Governor's Upper Yellowstone River Task Force

Meeting Summary
November 19, 2002
Community Room, City/County Courthouse
Meeting began at 7:00 pm

I. Introduction

Members Present:

John Bailey, Chair
Dave Haug, Vice Chair
Roy Aserlind
Andy Dana
Doug Ensign
Michelle Goodwine
Jerry O'Hair
Brant Oswald
Rod Siring
Bob Wiltshire
Ellen Woodbury
Jim Woodhull

Ken Britton, USFS Ex-Officio
Robert Ray, DEQ Ex-Officio
Laurence Siroky, DNRC Ex-Officio
Allan Steinle, Corps Ex-Officio
Stan Sternberg, MDT Ex-Officio
Joel Tohtz, FWP Ex-Officio

Others Present:

Liz Galli-Noble, Coordinator
Kelly Wade, Secretary
Duncan Patten, TAC Chair
Karl Biastoch
Tom Hallin
Jim Barrett
Deon Lackey
Phil Farnes
Lionel Dicharry
Karin Boyd
Steve Holnbeck
Brad Shepard
Jim Robinson
Dwight Hines
Bill Moser
Shirley Richardson
Jeanne-Marie Souvigney
Scott Compton
May Mace
Stan Todd
Rusty Collyer
Chuck Parrett
Todd Tillinger
Paul Hook
Brandy Logan
DeWitt Dominick
Bruce Rich
Ralph Richardson
Chuck Dalby
Daryl Smith
David Marshall
Tom Pick

II. Prior Meeting Minutes

John Bailey: Any discussion on the minutes of November 5, 2002?

> **Ellen Woodbury moved to approve the November 5, 2002 minutes as written. Jerry O'Hair seconded the motion. The motion passed unanimously.**

III. Financial Updates

Liz Galli-Noble reported on the following:

EXPENDED GRANTS			
Grant Name	**Completed**	**Amount**	**Study Component**
DNRC Watershed Planning Assistance Gra	6/30/99	2,100.00	Physical Features Inventory
DNRC HB223 Grant	7/30/99	10,000.00	Aerial photography
DNRC Riparian/Wetlands Educational Grar	6/30/00	960.99	*Hydrologic Response to the 1988 Fires* Workshop
DEQ 319 Grant (1st)	9/30/00	40,000.00	Coordinator position
DNRC Watershed Planning Assistance Gra	1/31/01	10,000.00	Watershed Land Use Study
DEQ Start-Up Grant	6/26/01	49,138.00	Coordinator position, Admin Secretar additional cross-sections, operating expenses.
DNRC HB223	10/1/01	6,500.00	Riparian Trend Analysis
BLM Funding	10/26/01	10,000.00	Wildlife Study
DEQ 319 Grant (2nd)	3/21/02	58,000.00	Coordinator position
DEQ 319 Grant (3rd)	9/30/02	44,000.00	Coordinator position
CURRENT GRANTS			
Grant Name	**Amount**	**Spent**	**Remaining Balance**
DNRC RDGP Grant (expires 12/31/02)	299,940.00	290,672.94	9,267.06
DEQ 319 Grant (4th) (expires 3/30/04)	122,200.00	12,828.54	109,371.46
EPA RGI Grant (expires 12/30/02)	30,000.00	27,000.00	3,000.00

IV. Research Presentation #3. Hydrology / Hydraulic Study

NOTE: This presentation was videotaped and may be viewed upon request. Contact the Task Force coordinator if you wish to borrow the videotape.

1. Introduction

John Bailey: Before we go into this research presentation, I have to remind you of our meeting rules. Some of you have heard this several times, but there are some new people here. The Task Force has adopted steps that we will follow for the researchers and these presentations. The researcher will give the presentation and there will no interruptions, no questions. When they're done, the Task Force will ask questions first, and after the Task Force has asked questions, or I deem it's time, I will allow the audience to ask questions. These questions can only be addressing the actual science that the research team has done. If you start speaking about your values or personal comments, I will be forced to cut you off and may not recognize you again. The question and answer session is only to deal with the science presented. Once we're through that process, then the Task Force will go into a general discussion session, where we talk generally about the research and how we view it. Again, the Task Force will be speaking first, and then we'll ask for comments from the audience. But there are two distinct parts: one, to deal with the research presented, and those questions can only be referencing that research; and one to deal with a broad scope and what various things it may mean, or whatever anyone wants to bring up. But there are two parts, and I just want to make that clear.

I'd now like to introduce Dr. Duncan Patten, who will introduce the researchers for tonight.

Duncan Patten: We've had two presentations prior to this, one was on the full watershed, and the last one (a couple weeks ago) focused on socio-economic aspects of the area. Starting tonight, we are now moving into the flood plain and the river itself. I'd like, in very simple terms, to talk about hydrology and hydraulics. I don't know whether you're going to talk about the differences between those two, but in very layman's terms hydrology basically deals with water in a broad sense; and hydraulics are, as I see it at least, what is the water doing and the energy and physical processes that it's doing. Hydrology might talk about the amount of rainfall, how much water's going down the stream, or how much snow there is. Today we're going to learn about what is the water doing, transporting sediment or possibly scouring. Then at the next Task Force meeting [December 12, 2002], we'll be looking at geomorphic processes and aspects of the channel, and changes in the geomorphology. And what we find is that obviously many of those geomorphic changes are based on the hydraulics that go on. So, tonight is Hydraulic Characteristics of the Yellowstone, and I'd like to introduce the research team leaders: Steve Holnbeck and Chuck Parrett from the Montana District of the US Geological Survey in Helena.

2. Hydrology and Hydraulic Study; Hydraulic Characteristics Analysis of the Upper Yellowstone River, Montana Power Point Presentation

See Attachment A. Hydraulic Characteristics Analysis of the Upper Yellowstone River Montana PowerPoint Presentation.

3. Questions and Answers Session

John Bailey: Thank you Steve and Chuck. We may now move on to the questions and answers session. Are there any questions from the Task Force members?

Jerry O'Hair: I was wondering why you picked the particular stretch [Pine Creek Bridge area] that you did for sediment models, over other stretches of the river? Is there a reason why you picked that particular stretch?

Steve Holnbeck: No, we kind of did it because we know that folks were interested in that area. There were some issues in there based on the 1997 flood, so we picked something in the middle, in the middle of where we were working. The fact that the Pine Creek Bridge was somewhat conveniently located within the reach where we were doing other activities, made it a logical spot to do our sampling. We could have sampled down at the Carter's Bridge cableway, but it's more problematic to hang that heavy equipment off of a cable car, and I wouldn't want to be working off Carter's Bridge because there is a lot of traffic going by, and it's fairly narrow. So there were some practical reasons why we chose the Pine Creek Bridge. We thought it would be sort of typical. The other thing too is that, if you go farther upstream, the river tends to be more of a single-threaded channel, especially once you get past Emigrant, although there are exceptions. We thought folks were interested in some of the braided and multi-channeled areas, and areas where there'd been erosion. Where we knew all that mess from upstream at some point would be making its way down over years, so it may be a useful area to be getting some ideas about.

Jerry O'Hair: What's your estimate on the 500-year flood cfs [cubic feet per second]?

Steve Holnbeck: 44,800 cfs.

Andy Dana: I want to follow up Jerry's question. The first data that I think the Governor's Task Force ever collected was river gradients, and the stretch that Jerry was talking about is the steepest river gradient outside of Yellowstone Park. Does that have any impact on the transferability of your sediment modeling to other regions of the river?

Steve Holnbeck: I don't think so, because of the spin-off of gradient to velocity; the steeper the gradient, the greater the velocity. And since our equations are, transport as a function of velocity, and velocity is the surrogate for shear stress, shear stress is really the force on the river bottom that either tends to put things in motion or not. So, I believe it's applicable.

Andy Dana: That's actually my second question, which is, did you do any studies of velocity?

Steve Holnbeck: In what way?

Andy Dana: The reason I'm asking is that some of the average velocities you showed in the computer sampling, which I think were some of Jerry's area, some of the velocities were over 15 cfs.

Steve Holnbeck: Extrapolation, you mean? All of this stuff we develop is only within what Mother Nature allowed us to collect the data, and yet our fiendish intent is to go beyond those because we want to look at big events and their effects. But one thing that is a useful tool is this HEC RAS water surface profile model. What I did there was quantity what you get out of that is shear stress, which is the real driving force for whether material is moved or not. I mean that's what the whole concept of sediment transport is based on, force per unit area on the stream bottom; and that's based on depth of flow, velocity, gradient, and those things. What I did was I looked at the two-year flood, and I found the shear stress as it varied along the channel. Then I did it for the 50-year flood, then I did it for the 100-year and for the 500. And for each discharge, I plotted shear stress. Now, you raise a good point that in some instances, as the stream gets to bank full, and then goes out into the floodplain, the shear stress is going to flatten out because there's just no more height to the river, and any extra water is—for the most part—tgoing out and dissipating. That's what floodplains are there for. But in the Yellowstone, the floodplain, even though there's a connectivity there, it's intermittent. There's a little bit of a reach where it's out in the floodplain, and then it kind of comes back in, narrows up, comes back in. Relatively speaking, I don't think that the floodplain in the Yellowstone— especially where we've got dikes now and stuff like that—it's not participating in the big, big way that it could. But in any case, that plot that I did for shear stress versus discharge was a straight line, and I did it all the way to the 500-year flood, which we could calibrate to the 100-year, and given that 38,000 to 44,000 cfs is not a big extrapolation, discharge-wise, we believe the stage we get for the 500-year is correct; and in turn, calculation of shear stress is just a byproduct of that. So, again, if I had done these things and I saw that the thing was flattening out, then I'd say well I better do something different out here because it's not continuing to have the same punch that it did.

Andy Dana: I guess I'm confused. But you didn't measure velocity or shear stress?

Steve Holnbeck: We measured velocity at the bridge, when we did our bedload samples. Yeah, I used a current meter.

Andy Dana: Your average there was eight?

Steve Holnbeck: We got as much as 12 or 13. I am using the average for the overall cross section, because our model is limited. Let's say I try to get 5 percent of the flow at everything, so we might have 40 verticals and some of them might be 14 feet per second, and then on the fringes it's 6. So our average is something and we're relating our transport to an average velocity because our computer models aren't going to have 40 spots along it, and we're not going to make such a finite element type model.

Roy Aserlind: I was interested in your simulation of the construction of the levee and your conclusions based on your data. Would it be possible to conduct the same type of simulation with the construction of a barb? Could you come up with any kind of figures on that, downstream?

Steve Holnbeck: That might fit in the scenario like we're proposing. A barb is not a long continuous structure; it's kind of this thing that juts out. Yet, for some of the barbs I've seen on the Yellowstone, you might as well have used riprap, because they are so close together that they are, in effect, like a riprap blanket. A lot of times people argue too that, well you know, the nice thing about these barbs is that the silt fills in behind them and then they build some kind of transition back. With that said, what we're planning to do, as one of those scenarios, is to narrow up the stream by either putting a bridge abutment in or we could use something like a barb, and then try and look and see what that does. I'd prefer to say that we use a series of them fairly close together and assume that the flow between each barb is inactive, so that it would basically be like squashing the channel tighter. And then we would show this same kind of thing, and so that here's what happens with so much length of barb and maybe double that, triple that, but we'd have to stop somewhere.

Roy Aserlind: I have another question, I don't know if it is legitimate or not, but say the River's cfs goes from 10,000 to 12,000; does that increase in sediment bearing, is that an arithmetic relationship or geometric?

Steve Holnbeck: It's pretty much geometric.

Laurence Siroky: You described one example, and you talked about the dike and the Pine Creek Bridge area. What other examples are you going to present in the report, and were you directed by the committee to pick those example areas?

Steve Holnbeck: No. One of the problems is that as I flip through my floodplain, and I look at the cross sections with my HEC RAS model, you can just pan downstream and look at them, and see what a 100-year flood is, so you can say no dike here because it's all confined. And that's the problem, at least when I did this first go around, I was surprised at how many areas we didn't have for a long, long dike kind of thing. It's sort of intermittent, and so I'll have to revisit them again.

Laurence Siroky: So have you picked out the examples already, or reaches where you're going to study?

Steve Holnbeck: Not exactly, no. Some of them are getting under way, because time is running out, what do you think Chuck? We talked one time early on in the project, about having a committee decide, and I shudder to think now that if we have to spend too much time debating that, we certainly won't make our deadline.

Chuck Parrett: It's certainly true we're a bit behind the eight ball in terms of trying to get this USGS report done. At the same time, we recognize there is a real need to look at some different real meaningful scenarios. And so the ones that we've been trying to focus on, and we may get in trouble because it may not work, but what Steve and I have brainstormed about and talked about using as real valuable scenarios, is the one that Steve's already talked about, the levee.

The second one sort of gets into this question of the barbs, and we've thought the same thing: what is it we can do with this fairly limited model that will address the problem of barbs? And what Steve is describing is the way we're going to try to do that. We'll take the cross section, and again we sort of have to look at the results to fit what would be a likely section, probably a section not a bend, where somebody would want to put one of these barbs, and then what we would do is to decrease the width of the section at that point to try to account for how far out in the stream this barb extends. We probably would just do that for one cross section, because the lengths of these barbs really only go around the bend, and that would probably only be one cross section. We think maybe we can at least look at the effects, potential effects, of the barb doing that.

The other scenario that we have talked about, is trying to get at this problem of bridges that are in place now, and what we see in terms of hydraulics is really a reflection of the bridges and where they are now. But certainly an interesting question is: what happens if the bridge gets replaced, and the bridge gets narrower and encroaches more into the stream? What effect is that going to have? Or conversely, if they replace the Pine Creek Bridge and they make it a much wider structure that doesn't encroach on the stream, what effect is it going to have?

So those are kind of the three general scenarios that we've talked about trying to simulate. We hope they are real world kinds of situations. We can only model them in gross ways, as Steve is saying. You can only make these kinds of relative comparisons to show how much the cross section might change downstream, compared to the way it is now. We'll never be able to predict really accurately for you if you put a barb in here, here's what's going to happen two sections downstream. The state of the modeling art just isn't there yet. But we're trying to do the best we can with the model.

Joel Tohtz: When you modeled putting a levee in, and you show the changes that you did, have you also modeled the existing levee that was taken out? What I'm really asking is, do you have to do something different to go from this structure was in place and now it's been lowered?

Steve Holnbeck: Just get it out of the way. That can be done.

Joel Tohtz: So, the exercise of putting things in is also a demonstration of what would happen if you took something out. Okay, thank you.

John Bailey: Further questions?

Dave Haug: Just for curiosity, going back on that suspended bedload curve and suspended sediment load in the river, and that river-to-river comparison. You said that you really couldn't make any real comparisons from one river to another, but if you compared the velocity, gradient, bank material, bed load, materials—if you put all those factors together—wouldn't they be real comparable?

Steve Holnbeck: Well they're not because the coefficients that I showed, that one Q is equal to A times V raised to the B power. What happens is those coefficients are different.

Dave Haug: If you factor in all the factors, wouldn't that offset the differences and eventually you'd come back to the same numbers?

Steve Holnbeck: No. We started out when we did our equation here, and we have these models/statistical packages where you put everything in that you think is going to be important. You put in depth, you put in slope, energy, slope feet per foot, and we actually surveyed those things, so we knew what they were for those data that we collected. I had a railroad spike driven in a tree 700 feet upstream right about where the Holstein cows are grazing upstream of Pine Creek. So we put in energy slope, we put in depth, and we put a couple other variables in, and we ran the regression. What the regression process does is it retains anything that is statistically significant, and anything that isn't it drops those variables out, and any variable that we know as hydraulic engineers that should work (except for maybe the phase of the moon, or intangible things). And the only thing that came out to be statistically significant was velocity. I liked this other equation that had velocity, depth, and slope included in it; I wanted to run it because it looked more complicated, and it seemed to incorporate more things.
I talked to Chuck and he said, "well if it isn't significant, it won't give you any better results" and being a little bit obstinate, I ran all these things to compare them anyway. I just wanted to prove it to myself, and I really didn't do any better. When calculated, one was 1,100 tons per day, the other was 1,200, but it's similar magnitude. A lot of times people use generic equations. If you take a generic equation—one that's already been developed in a lab at a college or something—and if you tweak and tune the model and you do your own calibrations, you can force it to work, and it's okay to do that kind of thing. But it's like coming in the back door, and a lot of times you may end up with more people out there saying "what kind of black box finagling did you do here to make that work?" You spend almost as much time spinning your wheels trying to defend yourself, and having experts from the other side taking pot shots at you. All I know is that I took this one training from old Daryl Simons whose a world renowned sediment engineer from Colorado State University and was the president of Simons, Lee, and Associates, which is a world renowned consulting engineering firm, and he said,

> He's been in more court cases, and it's like with any other thing in this business, if you go out and you get some real world data, and it's all done on the level—where you're not massaging it—any court case will take real world data and accept it better than any Ph.D. from the biggest university throwing math and equations all over the black board. And in the end you're still sitting there saying, Yeah, but I like the stuff you went out and got with your own two hands.

That's my take on it. There are times when the budget, the time frame, and all that, dictate that you have to use something out of a textbook and say, "well, so and so said this, make plenty of citations, and this was a sand bed river, and the Heckers and White Equation and the Molinas Equation indicate this, and this equation applies within this range, and so we'll use it." And a lot of times it will work okay. And if you use it, and you see that your results are in the ballpark then that's acceptable, there's nothing wrong with that.

Laurence Siroky: I have a question Steve. You showed on your overhead that you calibrated your model based on the 1996 and 1997 flood data. Did you look at other year's data to calibrate your model or was 1996 and 1997 the usual kind of information used? They were within the normal range to calibrate the model?

Steve Holnbeck: Well, for our floodplain modeling we used the high water marks from 1996/97 to calibrate the height because all we're doing in that effort is high floods. Admittedly they're almost even. We're also doing a 2-year, aren't we Chuck?

Chuck Parrett: We're doing profiles for 2, 10, 50, 100, and 500.

Steve Holnbeck: But the thing is, the frequency curve is pretty flat. Even at the 2-year you almost have bank full, where high water marks more or less rule. We felt that the results from the 1996/97 would pretty much apply because the stage isn't that much different. I think there is about three or four feet difference between the 1996/97 and 1999, which was 25,000 cfs versus 38,000 cfs.

Laurence Siroky: So the information you used from the 1996/97 floods aren't anomalies, at least compared to other data you might collect from different years?

Steve Holnbeck: Not for the flood plain.

Laurence Siroky: Did you look at other years for your sediment transfer report?

Steve Holnbeck: Yeah, and I'm still doing that. I used 1999 and I used last year [2001]. Last year, I had some data for Carter's Bridge, where we measured at 18,000 cfs at the Carter's Bridge cableway. So I took that flat hydrograph and I ran it and saw what we got at the cableway at that cross section (section #54). We got 1999 at Pine Creek on that part of the model, and I look at that cross section there based on 1999. So by the time I get finished, I'll be sort of using a potpourri of years where I can use them. And even then, they'll be a best average, a lumped all together thing. So, while we know we're within a couple of feet, where we have observed information, so we're going to call it good and run with it.

John Bailey: I'd like to take questions from the public now.

Karl Biastoch: When you get to the deposition, and you have your model where you put the dike in, that causes narrowing. Can your model also predict deposition downstream from there? Because you're going to raise the amount of riverbed there, which should spread the water out more. Can your model do that?

Steve Holnbeck: Yes, it does both. There are some sections that are filling, some will be dumping out as deposition, and then in other reaches there will be scouring. It's kind of a back-and-forth process as it goes downstream, and so it does both.

Robert Ray: With respect to the levee construction, does your relative transport model give you an indication of what might occur downstream with construction, with respect to bank stability and erosion type of issues? And if so, what kind of indications would you have for building these sorts of structures?

Steve Holnbeck: It wouldn't. The only thing you'd maybe get would be if you could force the water to stay in the main channel, which should increase the velocity. But a lot of times, if there's not a lot of flow in the overbank, you won't see that much difference; especially in the average velocity that often times we're using. But if it did, if we had a major thing that we were cutting off –where a lot of flow would normally go in the overbank, and now it's in the main channel—the velocity should increase and about really the only thing you could do then is to take that velocity and compare it to some tractive force or shear stress relationship. There are tables that NRCS and others use when you're designing non-erodible channels that say, if it's a granular, sandy something or other substrate, you shouldn't have a velocity to exceed four feet per second or something like that. So, if the velocity (because of the confinement into the main channel of this flow that would have gone onto the floodplain) if it's now in the channel with an increased velocity, it should maybe raise the velocity in the channel. But the sediment transport mechanics that are used in the program don't really tell you much; they won't show anything happening as far as bank failure or anything like that.

Todd Tillinger: I have a couple questions for you. Did you model the split flow around the islands? You mentioned you did an anabranch section of the river, a multi-thread section of the river for some of the hydraulic modeling, and then I guess for some of the sediment modeling as well. When you looked at the multiple channel reaches, did you use any kind of split flow around the islands, or did you simply model as a single section going through? And if you did either way, did you use any of the interpolated cross sections that the model itself can generate with some field verification?

Steve Holnbeck: Are we talking about sediment transport or the flood plain, the water hydraulic model, or both?

Todd Tillinger: I guess first, the hydraulic model, I know the sediment stuff kind of follows from that.

Steve Holnbeck: We didn't use any split flow routine because, for one thing, if we looked at our high water marks surveyed on both banks, they're pretty much the same at the high flows. There's no question that at lower flows that maybe the gradient might change. You can be floating down the river and you're getting to one place where the river's higher and another place where it's dropping off; you can almost see it 50 feet ahead, and it's falling off to one side. Being a one-dimensional model, we certainly couldn't do it in the straightforward use of HEC RAS. And we didn't use a split flow options because at that high a flow, we feel that the energy grade line is the same in all the channels, the slope of energy, and such.

Todd Tillinger: So, is there a different model then for the 2-year flood event compared to the 100-year, or did you simply use the same geometry fall?

Steve Holnbeck: We used the same geometry fall and the 2-year flood, which is 20,000 cfs is still pretty high up there. It's not like it's half way down the streambank, it's right up there. Bankfull is pretty well typified by that 2-year flood.

Todd Tillinger: What's the difference vertically between a 2-year and a 100-year?

Steve Holnbeck: When I was surveying high water marks (the remnant straw, seeds, pinecones and stuff) in 1999, we called the marks the "1996 slash 1997", because we weren't sure which event it was, but they were close enough that it didn't matter. And then, that same year (1999) we had 25,000 cfs floods, so we have nice high water marks for that. And I would say that roughly, just roughly, there was about four feet difference, something like that. Not a big one, when you consider 38,000 cfs versus 25,000 cfs.

Todd Tillinger: That leads into my next question, which is, with your calibration to the high water marks, you mentioned that you were getting some peak velocities perhaps up to 14 feet per second?

Steve Holnbeck: I'm sorry if that's what you heard. I got high velocities when I was out measuring off the bridge, using the current meter. And I'm not sure if it was exactly 14, it might have been 12 or something, and it was only one or two verticals, in other words 14 wasn't the average velocity.

Todd Tillinger: During a 100-year event, what is a typical average velocity in the channel?

Steve Holnbeck: I don't think it would be much more than 10 feet per second.

Todd Tillinger: Okay, you're still talking about a foot or a foot and a half of velocity. If you look at the high water marks as being indicative of your average water surface elevation, then did you look at that as the location of the energy line at the boundaries, maybe in a very low velocity area?

Steve Holnbeck: Well, we looked at it as the water surface, and in some instances—where we just couldn't get a match (and there were those cases)—we didn't know the high water marks. For example, we might have a high water mark at cross section 50 and then 51 (the next one upstream), but we just couldn't get it to match. And we might try putting it in interpolated, just to see if it worked, because we couldn't balance the energy equation or whatever. But if we had two more sections upstream and they matched well, then we just basically said well, if we're matching up here, we'd go with it. But that only happened very infrequently. We didn't always just try to do everything. We didn't triple Mannings N to force it to work with the observed high water mark.

Bill Moser: Your numbers for your 100-year versus your 500-year, what I'd like to know is how you arrived at the 500? The reason is, it seems from the data you presented, as your volume goes up, your velocity is going to go up somewhat, your scouring is going to go up, and some of us would interpret that the actual flood plain for the 500-year floodplain isn't going to be that different than your 100-year floodplain.

Steve Holnbeck: Well, it might not be a whole lot more.

Bill Moser: How did you arrive at, how did you extrapolate the 500-year from the 100-year?

Steve Holnbeck: I enter these rough Mannings angles (or the roughness coefficients) that are used from cross section to cross section, and they vary depending on if it's brush or it's open channels, smooth channel, and that type of thing. We tried to stay in reasonable numbers there; we did that separately and then, if we had to change them to match the high water mark, we didn't change them. For example a reasonable Mannings N in the main channel (with some bends in it) could be anywhere from .035 to .055. If we had a higher high water mark, we wouldn't jack the main channel Mannings N up to .095, which would be like an overbank flood plain with a bunch of willows and trees in it. We didn't do that. We tried to look at something else, although there are some other factors there too.
Let's say we have a cross section here and a cross section here, and in between there's a braided system that we didn't deal with; well you can't just look at the cross section here and the cross section here, because there is energy loss in between them because the water is going in and out through the channels. So you would have to deal with it artificially. You have a basis then to increase your roughness coefficients to recognize that what you're specifying for Mannings N isn't just that little slice of that plane, it's halfway down to the next cross section upstream and half way to the next cross section downstream. It would be like if you looked at a pipe and you got a pressure measurement on a pipe by Liz and the other end of it against the wall there, and yet you put pressure gage tubes on each end and figured out the pressure loss. You're thinking, well it's just a solid piece of pipe, I can't get a roughness for that pipe, but in between you've got a concentric reducer, two tees, all these things, there's a lot of pressure loss from all those other things that it's going through. Well that's what all these channel braids are, they're like pipe fittings and all kinds of appurtenances, so you have to account for them. So, on one hand I'm saying that we didn't try to make Manning (our roughness coefficients) so unreasonable, but in other cases, when we looked at the map and saw where we located them, we recognized that we had to reflect everything that's going on in the reach, and not just at the cross section.

Duncan Patten: To help restate a previous question asked: You have a number for the 100-year flood that's 38,000 cfs, how do you know what the 500-year flood is? And once you know what that section of volume of water is, how do you know how far out it's going to flow? Could you explain the probability approach to calculating the 500-year floodplain?

Steve Holnbeck: The flood frequency analysis, that's a statistical procedure.

Chuck Parrett: What's done is to take the gauged record at Corwin Springs and at Livingston, and that gauged record includes about 100 years of annual peak discharges, so you take the biggest discharge every year. And you've got a hundred of those values. The idea is that you rate them from the biggest to the smallest, and rank them from 1 to 100. Then what you do is you fit a probability distribution to those. It's like if you took everybody's height in the room, and we could fit a normal probability distribution to those heights. And that would pretty well describe the way heights are distributed. There are some probability distributions that describe the annual discharges pretty well. One that federal agencies have settled on is the Law and Pearson Probability Distribution. We think that when you have about 100 years of records, which we do at Corwin and Livingston, that you can reasonably well extrapolate on this probability curve that goes on out forever; you can extrapolate reasonably well out to a 500-year. And the 500-year discharge doesn't turn out to be a whole lot bigger than the 100-year. The 44,800 versus the 38,300 cfs. In 100 years of records, we haven't experienced anything quite like the 44,800 cfs, but we have experienced several around that 100-year. Certainly the 44,800 cfs is not impossible and well within the range of possibilities.

Bill Moser: I'm just amazed that it wouldn't be a little larger than that.

Chuck Parrett: The Yellowstone River has what we call a relatively flat frequency curve, which means that when you pile all these points and fit this distribution it's fairly flat, pretty much a straight line distribution.

There isn't a wide range in the frequency curve between the very smallest reported peak discharge to the very largest. And because this isn't a whole lot of variability than this curve tends to be wide.

John Bailey: I'd like to move into the general discussion session now, or we'll be here until midnight.

Andy Dana: I have one question and then one concern. One is you keep talking about how you think that some of the models are good enough. I'm curious about the statistical confidence in them. Are your models 90% accurate? That's what we've heard from other researchers that they have at least 90% confidence intervals.

Steve Holnbeck: We dropped out variables that weren't statistically significant; we used a 95% confidence interval.

Andy Dana: The other specific concern I have is that you made a comment that you did the floodplain mapping with the assumption that the 1996 and 1997 floodplain was identical. However, in 1997, the channel had cleared out and we didn't have the same flooding as we had in 1996. So the dimensions of the flood plain are not identical in 1996 and 1997. Are you adjusting for that? It seems to me it's a leap to say, this flood plain in 1996 is the same flood plain as the 100-year flood in 1997.

Steve Holnbeck: Well, there might have been some localized places where there is a different stage, that's not generally the case overall.

Andy Dana: That happened on three and a half miles of our ranch.

Steve Holnbeck: I think I'm pretty confident in our numbers. When we tried to calibrate, we weren't always exact, some places were a little higher, some places they're a little lower. I would say that there was not much difference between the two.

Andy Dana: That's the concern I'm raising with the floodplain mapping. There are going to be policy decisions made on those lines, and the flood plain changed significantly.

Chuck Parrett: If I could jump in. I think that is one reason to use a hydraulic model, to try to evaluate this 100-year floodplain, rather than to simply rely on a single recorded flood, even though that happened to be—at least in terms of discharge—about a 100-year flood. You're certainly right that there's a difference between the 1996 and the 1997 floods; in different locations that difference will vary quite a bit. At our gauge at Carter's Bridge, the peak discharges in 1996 and 1997 were identical, but the stage was almost two or three feet different at our gauging stations. So, it is certainly true that there is that kind of variation. And it's because of that and that maybe argues for using some kind of a hydraulic model based on the latest available cross section data as a basis for drawing these flood plains. Now, it is certainly true, we tried to calibrate our model (the hydraulics of our model) to the surveyed high water marks; but as Steve has indicated, we didn't automatically make sure that that core profile matched those high water marks. There obviously were cases where high water marks were going to be lower than what we're going to show for 100-year flood elevation, but there will be some other locations where the high water marks that we surveyed are going to be higher than what we show for 100-year flood.

John Bailey: One more question and then we're going to go to the general discussion session.

Karin Boyd: I have a question here. Your bed-load rating curve is a single line, but if you look at the points, the points at the low end are kind of below the line and at about 10,000 cfs it jumps above or to the line. It looks like at about 8,000 cfs there is sort of a threshold, where a lot more sediment starts moving.

Steve Holnbeck: I didn't see that.

Karin Boyd: My question is, did you see or do you hope to see when you finish this up, any flow conditions at which you hit a point where these armored reaches start mobilizing, or the threshold where everything really starts happening? To be able to identify thresholds of sediment mobility?

Steve Holnbeck: We got some data from old samplings at real low flows, which seem to show a flattening off. There are phases; you go through a low phase where the transport curve would get low, but we're not going to model down that low. We're only going to stay as low as we can extrapolate the curve down, and that was like around 2 ½ feet per second, which is around 3,500 cfs. So that's about the lowest that we want to go. I guess I'm taking the simple logic that beyond that flow you're not going to be getting a whole lot of transport anyway. And that's been proven with the data that we got: there's just sand, very fine sand that is being transported much below that. Now, at the high end—and I answered this earlier in another question—I took the shear stress and plotted it for these different stages. A lot of people, like Sandra Ryan, have written papers that show that there are phases where the transport curve is kind of flat down at the low flows, then it steepens-up, then it flattens out again at the top. But if the shear stress is shown to be a linear function (that is, as it's increasing it just keeps increasing), and in the absence of observed data (which is where we are, what we were charged to do here), nobody is going to be interested in us just recreating the flood events that we ran out and collected the data. Usually the charge that's made to people like myself is to go out on a limb a little bit and show at least in a relative way what's seems to be going on. And I guess from the supporting data that I've gotten, where I've used the floodplain model to show what these higher flows are (up to the 500-year flood), it's just a straight linear relation for shear stress. That tells me that I can use those transport equations in that realm. So that's what I plan to do. Now I, too, thought about the same things that the audience member brought up. I appreciate what she is saying, because I scratched my head about that as well, especially before I did that analysis. What I would have to say is okay, one option is to take the curve out to the 500-year flood, just extrapolating it out. The other one would be to say, well it doesn't go flat, and there's still got to be some energy left in the water, so I'll go half way, just as an arbitrary decision. That's one of those things where I can multiply that times a number of scenarios and then this adds in as another permutation and all these things. I guess on the basis of the shear stress example that I did—which seemed to indicate that as the flow increases, the power of the river keeps going—that's on point; I'm just using those curves as an extrapolation.

Karin Boyd: With the gradation that's out there, there may be a critical shear stress at which point all of a sudden that armor starts moving. You know that the Yellowstone can be a very quiet river, then all of a sudden things start happening.

Steve Holnbeck: Yeah. I don't know if it will show it or not, but I'm not sure that there's really much difference in the 25-year event and the 500-year. Everything started to go crazy at that lower level of flow, and not just when we got to the 100-year flood.

4. <u>General Discussion Session</u>

John Bailey: Okay, I'd like to thank you very much. We're going to let you take down and we're going to go into a general discussion session. Now we can talk generally about this data, any of your thoughts about it, or how we may or may not use it.

Laurence Siroky: I've got one comment. Andy, your concern about the floodplain line on the map. There's a process that would go on, once the maps come out. They're preliminary in the sense that they're not yet adopted as formal floodplain delineations. There's an administrative rules process that our department goes through, which means hearings and public review, and the kind of concerns that you raised would be addressed at those hearings. And those adjustments would be made to the maps before they are adopted as a final delineation map. That's within reason there. The decree of this study is that you can't do that for every inch of the river because you don't have all that data, but the short answer is that you have to go through a review process, that there is a process.

Andy Dana: Fortunately, it doesn't matter because it's under conservation easement.

John Bailey: Comments?

Andy Dana: Just one general comment, it doesn't seem to me unusual to have these flat trends on the Yellowstone.

Laurence Siroky: And the size of the basin makes a difference too. The different storms coming from different directions, different topography, so those kinds of things tend to flatten things out.

Phil Farnes: John, one of the reasons that this slope (that we're talking about) is flat is that this is a snowmelt driven system, as opposed to a rain driven system. If you had a rain event, you would have a much steeper curve. If you've got a snowmelt driven system you've got a much flatter curve.

Andy Dana: One thing I've noticed, correct me if I'm wrong, but the water profile analysis at Carter's Bridge showed what I would say is a dam effect from the bridge. It looked like a two-foot drop between upstream and downstream, and as we work through whatever recommendations we're going to make, I think we need to think about the dam effects of those bridges.

John Bailey: Yeah, it seems to me, when I look at this chart, that that's the one place they ought to use the model to take the bridge out and run the profile. Since before we ever started, everyone talks about bridges and they all talk about problems with the Carter's Bridge, and we now have this graph that looks to me like it's backing up the river. It certainly appears like those lines on the chart have changed quite a bit upstream, if that water did drop so much right there. If you put a dike upstream, it didn't show up or the effect wasn't carried on very far. I think if this bridge changed, it would show a big change in the profile right along the river upstream. What happens downstream, I have no clue. Everybody has pointed at Carter's Bridge ever since the floods. Wasn't it 1997, when all the phone stuff flooded out at Highway 89?

Brant Oswald: One comment. One of the things that I think is important from the discussion is the scenarios that Steve talked about. I think for a lot of us on the Task Force, and I'm sure a lot of the public, those are the things we we're kind of itching to get, and maybe this isn't the right way to ask this question, but I know you're under time and budget constraints to do the few scenarios we talked about. What sort of time and money are we talking about if we come up with another scenario that we want to look at? Is that something that you could give us some sort of ballpark figures and timeframe on?

Chuck Parrett: There really is nothing magic about the several scenarios that we selected. We did that to pick reasonable locations and what we thought would be reasonable scenarios along the river, but certainly what John just mentioned, our plan was to go to Pine Creek Bridge and see what effects narrowing the opening or widening the opening might have. We could go down to Carter's Bridge and do the same.

John Bailey: You may want to do both. One of the scenarios is to put a levee just upstream from Carter's Bridge. The interesting thing was it didn't show an effect very far down. In fact, if Carter's Bridge were widened, I think we would see a huge change in the profile of the river upstream. I have no clue what happens downstream, but it shouldn't drop. It looks to me like it's about a four-foot drop there, it's hard to read the graph here.

Jerry O'Hair: This probably isn't a very high impact area, but how about the bridge that they're proposing to put in at Corwin Springs, has that been taken into consideration?

Ellen Woodbury: That is a bridge that's going to be replaced.

Michelle Goodwine: I think they're redoing the KPRK Bridge as well.

Ellen Woodbury: Yeah, and the KPRK bridge as well. Those are two that will be replaced in the near future.

Chuck Parrett: I think the constriction at the existing Carter's Bridge is pretty small, so I don't think that the placement of that bridge is significantly impacting the water.

John Bailey: If you go out to Highway 89 and you lower the road that got built up; before they fixed that bridge, that road had a real low profile, so the water could just run around the sides.

Andy Dana: Do you mean the old East River Road?

John Bailey: Well, it was still Highway 89 when they fixed it.

Chuck Parrett: And I'll tell you quite frankly that our end products are USGS reports that we promised to deliver. One is a map report, a floodplain delineation, the other is a more traditional USGS report that talks about modeling efforts, and we're sort of under the gun to get draft copies to our cooperators as close to the end of the year as we can do it. So, gosh, if you want us to try another alternative, please let us know as soon as possible.

John Bailey: We understand.

Ellen Woodbury: My preference is that nothing interferes with getting both floodplain maps.

Todd Tillinger: What were the products that you have modeled that would be in the public domain? And if somebody wants to look at different alternatives, structure removal and such, that could be done after all of this work is completed, right?

Steve Holnbeck: Well, yeah. There are bound to be things that develop beyond this project. It would be a shame if this model weren't able to do something to help somebody beyond just this study.

Chuck Dalby: I just want to follow up on a comment that Andy Dana made and I think several people asked questions along the same line, and that has to do with using survey cross sections from the USGS and our 1999 topographic map as a basis to delineate the 100-year floodplain, which then becomes a fixed line in time. In fact, Federal Emergency Management Agency (I think they are changing a little bit; they oversee floodplain delineation) will only officially recognize flood plains that have been delineated using fixed-bed models. What that means is that hydraulic models—at the point in time that you surveyed it—are assumed not to change over time. One of the opportunities we have here, because we have both the fixed-bed hydraulic model and sediment transport model, is that we can use those to look at the sensitivity of the river channel to scour and aggregation and use that to put some uncertainty bounds on what normally would have been a line that's been fixed with current data. And I think if we do that, what we're going to find out is that there are some parts of the Yellowstone River where that fixed-bed model is very applicable, and other places, where you'll get into real trouble trying to apply it.

Bill Moser: I'd like to hear just a little more, looking at the cross section at Carter's Bridge, why would there be three channels that are deep on the outside of the piers, and a whole lot of fill between the piers, instead of having the deepest channel in the middle? Is that typical for all bridge structures that you've seen on the river?

Steve Holnbeck: Sometimes it happens at the pier and sometimes it doesn't. There's water migration back and forth. I suppose that deepest hole is on this side of the pier, and as the flow starts to subside, then things can back up against the pier. I did surveys for five years on an interstate bridge by Manhattan, where the Gallatin River goes under the interstate, and I was measuring it and nothing had changed for three or four years. There were three piers in the river and the deepest scour hole was on the leftmost pier, as you're looking downstream; it was about 8½ feet deep this scour hole. We got this event coming through and there was no debris on the pier or anything, but sometimes something happens—a tree trunk or something gets stuck—just something happened. And the next time I came back and measured, almost a mirror image of that scour hole was now on pier number two. The hydraulics engineer on the project was ready to issue a work order to have the contractor fill in the scour hole with material, and the spring event came along, and that 8½-foot hole filled and the hole just meandered over to pier number two. So, I mean, there's things like that that happen; it's a dynamic process.

John Bailey: Other comments?

Andy Dana: I was struck by the part of your presentation in which I think you said the river may not use as much of its flood plain as other rivers. I think you said the river is mostly confined to its active channel even during runoff and breaks out in the flood plain—which is important to local areas—and then comes back into the main channel. Does that mean that there is less importance of flood plain in this river?

Steve Holnbeck: Well, I believe in comparison to some other rivers where they are not inside the active channel.

Andy Dana: Well I guess what I derive from that is that, and I'm not sure I'm comfortable with this really, is that activities on the flood plain on this river may have less of an effect than on other rivers. In other words, the marginal effect of protecting the flood plain of this river is going to be small, compared to protecting them on other rivers.

Steve Holnbeck: I don't think so.

Andy Dana: You say you don't think so, but based on what?

Steve Holnbeck: Well, I tried to come up with a levee, I was hoping to find this levee, I should have been able to put it in for five miles of the river, and with the cross sections that I had and looking at the map, I couldn't come up with that. There were places where the river pinches down, and where it's got a flood plain, that flood plain is important. But just saying in comparison to some rivers that are exceedingly wide, where the water goes out five times as large as the longest reaches, so just relatively speaking, but that doesn't mean that that floodplain's not important at all.

Andy Dana: I'm not saying it's not important.

Steve Holnbeck: Well, I'm not saying it's not important.

Chuck Parrett: One way, at least from the hydraulics viewpoint, of looking at the river and the flood plain, is what's the relative amount of conveyance; that is, the total discharge that it's moving down the stream by the flood plain versus remaining in the channel. For the Yellowstone, the bulk of that flow is moved by the main channel. There's not a whole lot that's moved by the flood plain. For other streams in the state, the Sun River comes to mind, more of the conveyance there was in the flood plain rather than in the main channel. But that's not to say that that floodplain really isn't important or isn't affected by the dynamics of the flood plain. In a stream like the Yellowstone, where you've got more of a conveyance in the main channel, you're probably also going to have more bank erosion. So, it's sort of a mixed bag.

Todd Tillinger: And with such marginal increases and marginal stage differences between a 2-year and a 100-year event, if you have to add another 6 or 8 inches of water in your main channel because the flood plain is cut off, you could have significantly greater impact on the channel morphology itself. Because you're in effect increasing the amount of water moving down through the channel.

Andy Dana: It's just a marginal amount because the flood plain doesn't carry that much.

Todd Tillinger: There's not a lot of difference between ……

Andy Dana: But there's not a lot of difference and so, overall, on this river, it shouldn't have as huge an effect, as dramatic an effect, as it would on another river where you really cut off a big flood plain. I'm not saying that floodplains are not important. I'm just saying on this river, it seems that it has a more marginal effect than on some other river where you have spreading, wide floodplains. I think that's a fair assessment.

Bob Wiltshire: Are there significant areas on the Yellowstone where the historical flood plain is not available because of bank stabilization, from dike building and things like that?

Steve Holnbeck: Well, the dikes down in the your area [spring creeks area].

Andy Dana: Not on our side of the river.

Chuck Dalby: The answer to that is yes, and it's not just dikes. There are probably an equal number of secondary and minor lateral roads that constrict flood flows. They are not really dikes; they are simply access roads and things like that.

Steve Holnbeck: One thing that we could almost certainly say that is rather unique about the Yellowstone in some locations is that there are these secondary flood channels. You might not call them flood plains, but they really are channels that are perched higher, but at a high flow they're ripping because you can see the remnants of the scouring down, and this is rather unique. There are a lot of cool things out there; there are a lot of flood plains where it's like a marsh out there, but out here you have channels, there is individual conveyance and secondary flood channels.

Andy Dana: That's one of the problems I think, because you are just focusing on the reach between Pine Creek and Carter's Bridge and that area has a much broader flood plain.

John Bailey: It seems to me, when they get the stress factors, it'll mean a lot for various things when we look at them. As we look at the magnitude of the stress factors on the banks, that that may tie into a lot of the other issues that we're looking at. Stress factors should also tie to different kinds of projects that we may be addressing, and that's going to be interesting to see. I assume those are bank stress factors, right, is that what? So, if we'll be getting those, then we will be able to use that data, and I think that people will start applying and analyzing.

I don't hear a whole lot more conversation on this topic, so I'll start to bring this meeting to a close.

V Schedule Next Meetings

John Bailey: Our next meeting is December 12th and Chuck Dalby from the DNRC will be back speaking, adding much more to this conversation. Chuck do you have any idea how long your presentation will be?

Chuck Dalby: I would say that a nice, short, and concise presentation would probably be about two hours.

John Bailey: That's what I expected, because I know the kind of data that's coming in, so we need to be prepared next time for a fairly lengthy meeting. Also, we set meeting dates for February 2003: February 4th and February 18th, and we have found that Duncan cannot be here for those dates, so we are going to reschedule them. Duncan can be here on February 6th or the 11th, and the 25th. Are those new dates workable for the Task Force?

The group responded favorably.

Liz Galli-Noble: I'll make another announcement too. If it works for the wildlife folks, the fish habitat study will present later in February. Basically, those two studies will switch around. That's not 100 percent, but that's what we're going to try to work out.

Thursday, December 12th, 2002, Geomorphology Study
Location: Yellowstone Inn

Tuesday, January 7th, 2003, Riparian Trend Analysis
Location: Yellowstone Inn

Tuesday, January 21st, 2003, Fish Population Study
Location: Yellowstone Inn

TENTATIVE: Tuesday, February 11th, 2003, Wildlife Study
Location: Yellowstone Inn

TENTATIVE: Tuesday, February 25th, 2003, Fish Habitat Study
Location: Yellowstone Inn

John Bailey: Is there any other business tonight? If not, we're adjourned and thank you all for coming.

VI The meeting was adjourned at 9:30 pm.