler.
- The first nozzle configuration tested failed to remain acceptably isokinetic at velocities greater than 5.5 ft/s.
- A tapered nozzle configuration remains between ~0.95 and 1.08 of isokinetic over full range of tests (~1.5-16 ft/s).
- Isokinetic calibrations were performed under "warm water" conditions.
- Previous work done related to all FISP sampler nozzles, indicated technically supportable information on the isokinetic characteristics of nozzles indicates lowering in efficiency with lowering of temperature by as much as 20% (see FISP Report No. 6)
- FISP Chief Broderick Davis seeks TC approval of the sampler.

Decision: After some discussion, the US P-6 sampler was approved unanimously by the TC.

Action Item:

- FISP will purchase one US P-6 sampler to join and be stored with other "legacy samplers."
- Comments on the US P-6 memorandum are due Nov. 29 to Broderick Davis.

Discussion on the 9FISC Paper, "Field Evaluation of Sediment-Concentration Errors Arising from Non-Isokinetic Intake Efficiency in Depth-Integrating Suspended-Sediment Bag Samplers":

The subject paper, which was accepted for publication in the 9FISC proceedings but presented as a poster and not orally presented in a technical session, was distributed to TC prior to the meeting (the paper was missing from the JFIC Proceedings on Nov. 9, but added by Nov. 15 per communication from NRCS's Jerry Bernard).

The issue-at-hand emanates from field-calibration work done on the lower Colorado River by the USGSs Thomas Sabol, David Topping, and Ronald Griffiths, published in the Proceedings of 9th Federal Interagency Sedimentation Conference (http://acwi.gov/sos/pubs/2ndJFIC/Contents/P23_SABOL_02_23_10.pdf). Broderick Davis summarized his concerns with the Sabol et al. paper, which were provided to the TC prior to this meeting as a pdf file (reproduced in **appendix 2**).

Gray noted that Topping has intimated that another paper, "more in-depth" on the same subject, is in preparation. Topping indicated his intent to seek reviews from, among others, Gray and Mark Landers, and to provide a 'courtesy copy' to Davis – perhaps before January 2011.

Gray noted that the issues raised deserve careful consideration in light of recent information on temperature effects on the isokinetic efficiency of nozzles, coupled with same-topic information in FISP Report #6.

Discussion ensued on whether or not same-diameter different-taper nozzles should be made for a given sampler for use at "low" versus "high" water temperatures. Understanding the potential for confusion if more than one same-size diameter nozzle with different characteristics is available for a given sampler, it still might be one way to address, if needed, 'critical' situations (higher velocities, larger sand sizes, etc.). No meeting participant expressed opposition to this concept, although the opinion was expressed that a "high" and "low" temperature nozzle should be sufficient as opposed to a suite of nozzles for different temperatures.

Decisions:

- Include Broderick Davis' written comments on the paper (submitted to the TC in October 2010) as an appendix (2) of these minutes
- Consider, at the next TC meeting the suggestion for a FISP research topic to be initiated on water temperature effects on isokinetic and sedimentological efficiencies. It was surmised that it could be a future research topic for the FISP Chief or through a funded research project.

David Rubin/USGS, Digital Imagery System (Davis): Dave Rubin, USGS, and colleagues have developed an optical bottom-material size-characterization system. Several papers have been published on the subject, perhaps including 'ground truth' data.

- Gray observed that there is no reliable means for characterizing size distribution of material coarser than fine gravel in unwadeable streams, given that FISP bed-material samplers are designed for material finer than medium gravel.
- This effort is of interest to FISP. It may require "only" an evaluation of the literature, particularly if reliable ground-truth assessments are published therein.
- The TC decided that David Rubin's digital imagery system for bed material size characterization is something the FISP Chief could evaluate through a literature review, and that David Ruben could write-up a summary of the method and its evaluation to date.

Closure of the FISP Vicksburg, MS, Operation: Davis reported that the process to shut down FISP operations in Vicksburg is well along toward closure in CY2010. The new "home" of the FISP is Mark Landers' duty station in Atlanta, GA.

Discussion ensued on "FISP 'Heirloom' Equipment":

- Unanimity was expressed in recognition of the importance of permanently archiving at least one of each FISP sampler. The need to transfer pallets of these samplers at the FISP-ERDC warehouse to a presumably permanent archive location is urgent, given Davis' intent to retire at end of December 2010 and with no other FISP presence at ERDC/Vicksburg thereafter.
- Other 'surplus' equipment not identified as heirloom might be advertised as available to anyone willing to pay shipping. Four TR-2 bedload samples are among such surplus equipment.
- Joe Schubauer-Berigan suggests that the TC consider asking the Smithsonian Institution to consider archiving these samples (if so, the request might best go through the Department of the Interior).

Decisions:

- At least one of each FISP sampler will be kept as a permanent archive. The USGS will determine internally where those samplers will be kept.
- USGS will determine location of and permanently archive one of each kind of FISP samplers.

Status of LISST-SL Testing: See **appendix 3** for summaries of recent testing by the USGS out of Tacoma, WA, and Urbana, IL. These tests are additional to formal bench testing by Davis in 2007.

Report on the Subcommittee on Sedimentation: The SOS (http://acwi.gov/sos/) – under the ACWI (http://acwi.gov/) – was the parent committee of the TC before 2005. The SOS is quite active. In addition to sponsoring the "Federal Interagency Sedimentation Conference" series (now on a 4-year cycle), it hosts other sediment-related conferences and workshops on an approximately annual cycle, the most recent of which was the 2nd of two "Dam Removal-Sediment Management" workshops, in 2009.

The SOS currently functions largely through four workgroups:

- Federal Interagency Sedimentation Conference Series
- Dam Removal-Sediment Management
- Stream Morphology Database Development
- Reservoir Sedimentation Database

For more information on the SOS, see the home page at: http://acwi.gov/sos/ . For more information on the workgroups, see the more recent meeting minutes at: http://acwi.gov/sos/minutes/index.html .

After some discussion, it became apparent that the current level of collaboration between the TC and SOS was considered adequate. Agreement was expressed on the desire to continue the informal briefing series to SOS and TC.

Decision: There will be a report from the SOS included as part of all future TC meetings. A member of the FISP TC who is also a member of the SOS will give the report.

Memorandum of Understanding: The MOU has needed to be updated since at least June 21, 2006 (the date of the last mark-up copy that was not finalized). Gray was volunteered to work on this by Steve Blanchard. Joe Schubauer-Berigan agreed to help.

Action: John Gray, Joe Schubauer-Berigan, and Mark Landers will work on a revised draft of the FISP MOU to reflect the current focus and operation of the FISP and its member Federal Agencies and bring the MOU back to the TC for consideration.

Mississippi River Basin Sediment and Water-Quality Monitoring Proposal: This proposal (available as an attachment to the June 25, 2010, SOS meeting notes at: http://acwi.gov/sos/minutes/index.html) was developed as a prelude to a National Sediment and Water-Quality Monitoring Proposal.

The proposal was not prioritized high enough to be sent to the Department of the Interior as a 2012 USGS Budget Initiative Proposal. Although interest remains high in the concept, no funds have been secured to execute the program.

Suggestion for Development/Adoption of FISP Data-Accuracy Statement for Surrogate Technologies: Gray presented the concept of accuracy criteria for suspended-sediment surrogate concentration data. Suspended-sediment size criteria are also needed, as are criteria for accuracy of bedload sampler data, and for bedload and bed-material size data. Gray et al. 2003, and Gray and Gartner 2009 and Gray and Gartner 2010 have put out tentative suspended-sediment concentration accuracy criteria.

Suggestion is for FISP to codify a set of criteria for surrogate technologies and advertise those for sake of consistency and as a ‘target’ for surrogate-technology manufacturers.

See pages 8-9, “Surrogate Technologies for Monitoring Suspended-Sediment Transport in Rivers” (http://water.usgs.gov/osw/techniques/sed_aq_sys_chap_1_pdf_from_wb_3_16_2010.pdf) for the most recent (2010) suggested suspended-sediment accuracy criteria.

Decision: TC members should consider the published suggested suspended-sediment accuracy criteria and be prepared to address the topic in a more definitive manner at the Spring 2011 TC meeting.

Notes on Sedimentation Activities: The notes were published by the SOS annually until 1992, but were discontinued for financial reasons thereafter. Interest in more recent information on this subject has been discussed in the SOS. However, after some discussion, insufficient TC interest was expressed to pursue it further by this Committee.

Decision: The TC will not pursue compiling and publishing the Notes on Sedimentation Activities.

Shift from Plastic to Brass Nozzles for Sediment Work: FISP Technical Memorandum 2008.01 (http://fisp.wes.army.mil/FISP%20Nozzle%20memo%202008-01.pdf) presents the TC's position on the subject. The USGS has yet to confirm and advertise this decision in-house.

Decision: This is an internal USGS matter and hence need not be discussed further among the TC.

FISP Award Series: Davis says there was a FISP award-type in the past, but is unaware of any criteria for conferring such an award.

Gray noted that FISP has a certain cachet by virtue of its national and world-wide reputation. Offering an award specific to the private sector for producing a device useful to the FISP might have a bit of a carrot-on-a-stick effect to bring technologies forth. Or it can be used to recognize a researcher for a specific project success, or perhaps for "career achievement."

It was suggested for Technical Committee members to examine the four award series of the Sediment Subcommittee for an idea of what SOS has done in this regard.

USGS National Sediment Lab Quality-Assurance Program: The USGS has operated a National Sediment Laboratory Quality Assurance Program since 1996 (see: http://bqs.usgs.gov/slqa/). The QA program focuses on accuracy of suspended-sediment data (concentrations, particle-size distributions). Organizations other than the USGS participate in the Single-Blind program (quality-control samples that are identified as such, as opposed to double-blind samples, which are QC samples disguised as environmental samples). Some organizations participate in the double-blind program. TC-member organizations with sediment laboratories are encouraged to participate in the USGS Program.

Update on Previously Funded Research: See progress reports for five projects in **Appendix 4**.

Evaluation and Selection of FY2011 Proposals for Funding:

FISP has $70K carry over to FY2011. The maximum possible expenditure for all proposals based on the proposed draft FY2011 Financial plan is $148K. The actual amount available to fund research will depend on actual agency contributions and sales of FISP equipment.

Seventeen proposals were submitted. A pre-vote winnowing process reduced those to what the committee considered 10 non-redundant, viable proposals. Most of the proposals were submitted as 2-year studies, including some of the selected proposals. The committee agreed that selected proposal applicants will be asked to re-submit their proposals as a 1-year proposal. This will facilitate TC input and evaluation of progress in these studies. Also, the TC asked that the LISST-SL Proposals by Straub be re-submitted with some details on conditions and types of sampling.

Of those, each present member agency (COE, ARS, BR, EPA, USGS) was given the opportunity to vote for top 5 choices in priority order ranking 5 as top and 1 as bottom. The outcome based on a simple summation of priorities cast (number following name) yielded the following:

Priority	Principal Investigator(s)	Funding
	Carpenter and Chambers (15):	**$19K (fund now)**
	Abraham (11):	**$31K (fund now)**

Straub & Curran (10):	**$44K (fund as $$ arrives)**
Selbig, 1st year only (8)	**$25K (fund as $$ arrives)**
Wood (7):	**$24K (fund as $$ arrives)**
TOTAL	**$144K**

FISP Chief Priorities:

Transition FISP leadership to Mark Landers
Close out FISP operation in Vicksburg
Fund Carpenter/Chambers project
Fund Abraham project

APPENDIX 1: Fiscal Years 2010 and 2011 FISP Financial Reports

FISP FY 2010 Financial Statement

TRANSACTION DESCRIPTION	INCOME		EXPENDITURES
Carry over	$43,086		
U.S. Bureau of Land Management	10,000		
U.S. Bureau of Reclamation (carry over)	10,536		
U.S. Bureau of Reclamation	24,000		
U.S. Forest Service	10,000		
USDA Agricultural Research Service	18,452		
U.S. Geological Survey	110,000		
U.S. Environmental Protection Agency			
U.S. Army Corps of Engineers	(In-kind)		
Contributions Total	**$226,074**		
FY 10 Sales (HIF)	$63,106		
FY 10 Sales (FISP)	370		
TOTAL INCOME	**$289,550**		
Salary/Benefits			$112,185
Overhead/Intra-Division Billing			7,494
Travel			5,803
Contracts			704
Supplies			1,277
Equipment			12
Fuel/Maintenance (Trucks & Boats)			1,306
Shipping			539
Communication			380
USGS Wright			$24,567
NCPA			35,374
University of Kansas			28,831
TOTAL EXPENDITURES			**$218,472**
BALANCE ($13,119 BOR carry over included)			**$71,078**

FISP FY 2011 Proposed Budget

TRANSACTION DESCRIPTION	**INCOME**		**EXPENDITURES**
FY10 Carry-over	$57,959		
U.S. Bureau of Land Management	10,000		
U.S. Bureau of Reclamation (Carry over)	13,119		
U.S. Bureau of Reclamation	24,000 (partial carry-over to 2012?)		
USDA Agricultural Research Service	18,452		
USDA Forest Service	10,000		
U.S. Geological Survey	130,000		
U.S. Army Corps of Engineers	10,000		
U.S. Environmental Protection Agency			
FY11 Sales Income	$50,000		
TOTAL INCOME	**$323,530**		
Salary/Benefits			$130,000
Overhead (USGS 12 pct)			8,694
Travel			15,000
Contracts (Conference Exhibits)			2,500
Supplies			1,500
Equipment			2,000
Vehicles (Fuel and maintenance)			1,000
Shipping			2,500
Communication			1,500
In-house research			10,000
Contract research			148,836
TOTAL EXPENDITURES			**$323,530**
BALANCE			**$0**

HIF FY 2010 FISP EQUIPMENT SALES LIST (3 pages)

11/01/10

HYDROLOGIC INSTRUMENTATION FACILITY
HIF-CSS II
SEDIMENT SALES
10/01/09 - 09/30/10

STOCK NO	DESCRIPTION	SALE PRICE	QTY SOLD	TOTAL SALES
4101002	SAMPLER, US DH-48, WADING (001010). TWO	417.00	1	496.00
4101005	SAMPLER, US DH-59, HAND-LINE (001110), W	926.00	1	1,102.00
4101006	SAMPLER, D-74 (001150). FURNISHED WITH	1,667.00	1	1,667.00
4101014	SAMPLER, DH-95, (001350), WITH CASE. AL	2,519.00	5	12,669.00
4101015	SAMPLER, D-95 (001360), WITH CASE. ALSO	2,958.00	9	26,622.00
4101018	D-96 SAMPLER (001370) WITH CASE. COMES	6,415.00	2	15,274.00
4101019	SAMPLER, D-96-A1 (001370-1), WITH CASE.	4,658.00	4	17,920.00
4101022	SAMPLER, US DH-2 WITH CASE. THIS IS A 1	2,678.00	4	10,712.00
4103004	SAMPLER, US BM-54 (005020), BED-MATERIAL	2,285.00	1	2,285.00
4103009	SAMPLER, BMH-60 (005050), BED-MATERIAL,	972.00	1	1,157.00
4103016	SAMPLER, BLH-84 (005100), BED-LOAD, HAND	509.00	5	2,545.00
4104002	SAMPLER, U-59B, (007020), SUSPENDED SEDI	185.00	2	370.00
4107002	ADAPTER FOR THE US DH-81A (002010). THI	51.00	127	10,640.00
4107006	BAG, PFA, FOR USE WITH DH-2 SAMPLER. 20	17.00	33	462.00
4107007	BAG, PFA, (001371) FOR US D-96 AND US D-	16.00	237	3,972.00
4107008	BAGS, PLASTIC, 20 PER PKG, (001371A) FOR	4.00	80	330.00
4107009	BAGS, PLASTIC, FOR USE WITH DH-2 SAMPLER	4.00	3	12.00
4107012	BASKET, WIRE, (002720). HOLDS 20 PINT GL	67.00	1	80.00
4107020	BOTTLE, 1 LITER, HEAVY GRADE, (002040) F	10.00	241	2,813.00
4107021	BOTTLE, 1 LITER, TEFLON (002050)	227.00	26	6,372.00
4107022	BOTTLES, MILK, PINT, GLASS, (002110) CAS	19.00	8	180.00
4107027	BOTTLE, PLASTIC, 3 LITER, (002350).	44.00	67	2,243.00
4107034	CAP, PLASTIC (002390). FOR USE WITH D-77	75.00	130	10,408.00
4107036	NOZZLE HOLDER CAP, TEFLON, US D-95 (0013	350.00	28	9,934.00
4107037	CAP, REPLACEMENT (002050A) FOR 1-LITER F	15.00	7	111.00
4107039	CAPS, (002140) PLASTIC, PRESS-ON TYPE, F	6.00	86	518.00
4107040	CAP, PLASTIC, TFE INSERT, D-77 (002400).	22.00	1	26.00
4107046	CLOSURE, MASON JAR, 70 MM (002350A)	4.00	6	18.00
4107050	GASKET, PT (002150) FOR USE ON DH-48 AND	11.00	16	180.00
4107051	GASKET, QUART & PINT (002160), FOR USE O	3.00	17	51.00
4107055	HANGER BAR AND PIN, (001380). FOR USE W	24.00	12	293.00
4107062	HANGER BAR AND PIN, (002790) TYPE 2, FOR	24.00	2	58.00
4107063	NOSE PIECE FOR DH-2 SAMPLER, DELRIN	153.00	5	765.00
4107064	NOZZLE, 3/16", TFE, FOR USE WITH DH-2 SA	38.00	3	102.00
4107065	NOZZLE, 1/4", TFE, FOR USE WITH DH-2 SAM	30.00	11	330.00
4107066	NOZZLE, 5/16", TFE, FOR USE WITH DH-2 SA	38.00	8	232.00
4107067	NOZZLE, 3/16", PLASTIC, FOR USE WITH DH-	26.00	2	52.00

4107068	NOZZLE, 1/4", PLASTIC, FOR USE WITH DH-2	26.00	1	26.00
4107069	NOZZLE, 5/16", PLASTIC, FOR USE WITH DH-	26.00	2	52.00
4107070	NOZZLE, 3/16, WHITE, PLASTIC (001372).	21.00	15	355.00
4107071	NOZZLE, 1/4, WHITE, PLASTIC (001373). F	21.00	24	544.00
4107072	NOZZLE, 5/16, WHITE, PLASTIC (001374).	21.00	17	397.00
4107073	NOSE INSERT, DELRIN, FOR D-96 SAMPLER	91.00	5	351.00
4107074	NOZZLE, 3/16, TFE (001376). FOR USE WITH	21.00	10	210.00
4107075	NOZZLE, 1/4, TFE. (001377) FOR USE WITH	20.00	26	520.00
4107076	NOZZLE, 5/16, TFE (001378). FOR USE WIT	34.00	14	372.00
4107077	NOZZLE HOLDER, TFE (001379). FOR USE WI	92.00	5	460.00
4107078	NOZZLE HOLDER, PLASTIC. (001375) FOR THE	102.00	8	816.00
4107079	NOZZLE HOLDER, DELRIN, FOR DH-2.	74.00	3	222.00
4107080	NOZZLE, 3/16", BRASS, FOR D-74 (002170)	41.00	9	369.00
4107081	NOZZLE, 1/4", BRASS, (002180) FOR THE D-	41.00	9	369.00
4107083	NOZZLE, 1/4", GREEN PLASTIC, (002210) FO	18.00	10	180.00
4107084	NOZZLE, 3/16, WHITE PLASTIC, (002270) FO	22.00	11	246.00
4107085	NOZZLE, 1/4, WHITE PLASTIC (002280). FOR	27.00	45	1,060.00
4107086	NOZZLE, 5/16, WHITE PLASTIC (002290). FO	23.00	58	1,340.00
4107087	NOZZLE, 3/16, TFE (002310). FOR USE WITH	30.00	33	996.00
4107088	NOZZLE, 1/4, TFE (002320). FOR USE WITH	30.00	55	1,674.00
4107089	NOZZLE, 5/16, TFE (002330). FOR USE WITH	31.00	46	1,412.00
4107090	NOZZLE HOLDER, TFE FOR DH-2 SAMPLER	83.00	5	415.00
4107092	NOZZLE, 1/4" (002450), BRASS. FOR DH-48	55.00	10	590.00
4107100	NOZZLE, 3/16", (002570), BRASS, FOR DH-5	39.00	8	312.00
4107101	NOZZLE, 1/4", (002580), BRASS, FOR DH-59	31.00	9	285.00
4107103	NOZZLE, 3/16", RED PLASTIC, (002630). F	16.00	3	48.00
4107104	NOZZLE, 1/4", RED PLASTIC, (002635). FO	16.00	3	48.00
4107108	O-RINGS FOR DH-2 SAMPLER. REPLACEMENT PA	4.00	7	16.00
4107109	O-RING FOR BOTTLE, (001360C) FOR DH-95 A	1.00	38	38.00
4107112	STRAP, BAG-RETENTION, (1370H), FOR D-96	1.00	78	78.00
4107113	RETENTION STRAP ASSEMBLY, (002401) US D-	29.00	2	58.00
4107114	TAIL SECTION FOR D-95 SAMPLER. TAIL SEC	519.00	2	1,038.00
4107115	TAIL SECTION FOR DH-95 SAMPLER. TAIL SE	1,111.00	2	2,222.00
4107116	TAIL SECTION FOR D-96 SAMPLER (1370B). T	1,111.00	4	4,444.00
4107117	TAIL SECTION FOR DH-2 SAMPLER. TAIL SEC	926.00	1	926.00
4107118	TRAY, SLIDING, COMPLETE (001370E). THIS	433.00	3	2,028.00
4107119	TRAY, PLASTIC, (1370G), REPLACEMENT FOR	97.00	5	485.00
4107122	TUBING, HEAT SHRINK (002071A). SUPPLIED	3.00	43	129.00
4107125	WADING ROD, 1 FOOT EXTENSION (002030).	48.00	2	96.00
4107126	WADING ROD, 1 FOOT EXTENSION, (002031) P	54.00	1	54.00
4107127	WADING ROD, 3 FEET, (002070) WITH WHITE	54.00	16	914.00
4107131	WADING ROD, 3 FEET, (002071) PLASTIC COV	59.00	31	1,862.00
4107132	WADING ROD, EXTENSION, 3 FEET (002080).	50.00	8	410.00
4107133	WADING ROD, EXTENSION, 3 FEET, (002081)	56.00	3	179.00
4107143	NOZZLE, TFE, 1/4, FOR D-99	40.00	2	80.00
4107144	NOZZLE, TFE, 5/16, FOR D-99	40.00	3	120.00
4108006	BOTTLES, (004010) QUART, GLASS, 6-13/16	28.00	8	272.00
4108014	GASKET, HEAD, (003050D) FOR P-63 SAMPLER	16.00	2	32.00

4108015	GASKET, HEAD, (004070) FOR P-61-A1 AND P	16.00	1	16.00
4108016	GASKET, NEOPRENE, BOTTLE, (004030) FOR P	7.00	8	56.00
4108035	NOZZLE, BRASS, 3/16-INCH (004100), FOR P	52.00	4	208.00
4108045	SOLENOID (004160) FOR P-61, P-63 AND P-7	175.00	2	350.00
4109001	BAG (006010), SMALLER MESH, FOR BEDLOAD	60.00	5	300.00
4109002	BAG (005100B) FOR BL-84 SAMPLER (14-250	64.00	12	768.00
4109004	WRENCH, COCKING, 7/32 X 6 INCH LONG (006	3.00	4	44.00
4110032	US VTP-99 (011300). THE US VTP-99 TRANS	72.00	1	72.00
4111001	CHURN SAMPLE SPLITTER, POLYETHYLENE, 8-L	675.00	34	24,172.00
4111002	CHURN SPLITTER, TFE, US SS-1 (011400). T	5,370.00	9	46,681.00
4111005	CARRYING HANDLE, (011400-01), REPLACEMEN	72.00	8	590.00
4111006	AGITATOR HANDLE, (011400-02), REPLACEMEN	83.00	1	83.00
4111007	AGITATOR BASE, (011400-03), REPLACEMENT	209.00	1	209.00
4111008	AGITATOR DEFLECTOR, (011400-04), REPLACE	16.00	1	16.00
4111009	O-RING, RUBBER, (011400-05), FOR CHURN S	4.00	18	74.00
4111010	O-RING, VITON, (011400-06), FOR CHURN SP	1.00	14	14.00
4111011	O-RING, VITON, (011400-07), FOR CHURN SP	1.00	5	5.00
4111012	SCREW, TEFLON, (011400-08), 8/32", FOR C	20.00	7	140.00
4111014	CAP, (011400-10), FOR CHURN SPLITTER US	56.00	1	56.00
4111016	VALVE BODY WITH O-RING AND SCREW, (01140	112.00	5	560.00
4111017	VALVE INSERT WITH O-RING, (011400-13) RE	52.00	5	260.00
4112002	ANALYZER (GRAVELOMETER), (011000), US SA	55.00	6	330.00
4112006	SAMPLER, (012020), WEIGHTED BOTTLE, WITH	244.00	4	976.00
4112012	CASE, QUART, (012050), SHIPPING, COMPLET	100.00	2	200.00
4112013	CONTAINER, DAIRY-TYPE CRATE (012050A). F	16.00	23	368.00
4112014	DIVIDER INSERT, QUART (012050B) REPLACEM	41.00	22	902.00
4112017	COVER, PLASTIC, FOR SEDIMENT SAMPLING SH	5.00	15	75.00
4112022	CASE, PINT, (012060), SHIPPING, COMPLETE	112.00	22	2,485.00
4112023	DIVIDER INSERT, PINT (012060A), REPLACEM	48.00	3	265.00
TOTAL:				252,426.00

APPENDIX 2: General comments (March 11, 2010; unedited) by Chief of the Federal Interagency Sedimentation Project about the FISC 2010 proposed report, "FIELD EVALUATION OF SEDIMENT-CONCENTRATION ERRORS ARISING FROM NON-ISOKINETIC INTAKE EFFICIENCY IN DEPTH-INTEGRATING SUSPENDED-SEDIMENT BAG SAMPLERS" by Sabol, Topping, and Griffiths (*http://acwi.gov/sos/pubs/2ndJFIC/Contents/P23_SABOL_02_23_10.pdf*)

The authors are fully aware of previous objections to the subject and have at least on one occasion withdrawn a similar report from publication in which the FISP Chief was included as a reviewer. So the question arises, why continue to pursue the subject? After review of this paper and reports describing the Colorado River/Grand Canyon research, it seems that numerical models did not adequately predict the outcome related to the disposition of sand after release of water/sediment from Glen Canyon Dam. The prediction of the models were (and are) based on the data input to the models, so the adequacy of the data is suspect. This obviously and correctly leads to the data collected with physical samplers. It appears this is where the authors take a misguided approach as delineated in this report. The approach the authors take questions 70 years of sampler research, the function of FISP approved samplers, and all data collected with FISP samplers. It is important to note that the USGS is an integral part of the FISP and has adopted FISP equipment and methods as the standard for sediment data collection. The USGS in one agency, regardless of division, and if there are perceived issues with the accepted standards, the matter should be addressed internally and not in a public forum such as the FISC conference. It should be noted that the D-77 bag sampler was never a FISP approved sampler.

In the paper the authors state "Although extensive field testing of depth-integrating samplers in rivers occurred in the 1940s and 1950s to evaluate both intake efficiency and suspended-sediment concentration and grain size (FISP, 1944, 1951, 1954, 1957), few field tests have been conducted since then that include evaluation of suspended-sediment data (e.g., Allen and Petersen, 1981)." Which physical or natural laws have changed since the 1940s and 1950s that would require revisiting the operation of the samplers?

The authors state, "The majority of more-recent FISP sampler development and calibration has been conducted via flume and towing tests (e.g., Szalona, 1982; Davis, 2001). However, depth-integrating, suspended-sediment samplers are intended for use in rivers and streams where conditions are typically more turbulent and variable than those in flumes or those experienced by samplers towed behind boats in lakes." Not only were recent bag samplers tested in river conditions by the FISP, prototypes were tested in real river conditions by three to four USGS Water Science Centers during the evaluation phase.

The authors state, "Recognition of the influence of more complicated river settings on sampler behavior has led to recommendations that on-site field calibrations for intake efficiency be conducted for bag samplers before each set of samples is collected (OSW Technical Memorandum 99.01)." This is not a factual statement. The recommendation was because of the known problems and difficulty using the D-77 bag sampler. The US D-96 and subsequent bag samplers were not in use when 99.01 was written.

The authors state, "The predicted potential errors in 0.15-mm sand concentration associated with the US-96 type sampler are effectively zero (over much of its operating range) when water-temperature differences are accounted for between the warmer flume studies where the sampler nozzles were calibrated by the FISP and the much colder Colorado River." The title of the paper leads the reader to believe there is a problem with all FISP bag samplers.

The authors state, "The improved understanding of the sampling behavior of different depth-integrating suspended-sediment samplers under a range of conditions in real-river settings gained from this study highlights the need for more real-world river testing and analysis during future development of new suspended-sediment samplers and surrogate technologies for monitoring suspended sediment (Gray and Gartner, 2010)." If the authors have issues related to the testing of samplers by the FISP, they should contact the USGS representative on the FISP Technical Committee and have the representative communicate those issues, not express them in a public way such as this proposed publication.

Although the authors go to great lengths to explain how an "average" velocity in the vertical is obtained, it is still maintained that calculating a hydraulic efficiency in the field as described is not appropriate. If, and a big if, one would desire to determine an approximate hydraulic efficiency in the field, the appropriate technique would be to determine an average velocity at a depth of about three feet using a cup meter or other instrument that measures a point velocity. Lower the sampler to the same depth and hold it at that depth and collect a timed volume, and calculate the approximate field hydraulic efficiency from the information.
Essentially what this paper shows is what was already known, that the D-77 bag sampler was difficult to use and there were problems with it. In FISP Report Y cited by the authors, Szalona concludes that, "Field-tests should be conducted to test the bag sampler and P-61 sampler side-by-side. Tests should be at stream velocities and depths greater than those attainable in the laboratory. Samples should be collected and analyzed for sediment concentration and particle size. Tests should be conducted to authenticate or improve procedures mentioned in this report." Subsequent tests by the FISP concluded that the D-77 bag-type sampler was not an

adequate sampler. The sampling program presented in this paper accomplished what Szalona recommended and the results show the D-77 bag-type sampler was not an adequate sampler. Because of the inadequacy of the sampler, the FISP Technical Committee tasked the Project to develop a completely new sampler, which resulted in the US D-96 and subsequent collapsible bag samplers.

Some issues the authors should consider when looking in hindsight at all the samples collected with the D-77 bag sampler:

- The D-77 bag sampler was never approved for use by the FISP Technical Committee.
- The authors state, "Deployment configuration of the US D-77 bag-type was most similar to that described in figure 9 from FISP Report Y (Szalona, 1982) with the exception of the solenoid valve (only practical for flume tests), the flow deflector over the upper vent hole, and the thin mask covering the gap between the casting and the bottle." Was this a sampler that was fabricated and flume calibrated by the FISP? Was the sampler modified in any way? If it was modified by the user, was it recalibrated by FISP after modification?
- The successful operation of D-77 bag sampler was very user dependent. Were users appropriately trained? How much of the actual sample collection did the authors observe to insure proper sampler operation?
- How close to the bottom did the user sample? Did the user sampler to the same distance from the bottom at every transit? Some informal communication with a hydrotech indicated that one user did not sample very close to the stream bottom where most of the sand moves in most rivers.
- The authors mention the use of the US VTP-99 metronome which means the samplers were hand-cranked by the user. It is very difficult to maintain a constant transit down and up with these heavy samplers. That is why most users employ a variable-speed power reel. A non-uniform transit rate leads to errors in sample concentration. It is another reason it is not feasible to calculate hydraulic efficiency as described.

The authors state, "Beginning in 2003, paired US D-96 type – US D-77 bag-type, suspended-sediment samples were therefore collected under a wide range of flow conditions at all cross-sections to evaluate potential biases in suspended-sediment concentration and grain size between the two types of bag samplers. This comparative analysis was required to develop any bias-correction factors needed to make the older suspended-sediment data collected using the US D-77 bag-type sampler equivalent to those collected using the newer, more hydrodynamic, US D-96 type sampler." If this is the intent, use the information from the US D-96 sampler to develop a bias-correction for the suspect D-77 data. If the authors wish to publish how they corrected for less than desirably collected samples using a less than desirable sampler, let that be the intent of the paper.

My recommendation as Chief of the FISP is that this report or any future report addressing this subject in the manner presented here not be made public. Any issues related to the operation of FISP equipment should be handled internally. Any changes that need to be made will be recommended, approved by the FISP, and disseminated publicly by the FISP.

APPENDIX 3: Summaries of Recent Field Tests of the LISST-SL by USGS personnel in the Tacoma, WA, and Urbana, IL Water Science Centers:

Chris Curran, from November 4, 2010, EMAIL MSWord Documenet, Subject: LISST-SL Testing in Western Washington (unedited):

In 2009 the USGS Washington Water Science Center (WAWSC) and USGS Coastal Marine Geology (CMG) jointly purchased a LISST-SL from Sequoia Scientific Inc. for the purpose of using it in multi-disciplinary research of large deltas, specifically to quantify the suspended-sediment load of large glacier-influenced rivers that drain into Puget Sound. At the time of purchase, we were aware that the LISST-SL was undergoing laboratory testing within the Federal Interagency Sedimentation Program (FISP) and that initial results appeared promising. Since our purchase in mid-2009 until present (2010), we have repeatedly experienced field-related issues with the LISST-SL that have required the manufacturer to fix. These issues have been set-backs in both our schedule of field testing and the intended use of this instrument in data collection for research projects. Most recently, the instrument was brought back to Sequoia for an examination of the optics (misalignment was suspected) and sediment that had become lodged inside was removed. Sequoia has for the most part been willing to address issues as they have arisen, but these issues have taken time to resolve. At present we are cautiously optimistic that the kinks are being worked out to make the instrument field ready under the right hydraulic conditions and specific research applications, but we also have some reservations as to whether the LISST–SL (in its present design) is robust enough to endure regular field-use and replace traditional USGS samplers. For example, the issue of instrument 'swimming' on station has not been resolved, nor have we pressed this with Sequoia since other issues have been more important to address. The following is a general timeline of the testing that occurred and the issues that were raised and in most cases addressed:

- April 2009, Skagit River –Deployed with Sequoia personnel on site. The velocity and depth readings were in error, concentrations were very suspect, and the instrument was observed 'swimming' in the water (not staying on station). No SSC samples collected. Instrument returned. Sequoia found bug in software and fixed. A new tail assembly was installed to reduce swimming.
- May 2009, Cedar River – The instrument was deployed in shallow river environment with help of Sequoia personnel on site. No SSC samples collected. Water was too clear for data collection. Instrument was observed swimming (not staying on station) and left with Sequoia for further testing.
- July 2009, Skagit River – Deployed with Sequoia personnel on site. New tail fin assembly devised to keep instrument from swimming. Tried deployment from boat, instrument collected too much sediment, possibly results of nose-dive into bed material (sand). Sequoia keeps instrument for cleaning and inspection.
- October 2009, Bellevue, WA – Meeting and training at Sequoia office, LISST-SL device handed over to WAWSC and CMG (Grossman, Curran, Huffman) to begin field use (testing).
- November 2009, Puyallup River- First attempt at Brod Davis' protocol. Depth readings were in error, velocity seemed OK. Data sent to Sequoia for review. Yogi and Chuck discover a scintillation issue caused by temperature contrast between LISST-SL optics and water sampled which would affect measured concentrations. Some SSC samples sent to CVO for analysis. Sequoia devised a thermal equilibration coil and added procedures to deployment method.
- December 2009, Puyallup River – Second attempt at Brod Davis's protocol. USGS personnel only. Thermal equilibration coil used. SSC samples collected. After two depth-integrated verticals, testing

aborted after instrument touched bed and velocity and concentration readings were obviously in error. No point samples collected. Sent instrument to Sequoia for evaluation/ cleaning. Sequoia questions depth-integrated approach with LISST-SL since transit rate would need to be very slow << sampling rate.

- March 2010, Cowlitz River – Demonstrated the device to USGS Sediment Data Collection class where multiple devices were used to collect data. Sequoia reviewed the data and reported the LISST data was not good due to poor quality background. Sequoia suggested we rigorously clean using their procedures in the manual. We did this but the background file remained significantly different (higher) from the factory value. Instrument brought to Sequoia and cleaning procedure reviewed with staff. Background improved but still higher than factory.
- August 2010, Puyallup River - Third attempt at a Brod Davis protocol on two rivers running milky color due to glacial flour. Despite high background, Sequoia suggests continued field testing. Sampling protocol was modified to avoid touching bed with LISST, depth integrated samples were not taken. Point samples taken at 0.2, 0.6, and 0.8 depths only. Data appears to be reasonable at Puyallup R. Samples sent to CVO. LISST data sent to Sequoia.
- August 2010, White River – Background still appears high. Concentrations appear higher than expected and the –SL swims from side-side and porpoises at the higher velocities (7 fps) in this river. Sent samples to CVO for analysis. LISST data sent to Sequoia.
- September 2010 – LISST-SL returned to Sequoia for inspection (misalignment was suspected) and cleaning. See email below (NOTE the mention of Puyallup River and White River data should be reversed) :

[We have the modified nosecone with the bleed port, so in addition to having the nose mounted filter, obtaining backgrounds should be less cumbersome on the river.

[We] reviewed the Puyallup and Whiter River data yesterday. We observed that even though the concentrations were below our range, the White River was measureable, but the Puyallup River was not. The mean size was around 10um, but a correction was needed for the concentration. We believe the concentration was ½ to 1/3rd as measured (not 40mg/l). The cause is most likely the conditions for the background. The change in the background was very characteristic with the pattern we have seen before when the temperature had not come to equilibrium. We have always said to wait 15 minutes after setting the SL in the river before collecting the background, but if the temperature differences of the SL and the river are radically different, this period of time may be insufficient.

The Puyallup River data had a more serious discrepancy and would require data processing by fabricating a mock background. This is a laborious process that only the data wizards can achieve.

On the mechanical/optical front we are making a few improvements. We had a small gap in the couplings between the nose and the optical windows. This may have held some dirt that was difficult to remove. I remember Raegan saying she continually say ‘rust colored’ dirt on the wipes when she was cleaning. We are filling in the gap. This should help with cleaning.

We are tightening up our mounting hardware and even dropping the SL to check for misalignment. Please do not drop the instrument, unless you want to do drop test your cell phone at the same time.

We are going to run temperature and background stability tests.

We will check the isokinetic correlation and check the concentration measurements with ISO coarse sediment before sending the instrument back to you.

I was also curious about the video you said you had of the SL 'swimming'. Did you have that in a format you could send me?]

Tim Straub, from October 21, 2010, EMAIL, Subject: LISST-SL Testing Update at the ILWSC (unedited):
After a successful deployment of the list LISST-SL, including taking two manual single vertical samples (now being processed at the lab), the LISST-SL was sent back to Sequoia at their request for an upgrade. The upgrade included drilling/installing a bleed port for clearing air out of the pitot tube chamber (we no longer need to take apart some of the sampler and put it back together underwater to accomplish this). We received the sampler back and did a follow-up call this week to make sure we know the proper use of the bleed port. Also, a new easier field filtration system for background sediment concentration checks has been received from Sequoia and should make testing much simpler in the field.

Also, we did have one other earlier deployment, we had good success with the background checks on the sediment portion of the instrument in the lab and the field (even with the more complicated filtration system). Although in the field, the pitot tube was reading zero velocity and an erratic depth. We brought it back to the lab and at that time did the more extensive fix on the pitot tube which involved taking apart some of the instrument in the lab and putting it together underwater. The next deployment appeared to be a success as noted in the paragraph above, but the lab data will further confirm.

Early on in our testing we were also in contact with Chris Curran in Washington to gain knowledge from their experiences.

Our next step is to respond to the FISP call for proposals to see if funding is available for further testing required by the FISP for the LISST-SL. This testing includes obtaining 12 LISST-SL readings and 24 manual samples for each single vertical condition. Funds to cover the labor and analytical costs will greatly help in obtaining a wide range of single vertical conditions for testing.

APPENDIX 4: Three Progress Reports from 2009 FISP Projects (unedited):

FISP Progress Report: Development of Automated Extraction of Reservoir Pre-Impoundment Surfaces from Acoustic Echosounder Data

Establishment: Kansas Biological Survey, University of Kansas, Lawrence, KS

Principal Investigator: Dr. Mark Jakubauskas and Dr. Jude Kastens

Date: November 1, 2010

Reporting Period: 5/03/2010 – 10/31/2010

Summary of Progress for Reporting Period:

Work during the reporting period focused primarily on field-based aspects of the project, specifically, expanding our database of acoustic echosounder data and sediment samples for multiple sites within reservoirs in Kansas. Acoustic echosounder data was acquired for three new federal reservoirs in southeast Kansas (Toronto, Fall River, and Elk City Reservoirs) and two non-federal reservoirs (Santa Fe Lake and Augusta City Lake) that have exhibited severe sedimentation. Sediment sampling of 10-15 sites in each reservoir was conducted using a vibracoring unit on a dedicated pontoon boat; sediment samples were analyzed for particle size distribution (percent sand, silt, clay), percent organic matter, and bulk density. Reviewing and reprocessing of acoustic echosounder data from previously surveyed reservoirs is also ongoing in order to identify and extract acoustic data sets as test and training data for the reservoir preimpoundment surface detection algorithm development.

Work during the remaining period will focus on the continued development, testing, and validation of the reservoir preimpoundment surface detection algorithm, and porting the algorithm to the Biosonics software with the assistance of Biosonics, Inc. (Seattle, WA). This will include travel by the principal investigators to Seattle to work with the Biosonics software engineers on raw data ingest, algorithm integration, and processed data output formatting.

Status of Deliverables (percent completed):

From contract:

- **Phase I software development: 10% completed.**
- **Phase II bottom sediment coring: 90% completed.**
- **Phase III sediment attributes determination: 90% completed.**
- **Phase IV delivery of report and software: 0% completed.**

FISP Progress Report: Acoustic Measurement of Suspended Fine Particles In A Fluvial Environment By Attenuation

Establishment: University of Mississippi, National Center for Physical Acoustics

Principal Investigator: James Chambers/Brian Carpenter **Date:** 11/3/2010

Reporting Period: June 1st – October 31st 2010

Summary of Progress for Reporting Period:

See attached report

Status of Deliverables (percent completed):

See attached report. Experiments are nominally complete with *estimated* concentrations gleaned from sediment added. Data analysis for *actual* concentration via pump sampling is underway. An international presentation is planned for November 2010. The results will be published in an archival journal if warranted. 75% complete.

Results obtained to date suggest that using a combination of attenuation and backscatter from a single-frequency instrument to make a rough differentiation in particle sizes is possible. However, during the course of data collection, the issue of effective particle size became more important than anticipated as evidenced in Figures 1-3. The decrease in signal level for increasing particle size (indicating increased attenuation) from bentonite to kaolinte to silt can clearly be seen in the data. These results have been shown in previous FISP reports and archival literature. [1,2] Conversely, the *backscatter* amplitude for silt (D_{50}≈50 µm) should be much larger than for bentonite clay (<1 µm) as more sound is reflected back toward the source for larger particles.

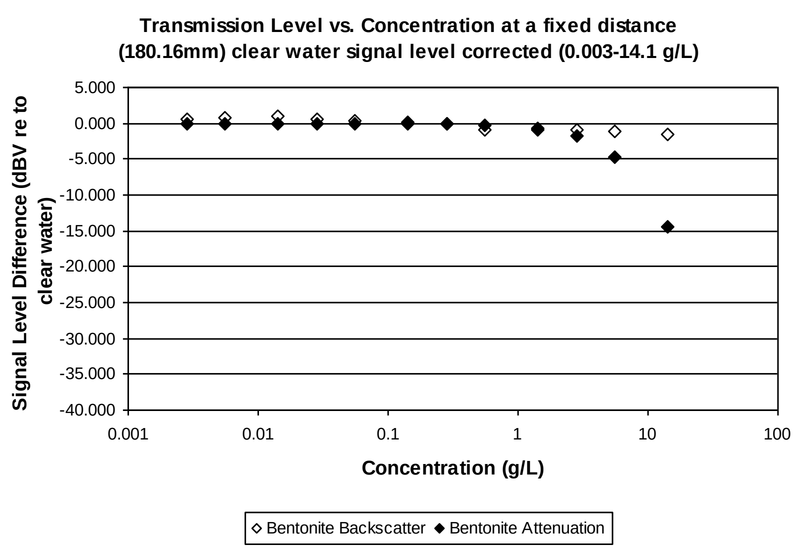

Figure 1: Attenuation and Backscatter for bentonite

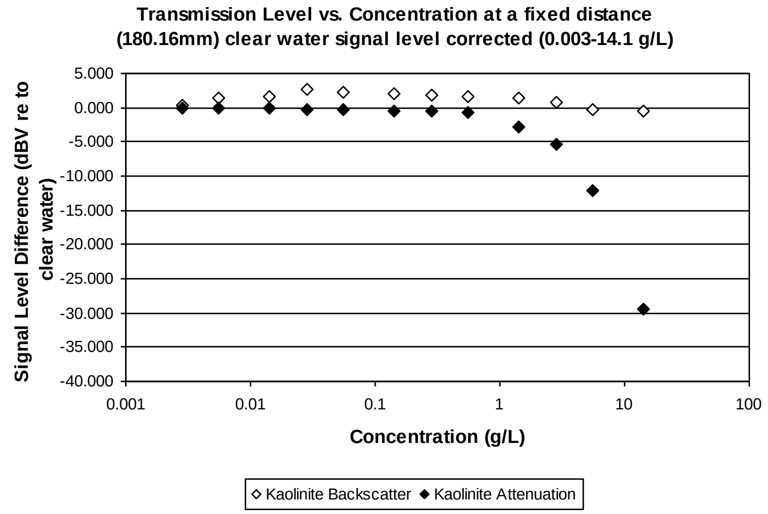

Figure 2: Attenuation and Backscatter for kaolinte

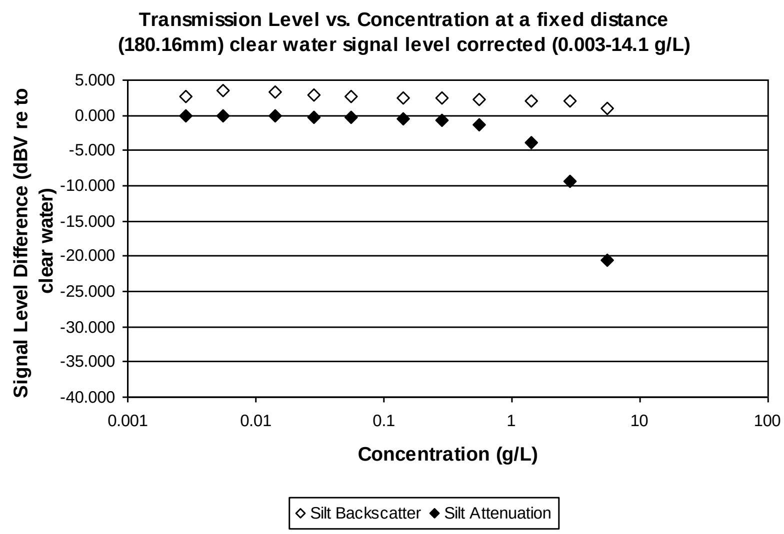

Figure 3: Attenuation and Backscatter for Silt

Indeed, there is more backscatter in the silt data than the bentonite data. However, the silt data does not strongly distinguish itself from the kaolinte data. Moreover, the backscatter measurements have a minute differential when compared to the attenuation data. These conclusions are illustrated in Figure 4.

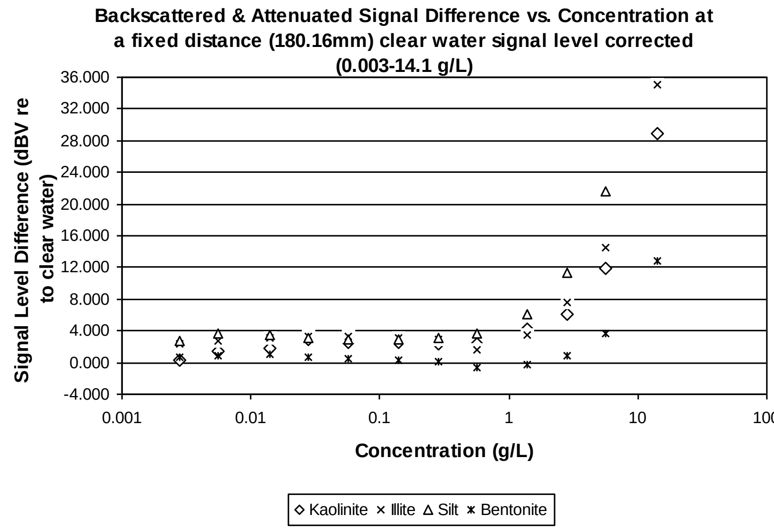

Figure 4: Backscattered and Attenuated Signal Difference for Clays and Silt

Figures 5-7 show the work that has been compiled to measure attenuation for clay/silt mixtures. In these experiments, sediment was added and then held constant while another sediment type was added. As expected, the clay/silt ratios that favor higher concentrations of silt relative to clay display more attenuation due to greater size distribution of large silt particles. Conversely, the clay/silt ratios with higher concentrations of clay relative to silt have less attenuation due to greater size distribution of smaller-sized diameter clay particles. It was also noted that the attenuation values converged as the ratios of clay/silt approach 1:1.

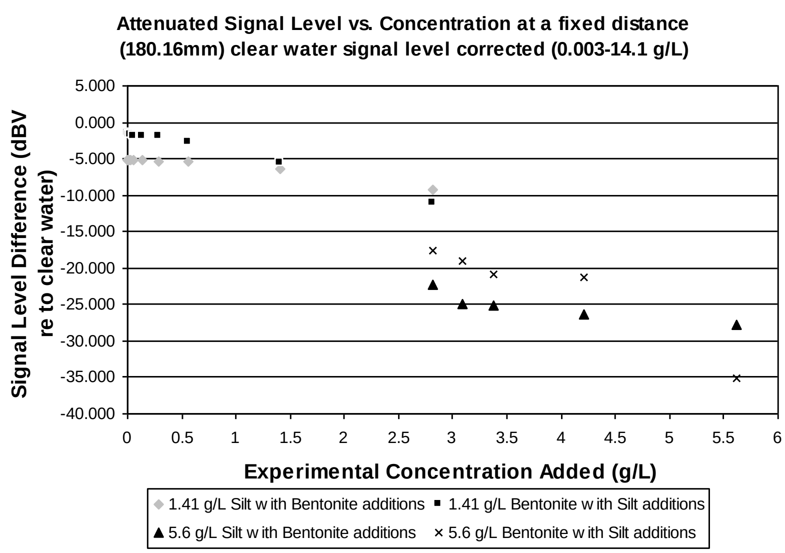

Figure 5: Attenuation vs. Concentration for a Range of Bentonite/Silt Ratios

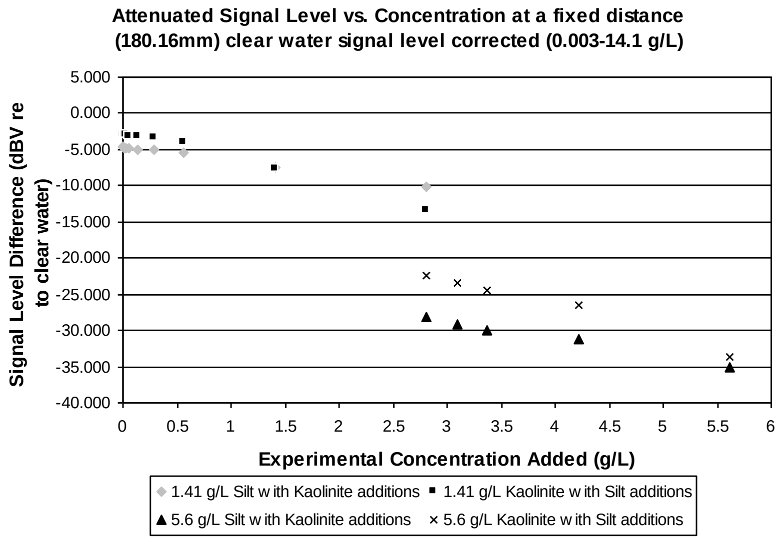

Figure 6: Attenuation vs. Concentration for a Range of Kaolinite/Silt Ratios

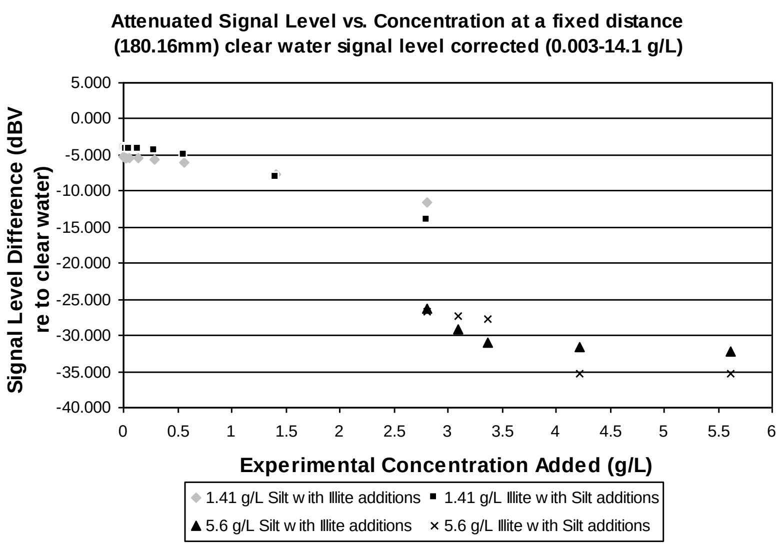

Figure 7: Attenuation vs. Concentration for a Range of Illite/Silt Ratios

At the time of the experiments, we did not have any way to measure the in-situ particle size during our experiments. The collection of a physical sample would have broken up any aggregates, making it virtually impossible to know what size particles we were measuring. Since then, we have obtained a LISST-100X from Sequoia Scientific which will be used in a series of experiments to measure the in-situ effective particle size. Our plan is to repeat the experiments that resulted in the data shown in Figures 1-7 and, for each run, collect particle-size data with the LISST-100X. This step should add important information on what is happening with the acoustic backscatter from fine suspended particles. A proposal has been submitted to FISP to support this research effort.

Sources:

[1] Carpenter, W. O. Jr., Chambers, J. P., Wren, D. G., Kuhnle, R. A., and Diers, J. A., "Acoustic Measurements of Suspended Fine Particle Concentrations by Attenuation", USDA ARS Research Report No. 67 12/2009

[2] Carpenter, W. O. Jr., Chambers, J. P., Wren, D. G., Kuhnle, R. A., and Diers, J. A., "Acoustic Measurements of Clay-Size Particles", J. Acoust. Soc. Am. Express Letters 126(6) (2009)

FISP Progress Report: Bedload Impact Plates, Elwha River

Establishment: Bureau of Reclamation, Lakewood, CO (installation, Port Angeles, WA)

Principal Investigator: Rob Hilldale **Date:** 11/22/2010

Reporting Period: June 1st – October 31st 2010

Summary of Progress for Reporting Period:

See attached report

Status of Deliverables (percent completed):

All plates and sensors are installed and wiring for all sensors is routed to a cabinet (powered by 110 VAC) on river right atop the intake structure. There is a combination of geophones and accelerometers attached to the underside of the plates. There is one hydrophone installed above the plate at river right. It is mounted on the concrete intake structure and the wire is also routed to the cabinet.

In September, there was a one day meeting between Jeff Marr and Chris Ellis (SAFL, U. of Minn.), Jim Chambers, Brian Carpenter, and Bradley Goodwiller (NCPA, U. of Miss.), and myself. On the phone for a couple of hours was Dieter Rickenmann (Swiss Federal Inst.) and Tim Randle (Reclamation). There was a successful passdown of information regarding the bedload impact research from SAFL (U. of Minn) to NCPA (U. of Miss.). Before the FY closed out Reclamation provided $50k of funding to NCPA to continue this research. The current contract asks NCPA to:

determine a sampling scheme (frequency and duration) for the 72 sensors,
determine a level of processing that will take place prior to data storage,
what data will be retained and what will be deleted,
provide options for Recalmation personnel in Denver to remotely access the data,
determine the frequency that all raw data are retained,
purchase and install the hardware, loaded with appropriate software to do these things,
assist Reclamation with performing an initial operational check of each sensor and determine the signal loss comparing far left bank to near right bank (if any) and calibrate accordingly.

There are some more details in the contract but I think I've captured the general direction we're going. The hardware and software are expected to be installed and ready to begin testing in May 2011.

Future plans are to begin planning a field calibration with live sediment and hopefully install a support on river left that will provide an anchor point for the raft used to sample the bed load (an eye bolt can be mounted on river right to either the concrete structure or the bedrock). We're in contact with Chris Magirl (USGS, Tacoma) regarding this effort and their plans to sample suspended sediment at or near this site.

APPENDIX 5: Proposals for FISP Projects Approved on Nov. 9, 2010 (more or less unedited):

ABRAHAM AND MCELORY, COE AND USGS, Proposal:

1. We seek support in the development of an application of multibeam sonar technology as a surrogate for direct measurements of bed load and bed material load in large sandy rivers. Because of their depth, velocity, and/or turbulence, deployment of physical samplers is nearly precluded in large rivers, and as a result of the difficulty and cost, bed load is very rarely measured in them. As an alternative to physical sampling, Abraham and others (in review, JHE) and McElroy and Mohrig (JGR-ES, 2009) have proposed methods to determine bed load fluxes and bed material fluxes, respectively, from repeat topographic surveys. While each of these methods has been supported by laboratory data, simultaneous vetting with appropriate field data will provide the necessary scientific and technical background to use the topographic evolution of sandy beds to calculate both bed load and bed material load sediment fluxes in general. This objective is parallel to FISP's goals of developing practical field applications of emerging sediment-sensing technologies. Because bed material is immediately related to riverine physical habitats, structural stability, coastal land-building, and reservoir filling, we suspect that this work will have immediate relevance to the engineering, scientific, and management efforts of FISP's partner agencies as well as many others.

2. The purpose of our proposed work is to perform some initial tests on the ability of a new method to compute total bed material load in large sand bed rivers. We suggest that this can be accomplished using ***only*** sequential bathymetric profiles obtained in repeat-bathymetric-surveys. This would be a significant development and advance in sediment transport studies that would have far reaching implications. If shown to be viable, many research questions could be addressed regarding the proportions of suspended bed material load transport and the bed material load which moves in the bed forms. The method could possibly be more accurate because only one data set is necessary, where as with present methods, two data sets are necessary (suspended transport data and bed-from transport data). Using traditional methods, the two data sets are also acquired using two separate data collection techniques, which can introduce bias and/or overlap. The new method will require only one data set, and is non-intrusive. Possibly the most important result of the new method would be that the need for collecting suspended bed material load samples would no longer exist. This would of course require some transition time and rigorous verification tests. For the present work, we would use the following methodology.

- Compute the bed material load transport in the translating bed forms (BML_b) by using the ISSDOTv2 method.
- Compute the total bed material load (BML_t) using equations 18 and 20 in McElroy and Mohrig.
- Subtract BML_b from BML_t. The difference should represent the computed bed material load in suspension (BML_{sc}).
- BML_{sc} can then be compared to the measured suspended bed material load (BML_{sm}). It is important in this case to make sure that the wash load is removed from the suspended sediment samples. This would require that the particle size distributions for the bed and the suspended sediment samples are known.

The researchers have much experience in sedimentation work and have published several relevant papers and/or dissertations on the proposed methods. Abraham has already developed a methodology for computing bedload transport in large sand bed rivers, where in the past, it has not been possible to do so. The method requires sequential bathymetric profiles and is non-intrusive. This will be used in step one. McElroy has developed a methodology for measuring a deformation (vertical) flux and translational (horizontal) flux of bed material using sequential bathymetric profiles. This will be used in step two.

Besides the experience mentioned above, the researchers have access to Mississippi River measurements taken in the spring and summer of 2010 which will provide all the bathymetric profiles, suspended sediment, and grain size distribution data required to test the new methodology. These data will be used in all steps, and though already collected, will require much additional processing.

3. Abraham and others have demonstrated with flume data that integrated surface differences of bottom topography are faithful recorders of bed load fluxes when sediment suspension is negligibly small. In the field where this condition rarely holds true, it is hypothesized that bed load fluxes are still accurately captured by integrated surface differences. Although this method clearly does not capture all of the transport of bed material. McElroy and Mohrig have shown how the combined translation and deformation of trains of bed forms creates an estimate of bed material flux. The difference between the bed load flux and the bed material flux is accounted for by the portion of the bed material that is transported in suspension. We propose to utilize an existing dataset with simultaneously collected bed topography, bed sediment samples, and suspended sediment samples to demonstrate how these three parts of sediment transport are related to each other and are also reflected by the evolution of bed topography. Because the suspended and bed sediment samples were collected together, the suspended sediment concentrations can be broken down by size fractions represented on the bed, and therefore the suspended bed material flux can be calculated. In this way the method of Abraham and others to calculate bed load can be related to the method of McElroy and Mohrig through the suspended portions of the bed material load.

4. The project will be completed in one year's time from the time of acceptance and receipt of funds. The first quarter (year) will be used to acquire the data and perform any necessary processing. The second quarter will be used to perform the computations as described in item 2. The third quarter will be used to analyze the outcomes and perform any feedback computations. The fourth quarter will be used to summarize and finalize the results and write a technical and /or journal paper describing the outcome. An appropriate conference will be selected in which the work can be presented.

Costs:
The salary of McElroy will be leveraged and not cost the project any $'s.
The salary of Abraham will be $19.2 K for an estimated work time of 4 weeks. An additional work time of 3 weeks will be leveraged through the project for which the data were already collected.
There will be no direct costs associated with the data collection.
For travel and per diem, $6.6 K is requested. This is for one trip for McElroy to be at ERDC when necessary for discussions and data evaluations, and for one trip for McElroy to present a paper at an appropriate venue.
For reporting and publication, and miscellaneous technical expenses $5.0 K is requested.
Total Requested funding: $30.8 K

CARPENTER AND CHAMBERS, NCPA, PROPOSAL:

Acoustic backscatter/attenuation discrimination of particle size with in-situ particle-size measurement

The past year's acoustic data collection was performed with the goal of using a combination of backscatter and attenuation to differentiate between particle sizes in two rough size ranges: >≈10 µm and <≈10 µm. These ranges were chosen because they roughly represent the transition between the silt and clay size ranges. Typical acoustic instruments are 1 MHz or lower in frequency and so will produce very little backscatter from such small particles. Optical backscatter instruments (OBS) can be used successfully to measure these particle sizes, but there is a strong dependence of particle size which results in a need for regular physical samples to supplement the readings of an OBS probe. A high frequency (≈20 MHz) acoustic device that can discriminate between clay and silt-sized particles has the potential to be useful by providing a continuous record of particle concentration at a low cost and with little user intervention. Therefore, multiple data sets of backscatter and attenuation from various combinations of kaolinte, illite, bentonite, and silt were collected in the last year.

Results obtained to date suggest that using a combination of attenuation and backscatter from a single-frequency instrument to make a rough differentiation in particle sizes is possible. However, during the course of data collection, the issue of effective particle size became more important than anticipated as evidenced in Figures 1-3. The decrease in signal level for increasing particle size (indicating increased attenuation) from bentonite to kaolinte to silt can clearly be seen in the data. These results have been shown in previous FISP reports. Conversely the backscatter amplitude for bentonite clay (<1 µm) should have been much smaller than for silt (D_{50}≈50 µm) as more sound is reflected back toward the source for larger particles.

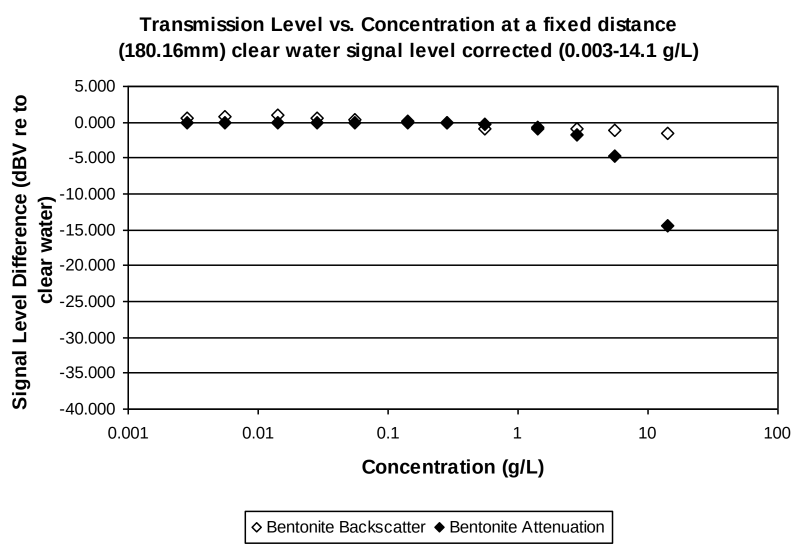

Figure 1: Attenuation and Backscatter for bentonite

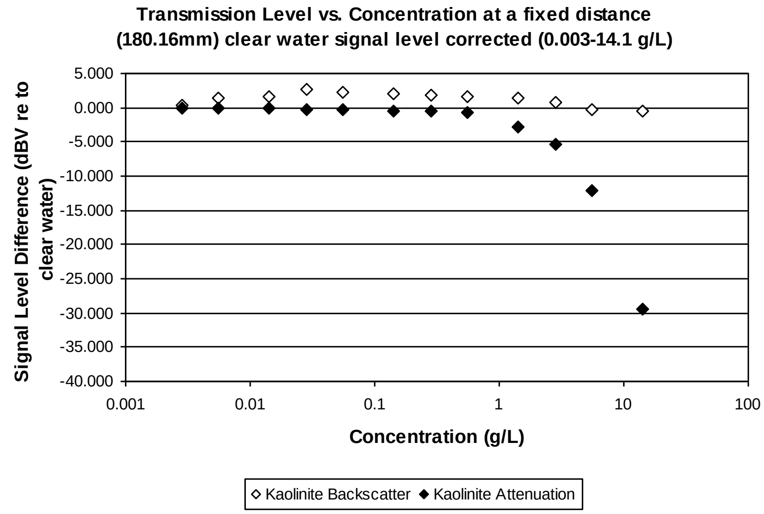

Figure 2: Attenuation and Backscatter for kaolinte

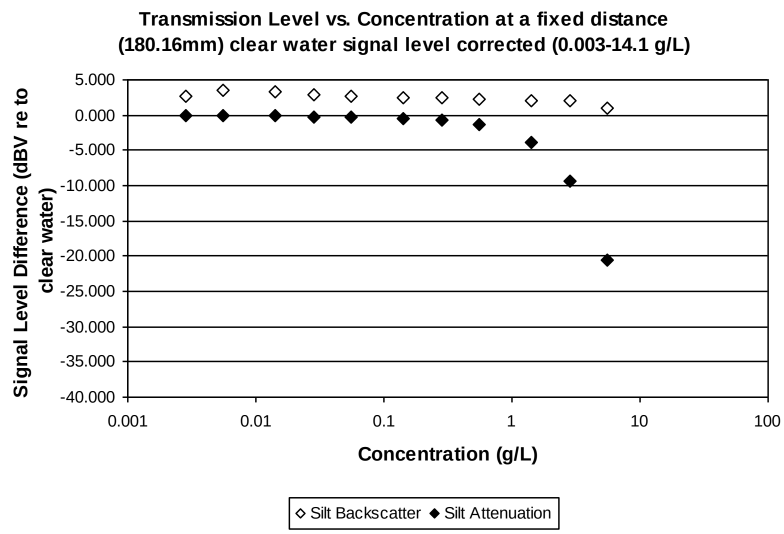

Figure 3: Attenuation and Backscatter for Silt

Indeed, there is more backscatter in the silt data than the bentonite data. However, the silt data does not strongly distinguish itself from the kaolinte data. The backscatter measurements suggest that the deflocculation procedures used in the work may not have been sufficient, resulting in unknown aggregate particle sizes. At the time of the experiments, we did not have any way to measure the in-situ particle size during our experiments. The collection of a physical sample would have broken up any aggregates, making it virtually impossible to know what size particles we were measuring. Since then, we have obtained a LISST-100X from Sequoia Scientific which will be used in a series of experiments to measure the in-situ effective particle size. Our plan is to repeat the experiments that resulted in the data shown in Figures 1-3 and, for each run, collect particle-size data with the LISST-100X. This step should add important information on what is happening with the acoustic backscatter from fine suspended particles.

Budget: $19K
$6K to NSL for technical support
$13K to NCPA for salary, materials, overhead etc.

Proposal Title: Verification of New Technology to Reduce Solids Stratification Bias in Urban Runoff Sampling

Project Chief: Bill Selbig

Project Chief Location: USGS, Wisconsin Water Science Center, Middleton, WI

Proposed Start Date: January, 2011 **Proposed End Date:** December, 2011

Relation to FISP Goals

Collection of representative stormwater-quality samples in urban runoff can be difficult due to large sources of variability, both temporal and spatial. Use of automated water-quality samplers has vastly improved the way water- resources professionals collect samples in these environments, but the stratification of solids by particle size in a flowing water column may result in biased concentration data collected from urban conveyances, both in the past and present. Millions of dollars are spent annually by environmental managers, engineering consultants, manufacturers of proprietary stormwater treatment devices and others to mitigate, control, and prevent stormwater pollution in our nation's waterways. Accurate concentration data is vital to their decision-making process. Therefore, the location of a sampler intake can be critical depending on the degree of stratification in the storm sewer pipe.

Recognition of autosampler inefficiencies has led to new advancements in sampling technology. Smith (2002) developed a hydrostatic-mixer assembly used to artificially provide agitation in the flow path to produce a sample representing the average concentration of suspended sediment. Quality- control data showed an even distribution (by mass) of particles less than 62 µm throughout the water column but particles greater than 62 µm tended to be concentrated near the bottom of the pipe. Kayhanian and others (2005) suggested designing a new autosampler system that uses a float system to place the intake at the midpoint of a flow path. DeGroot and others (2009) designed an intake manifold that adjusts itself to the depth of flow in the pipe by use of a fin. Although this device showed promising results for accurately collecting sand-sized particles in a small-diameter pipe, an alternate mechanism would be necessary for pipes larger than 24 inches in diameter (DeGroot and others, 2009). These ideas mark the genesis of new technologies to improve the way a stormwater-quality sample is acquired by use of autosamplers.

To address the concern of stratification of solids in urban stormwater, the USGS has developed a new prototype Depth-Integrated Sample Arm (DISA). The DISA is designed to integrate with existing autosampler configurations for collection of stormwater-quality samples of urban runoff in a storm sewer. Use of the DISA facilitates collection of stormwater-quality samples from a single or multiple point(s) in the water column. Integrating samples from the entire water column, rather than from a single, fixed point, can result in a more accurate representation of stormwater-borne solids. In a recent study, the DISA and a fixed-point sampling method were used to collect samples of urban runoff (Selbig and Bannerman, in review). Results from the two methods were compared on the basis of concentrations of suspended sediment, organic content, and particle-size distributions. Concentrations of suspended sediment in runoff were statistically greater using a fixed- rather than multi-point collection system. Median suspended- sediment concentrations measured at the fixed location were approximately double those collected using the DISA. This relationship was consistent across a range of concentrations and was duplicated at two different study locations. In general, concentrations and size distributions of suspended sediment decreased with increasing vertical distance from the storm- sewer invert. Coarser particles tended to dominate the distribution of solids near the storm- sewer invert as discharge increased. In contrast to concentration and particle size, organic material was, to some extent, homogenously distributed throughout the water column, likely the result of its low specific density, which allows for thorough mixing in less turbulent water.

Results of this study have potential benefits to federal, state, and local agencies, consulting firms, research laboratories, and universities with responsibilities for collecting and disseminating accurate stormwater-quality concentration data. Water resources professionals responsible for interpretation of stormwater-quality concentration data such as trend detection, modeling, evaluation of Best Management Practices (BMPs), and site characterization will also benefit from the reduced bias and improved precision of stormwater-quality concentration data offered by this study.

Technical Merit and Context

Although evidence of stratification of both sediment concentration and particle size was found in field-collected data, comparison of these data to a known quantity was unfeasible. Therefore, comparisons between the DISA and a fixed-point sampler can only illustrate the differences between each sampling method but cannot make inferences as to which method is more accurate. Research similar to what has already been done in the field was recently duplicated in a controlled laboratory setting where concentrations and distributions of sediment can be compared to a known quantity across a range of flow conditions.

Phase I of this study was to statistically quantify the precision and bias errors of sediment concentrations and distributions for the DISA and fixed-point sample collection methods. Colorado State University's (CSU) hydraulics facility served as host for this effort. Complications with the sediment injector resulted in appreciable uncertainty when trying to maintain a consistent suspended sediment concentration. Additionally, a considerable amount of time was required to adjust the pipe slope in order to mimic hydraulic conditions similar to what is found in the field. For example, during one flow test, the fixed-point sample intake became buried in sediment accumulated in the pipe due to improperly maintained velocities. While not entirely successful, a considerable amount of data was collected which provided "proof of concept" towards the efficacy of the DISA.

Phase II will build upon what was learned during Phase I by revisiting the CSU hydraulics lab or other suitable location. Adjustments will be made to the configuration of the sediment injector in order to provide a more consistent injection rate of manufactured silica. Use of a variable-speed auger system will replace the current paddle-wheel type design. An Equal-Depth Increment sampler will be used as a secondary measure to determine the true concentration and distribution of sediment in runoff. Also, a portable particle size analyzer (LISST-Portable) will provide near real-time analysis of particle size distribution in collected water samples. Suspended sediment concentrations will also be determined by converting the volumetric concentration reported by the LISST-Portable into a mass concentration. Finally, adjustments to the location of the DISA sample intake will be made to optimize sample accuracy. For example, currently the DISA is set up to take a sub-sample at three locations in the water column. The first is located near the bottom of a storm sewer, the second at 30% of the water depth, and the third at 60% of the water depth. Initial results of Phase I suggest the upper portion of the water column may still be underrepresented. Phase II of this study will also focus on experiments designed to answer the following:

- If three sub-samples vertically spaced across the water column is too many or too few;
- If the percentage of the water depth for each sub-sample should be increased or decreased;
- If the number or vertical spacing of each intake location should be consistent or variable depending on changing flow conditions.

Field-collected data comparing the DISA and fixed-point samplers has already been summarized and accepted to the journal *Water Environment Research* and is currently in review (Selbig and Bannerman, in review). Phase II will build upon information learned during Phase I.

Proposed Budget and Timeline

Funds requested from FISP for the successful completion of this study totals $25,000. This amount will be used primarily for laboratory fees, salary, and travel expenses. It will also be used to purchase necessary equipment and supplies to improve injection of sediment into simulated runoff. The duration of the project is estimated to be 1 year.

The total project cost is estimated to be $61,000. The Wisconsin Department of Natural Resources and U.S. Geological Survey will contribute approximately $25,000 and $11,000, respectively. The USGS will also provide all equipment necessary to operate the DISA, collect water-quality samples, and measure both concentration and distribution of suspended particles.

CSU's hydraulics facility is open for general use during late summer to early fall. It is anticipated the time needed to complete testing of the DISA will require less than two weeks. Data will then be analyzed and summarized for future publication. Table 1 shows major milestones chronologically for this study.

Table 1. Chronological timeline and anticipated milestones.

	Calendar Year 2011											
Milestone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Conduct experiments at CSU hydraulics facility								■	■			
2. Data analysis										■	■	■

Partners

Roger Bannerman, Environmental Specialist, Wisconsin Department of Natural Resources

Robert E. Pitt, Ph.D. (University of Alabama), Cudworth Professor of Urban Water Systems.

Amanda Cox, Manager, Colorado State University Hydraulics Laboratory

References

Degroot, G.P., Gulliver, J.S., and Mohseni, O., 2009, Accurate sampling of suspended solids, ASCE Conf. Proc. 342, 81 (2009).

Kayhanian, M., Young, T., and Stenstrom, M., 2005, Limitation of current solids measurements in stormwater runoff, *Stormwater*, v. 6, no. 5, p 40 – 58.

Selbig, W.R., and Bannerman, R.T., Development of a Depth-Integrated Sample Arm (DISA) to reduce solids stratification bias in stormwater sampling, *Water Environment Research*, in review.

Smith, K.P., 2002, Effectiveness of three best management practices for highway-runoff quality along the southeast expressway, Boston, Massachusetts. U.S. Geological Survey Water-Resources Investigations Report 02–4059, 62 p.

STRAUB AND CURRAN (USGS), PROPOSALS (Curran support based on previous-year proposal, not included herewith)

Proposal Title: **LISST-SL Testing**

Project Chief: Tim Straub, Sediment Specialist

Project Chief Location: USGS, Illinois Water Science Center

Proposed Start Date: January 1, 2011 Proposed End Date: December 31, 2011

1. **Relation to FISP goals** – A Stream Lined (SL) version of the surrogate technology Laser In-Situ Scattering and Transmissometry (LISST) has been developed, but not thoroughly tested. Continued testing of the LISST-SL is directly related to the current vision of the FISP in working on emerging sediment surrogate technologies for practical field application.

2. **Technical merit (Scientific merit) –** The purpose of the proposed work is to complete the FISP testing guidelines for the LISST-SL. The current use of physical samplers and subsequent lab analysis is costly and slow. The LISST-SL provides a potential for more timely results and continuous records computation for sediment.

3. **Technical context (Relevance and importance)** – The LIST-SL was loaned to the ILWSC for testing in 2010. Initial testing of the LISST-SL has been completed by the ILWSC (without FISP funding) and the manufacturer has completed upgrades to the instrument during the testing period. With the upgrades, full FISP testing is the next step. This testing includes obtaining 12 LISST-SL readings and 24 manual samples for each single vertical condition. Funds to cover the labor and analytical costs will greatly help in obtaining a range of single vertical conditions for testing.

Timeline, budget (Feasibility), and partners – The proposed duration of the project is one year starting in January 2010. A minimum of 15 single vertical conditions will be obtained. From the 360 samples needed for the FISP testing (15 conditions times 24 samples), the lab analysis will include concentration only on 300, sand-fine splits on 30, and full particle size on 30 (assuming enough material is available for full particle size analysis). A comparison of the LISST-SL readings and physical sampler sample lab results will be summarized in a technical memo to the FISP.

Budget

Item	Cost
Salary	17,000
Travel	1,000
Vehicles	1,000
Lab Costs	15,000
TOTAL	**34,000**

WOOD (USGS), Proposal

FISP PROPOSAL FORM

Proposal Title: Pilot Study for Evaluation of Multi-Frequency Acoustics as a Surrogate for Bedload Transport in Two Rivers
Project Chief: Molly Wood
Project Chief Location: Idaho Water Science Center, Boise
Proposed Start Date: March 2011 **Proposed End Date:** September 2012

1. Relation to FISP goals

This proposal is directly related to the FISP goal of developing sediment surrogate techniques for practical field applications. The U.S. Geological Survey (USGS) is proposing a pilot study to evaluate whether acoustic Doppler current profilers (ADCPs) of various frequencies can be used to estimate bedload transport in the Clearwater River at Spalding, Idaho (USGS gage #13342500) and Snake River near Anatone, Washington (USGS gage #13334300) (figure 1). This is an emerging sediment surrogate technique that has had limited evaluation in the field. If the technique proves useful, the USGS may pursue future funding for evaluating fixed acoustic deployments that can provide continuous estimates of bedload transport. The secondary FISP goal of developing improvements to physical samplers is indirectly met by a project element that involves attaching an underwater video camera to the top of a bedload sampler. The video work will help the project team to (1) qualitatively assess the performance of the sampler in capturing true bed movement in a specific location and (2) provide recommendations for the sampler's future use in similar studies.

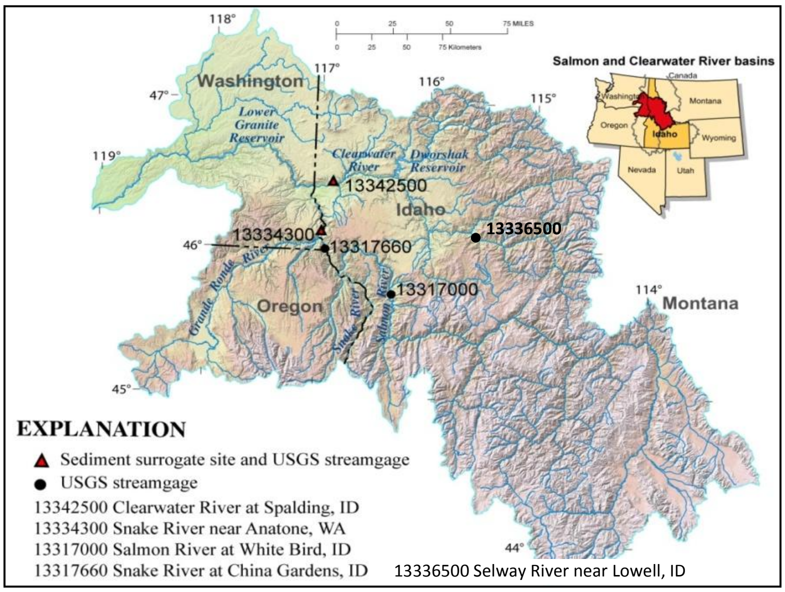

Figure 1. Study area for existing and proposed work.

2. Technical merit (Scientific merit)

Limited research has been conducted to evaluate whether indirect or surrogate techniques can be used to estimate bedload transport and improve accuracy while reducing some of the difficulties associated with direct measurements. Bedload surrogate techniques are very experimental, and success has been site-dependent. However, if a surrogate technique is successful, it may be possible to obtain instantaneous or even continuous estimates of bedload transport and reduce or eliminate the need to collect direct bedload measurements.

Active acoustics, through deployment of ADCPs, have been tested as a surrogate for bedload transport in Canada's Fraser River (Rennie et. al, 2002; Rennie and Villard, 2004) and the United States' Trinity River (Gaeuman and Pittman, 2007) and lower Missouri River (Gaeuman and Jacobson, 2006). However, little work has been done to evaluate the performance of multiple frequency ADCPs outside a laboratory environment and whether the response of the various frequencies can help identify types of moving bed based on differing depths and velocities of the moving layer.

Results of sediment sampling conducted by the USGS in the 1970s and 2008-2010 in the Snake and Clearwater Rivers showed that when both suspended and bed samples were collected, bedload comprised 2 to 10% of the total sediment load at each site, with an average of 5% (U.S. Geological Survey National Water Information System, 2010). Depending on the flow regime, bed material size distributions were generally bimodal, with high percentages of medium to coarse sand and very coarse gravel. Therefore, a successful surrogate technique would need to be able to measure movement of a range of sediment sizes.

One feature of an ADCP is that it transmits a sound wave, called a bottom track pulse, to keep track of its position as it moves across a stream (Gordon, 1996). If material is moving along the bed at a particular site, the ADCP will falsely appear to move upstream, which introduces bias in the streamflow measurement unless it is corrected (Mueller and Wagner, 2006). If the exact location of the ADCP is known (by fixing its position or by connecting it to a differential global positioning system (DGPS)), and the apparent or false position of the ADCP is measured over time, an apparent bed velocity can be inferred. Bedload transport rate can be estimated based on the apparent bed velocity and empirical parameters or through correlations between near-simultaneous measurements of apparent bed velocity and bed material movement.

The average velocity of the bedload layer depends on the various sizes and velocities of the particles. Apparent bed velocity should be representative of the average surface velocity within the volume measured by the ADCP; however, the measurement is influenced by the frequency of the instrument and the characteristic size of the particles. An ADCP preferentially measures reflections from particles with a diameter equal to or greater than the wavelength of the instrument's sound wave (Thorne et al., 1995). For example, a 1.2 MHz ADCP will be most sensitive to particles with diameters equal to or greater than 0.8 mm, and the weighting of these particles in the apparent bed velocity should be greater. The use of multiple ADCPs with different frequencies should theoretically allow the computation of apparent bed velocities for different grain sizes. As a result, relations between bedload transport and apparent bed velocity may be developed separately for the gravel and sand fractions.

The use of ADCP-measured apparent bed velocity as a surrogate for bedload transport is a technique that shows considerable potential, although calibrations are site-specific, and instrument and sampling errors can be substantial. However, because conventional bedload transport measurements are typically difficult and unsafe, surrogate techniques that can provide quantifiably reliable bedload data are desirable. If the technique is deemed an adequate surrogate for bedload transport, ADCPs could be used to obtain an instantaneous estimate of bedload or could theoretically be installed at a fixed station in the river for estimating bedload transport on a continuous basis. In addition, qualitative results from this study will help in characterizing the variability of bedload transport in a natural channel, thus allowing for better sampling design whether using new or traditional methods.

The proposed Project Chief, Molly Wood, is a Hydraulic Engineer and has worked with acoustic instruments for 9 years and sediment surrogate concepts for 4 years. She has evaluated the use of acoustics as a suspended sediment surrogate in the Kootenai River and Boise River in addition to the Snake and Clearwater Rivers, has published a conference proceedings paper on some of the results (Wood, 2010), and has written 2 journal articles on related topics that are currently in review. She is also co-chair of the multi-agency Hydroacoustic Work Group (HaWG), sponsored by USGS Office of Surface Water, and is an instructor for USGS training courses on the use of acoustics for velocity and streamflow measurements. Ryan Fosness, another Hydraulic Engineer on the project, has extensive experience with bedload sampling and has used underwater video camera equipment to record bedload transport on the Kootenai River. An example of these video surveys can be viewed at: http://gallery.usgs.gov/videos/289.

3. Technical context (Relevance and importance)

The USGS Idaho Water Science Center, in cooperation with the U.S. Army Corps of Engineers (USACE) Walla Walla District, has operated a sediment monitoring project in the Snake and Clearwater River basins since 2008 as part of the Lower Granite Reservoir Programmatic Sediment Management Plan. Key objectives of that project are to: (1) develop sediment transport curves for suspended and bed loads at 12 sites to identify source areas and quantify total sediment loading into Lower Granite Reservoir and (2) evaluate surrogate technologies (multi-frequency acoustics, turbidity, and laser diffraction) for estimating suspended sediment concentration (SSC) in the Snake and Clearwater Rivers. The work described in this proposal would enhance the existing program and may help determine whether acoustics can be used as a surrogate for bedload in similar rivers.

USACE is developing strategies for managing sediment transport and deposition in lower Snake River reservoirs, which has negatively impacted navigation and flow conveyance. Historically, sediment has been managed through periodic dredging of the federal navigation channel; however, USACE hopes to identify more opportunities for controlling sediment by quantifying sediment sources and transport in contributing watersheds. The Snake and Clearwater Rivers are partially-regulated, meaning that some but not all of the flow is controlled by dams. Some flow passing each study site is contributed by unregulated tributaries. These sites are thus good candidates for sediment surrogate studies because the relation between flow and sediment transport is often poor. The USGS has found acoustics to be an excellent surrogate of SSC at the study sites, resulting in improved estimates of SSC over short (hydrologic event) and long (annual) time scales in comparison with traditional transport curves that relate streamflow to SSC (Wood, 2010). Given the success with SSC, the project team hopes that acoustics will also prove to be a good bedload surrogate so that total sediment loading to the reservoir can be more accurately and safely estimated.

4. Timeline, budget (feasibility), and partners

The pilot project is expected to last approximately 1.5 years, from March 2011 – September 2012. Phase 1 (March – Sept 2011) will include all of the field work, to be conducted during 1 or 2 field trips in the spring/summer of 2011, depending on flow conditions at the two sites, and some data analysis. Phase 2 (Oct 2011 – Sept 2012) will consist of additional data analysis, preparation of journal article, and formulating suggestions for future work. Some costs for labor, equipment, and travel in FY11 are already covered by base funding from the existing USACE monitoring project. USACE is contributing $421,000 for sediment sampling and $170,000 for suspended sediment surrogate work in the Snake and Clearwater River basins in FY11.

Proposed work elements include:

- During 1 sampling event at each site at higher flow when the bed is moving, deploy 3 ADCPs of different frequencies (2 MHz, 1.2 MHz, and 0.6 MHz) with DGPS using a special mount off a boat (Clearwater River) and bank-operated cableway (Snake River). Bedload sampling at the Snake River site has been difficult at times due to high velocities and reduced control of the sampler using the cableway. Another existing sediment sampling site in the basin where bedload sampling has been more successful (such as 13336500, Selway River near Lowell, ID) may be substituted for the pilot study depending on flow conditions. The ADCPs will be lowered to just below the water surface and will collect apparent bed velocity data for approximately 5 to 10 minutes at each of 10 discrete stations. Timing of data collection for each ADCP may be offset to avoid frequency interference.
- Collect bedload samples using conventional techniques during the sampling event described above. Samples will be collected using a US-TR-2 or Helley Smith bedload sampler from the same 10 discrete stations within the stream cross-section, immediately after the ADCP data are collected at a particular station. Samples will be collected according to USGS policy in Edwards and Glysson (1999), but will not be composited into 1 sample.
- Correlate apparent bed velocities measured by each ADCP with the bedload mass and grain size distribution collected at each station at each site (up to 10 data points at each site). Evaluate data separately for each frequency ADCP to determine if separate relations could be developed for the sand and gravel fractions of bedload.

- Attempt to quantify an approximate thickness of the moving bed layer by examining the difference in depths measured by the different frequency ADCPs. Acoustic signals from the lower frequency ADCP may be able to penetrate finer material moving along the bed and therefore may report a larger depth than the other frequency ADCPs.
- Evaluate cross-sectional variability in bedload to determine whether one or more ADCPs deployed permanently at one station could represent the average bedload in the entire cross-section.
- Attach an underwater video camera looking down onto the opening of the bedload sampler during the sampling event at the Clearwater River site to qualitatively assess performance of the bedload sampler during measurement. The sampling site on the Snake River is not conducive to use of the video camera because all equipment are deployed via a bank-operated cableway.
- Develop suggestions for future work that might help further evaluate the use of bedload surrogates at these sites.
- Summarize findings and submit an article for publication in a peer-reviewed scientific journal.

Approximate schedule:

Task	Estimated Duration	Timeframe
Data collection	1 day each site	April – June 2011, flow dependent
Data analysis	2 weeks	September – October 2011
Draft journal article	2 weeks	November – December 2011
USGS peer review of article	1-2 months	January – March 2012
Submission of article to journal	N/A	by September 2012

Personnel:

The following USGS personnel will be included in the project:

Molly Wood – Project Chief, acoustic data collection, data analysis
Ryan Fosness – Hydraulic Engineer, underwater video camera operation, data analysis
Technicians from USGS Post Falls Field Office – Bedload sampling and field support

Costs:

Work performed with funds from this agreement will be conducted on a fixed-price basis. Total funding needed to cover labor, travel, equipment/supplies, and analytical services is $49,000 over 2 fiscal years.

Budget for Snake and Clearwater Rivers Bedload Surrogate Study, Gross Dollars

	Phase 1 FY11 Cost	Phase 2 FY12 Cost
Labor*	$ 17,000	$ 24,000
Travel*	$ 1,700	$ 0
Equipment/Supplies*	$ 3,500	$ 0
Analytical Services (USGS CVO Sediment Laboratory)	$ 1,800	$ 0
Journal Fees	$ 0	$ 1,000
TOTAL	**$ 24,000**	**$ 25,000**

***These costs are kept low in FY11 because much of the base funding for sampling, equipment, and travel is already covered by the existing USACE monitoring program.**

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