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Dr. Jim VanGundy 4/17/86

Davis & Elkins College

Michael: Today is Thursday April the 17th. And what is your full name?
Jim: James Justin VanGundy.
Michael: And you live...
Jim: In Elkins.
Michael: And what is your profession?
Jim: I am a professor at Davis & Elkins College. Professor of biology and environmental science.
Michael: OK. What is your background, please, in the area of environmental science?
Jim: I am actually a biologist by training. I have a bachelor's masters and doctorate in biological areas. A bachelors degree in biology, a masters in aquatic ecology, and a doctorate in aquatic ecology as well. A doctorate from the University of Utah and a masters from Penn State. And am a graduate from Washington and Jefferson College.
Michael: So you've thought a lot about water.
Jim: I've thought a lot about water. Right. Especially about water quality and the things that live in water. But I've also had a long-standing interest in....I am actually a stream ecologist. So I've spent a lot of time thinking particularly about moving water. And West Virginia happens to be a real good place to study streams because there are lots of streams and lots of different types. And as a consequence of my interest in streams, I've also tried to learn something about the physical and chemical nature of streams. Not just the biological....to understand what's going on biologically in a stream you have to be able to understand something about the way the stream system behaves physically. What effect floods have, for instance, on the things that live in streams. What effect floods have on the chemistry....and just to understand the system as a whole.
Michael: Good. What are some of your recollections about November 4th? Personally.

Jim: My personal recollections are that I was simply astounded. I had never seen flooding of that magnitude. Like everyone else, I guess I underestimated the seriousness of the rainfall. The precipitation event that produced the flood. As a matter of fact, Monday afternoon, my wife and I drove over to Meadowbrook Mall. And I took note of the fact that it had rained heavily for a long time and that we would probably encounter some minor flooding, especially in the Elk Creek valley. And we decided we'd have to come back through Grafton, but didn't come close to realizing how large a flood we were really going to have. When, on the way back from Meadowbrook Mall, from Clarksburg, we must have been among the last people to cross the covered bridge in Philippi. We came across that bridge about 9:30 at night and the water was up almost to the bridge floor at that time. And we were impressed, to say the least, at that. When we got to Belington, the downtown section of Belington was flooded, and we were very surprised by that. We realized we were dealing with something potentially scarey. In the eleven years I've lived in this area I've never seen water in downtown Belington. We were able to get through Belington, by being routed around the upper side of town. And got back to Elkins, although there was an extraordin ary stream of water coming out of the Weaver Road intersection. Again, something that uh.....and a lot of rocky debris on the highway, something that I never expected to see. And we covered the stretch between Norton and Elkins uneventfully, and we got to....near the China Gardens restaurant there at Crystal Springs, there was a fairly extensive debris slide off the hillside onto the highway that almost blocked the highway. And of course, that's something that happens when soils and geologic materials become saturated with water, you expect to see a lot of that, but it underscored to me just how much water had fallen. Because again, in the eleven years that I've lived in this area, and actually I have a much longer familiararity with this area, I've been coming down here since.....to cave explore and hike....since I was in the 10th grade, back in 1954. And I had not seen that kind of sliding around here before. So I knew it was an unusual

event. We woke up Tuesday morning and of course started to get some reports of the full extent of the flooding. We drove out to Georgetown Road and saw how bad it was there above the flood control and my wife and I drove out to Bowden. And of course the water was on its way down at Bowden but it was clear the water had been higher than it had been in my experience and it was clear that an extensive amount of damage had been done to the trailers to the community there at Bowden. And the bridge was partially washed out on the eastern side, the blue bridge there at the Cheat River Inn. That's as far as we went that day....the following day, I took some time out and drove over to Harman. And was just aghast at what had happened to the lower section of Harman. Houses had been moved and the Dry Fork bridge on route 33, the approaches on both sides had been severely damaged. As a matter of fact, I was surprised that bridge was able to be put back into service so quickly. I feared for structural damage to the bridge which apparently wasn't there. That day I drove on over, at that time 33 was not closed off by the national guard yet, and this was the following day, I guess, Wednesday, and I drove on over into the headwaters of Seneca Creek and got down as far as...oh...where Seneca Creek comes in at the national forest campground. And I don't know if anything has ever impressed me quite so much as that did. The devestation of the Seneca Creek valley was extraordinary. The changes in the channel, the clear amount of geological work that had been done. The huge, well not huge, but large numbers of large coobles had been moved. The soil had been stripped off; and sand and silt had been deposited to a depth of a couple feet. Boulders deposited to a depth of 3 or 4 feet in some places. The little bridge there that goes over to the forest service campground was nearly buried in cobbles and boulders. There were essentially deltas along 33 where small streams had come down off the steep slopes, and moved obviously extraordinarily large amounts of rocky debris and woody debris relative to their usual size. I was tremendously impressed. And as many people who study things in the academic sense, I had an intellectual acceptance

of what heavy rainfall and what flooding can do, but I had no emotional acceptance, had no emotional appreciation for what a true natural rampage can do. And I was suitably impressed. And I will never forget it.

Michael: That's great Jim. There are a lot of questions.....all these boulders....where do they come from? Obviously they came from higher up but what kind of physical activity of water could have....

Jim: It's not just the physical activity of water it's partially the physical activity of gravity. The fact that materials tend to move down slopes when they are allowed to do so. To understand a stream....well, our landscape, West Virginia, it's entirely stream-sculptured, the mountains have been cut by streams, in every bit as much as the valleys have been. And it's running water that really shapes the landscape. But gravity works with running water, there's a process that geologists call "Mass wasting", which is actually a whole series of processes whereby material is moved downslope, not necessarily steep slopes, although it moves down steep slopes faster than it does gentle slopes. But material moves down slope simply under the influence of gravity, and without the help of water or glacial ice or wind. The normal erosive agents. So mass wasting tends to move materials down slopes and the steeper the slope the more rapidly materials move down and the larger the materials that are moved down slopes. Until it gets to the stream channels, and then once in the stream channels, it can be further moved down, and generally more rapidly moved down through the drainage system by the flow of water. Now most streams, if you go out to most of the streams in this area, at any normal time of year, when it's not flooding, you see that the water is flowing clearly and it's not moving much in the way of geologic materials, when you go out following a heavy rain, and perhaps there's minor flooding, or the stream is flowing bank full, the streams are muddy. And what you're seeing is silt and sand sized particles, small particles that are being moved by the water. So the ability of running water to move particles

is a function of the velocity of the water. The faster the water the larger the particle that it can move. Most of the fragments that are moved down slope into the small headwater stream channels, what we call a run or....other places they are called brooks, they call them runs around here I guess, the smaller streams, the little tributary streams, most of the material that's moved down slope to those small stream channels simply accumulates in the channels under normal flow conditions. Because there's not enough water flowing in the small tributary streams to move that stuff. So typically, when you walk up the valley of one of these streams, these small stream channels, you see that it's full of rocky debris. Sand and silt and cobbles and boulders. Things that mass wasting has brought down to the channel, but the stream is incapable of moving much further. Now in the extraordinary flow periods, where you get a very heavy precipitation event like you did in early November, where there were some parts of Pendleton County that the weather bureau recorded 24 hr. rainfall in excess of 10 inches, I guess 10 and 1/3 inches, and really the unofficial rainfalls were probably even higher than that, because there tends to be a relationship, and the type of storm we had, and the heaviest rainfalls tend to occur at the higher elevations. And for the most part there aren's rain gauges at the higher elevations, they are down in the valleys. So probably 10 and a third inches in a 24 hr. period is kind of a minimum rainfall in the areas that received the heaviest rainfall; like Pendleton County and southern Tucker County. Canaan Valley area. So anyway, when you dump that amount of water on to a watershed in that short a period of time, the ground can absorb a certain amount but nowhere near that amount of water, and to make matters worse, of course, in this flood, there had been rain, in the heaviest hit areas, there had been a couple of days of rain preceding it. And especially it occured after the leaves had fallen. As the leaves on trees tend to increase the amount of evaporation. So once the leaves fall, the ground water tables tend to come up

anyway, naturally. And then we put a couple days of moderately heavy rain on top of that....actually a couple inches of rainfall, which tended to bring the ground water tables right up to maximum, and then to dump ten inches of precipitation or 8-10 inches, or perhaps a little bit more depending on what area you are talking about. But anyway, to dump a very large amount of water on top of already saturated soils, there's no place for the water to go except to run off and run very rapidly off through the stream channels. So suddenly these little tributary streams, are carrying extraordinary volumes of water. And there's ample evidence, you go around and you can see high water marks, you can see bark pounded off trees, 6 and 7 feet above the floor of a little stream valley where the stream normally is a foot and a foot and a half wide, and maybe carries a half a cubic foot per second of flow, and you can see that hundreds or even thousands of cubic feet per second were flowing out some of these little stream valleys. When a stream is flowing like that, it has the capacity to pick up all these materials, these coarse, rocky materials...
Michael: So when these small streams are increased to the depth of 6 or 7 feet moving thousands of gallons of water per second...
Jim: Yeah, as I said earlier, the ability of the stream to transport a certain rock size is a function of its velocity. The more rapidly the water is flowing and the more, the greater the volume... of course the greater the volume of materials that can be moved and the greater the size of materials that can be moved. As a matter of fact, it doesn't increase in so-called linear porportion, it varies as, I believe, it's the 4th power of the velocity, so that as the velocity increases a little bit, the ability to transport larger particles increases very much more rapidly. So when the flow picks up in the channel, it can move some surprisingly large things and when the flows are as high as they were in Nov. 4th and 5th, a small stream can do an extraordinary amount of geological work in a short period of time. And that's what you saw happening here. Several weeks after the flood, I was able get up in the

Seneca Creek drainage above where Seneca Creek joins route 33 there above Onego. And up there there is a little stream that at the time, I visited after the flood, it was perhaps two feet wide. And I had seen that stream before, it crosses the road that goes on up over to Job. That little stream, White's Run, was clearly flowing 6 or 7 feet deep where it crosses the road. And moved something on the order of perhaps a thousand yards of course rocky debris out onto a pasture there. In other words, it formed what you would call a delta, and that....that's one of the reasons....Ok as the small streams do that....you see the small streams have a high gradience, that is their channels, if you look at the change in elevation along the channel you find that it's quite steep. They change, they drop elevation very rapidly. The steeper the gradience of a stream the faster the water moves. I think everybody understands that, and again, the faster the water moves, the more geologic work it can do. The more rocks and the larger rocks it can move. So as this rainfall event proceded, it's the tributary streams, these little high gradience streams, that flood first, because the water that's running to them is closed...well, they flood first. They have steep enough gradience, that they can move, the water will move very rapidly and they have also accumulated a large amount of rocky debris and dead trees and things over long periods of time. Perhaps hundreds of years. Really they've been accumulating that debris, since the last flood of this magnitude. So suddenly there's a great deal of water flowing in these narrow channels that have steep gradience, and it can move all of this debris that's been accumulating for a long period of time, can move it out. So it moves downstream, and where the tribuaries join the main stream, for instance to use Seneca Creek as an example, the mainstreams that flow in the major valleys have a much shallower, much gentler gradient, and so the water is not... first of all they are just beginning to flood while the tributaries are in full flood. So their channels aren't necessarily full, and the water isn't necessarily moving real rapidly because the gradients is lower, so the little streams have a tendency to drop every-

thing they're carrying in the channel of the main stream, or on the flood plain of the main stream. And the effect of this is to create dams of sand and gravel and cobbles in the channel of the main stream which starts to store water. In effect you're putting a series of little ponds in the main stream. Now as more and more water is delivered to the main stream channel it comes into full flood, and when it's in full flood, now the water is moving rapidly but it starts breaking those debris dams, washing them out, and as it goes, it releases the water that's stored in them and so you get more and more water moving downstream, first one dam breaking and then the next and then the next. And don't get it wrong. These are not nice clear man-made dams. These are big piles of rocky debris and dead trees that are damming the flow, but nonetheless, they are effective in damming the flow. So as the flow in the mainstream picks up, one after another of these things yields and more and more water is released and is now moving down the channel but not only is water moving down the channel, but you have a lot of rocky material moving down the channel now, and a lot of woody debris, dead trees, plus living trees are now being taken out by this moving mass of dead trees and rock and water, until you can have, what amounts to, a wall of water and mud and rock and dead trees moving down down a valley at a fairly high rate of speed, and of course, that is devestating. And I think it's that kind of thing that caused the damage you saw, a lot of the damage you saw in places like Seneca Creek, moderate sized streams flowing in fairly narrow valleys. I think it's probably true of....a lot of the damage on smaller streams. Places like Brushy Run and Roaring Creek that are tributaries to Seneca Creek in Pendleton County. Both of those valleys are narrow valleys, containing moderate sized tributaries to Seneca Creek, and to me the evidence looks...I've been up both those valleys since the flood, and of course by the time I got up there, there had been a good bit of clean-up work done, but it looks to me like in both cases the masses of debris, mud, rock, stone, came roaring down the valley and just wiped the valley floor clean in a lot of cases. And of course, did a lot of bank erosion and channel deepening, and sometimes changed the position of the

channel in the valley. So when a stream gets moving like that, that much water and that much rocky debris, which can act as kind of a cutting tool, it can do a tremendous amount of geologic work in a very short period of time. And you see evidence of that all over the eastern counties. Particularly Pendleton and Tucker, southern Tucker.

Michael: So when you hear somebody like Helen Sites talking about a sound she couldn't describe, and her reaction to that was to turn to her friend and say,"Honey, the end of time has come." This is the action that you are talking about, in a place like Brushy Run.

Jim: That's right. Again, I only have an intellectual appreciation for what happened, and you would have had to be there to really understand in your heart of hearts what really occurred there. Helen Sites, whom I know, sat up and watched it. And the sound that she described is probably unimaginable to you or I, or to anyone else who hasn't witnessed it; but it must be the sound of a terribly large volume of turbulent water moving rocks. Rocks grating against one another, large logs being snapped in two like they are toothpicks, trailers and homes being ripped apart, it must indeed sound like the end of time. I doubt if you and I can imagine it. No matter how hard we try. Just the noise that a stream can make when it's moving a lot of rocks; in Utah, I experienced a moderate flood, actually nothing like we're talking about here, but a moderate flood on a steep canyon stream, and at that time, I stood beside the stream up above it ten feet or so, and was amazed at the noise it made, you could hear the rocks grinding against one another. If you go out to a stream in just moderate flood, where it's moving some things, and stick your head under water, you can hear this action. Usually you don't hear it if you're standing in the air. But when you have a wall of debris moving down a valley with water, like what Helen Sites experienced, but the noise must be extraordinary. Must be unlike anything you've ever heard. And as she said, perhaps the end of time...that's the best way to describe it.

Michael: She also commented that there had been extensive timber-

ing at the head of Brushy Run for two years previous to the flood. Which reminded me of all the timber cutting, the agricultural activity, the surface mining, everything else that's happened within the 29 county area, generally over a long period of time. I'm wondering...such speculation may not be worth very much, I'm wondering what the effect of this much water would have had on the original forest, the virgin forest. And to what extent, how these various extracting, and land cultivation, and clear-cutting have, might have contributed to the flood.

Jim: Sure. I think I know what you're talking about. I know in southern West Virginia there's been some work done suggests that the greater the amount of strip-mining for instance, in a watershed, the more frequently they have floods and the greater the magnitude of floods when they occur. That's really a fairly well understood relationship. An undisturbed water shed with intact soil and intact vegetation, good plant cover, certainly is able to absorb much more precipitation without creating a flood, than a disturbed water shed is. There is a ...it's pretty well understood that the more you disturb the soil, and that may be stripping the soil off, or compacting it by running heavy equipment over it. And the more you alter the natural vegetation cover, the less able a landscape is to handle heavy amounts of precipitation, without producing a flood. So there is a relationship between flooding and disturbance to the water shed. There's no doubt about it. Probably the worst thing you can do is build a town in a water shed, because roads are impervious to water. And sidewalks and streets are impervious to water. And so the water that falls in an urban area, like downtown Elkins for example, runs off very rapidly. And Elkins changes the flood behavior of the Tygart River below it, to a certain extent. But a truly great precipitation event, like we had, I think what has been done to the watershed is less important actually. There may be some effect; and I can't say what that effect was. I'll come back in a minute and I'll relate a subjective impression that I have that relates to what you asked me. When so much water is dropped in such a short period of time

really, even the virgin forest, even completely undisturbed forest soils, which have an amazing capacity to absorb water, would not have absorbed it all. You'd still have a tremendous flood. And if you look back, there are ways of determining.... a flood of this magnitude leaves geologic evidence. And so you can look back through the sequence of gravels (?) say over in the North Fork River valley, the North Fork of the Potomac valley, in Pendleton County, and you can find evidence for former floods of perhaps a similar magnitude that occurred long before European settlers ever came into this country. Floods of this magnitude are fortunately uncommon, but they do occur from time to time. And they have occurred in the past. They occurred when there were perfectly intact forest soils. And my own impression is that if this part of West Virginia had not been touched by the hand of man, we still would have had very very bad floods in November of 1985. It was an extraordinary event. There's no doubt about it that the works of man made it worse in certain areas. And it did. That may have been true in Brushy Run and Roaring Creek, I don't know, and I don't really want to speculate because I'm not that familiar with the water shed. I know there is some agricultural clearing and I know there's been some timbering in both; I mentioned a moment ago that I had a subjective impression that relates to this. And I'll relate that now. As you go from Elkins eastward, you cross first the Shavers Fork of the Cheat. And the Shavers Fork of the Cheat, that drainage has been fairly heavily altered by man's hand in recent years. It's been heavily timbered, there's fairly extensive strip mining in the upper basin, up above Cheat Bridge. And if you look at the effects that the flooding had on the Shavers Fork, they are fairly profound. There was a lot of damage in the Shavers Fork valley. As you continue eastward, the next stream you cross is the Glady Fork. The Glady Fork has a little bit of modification. There's been some timbering and there is some agricultural clearing but it's relatively modest. And if you look at the apparent damage at the Glady Fork, where route 33 crosses it, you can see there was high water, but nowhere

near the kind of damage that you saw on the Shavers Fork. If you continue eastward, the next stream you cross is the Laurel Fork, and it's hard to see where 33 crosses Laurel Fork that there was even much in the way of high water. And the Laurel Fork, at least it's my subjective impression, is of those three drainages that I've already mentioned, the least affected by the hand of man. And the least altered. It's the most undisturbed. Although it's not totally undisturbed either. And it seemed to have the least, the smallest magnitude of flow. If you continue on eastward, one more drainage, you'll encounter the Dry Fork drainage, which has been very heavily timbered. There's a lot of agricultural clearing, and the Dry Fork, of course, was devestated. Now, superimposed on that there is the precipitation pattern. And it's true that the rainfall was heavier in the east and then became lighter as you came west towards Elkins. So if that....and I'm not sure of the exact pattern. Sometimes, in a storm like this, it's kind of patchy. And it certainly wasn't a uniformed gradient from east to west. Although in general the rainfalls got heavier as you went towards the Allegheny front, towards the east. OK. If heaviness of rainfall was the determining factor alone, on the severity of the flood, the flood should have been most severe in the North Fork valley. And it was very severe there. Somewhat less severe in the Dry Fork, and less severe in the Laurel Fork, less severe yet in the Glady Fork and less severe yet in the Shavers Fork. Because you're coming eastward. And yettthat is not the pattern you see. The pattern that I see, and again, I have made no quantitative measurements, it's just a subjective impression, the pattern that I see is that the ....yes, there is a pattern that you can see that is linked to the heaviness of precipitation in the east-west gradient. But there is also another pattern that I think I see, that the less disturbed the watershed, the less water came down it per unit time. That is the less severe was the flooding. I think the damage that you see in the North Fork valley and the Dry Fork valley are certainly partially a consequence....and the Blackfork

Valley of course in Tucker county as well, which is on down the Dry Fork. It's certainly a consequence of the fact that those areas get very heavy rainfall. But I think it's at least partially a consequence of the disturbance, of the modification of the watershed and the impairment of the watershed to handle rainfall. The less well it handles it the more rapidly the rainfall runs off. There's another way in which of course man's activities can influence the severity of flooding as well, and that is the structures that we put across streams, stream channels. Particularly the major stream channels like the Black Fork and the Shavers Fork. The bridges. We lost a lot of bridges in the flood because debris built up against the upstream side of the bridges, and then the force of the water took the debris and the bridge out. You saw that in the upper bridge at Bowden. What I see....what I've seen in the flooded area is that the older bridges tend to be washedout. The newer bridges that are built with more rigid construction standards and the railroad bridges which are built to endure heavier loads, because they have to handle trains, not just cars, they tend to be more rugged. And the railroad bridges and the newer highway bridges held, although the approaches were often washed out. And it seems to me that's what happened in Parsons for instance. That the first real bridge of any substance that the debris and the high water coming down the Blackfork reached was the railroad bridge there, just below the nursery bottom. At the head of Pennsylvania Avenue in Parsons. Even after the flood you went up there and you saw that there was tremendous debris down there. Logs and building materials from Hambleton and Hendricks up the valley, that had lodged against the railroad bridge. That had formed apparently a fairly tight, just like a beaver dam. It can be fairly tight. A beaver dam of course is an impounding structure out of segments of wood and mud and finer debris. And that's really the kind of thing that built up, not as orderly as a beaver dam, certainly much more chaotic, but nonetheless the main structural strength of the dam is because of the inter-locking of logs. And

then that essentially creates a sieve which traps finer materials grass and leaves, sand and silt, and pretty soon the whole structure becomes relatively water tight. It impounds a lot of water very quickly. Has that water backed up very rapidly upstream of the bridge because there was so much water coming down the Black Fork channel, it wouldn't have taken much time to bring that dam up. And of course the more water that piles up the more debris is brought in. Anyway, a fairly large impoundment probably formed above the bridge. When it got high enough that it overtopped the dam, then it started to cut through it. It cut through the dam and the dirt, the stone, approached the railroad bridge. Now the bridge is concrete and steel and it's fairly substantial. But the approach is just the ties and tracks on top of rip-rap or aggrgate, loose rock, basically. And the water can cut through that very rapidly. So what it did was cut through the debris dam and cut through the approach to the railroad bridge, and that just funneled all this impounded water right down Pennsylvania Avenue. At least that's my impression of what happened there. So the hand of man, in building that railroad bridge, increased the severity of increased the damage in Parsons. Or at least that's the way it looked to me. And I'm sure that happened other places. Many of the newer bridges....many bridges were initially reported as being out. But indeed the bridges themselves weren't out, it's the approaches that were out. And I think many of those bridges did the same thing that I just described for rhe railroad bridge in Parsons. They served as the pillars, and the bridge itself served as catchment for debris. Which formed a debris dam and impounded water that spilled around the sides and rapidly cut through the approaches. So the approaches were washed out and yet the bridges, if they were built to modern construction standards, the bridges themselves were intact at the end of the flood, once the debris was cleared away. But there is no doubt in my mind that that sort of process increased the severity of the flooding in certain places. Certainly that was true in Parsons and consequently down stream from Parsons. Perhaps in St. George. Of course dams can, while

I'm on the subject, something else happened with a man-made dam at Lake Lynn on the main branch of the Cheat. The debris coming through the lake, they attempted to....the people whose responsibility it is to control the flood gates in the lake, opened the flood gates up wide early in the flooding event, apparently, to protect the dam, to keep the large volume of water from damaging the dam. But then the debris that went through the lake very quickly, the floating debris, logs primarily, jammed the gates open so they could not be closed, and the dam actually emptied, and so the people downstream of the dam at Lake Lynn, not only did they get the flood water but they got all the water that had been impounded in Lake Lynn prior to the flood. It was released during the same period of time. I guess that's one thing that concerns me. In the wake of a major disaster like this, there's always a cry for measures to prevent it in the future. And that's a very human thing to do. The flood control measures are things like deepening and straightening the channel, cementing the channel so the water runs through it more quickly, so-called channelization projects, and building of flood-control dams. And levies. There are various ways you can control flooding. My impression is that no amount of flood control dam and stream channelization and levies would have prevented most of the damage that occurred here. Because we're dealing with an extraordinary flood. I have a concern that often what so-called flood control projects do is they lull the population into a false sense of security. That the population says "Ah...now we have stream channelization, now we have levies, now we have flood control dams, we are protected from floods." And so they go ahead and they put trailer parks on the flood plains. And when the infrequent but inevitable large flood comes along, those people are completely without protection and you have high amount of property damage, and you have high loss of life. So...in one sense you can never, there is no such thing as flood protection from the kind of flood we had in November. It's just too large an event. Yet you can protect a population from the little ordinary floods. Flooding is a normal

part of the way a stream behaves. Most streams in this part of the country, if you define flood as the channel being full and water running out onto the flood plain a little bit, then minor flooding occurs on most streams a couple times a year. And the larger flood is less likely to occur statisically. So a little bit larger flood may occur only once every couple of years. And larger floods yet may occur only once every five to ten years. And larger floods yet you may only see once every ten to twenty years. And so forth and so on. And when you talk about the very large floods, such as we had in November, Now I don't know what the recurrence of a flood that size is. I haven't seen any figures. I've heard estimates that it's a 500 year flood. In other words, on the average, you only see a flood of that magnitude once every 500 years. I've heard estimates that it's a 2000 year flood. And it may indeed be a 10,000 year flood for all I know. The point is, we could have another flood the same magnitude next year. To say that on average, floods of that magnitude only occur once every 500 or 1,000 or 2,000 years or whatever, doesn't mean that we are now safe for the next 500 or 1,000 years. That's a statistical frequency. Now there's nothing to say that it can't happen again next year. The weather conditions that produced that flood could be repeated next year in the hurricane season. It's unlikely that they will be. But it could happen. And I don't believe you can protect a population, 100%, from a flood of that magnitude, by dam. As the example I gave for the Lake Lynn dam, dams are a double-edged sword. They may provide protection if it's a relatively small flood. You may be able to store the flood water and prevent damage downstream. If a dam is full of water when the flood occurs, it's no good. And of course, usually, this storm was produced by a hurricane. And generally the hurricanes that we get on the east coast, occur in August or early September. But often August. At that time, most of the so-called flood control structures, flood control dams, in West Virginia, are full of water. They are maintained at summer pool for recreational use.

And they don't have much storage capacity. So a storm, in a way, you might say we are lucky that this storm occurred as late as it did. This was an abnormally late hurricane. We are lucky that the storm occurred as late as it did, in one sense, because the flood control dams had been dropped down. Generally after Labor Day they drop them to winter pool, where they have a good bit of bit of storage capacity. But even at that, they don't seem to do much good. Dams are, I think, a double-edged sword. They can prevent flood damage for the smaller floods, but big floods, they may or may not produce adequate protection. And they may actually be counter productive in that they encourage development of the flood plain. In West Virginia I think you have to have development of the flood plain because we have so little suitable land for development. There are parts of the flood plain that you shouldn't rebuild on. I think that's clear. But other parts of the flood plain, for instance, the North Fork valley, I don't think people ought to pick up and abandon agriculture there. That's a good agricultural valley. And it's unlikely that they're going to have a flood like that again. In the near future. But, that's a risk you run of living in a valley anywhere. It's a risk we run of living in Elkins, a somewhat larger flood....Elkins was lucky, really. Some things that can be done....for instance, and I don't pretend to be an engineering expert, but just as a layman, it appears to me that things like avoiding building sturdy bridges close to river level, in a situation like the railroad bridge at Parsons, in other words if that bridge would have been higher, without any central piers so that it didn't tend to trap debris, then my suspicion is that you would, if you would have had a bridge like that, my suspicion is that you would not have had the disastrous flooding on Pennsylvania Avenue that you had. You would certainly have had some flooding there, because it was an extraordinary flood, but I think you would have had less damage. You would have seen less houses completely demolished and washed away. That was largely by the debris and high water mix. So the way in which we place possible obstructions across the channels is

something that we might give more thought to in the future. While you can't completely avoid the effects of a large flood like this one, but you can perhaps by not developing the flood plain areas that are most prone to damage, and not building structures that will tend to encourage the formation of debris dams, you may be able to reduce the amount of damage. Also a flood warning system is possible. There's been flood warning systems in use in southern West Virginia for several years. And now there is one proposed for the eastern counties. You have remote rain gauges in various drainage basins, when you have the rain gauges record when there was an abnormally heavy precipitation event, an abnormally heavy rainfall, and it telemeters that data, that is a radio or telephone link to some central data collection point and someone can say, "Wow. They're getting real heavy rainfall in the upper Dry Fork." And then they can compare that with the behavior of the Dry Fork....the flooding behavior of the Dry Fork to past precipitation events and say, is this likely to produce a flood. And if it is, then you notify the people in Harman to take the high ground, and you are not going to necessarliy save structures there, but you can save human life. And that's really the important thing. You can always rebuild structures, but you can't replace lives. The loss of life in the November flood was terrible.

Michael: Forty-eight. If you count, I think it's safe to count all the missing.

Jim: I think so too at this point. I don't want to say that shouldn't have happened, it's...you would hope...let me say this. I think it would be possible to design a flood warning system, that is relatively inexpensive, that would have prevented,were the same magnitude of flood to occur again, it would have reduced the loss of life, over what we saw in this flood. In other words, there was not adequate warning. And I'm not trying to place blame on anyone. No one, like you said at the beginning of this interview, and I have some sort of a professional interest

in streams, I never expected to see a flood of that magnitude here. It caught me by surprise, it caught the civil defense people by surprise, engineers by surprise, planners by surprise. And the people who live out in the valleys by surprise.
Michael: Weren't they predicting that storm though?
Jim: Yeah. They were. And perhaps there should have been a better flood warning, I don't know. It was clear that we were going to get a lot of rainfall. But I guess everyone underestimated it. Again, as I said, my wife and daughter and I went off to Meadowbrook Mall. Had we really fully appreciated what was happening, we wouldn't have done that. We would have stayed at home.
Michael: In effect the hurricane drifted up over eastern West Virginia and then sat there for awhile. Is that right?
Jim: I don't think it's real accurate to say the hurricane drifted up over West Virginia. The hurricane, the storm center really sat off the coast, but just off the east coast. And what it did....a hurricaneiis a low pressure area. And in the northern hemisphere, a low pressure area sets up a pattern of counter-clock wise circulation of winds around it. So around a hurricane you have, just like in the center of the hurricane, you have real high velocity winds, going around in this big circle, that's what the hurricane is about. As you get further out, the wind velocity drops down below the hurricane velocity, what is it? Seventy miles and hour or whatever. And winds get much gentler. But still the circulation pattern exists. So around the hurricane you have this tremendous circulating system of wind and what happened is that the pattern of circulation brought warm, moisture-laden air in off the Atlantic Ocean. And the moisture-laden air was brought in across the West Virginai mountains. Well, as an air mass is forced to flow across the top of a topigraphical obstacle, the air flows up over the mountains, just like water flows up over rock in a stream. As air flows above the mountains, over the mountains, it's lifted, and as it's lifted, the atmospheric pressure decreases and it's cooled by a process known as adiabatic cooling. But the temperature of the air mass drops by virtue of it being lifted over the mountain. And of course the ability of air to hold water vapor

in suspension is a function of the temperature. And the warmer the air the more water it can hold. And that's why this air mass was so moisture-laden. It had come in off the Atlantic and it was warm. So this warm moisture-laden air comes in over the mountains as the air mass is cooled as it's forced to flow up over the mountains, it's ability to hold moisture is decreased, and so it rains. And that's why you saw such heavy rainfalls in the eastern counties. That's where the highest mountains are. They are along the Virginia-West Virginai border. And that was the first major topographic obstacle that the warm moist air mass encountered. And that's where it dropped most of the water. As you come westward, you saw the precipitation less and less. And that's because for one thing the mountains were less high so the air mass was descending a bit, and tendstto be warmed a little bit by that descending, and so its ability to hold moisture increases somewhat, and to some extent, a lot of the water that was available to be dropped had already been dropped on the eastern mountains. And so....the rainfall drops off relatively quickly as you get to the....as you come to the west of the Virginia-West Virginia line. Ten and a third inches in areas like Canaan Valley, and Pendleton County, adjacent to the Allegheny front which is the highest elevations. And as you come eastward, I think Elkins got about 6 inches and then you get over to the West Fork valley, you got 4 or 5 inches. It dropped off fairly rapidly. Over a hundred miles it went from extremely heavy rainfalls to just moderate rainfalls, over a 100 mile transect. The east-west transect.

Michael: Are we out of time?

Jim: No. I've got a little bit more time. Another 5 minutes or so.

Michael: When we talked a couple of months ago, you said that you were interested in talking to people who had lived in these outlying rural areas who had been natural observers of nature. And to get their accounts of what had happened. Were you able to do that and what were people's perceptions? Did you think they had

a good understanding of what happened?
Jim: I've not been able to do that. It's been a busy semester for me, and I haven't been able to get out. And I feel very badly that I haven't. I haven't completely abandoned my hope to do that, but of course the longer you let it go, the more hazy people's memories become. Although an event like this I think people are going to remember the flood of 1985 for a long time. In fairly good detail. But my impression in talking to the people that I have talked to is that maybe they didn't understand the weather system thatproduced the flood and maybe they didn't understand the relationship between tributaries and debris dams and things like that. But apparently a lot of people have reported, especially on the intermediate sized streams, seeing the kind of things, seeing and hearing the kind of things that Helen Sites described. This roaring, churning, grinding snapping mass of material moving down through the stream valleys. And that's the kind of thing that I would like to get a better understanding of. Again, as I said, I can't gain the emotional understanding, I didn't see it myself. The intellectual understanding, yes, I have. But I would like to understand it better through the eyes of people who actually witnessed and experienced it. And as I said, a lot of these people are real good observers of nature. Much better than city folk like me are. I don't have much to share with you. And I'm sorry I don't. I hope to do some talkin g to people this summer, when I have a bit more time.
Michael: One thing that came to my mind when you were talking about how these dams were first created, and they were over-topped and broke, something that someone said, who was trapped in a house in Hendricks, he described the water as coming up to the 13th step on the stairway going up in the house. And then he said, all at once the water began dropping. And the water dropped very fast, as though a plug had been pulled in a bathtub. So your description of this damage is wonderfully clear and it also may account for descriptions downstream of Parsons of people between 9 and 9:30 describing a wall of water...as the debris dam at Parsons let go.

A wall of water came down ....I just interviewed the sherriff of Tucker County and one of the state troopers who were washed off the approach to the St. George bridge by a wall of water. They were in a Ram Charger, a heavy 4-wheel drive vehicle. And all of a sudden, they saw this wall of water coming at them in the dark. It was around 9:30, 9:15. Washed them right off the approach. Fortunately there were some people close by and as it happened they had a length of rope in the Ram Charger, standing on top of it they were able to throw a rope to these folks, and get a line tied off and they were able to get back. But I gather there was a similar wall of water, I don't know what time, that came down through the North Fork and the South Branch valleys, may have caused the deaths of the two Harper brothers, and Mrs. Painter and some other people who were trying to get back to this area from Moorefield.

Jim: Yeah....the people who were at the mouth of Jordan Run and trapped in a house and then on the roof of the house, and eventually the house gave way. I know Margaret and Bill Painter were apparently in that group, the Harper brothers though I'm not sure. The North Fork is a big wide valley. It is constricted in a couple places. It's constricted right there below Jordan Run as the North Fork rather abruptly turns eastward and crosses, cuts through the North Fork mountain, there in that narrows the river is constricted, and it's possible, I suppose there that a debris dam of some form formed there; I don't know for a fact, I think in most of the North Fork valley, the valley is simply too broad to dam the valley, the valley wall. At some of the constriction points, like there just down the stream from Jordan Run, and above Petersburg where the Potomac cuts through that little ridge there and the bridge on US 220 was taken out, there is kind of, I'm sure there was kind of a damming effect. Whether it was kind of a debris dam that I talked about earlier I'm not sure that sort of thing could form there, but certainly above the bridge at Petersburg, and possibly above the bridge that goes over to the Smoke Hole downstream from Jordan Run both those bridges were taken out and probably debris dams did form

above those bridges. The rather rapid rise of water at.... reported by the people who were there at the mouth of Jordan Run, may have been simply the fact that the valley constricts there. And, while a dam didn't form, the valley is narrow enough there, that it impeded the flow of water sufficiently to allow the water to back up behind those gaps. That's my impression of what probably happened there. And then of course, right on the other side of the gaps there is evidence of water just bursting through there as a wall of water. Because you have this rising wall of water behind and tremendous acceleration, tremendous velocity as the water comes out of those gaps. It's kind of akin to what happens when you run water through a hose to the nozzle. That the water accelerates where the channel is constricted and just essentially blows out of there. There's a place on the North Fork, that's right, it's right above Jordan Run, the river is part constricted by a ridge of resistant sandstone that comes down to the river there. It's quite constricted. Right above Jordan Run Road. And the water must have blasted out through there. And of course the river completely changed channel there. It moved way over to the west side of the valley, took out that whole stretch of road.