Ken Rood: Good morning, all. You'll probably be glad to know I'm the last speaker of the day. I'm never sure if that's a good thing or not. But [lucky me]. And I'm going to talk today -- the title of the talk is called Vegetation on the Water Side of the Sacramento River Levee, and the talk is really based on two things. The first thing is a study that we just started in June for SAFCA, where we went out and did some vegetation sampling to kind of see what the implications of the white paper policy guidelines for vegetation management would be in certain parts of the SAFCA area, especially along the Natomis reach. And also we do a fair bit of work for SAFCA right now on design of bank protection works, and I'll talk a little bit about that as I go along, too.

The title slide here is a picture you haven't seen so far. So, it's kind of from the river looking at the bank. And you can see some of the features of the bank here that I think are interesting. The bank is shallow, but it's quite steep, and you can see -- it's not clear here, but there's kind of a wave cut erosion bench from recreational boat traffic down near the waterline. And the levee's also quite close here. You can just see the -- I can't point to it here, actually, I keep forgetting that. But you can see the crest [of it at the back of the] photo, and a few couple of trees lying between the bank top and the levee crest as well.

[The levee crest, sort of line just behind the trees.] These trees kind of show a couple interesting facts about the vegetation here. They probably provide some benefit to the bank stability. They kind of stabilize the soil at the top of the bank and help keep that bank steep and slow down rates of erosion. In this case, they probably brought a little bit, maybe not very much, kind of protection from waves [as it impacts] directly on the levee slope itself. But you can also see that these -- if I can point it over here -- this tree over here on the far side is significantly [undermined], and these are the trees that are kind of at risk to fall down. And where the levee section is quite close to the bank here, these trees do have some potential to cause some erosion of that section.

Just a couple of [unintelligible]. I put this in here just because I recognize there are some people that are not from the Sacramento area. And Ed showed some video overview of the Natomis reach. What's going on there right now is kind of a major upgrade of the levee itself, and this project includes the blue area that you can see on the slide itself, which is the -- [sorry, I'm doing this wrong here, now]. [Unintelligible] okay. And this, as I said, area is under construction or right now is being upgraded by Natomis -- the Natomis area is being upgraded by SAFCA. And the upgrade consists both of the levee itself along the Sacramento River that's shown in blue here, and it's about 20 miles long, as well as upgrades on the cross canal, which heads from Verona off to the east, and other upgrades along this system.

Kind of right now, the levee project is actually underway, and they are building on the cross canal. And next year, there's a plan to start the kind of levee upgrades on the Natomis itself, starting at the upper end, near Verona. So, one of the reasons why this vegetation survey went ahead is not only do we want to get a handle on the implications of the policy guidelines that are in the white paper for SAFCA and also understand the cost of compliance, but because this project's going on right now in a design phase, there's a lot of interest in getting a quick grasp on a good understanding of what the implications would be and how that might affect the designs themselves for the Natomis reach.

I put a little note down here just to mention encroachments. I think you've probably seen these from the aerial video. But it is unusual, and this is a picture from the Natomis reach. You can see a lot of people have built things on the side of the levees themselves, including this wall. And there's a lot of vegetation planted along there that's basically a screen between the Garden Highway and the property.

Switching now just to talk a bit about what we did in this vegetation survey program. It was a sampling approach, and we looked at -- we wanted to look at three areas. They're shown on the most left-hand -- in your case, actually, the most right-hand photo. So, the red area up at the top is what we call Natomis reaches one to four, and this is the area that's planned for kind of levee upgrade construction next year. The yellow area just kind of carries on down the Natomis, and it's about 16 miles long. And then the third area, down at the bottom, is another area you saw the video of. It's the pocket area. And that's the orange part. That's about a 13-mile section down there.

So, like I said, we took a sampling approach. And because this most upstream part of the Natomis is of most interest right now, we put a big effort in there. And we looked at vegetation sampling on about 20 [transects] space, [about 1,000 feet] apart there. As we went farther downstream, the effort was much less. In the lower part of the Natomis, we added another 16 transects, mostly to sample areas that weren't well represented in the upper part of the Natomis. And then in the Pocket area we [do] [unintelligible].

So, our main interest here was trying to extrapolate from these samples to the larger area, so the numbers that I'm going to present here are really kind of ones that are intended to represent the whole area [for these reaches that are showing here], but keep in mind they are based on a limited number of samples, so they are [just estimates]. I'll talk a little bit more about the way we did the extrapolation, but what we ended up doing was dividing our sample areas into what we call residential or recreational areas, in other words, [on the waterside of the levees, there was either a commercial development or a property]. And then the rest of them [we just called natural]. But those natural ones [included a very sort of riffraff, so it's not going to be just natural bank]. And then we divided the berms up into three width categories, so we ended up with six different bank types. And we looked at average vegetation conditions inside those and

then extrapolated to larger area just based on the length of bank [that actually falls in this category].

I think it's important here to spend a couple of minutes just looking at this waterside profile. I think you've seen it a few times before, but this is the standard [unintelligible] the crown of a levee, [and along a lot of the Natomis reach, the Garden Highway's on here, and the levee crown is kind of above the minimum width]. From there, the levee slope [heads down] at about 3 to 1. And it toes out on -- the constructed levee actually sits on a berm. On this one, we've shown a fairly narrow berm, but as Ed pointed out, it ranges from basically nonexistent to more than 200 feet wide. And the berm itself is kind of significant here. It sits at about the elevation of a 1.5- to 2-year flood level along much of the reach. But really the levee toe itself is [above] the kind of [mean annual flood] and is actually above the ordinary high water marks.

So, when we look at the guidelines that are in the white paper, this type of situation allows fairly very heavy vegetation on the lower slope, providing that certain conditions are met. And again, here, I've shown the projected levee template. [Though it's not actually constructed] [unintelligible] [it's considered to be -- the 3 to 1 projection is considered to be part of the levee.] And I've shown here kind of the typical features of an eroding bank site. We usually have a wave-cut bench somewhere up above the summer water level. And in some of these ones, we have some fairly significant erosion down at the toe of the bank where it joins the riverbed.

So, this is just to give you an idea of the relative distribution of the berm, the width of the berm in these two different areas that we sampled. [The Natomis one, as you saw from the over flight, a lot of the area really lies in this fairly wide] category, and a lot of the area that's in this wide category is [this purply color, and these are areas] where there's residential development on the berm. Pocket areas, quite different, and I

think this was kind of shown a bit in the over flight too. A lot of the levee along there has a very narrow berm. [Now, there's really small -- only small sections of the levee] [unintelligible] [berm is wider than] [unintelligible.]

And just [these classes, the narrow is less than 25, the medium is 25 to 75, and the wide is more than 75 feet]. So, just to talk about how we did our sampling, again. This just shows what's called the vegetation free zone in the white paper. And in this, what we were looking at -- we went out and sampled the vegetation about 200 feet upstream and downstream of each transect, and we looked at the number of trees that are lying on the slope itself, which is shown in green there. And then also the number of trees that are in this 15-foot easement zone that extends out from the toe of the levee. We also looked at a number of other characteristics of the vegetation and also looked at some features of the levee slope itself. But in this talk, I'm mostly just going to stick with numbers [of trees].

We also wanted to look at this root free zone, which is mentioned in the white paper. Steve Chainey talked a little bit about this when he was looking at some of the trees [that currently sit down near the summer water level]. And the way we looked at this, and this is not entirely clear to me from the white paper, we looked at the same projection of the 3 to 1 slope that we've talked about before. And what we did is we said if [a tree -- the elevation of the ground at the base of the tree is within four feet of that, then that tree probably has roots going in there. And we counted it in our survey on those transects]. And that just shows an example of a tree [that's actually sitting] inside that zone.

As you might imagine, it's not really easy when you're out in the field to see where this projected 3 to 1 slope is, if you're really trying to do it that way. It's more or less guesswork. So, instead, we relied here on recent detailed topographic surveys along the Natomis reach that have been used [for design]. And we just basically, in our transect surveys, we extended

the template, and we had [surveyed elevations of the trees, so we looked at threes that were within the four-foot zone. And this is just an example of one here], the large cottonwood that sits down near the waterline, that actually projects in the 3 to 1 template. And the photo over [this slide shows] that [same] tree and also shows a section [of the levee that kind of meets pretty close to the Corps's standards. No vegetation] on the levee slope and no vegetation on the berm, except for grass.

I mentioned before we have some concerns, and I think others do, too, about the erosion that might result from [failure of large trees that are actually close to and growing in the levee slope]. So, we went out and did a boat survey in the upper part of the Natomis to try and identify trees that were significantly undercut or potentially likely to fail from erosion. This is just a couple of examples here, these two [unintelligible]. And then we tied these ones back to the same database of trees that are close to the [unintelligible] [so we can get an idea how many trees] that are close to the levee [unintelligible] [are actually in a situation where they might fail].

This is just switching now to the results. What I did was combined all the results here for the two Natomis reaches, so this includes basically about 20 miles of levee. I don't know if it's clear or not. [The scale here is the number of trees that fall within the vegetation free zone, and this includes both the levee slope and the] [unintelligible] [from the berm. And you can see that here, along the Natomis, most of them fall into this wide zone or into the medium zone, and a large, significant number] of them are actually in the residential area. [This raises a couple points here] I think are worth bringing up.

First, a lot of the trees that are shown here are ornamentals, trees that have been planted for landscaping or basically privacy screens from the highway. And, second, when you're looking at these wide berms, these trees that are on the levee slope or close to levees are a long way away

from the riverbank itself. They're more than 75 feet away. And they're really in an area that's not flooded very frequently. And this may have some implications for [continuing the value of these trees for repairing the habitat].

It's probably not easy to total this up, but it's about 3,800 trees in the 20 miles there that would need to be removed to absolutely comply with the guidelines. And I didn't show here the split between those that are on the levee slope and those that are on the berm itself, but half of those trees, [some of them around 1,500, 1,600 or so, are actually growing] in the levee slope, so their roots are truly [within the levee] [unintelligible].

This is just a quick overview of the ones that we looked at that are in the root free zone. So, we only identified based on the topographic surveys -- [but there's only] 27 trees that lie close to the levee template [lower on the slope], and all these really lie in the [unintelligible] [bank, where there's a narrow berm and really no residential development, which is no surprise, because the berm is too narrow for development. We extrapolated this just based on the number of trees per thousand feet for the whole Natomis region and came up with about 173 trees that might be in that root free zone.

We also, like I said, looked at the ones that were either eroded or undercut, and we only identified two that met both these criteria, meaning that they were undercut and also [close to the 3 to 1 template], so it's quite possible there may only be a few dozen along the Natomis reach that would be a significant concern for erosion. These are just the results for the pocket area based on the same thing, so this includes the trees that are either on the levee slope itself or, again, in that 15-foot zone. And the photo here kind of shows you an idea of the trees growing right along the toe of the levee slope. The total here is about 1,300, and almost all of them lie in this narrow berm category, and that's because, as were

showing a bit earlier, almost all the pocket area has either a berm narrow or no berm.

We didn't do surveys. We didn't have enough topographic details to figure out which -- or how many -- trees lay in this kind of root free zone farther down the slope. But we just used the numbers from Natomis to kind of [project them], and it came out to about 800 trees or so that might lie in that zone. But you can see from the over flights that Ed showed you, a number of those [have actually] been protected by riffraff, and it's really not clear how many of those trees actually pose a threat to erosion. But it's certainly one of those issues that needs to be looked at a little bit further.

I just want to spend a couple slides now and just talk about some of the implications that there might be for SAFCA. Just assuming that the levee stays in place where is right now and that we do try and comply with these deadlines, the average number of trees in the vegetation free zone is about 37 trees per 1,000 feet. It's not really easy to make a guess as to how much disturbance would be required to take all those trees out because really we just don't know how big the trees are and how big an area of root would actually need to be excavated to remove sufficient roots to meet the policy guidelines.

But I just thought, well, maybe if we think about a 20-foot circle around these trees, how much area would that be? And that really comes out to about 12,000 square feet. That disturbance level is really starting to represent a significantly large portion of the berm and levee [itself]. And really in a lot of cases here, where [these things are thick], you're probably looking at significant reconstruction of the levee in order to remove these trees and restore the levee back to current condition.

I don't really know what the costs are to do this, and I don't really have a good way of guessing it. Maybe someone from SAFCA or someone from

the Corps can provide a good number on that, but certainly if it requires significant rebuilding of the levees, the costs are going to be quite high. And even if it's just removal of a few trees, you know, the costs are still going to be several tens of thousands of dollars for a 1,000 feet.

One of the things that have been discussed for the Natomis levee improvement project [as a way of upgrading the levee] here is this idea of either a fat levee, sometimes it's called a wide levee or [an adjacent levee]. What this really means is you'd build the new levee on the back or the landward side of the existing levee, and by doing that, you really kind of move the levee template and the toe of the levee away from the existing vegetation and away from the encroachments.

That actually seems quite sensible, as far as treating the vegetation problem, and it would certainly work up in the Natomis reach. It would work there primarily because, as you saw from the video clips, there's not a lot of development on that side of the levee, so there is actually potential to use that land for levee construction. It's not really practical along much of the rest of the reach. And as you can see from the video over flight, there's a lot of residential development there and really some other approach would have to be taken to try and [unintelligible] [vegetation].

I just want to mention this. This is the slide that Steve showed. We are, right now, in the process of trying to construct erosion protection [unintelligible] Natomis. One of our concerns is we do want to try and provide this vegetation down on the lower slope, but it's not quite clear whether this conflicts with the existing guidelines or not, or whether it will consist with existing guidelines if we actually growing large [trees here]. In a number of cases, this projected levee profile or template is quite close to the existing bank, and that's one of the reasons, of course, why [[unintelligible] [protect] [unintelligible] [concern about erosion] [unintelligible] [template].

So, just a quick wrap-up. [I] put these questions up there, and I didn't think very much about what I was going to say to answer them. Trees in the root free zone, [Steve was talking about]. Well, certainly in the Natomis area, this may not be a huge problem. The numbers may be relatively small. And maybe there's things we can do. Possibly for some of these trees you can take some of the [sale area] out, you can cut them back, you can do something to buttress them just to reduce the risk of erosion. So, perhaps this is really a manageable issue.

The photo here is of the recent Corps construction, and the tree right there actually lies well within the root free zone. And you can see here what they've done is they've built a [toe rock], and it kind of buttresses these trees, so these trees are kind of incorporated in the bank protection now. So, perhaps really this is maybe possible also to kind of carry on and maintain some of these existing vegetations as part of the bank protection.

As for the bigger question: do we need to dig up the berm and rebuild the levee section to address all the vegetation that's on there? I don't really have an answer to that. From what I've listened to the last couple days, I'm not quite sure how many of those threes would need to be removed. Perhaps if there's a goal or benefit here to thinking about taking all the ones off that are on the levee, and that's still a fairly significant project [here to the areas that SAFCA manages]. So, I will stop there, and thank you.