PROFESSOR: I'll do the Vanna White thing. So this sucks in air here, and inside, 57% of methane or other combustible gases in it. And it sucks in about I think half liter a minute. And so you can get a percent gas in the air.

And so luckily, at the moment, there's probably 0% methane.

AUDIENCE: Is that what gas companies quickly use to find leaks?

PROFESSOR: Yeah, yeah, they normally have a big probe on it. And what they do is they take bang bar, which is like a big stick and they stick it in the ground until they get a hole, and then they stick this with a probe on it, suck air in and figure out what the percent gas is in the soil. Then they know by where the highest percentage is in the soil. They figure, OK, that's probably where the leak is, and they start digging there. So it's a really simple and fantastic tool. CGI, yeah, combustible gas indicator.

PROFESSOR: And right here is where the inlet is, OK, just off of here. We do this-- it's better to do it than in the back bumper, because there can be some exhaust contamination. Actually, well, two cars, we've tested it, do not interfere, but this is a little bit of an old van. So sometimes-- I mean, it passed the emissions test, but still there can be some contamination. That's why when we stopped, sometimes you'll get some measurements, but when you're moving forward and the wind is upstream, you know you're getting readings.

This is the methane reading that analyzers are reading right now. So it's anything below 2, it's right now, 1.96 is pretty clean. There's no leak where we are right now. So if it's under 2, you know we're in a place with no leak. And even if it creeps up over 2, if it's like 2.01, 2.02, that's not really indicative of a leak.

But if you see it go up to like 2, your eyes can tell you in time that oh, it seems to be going up pretty rapidly here. And so you'll see it maybe go for 2.3 sometimes, and then drop back down. And that's kind of unusual. That's like, OK, there's probably something around here. And then every once in a while, you might see something that goes up further, 3, 3 and 1/2, and those are like definite leaks.

AUDIENCE: What's the highest number you've ever seen?

PROFESSOR: Well, in DC, we got I think very near to 100 parts per million. And that's in the air that we're breathing, so it's not explosive at that level. But it's like 50 times more than the background value.

AUDIENCE: So 2 is baseline kind of background.

PROFESSOR: Yeah, yeah, you can consider 2 to be a baseline level. Now it's like CO2, well, it used to be 280 parts per million, and now it's like over 400. So 2 parts per million methane is the new normal. I mean it was 0.7 parts per million, preindustrial. So I would like to point that out that are our normal baseline is very abnormal. So we're going up about that with leaks.

Now this is a timeline here, this graph, and you can see as I came in here, we did get 6, 7, we got a few leaks here. And that was right at the Allston/Brighton tolls coming down off of the Mass Pike. There's a leak there.

AUDIENCE: So what happens in terms the reporting that or following up with it?

PROFESSOR: So we don't have any evidence, but based on driving by. We can't say whether it's a green one hazardous leak, a grade two, or a grade three so-called non-hazardous leak. So I don't feel obligated that each what we see that OK, we got to call the gas company.

First of all, they do know about these leaks. They know-- to a large degree where they are. But if we get out, and we could, because we have the CGI. If we decide to get out and poke around and look through it, and we find evidence that it is like a grade one, then that's when I feel obligated to call the leak in. 'Cause it's like we have knowledge that something seems to be unsafe, and so then we call it in. Yep?

AUDIENCE: Is there a clear indicator when it's a grade one?

PROFESSOR: This machine is not going to be able to tell us whether there's a grade one, a grade explosive hazard, grade two, or grade three. And that's because you can have big leaks with lots of gas coming out that are not explosive hazards. Like the Porter Ranch gas leak in LA, Audrey makes this point a lot, it was technically a grade three non-hazardous leak, 'cause it wasn't going to explode. And it wasn't that close to the neighborhood, it was like a quarter mile away from the neighborhood.

So it's an indication that that grading scheme is only a single variable grading scheme. And explosion and hazard is a big deal. There's no doubt about that, and no one wants that. So what the grading scheme has to incorporate the amount of the flux.

There is a GPS on this roof right now, and it's plugged into the back of the machine, and the data file that comes out is already integrated with GPS with the time stamp. Straight?

AUDIENCE: Left, if we can, yep. So what are the objectives for today? Is it just to see how methane is measured, or are we trying to answer any particular questions?

PROFESSOR: So what we call this is a gas leak safari. So one of the objectives-- OK, here we are, 2, 3, 2, 3, so there's something there. So just to educate and to show first of all what this process is of mapping the gas leaks. I think that we're going to places that we have surveyed in the past, Audrey and Heat did the study now, two years ago, is it? But things change.

AUDIENCE: Take a right here.

PROFESSOR: Right on Portland. 2.1, 2.1, OK, here we have something, 2.1. So there's something here I think.

AUDIENCE: 2.3.

AUDIENCE: 2.5. 2.7.

PROFESSOR: OK, yeah, read them out.

AUDIENCE: 2.8.

PROFESSOR: OK, so there's a leak here in this facility.

AUDIENCE: Portland and Main.

AUDIENCE: So that's at 2.3. Oh, 3.3, well, 4.4, 4.4.

AUDIENCE: 4.2. 3.8.

PROFESSOR: So you can see there's the spike on the leading edge. Right? It's really as you can imagine, as any lay person can imagine, the vagaries of wind are going to the plume. The plume is coming out of wherever it can come out. I could come out of a man hole slot-- straight on?

AUDIENCE: Straight on.

PROFESSOR: It could come out of the soil. A leak is going to to just find whatever parallel pathways it can get out. And so you can imagine, at the surface there's some kind of profile of this stuff coming out. And then the wind's going to carry it and blow it around. And so that makes it a little tough. We can't really pinpoint exactly where it's coming out of the ground. We can know when we have driven by it.

There's a leak in this vicinity, and I would always say within 50 to 100 feet of where we measured it is probably part of the source coming on the ground. But to actually really pinpoint where the pipeline leak is would require stopping, getting out, and using the instrument that Audrey has as well as maybe some other instruments, handheld snippers to really find out where it's coming out.

What you're realizing right now that makes it like discreet when we see a leak, if you look at this timeline here, this trace, you can see there's a lot of flat and then some fairly well resolved spikes. And so it's not very ambiguous when you get an elevated anomalous reading. It's like, oh, there's one, there's one, there's one. Here's a couple that are small, but they really need to go very clearly from the back ground.

So there's not that much ambiguity about like, well, is this kind of giant blob a leak or not? They're well resolved spikes in time and space.

AUDIENCE: What's the biggest leak you've seen in the Boston area?

PROFESSOR: Maybe like 40 or 50 parts per million in the air.

AUDIENCE: Where was that?

PROFESSOR: Well, a couple of places that were close to that. One was Sullivan Square, Rutherford Street in Charles Town, kind of on the Somerville Charles Town border, the giant rotary.

AUDIENCE: Yeah.

PROFESSOR: I mean, we could go over there, there is a big leak there. And then Nonantum Road between kind of Watertown and Newton. 2.2, 2.3, OK, so there's something here, OK. 2.3, OK, so we've got, 2.5.

AUDIENCE: 2.5.

AUDIENCE: 2.8. 3. 3.2. 4.8.

AUDIENCE: 6.

AUDIENCE: Oh boy. Oh boy.

AUDIENCE: 5.3.

PROFESSOR: So I mean, we could get out and take a break and find it if you wanted on this one. It's kind of quiet. This is definitely a much blunter instrument than that one. And it's made to find out like percent level, 50%, 10%, not parts per million. OK, so this is now when you want to find out where is it coming out at, OK? The professionals right now would have this bar, it's called a bang bar. It's like one of those construction pile drivers, it's like a handheld version of that. And you would find out, maybe right here, you'd like slam it down maybe up to a meter. And this would have a longer thing, and you'd stick it in there.

Now I don't do that, because I'm not certified to do that, and I don't want to puncture any gas lines and create an explosion. So what I do is I just kind of do like this, and sometimes I'll use like a screwdriver or just a stick even, and kind of-- this is right at the surface-- and poke around. So actually look, there is something, point 0.2. Now the fact, 0.25%. So 0.25% is, let's see, 1% is 10,000 parts per million, right, 1% is 10, 000 parts per million. This is 8,500 parts per million right now-- 0.85, 0.9.

OK, so the thing is that this is right at the surface. If I was down even probably that much, it would probably be I don't know 15%, 20%. And if we went down a little further, this could be 90% gas. See this is 0.25. Yeah, so about the same. I'm just like about that far in. So this is an indication that there's definitely a leak here. And it's no mistake we got the 15 parts per million in the kind of air that we're breathing.

So now let's look around for just infrastructure. Let's see I mean, that was a very arbitrary choice of a place to look. It's just we got out, we're here. But now I want to see like, OK, where is the gas line?

AUDIENCE: And all that.

PROFESSOR: That could be a vestige of a gas leak marking. And this big patch has been for some purpose, I don't know if it was a gas line. I see some more yellow paint out here. OK, so this is -- OK, yeah, always be very careful with the cars of course. So this is a service line coming off of the main, OK? So service lines going this way, mains generally going that way.

Mains can be at an angle, they can be running under the sidewalk, so anything can really happen.

AUDIENCE: So were mains laid down before the streets were gridded or something or what?

PROFESSOR: Or sometimes afterwards.

AUDIENCE: OK, but if it's afterwards, I'm going to assume that there-- configures to the street.

PROFESSOR: They probably would do it running that way if it was done afterwards.

AUDIENCE: OK.

PROFESSOR: This is an electrical manhole. The gas can come in any-- it can seep in anywhere. So 0.25, OK, so gas in there. All right, so we did this. OK so, all right, so there's definitely gas in here. That's very, very clear. I mean, if you really wanted to, you could smell, and smell the gas, but I'm not going to recommend that.

But this is not an explosive thresh hold. So I don't feel like, back off, don't smoke or whatever. Well, don't smoke, but if it were 4%, then that would be a grade one explosive hazard, OK? And we would call it in, and they would come out immediately, well, within a half hour or so.

AUDIENCE: And again, 4% is what on that readout?

PROFESSOR: 40,000 parts per million. 4% is equal to 40,000 parts per million. So if the 4.0, that's 40,000 parts per million. And that's the lower explosion threshold, the higher explosion threshold is about 15% gas. If it gets above that, there's not enough oxygen for it to explode.

PROFESSOR: All right, where little kids are like playing in the playground, there's a grade one leak under a manhole, we call it in, and these two guys from Evershore arrive, and they don't even have like a bang bar, and they didn't have the right instrumentation to do anything.

So we pop open the manhole for them. And they look and they're like, yeah. Then we go off to the side, and they actually said in front of me, because I don't think they realized that I wasn't a utility person, they're like, yeah, you just got to think sometimes, an explosion is the price of using gas. And like the kids are behind us playing in the playground.

AUDIENCE: It wasn't a facetious comment, huh?

PROFESSOR: No, it was an--

AUDIENCE: Like it comes with the territory?

PROFESSOR: Yeah, and I mean, yeah, it was sort of, in front of the kids, I just thought that was really strange.

AUDIENCE: So did they do something [INAUDIBLE]?

PROFESSOR: They did fix it after a while, what Bob said, but they didn't fix it at that point.

AUDIENCE: That's the highest we've seen.

PROFESSOR: Yeah, 1, 1, 1, it just exceeded 1, 1.2. So the gas company, so 2.2. OK, so this is too close to this tree to be good for this tree. And clearly this tree is not that old. How long ago did they put this in here, how much did it cost to put this in here? And now you've got a leak here. And this white paint, that's a sign of the gas company having been out here at some point to monitor. Here's the service line. So I don't know, I mean--

AUDIENCE: Sorry if I missed this earlier, but why does methane kill the tree?

PROFESSOR: Oh, yeah, sorry. The methane, the natural gas has no oxygen in it. And the root systems need oxygen to metabolize, so you've got this plume of anoxic soil volume, and it kills the roots.

AUDIENCE: So in fact, right here, isn't it the case that there could have been an older tree the same age as these tall ones that died and was replaced by this. And possibly it died because of methane leak.

PROFESSOR: Yeah, I mean, it would be very interesting to find out what the history of this is, because this is I don't know, this is maybe two to three years old is my guess from the sampling from whatever it was planted. So OK, I'm not getting anything at the very surface here, but we definitely got some there. And that's two too close to this tree, because I mean, the root system is certainly going over there.

Another really interesting thing, so it actually does come back to being-- so I'm a tree physiologist actually. That's what I'm suppose to be doing, that's why I got into this stuff. But it's interesting, because some trees have a vasculature that is called segmented, and some tree species have an integrated vascular structure. What that means is that some species, the roots on this side are connected to the pipes that run water on this side and are connected to the branches on the side. And then this side operates kind of like as a parallel path.

Whereas other trees species like pine, a lot of the pine species, it's like whatever comes out of here or goes through here could have been from anywhere in the soil, it's integrated, OK, spatially integrated. So if the gas leak has some spatial pattern to it, you could see differences in where it shows up on the tree depending on the tree species and its vascular structure.

Look at this, look how it's breaking off, like the twigs are just snapping. This tree is not in good, it's dried out. And so this is not, this tree is having problems. You can just, I mean, I'm not killing this tree, it's just like these tips are dead. They're not hydrated.

AUDIENCE: Well, this one's OK. OK,

PROFESSOR: Yeah, so these are OK over here. This side is not doing so good. So I don't know.

AUDIENCE: So it's something that you envisioned citizen scientist doing like measuring for methane and trace the problem for their trees, and then reporting it to the city or reporting it--

PROFESSOR: Totally, yeah. And that's the whole idea behind making this available through heat by the Sierra Club, I'm on the executive committee of the Sierra Club, so I'm like promoting the Sierra Club. But they're making these things available for communities to do what we're doing, to use your nose, to use your eyes to find. People will walk by it's like, oh, I smell a leak, and then you can go and check this out and actually find out where it is, and then report it.

You don't have to wait to report it if you smell a leak, you can and should report it. But it empowers you to find out more. And Mothers Out Front has been amazing in terms of also-- it's not just what they know, but when they plant that flag in the ground, it's showing everyone else that there's a leak here as well. So just essentially making the problem transparent to everyone.

AUDIENCE: [INAUDIBLE]?

PROFESSOR: So Mothers Out Front has had and maybe still do a campaign where there's a leak, they just plant a yellow flag, and it has a sniffing nose on it and it basically makes it clear that there's a leak there.

AUDIENCE: We did in a concentrated time period, and then we collected the flags back again. But during that process, a lot of people talked with us and were reading the information that we left attached to the flag--

AUDIENCE: Did the utility companies respond to those flags at all per se?

AUDIENCE: Not in any way that we know. Audrey might know a little bit more. We didn't do any measurements, we were just going from the mapping that had been done, and we were given points where there was more significant leakage going on.

PROFESSOR: And so that was actually driven by information provided by the utilities. But like a follow on development of this could be-- 'cause we know that the leak map provided by the utilities, as good as Audrey did to put them faithfully down where they were looking. The utilities get it wrong sometimes, or these missing leaks-- what are we calling them?

AUDIENCE: Yeah, missing leaks.

PROFESSOR: Missing leaks that have come off the books. And it doesn't seem like they like 15% of them came off like on December 31st, it doesn't make sense. So it's kind of auditing them as well. And this is just us being parked here, OK? So you can see it going up and down and up and down, and that again, is just the wind wafting this leak around.

So it gives you an idea of the vagaries of the weather conditions. But you can see also that even when it goes down, I mean, the lowest it ever went here is like, I don't know, 2.7 or maybe 3 or so. So it's obviously a leak. But depending on the conditions, I mean, we were up above 16, we we're down to like 3. And so if you drive a leak two different times, you're going to get two different peak readings. That's part of the thing that makes it difficult to estimate like really how big the leak is.

This is still the Swiss Alps of leaks. OK, here's the school.

AUDIENCE: What are you at?

PROFESSOR: 2.4, 3.3, OK, so there's a leak right here at the school, 2.37. So when you see it dip down like that and then come back up like that, that's pretty clear. We're moving at a steady pace here, so got a leak here. I didn't pay attention to the trees.

AUDIENCE: 4.

PROFESSOR: 4, OK. Some young trees, patches.

AUDIENCE: 3.8, 3.4, 2.9.

PROFESSOR: OK, that tree [INAUDIBLE]. All right, so leaks there. 9. We got 9.

AUDIENCE: 12.

PROFESSOR: 11.

AUDIENCE: 11.

PROFESSOR: You want to pull over?

AUDIENCE: Yeah.

PROFESSOR: OK.

AUDIENCE: And you see the yellow markings everywhere, and that's always gas, the yellow is gas.

PROFESSOR: Yeah, yellow always refers to gas. Blue is water.

PROFESSOR: So it's like you see stuff every time that's just a little different. Like I don't know if I've ever seen a marking like right on a curbstone like that for [INAUDIBLE]. I guess that's the arrow [INAUDIBLE].

PROFESSOR: Yeah, but there seems to one here too, so are there two 12 inch mains running down the street that way underneath us.

PROFESSOR: You have multiple mains. Oh, I think of bracketing it here. So you can see the two yellow lines. But here it is, 12 inch cast iron. Cast iron is the old leaky stuff. It's the most leak prone, most prevalent leak prone pipe.

PROFESSOR: So with cast iron, they way they originally did it is they put jute, which is sort of a grass, between the two joint-- to close the joints. And then as gas got less humid, because they decreased the humidity of the gas, that jute dried out. And so they're basically almost all cast iron has problems, every 12 feet, because of that.

AUDIENCE: Wow.

PROFESSOR: Let's see if we get anything out of here.

PROFESSOR: Nathan and Bob Ackley went out to--

PROFESSOR: All that work and we got nothing. So it's not [INAUDIBLE]. Now these are drill holes, so kind of push it there and see if you get anything. Just hold it down, you'll hear it slow down, the pump slow down if you push it too hard. OK, nothing there. So drill holes are for the gas company when they come out.

OK, let's come out quick and try these. All right, so let's go out here and let's just test-- let's stick it in one of these things real quick. Leave it in for about 10 seconds. And maybe someone can make sure we don't get hit. Keep an eye out.

AUDIENCE: OK, there we go. 40.4.

PROFESSOR: Keep it in there. Keep it in there.

AUDIENCE: Cars coming.

PROFESSOR: All right, we can get up. OK, so definitely gas in there. OK, so yeah, we didn't really find-- we found the leak, but we didn't find any large concentration.

AUDIENCE: It might have been a little further down the block, the scent.

PROFESSOR: I mean, it's all along this block, so yeah. This is relatively new, right, look at the line where the new paving was. This intersection was redone with a new everything, we got gas. So this is an example of a lost opportunity.

PROFESSOR: With MAPC, he did a study to sort of figure out how much municipalities and gas companies could save by doing sort of more integrated infrastructure repair and not screwing up like this.

AUDIENCE: Here comes a, yep.

PROFESSOR: And it was like $1 billion. You can check it out and fixourpipes.org. It's a really beautiful website.

PROFESSOR: So it was just a little bit. But there is gas, I mean, so that's not good.

PROFESSOR: So you can sort of imagine like all the infrastructure underneath, both the gas pipes and the electric and the water mains and stuff like that, as well as the paving. And the paving alone in Massachusetts I think is $600,000 on average per mile. So it's just expense layered on expense on expense.

And so if you fix anything, if you cut into the pavement for any reason, you should just fix all of it at the same time. 'Cause otherwise, it's like operating on somebody's appendix and finding a broken artery, and be like, oh, whatever. Forget that, we'll take care of that some other time. Not our responsibility.