Tracey Peake ([01:13](https://www.rev.com/transcript-editor/shared/qa0TO8ZW6bMcO9BZnze1-iN4cIgb4lnZYWNkS4el4OJC2O1QdciLNUzumIEpGr2lEPBDIVoAuiT-oWr17K2pKBQrw-E?loadFrom=DocumentDeeplink&ts=73.11)):

Hello and welcome to NC State's Audio Abstract. I'm your host, Tracey Peake.

([01:20](https://www.rev.com/transcript-editor/shared/6MjRJn23yqCiodsC64yQYcPsmqJTuv255uZx7pDNZSDHmos_Xgj4n0LrvlpO9-ZKMjpV1FRNSKQ1mq1kuK7lkNoDHuM?loadFrom=DocumentDeeplink&ts=80.34)):

For most of us, sanitation isn't something we need to think about. We can just flush our problems away, literally. But globally, that isn't always the case. We're speaking today with Francis De Los Reyes, professor of Civil Construction and Environmental Engineering here at NC State, about the challenges of dealing with poop. And what access to sanitation means for developing nations. Welcome Francis.

Francis De Los Reyes ([01:46](https://www.rev.com/transcript-editor/shared/sgEvxDYzdzkaHRfGf5L4Pmzj3S9z7M6D6QI7hgC8wKCBRDUKud4Hrg8XGkZT_cbsHq8Ey-3UEGU-Fi9xwXIUnO2K1R4?loadFrom=DocumentDeeplink&ts=106.05)):

Thank you, glad to be here.

Tracey Peake ([01:47](https://www.rev.com/transcript-editor/shared/vXxFpbuw5_xvtpJwrwVL7jsWgyL5v2jWAvMfCFap7nv0Hq-j-RqSORQavEK-80j_XdyNWatFWjxImvDbt0PB27wmKXk?loadFrom=DocumentDeeplink&ts=107.37)):

I'm glad you're here too. This is kind of a weird topic, but an important one, right? And not one that we think about here, because it's not a big deal. So let's get started with, what happens in a developed nation like the US where, we go to the bathroom, we flush the toilet. Then what happens to all that stuff?

Francis De Los Reyes ([02:06](https://www.rev.com/transcript-editor/shared/eFwr7RmHzSqMTJmgMiClwsj4lEjP9ZGbI7TW5FPUFRJNmb4SXTG3nnOR2aV3EHRjZoF54nyYV_A608hhdH8-jI0KRkE?loadFrom=DocumentDeeplink&ts=126.54)):

Yeah, so like you said, most people don't think about it. And we all have to go, and we all have to poop and to pee, and so we go to a toilet. And we do our business, and then we flush. And then in most cases, if you live in the city or in the suburbs, you're connected to a centralized system.

([02:33](https://www.rev.com/transcript-editor/shared/Ix0b7ii9iq9Kh8VNTMNo0rI0OcFsCOyk-XdIu-K6g5Imy4e69pH2tlnX0RHJGBhrG5oD1ofYOvfGEzmp8cJEnbrFK1Y?loadFrom=DocumentDeeplink&ts=153.15)):

The system starts from the home. So when you flush, that water actually goes out to pipes that meet up with other pipes from other houses. And so these are the sewer lines. And there may be miles and miles of these sewer lines, and they get bigger and bigger as they get more and more waste from more and more people. And then typically, they would end up in a large wastewater treatment plant.

([02:54](https://www.rev.com/transcript-editor/shared/4JEMM_aKISYacJzyJiikoVnwVV9J7xTOg-9U7P4hkw8UeuiATSc3OuJlhFvjg0WipKJlCztM3R42DIEPYxf9wOBo6iY?loadFrom=DocumentDeeplink&ts=174.42)):

And in that wastewater treatment plant, you're going to have the engineered systems. These are physical, chemical, and biological treatment systems that actually take care of the waste, eat the waste. And the heart of this is really a biological system. Microorganisms eat the waste and clean it up until we can actually dispose of the water into a receiving body of water, like a river or a lake.

([03:19](https://www.rev.com/transcript-editor/shared/W2zufx6WYfGMZ48-GFpcpCL1I_Rtm__rYe1ZyGMwizDz009SKm3TrbEIVP7kbLOfNCx-VFvgHpE8Ff5G8tpe2qU6kHo?loadFrom=DocumentDeeplink&ts=199.02)):

So believe it or not, it actually goes back to a river or a lake. Which many people don't realize, can be the drinking water source for some other downstream communities. So for example, in Cary and Apex, the drinking water comes from Jordan Lake, which is a big body of water. But parts of Durham, South Durham, the wastewater treatment plant there actually discharges its wastewater, it's treated wastewater to Jordan Lake. So it's kind of like a cycle, right?

Tracey Peake ([03:51](https://www.rev.com/transcript-editor/shared/btfvXsXND6q0qLyIZuD0B6-VEmto0stwqOluXelE-mPmJ-NERefxcuBurTYgv1AqsxqP5gcao8WFIhm5p-X4JQlGUXs?loadFrom=DocumentDeeplink&ts=231.72)):

And you really want to be at the top of the water source, I guess.

Francis De Los Reyes ([03:55](https://www.rev.com/transcript-editor/shared/U9yxxjd2Vo1mNq1L3ONrkQ1I3UnBzOKGxtP5JWMtb4L-7A1HfE366_fZ0-0bbjT4kAJtD92v6Ia0DeLX78UXKrmai5s?loadFrom=DocumentDeeplink&ts=235.41)):

Well, it's a circle. There should be no top or bottom. And the reason why we have these wastewater treatment plants, and then also water treatment plants that then take that water and clean it before sending it out for drinking, is that we protect the environment and would protect public health. Because it's all the same water.

([04:15](https://www.rev.com/transcript-editor/shared/V17835TWYMSFJfOL_BgiChfKPJbjlehtSAOXpkAXMuCcsdVvJdp8T6MyhMEJf-rOoevDkyBQ_s7H15978usw0I3cs6M?loadFrom=DocumentDeeplink&ts=255.45)):

Now that's if you are in a city or in a suburb, where you're connected to a centralized sewer system. But if you are in the rural area, and the houses are far apart, then the sewer lines are too long and too expensive. And so we have septic tanks.

([04:33](https://www.rev.com/transcript-editor/shared/wZUHvUAbqtTOpVPukdpG_pZK9FOvtFGkDMYxPuZc5xbcWp1gtxWAXtx5MrN2uew0FVJYJ3L486CWI98h-PxXhH4nzB4?loadFrom=DocumentDeeplink&ts=273.03)):

And so in your backyard, you might have a tank. And again, it goes through the same kind of biological processes. And then the overflow, the water goes to a beach field, which is a series of pipes buried under the ground, which basically distributes that water into the soil, and then the soil microorganisms take care of the waste, and then filter out and clean up the organics that are associated with the wastewater.

([04:57](https://www.rev.com/transcript-editor/shared/bdKS0UuoPx3aRuXF3TZpf8TrOVb7VWTdD_fEiPA6xHSznm4d1XjZfNmLj9cAc4ywNmVVKBJeXDU6mDgp2ScYfQcOm1E?loadFrom=DocumentDeeplink&ts=297.69)):

So that's what happens in the U.S. Generally, right? So you have these two systems, you have a variety of systems in between, smaller packaged plants. But in general you can say about half of the people in the U.S or, a little bit more than half, have centralized systems. And then the rest actually are in septic tanks.

Tracey Peake ([05:18](https://www.rev.com/transcript-editor/shared/8Lw-3GA4pn5MhnVcmps0oTeVMJ5koDMlWpBCCgAnLZukgTG_QFEPBaLvs0P1VvgJ4q8VRNwbyqwSmv_Eo80A2b51N9A?loadFrom=DocumentDeeplink&ts=318.27)):

Okay, so that's good to know. Because then we can compare that with a lot of places in the developing world that do not have these large sewage systems. And so, what are the challenges facing the developing world in terms of sanitation? How many people don't have access to indoor plumbing?

([05:38](https://www.rev.com/transcript-editor/shared/1wHRVfUVm-kMwrhN-Ll5xLx452-JWooxTk8XHHfOC7SRfjcm10daXMRztn9D99dvTtvFDA0vIe1kDE1etY5LZWgd39Q?loadFrom=DocumentDeeplink&ts=338.67)):

Francis De Los Reyes ([05:58](https://www.rev.com/transcript-editor/shared/nI0Srw9ggRZ1EYyffYNS7zVfA7sYAmp-47pLu-O4tIQaIfteeU3a3EC3dh5bZM44_LPJ6mnkEnFh6YN1c0qIt7LgEh4?loadFrom=DocumentDeeplink&ts=358.11)):

Yeah, so in many ways what you described is right, in that many of these low and medium-income countries are really maybe 50 years, maybe even a hundred years behind in terms of the technologies and the access.

([06:13](https://www.rev.com/transcript-editor/shared/bD72qSx_F3TKCdnRFymWESjjt7Zi_uUX2NtSt5iUMe6tnBm5tOsxWDtT44n2xsgJ_1eZ8SQzDkaX9ZwIQuPCgoExSoc?loadFrom=DocumentDeeplink&ts=373.98)):

In a lot of these countries, we don't have a lot of people covered by decentralized systems. And if you go to any major city, maybe 20% of the population would be connected to the sewer lines and centralized treatment. And then sometimes these treatment plants don't really work as well. So in fact, it's really not treated well to the extent that we would like it to be treated.

([06:40](https://www.rev.com/transcript-editor/shared/fbz_eXstxkbYEPq-1t6GbjpkTXdu5ZiJQz3r6ZhRKB_oLveoWVsHOqJvzwDBj9cR-KBd8Asu0RqyRA8BcBNYgzTgk1I?loadFrom=DocumentDeeplink&ts=400.08)):

So there's actually a project called the SFDs, The Shit Flow Diagrams.

Tracey Peake ([06:47](https://www.rev.com/transcript-editor/shared/ZdGuakeTmDM5XA8rzffmnRNokcj576V5W1qxanp7dhZ78v_i2DEC5DmPwIOelSd2F1Qrf5a89pWksMVXjgasyE7iVCE?loadFrom=DocumentDeeplink&ts=407.82)):

That's hilarious.

Francis De Los Reyes ([06:48](https://www.rev.com/transcript-editor/shared/v0Wgt7vrEe6D_ppbMiLMgdTVVpiefoqVyB13J1hb26TBYV6fjc2jTCtPxdGhFvdo9_Ku2dzdzy6SfB2AyI6rsJdnRv0?loadFrom=DocumentDeeplink&ts=408)):

You can Google this.

Tracey Peake ([06:48](https://www.rev.com/transcript-editor/shared/jj3NtN3J7H1pOjwyqQCG9dFlFpI-IsEkgm66qR8z7RQYC1j3Vkm_Ac6vffvLCQ8C5e24dcwgUMe8lE6bDCvkr0e2jkM?loadFrom=DocumentDeeplink&ts=408.57)):

Yes.

Francis De Los Reyes ([06:49](https://www.rev.com/transcript-editor/shared/x6fYvIFNJinSNe4PQ25bWfLuNfwSBeTXxErq2favvMiUGmwCNHW41IB9fVI4bxVPQKjmHdsKvHxFPv6pIfgOC8gdEOM?loadFrom=DocumentDeeplink&ts=409.53)):

And what they do is, they do what's called a mass balance of all of the fecal material, all the poop generated in the city and where it all goes.

([06:59](https://www.rev.com/transcript-editor/shared/oZM9KmmxBpf5ituhqH9b3QLykwjKh0al_-5FoNc-unlXhkeSe6NoELh61GMYO94vg1wozePCp8sA0MGxWHbCnI8fp_g?loadFrom=DocumentDeeplink&ts=419.01)):

So you can see, basically from going from left to right, a mass balance of, we generate all this waste. And some portion of that goes here, some portion of that goes there. And in many cities, maybe 90, 80% of all the fecal material actually ends up in the environment, not treated. So you can imagine in the cities, again, there's a lack of facilities, a lack of treatment technologies.

([07:28](https://www.rev.com/transcript-editor/shared/xxNkJLxXsk5Csobp-s11-CWav2zPhsosQmG5Y4NgR4hjhlB3UKTvYEfVe8VtW1gaaNNaYOtr0AZF82O_wsYVx_1DT_I?loadFrom=DocumentDeeplink&ts=448.86)):

And so an example might be pit latrines. We talked about the flush toilet. Basically, the flush toilet, we're using water to convey the waste. Now, in many countries we don't do that. We have maybe a dry toilet, or a composting toilet. Imagine a hole in the ground, and then you put concrete slab, and then you put your bowl. And then basically your fecal material just goes to the ground, below ground. And then when that's full, that's emptied and transported.

Tracey Peake ([08:02](https://www.rev.com/transcript-editor/shared/srRDldRX83iXy8rK0kV3g9DHrQya1nzGA4YtH74XOjmNxlFApk98G5LLA-I4GQYptnFOBQp79vWS86kR5JmyieBybaU?loadFrom=DocumentDeeplink&ts=482.76)):

How is that emptied?

Francis De Los Reyes ([08:06](https://www.rev.com/transcript-editor/shared/MWt44R694Wh3JkHmPP76-hnpRYejR2A4cJRnUkg-VAR_ZsluK1kPC2w7XgZh1EQmpBApLnvJmC5poDgCZTWS7jR9jVg?loadFrom=DocumentDeeplink&ts=486.27)):

So we're talking about a chain, really, right? So I know people talk about the toilet. But really, that toilet is just the first step. So you have the toilet, and then you have a way of containing it, a way of transporting it to a treatment facility, treating it, and then disposing of the liquid or the solid.

([08:26](https://www.rev.com/transcript-editor/shared/ZRtkO2kmiJ2B-wQ1qTnJ5giplLoefGEfS87VYXK2MGD0duw4jR90TU3qEiQjA6pvBqFilUx2ruLEv1fw-z0zABsI71M?loadFrom=DocumentDeeplink&ts=506.43)):

Now again, in the US and developed countries, all of that is hidden because it's all sewer lines and treatment plants. And if it's a septic tank, it's contained in the septic tank, and then the water flows out. And then maybe five, 10 years later when your septic tank is full of solids, you get a service to pump it out.

([08:44](https://www.rev.com/transcript-editor/shared/h8p1SG62e3wW6rAh90S_f0DpYs3pViQl1Ho76Aknr7U3of8nbtFIalT0o__h0IzGKNJhO3BwjLFl1mkndT0Hmpr9Q54?loadFrom=DocumentDeeplink&ts=524.1)):

Now in many countries that are in this low and medium-income countries, these spit latrines maybe every two years, maybe five years they have to be emptied. And they're not emptied with vacuum trucks and fancy equipment. Sometimes they are emptied manually. You do have manual pit-emptiers that sometimes have to go in there and do it hand-over-hand, bucket by bucket. That's one way you can see that the whole chain is broken.

([09:23](https://www.rev.com/transcript-editor/shared/Cuj4EiIyEAsVAsrgEvAvOjdyo9yox7875tMuvA6_Jaao7izULFtPT1Chop2qbjoM4dX4w6h4AuBmdRLxGOCExDupsFM?loadFrom=DocumentDeeplink&ts=563.22)):

And then when they do transport it, there is sometimes, well, often there's no waste treatment facility. And so they end up dumping it into a river.

Tracey Peake ([09:35](https://www.rev.com/transcript-editor/shared/9JB6lN4X6dedMM6lQ9l0Fk9pvHNF10jWfOb9zhZM5bQ8-3FF8ZSxw6_TZ4xAbLAeFPChxB-89m1E9suc3QN5UVLFupY?loadFrom=DocumentDeeplink&ts=575.07)):

Oh.

Francis De Los Reyes ([09:35](https://www.rev.com/transcript-editor/shared/0_kSuPaDUBdGV8iRzaDXPIuBaNrgrg7JHvXva5YeHMPHJrWLNuZHG0i46SdD9s_6_Ey8wQmWU5RJEZ6TYIeIH8yQKKA?loadFrom=DocumentDeeplink&ts=575.1)):

And sometimes they just leave it there, and cover it up, and then dig another hole. And so all of that means it's not really properly treated. And that's why you get this statistic that just I said, was 80 to 90% actually goes to the environment untreated.

Tracey Peake ([09:50](https://www.rev.com/transcript-editor/shared/BJnBYbdJPXIqgZPFh7BTHQ_dpwMFhGwLZgBKHcvrfV4ztRQnDd4R0yCvUz_8cpgsxAJwlNvYfTtY_UuilBsYOWXnQEw?loadFrom=DocumentDeeplink&ts=590.01)):

Which of course has a lot of knock-on effects with disease and other stuff. You can't live in your own waste.

Francis De Los Reyes ([09:55](https://www.rev.com/transcript-editor/shared/CC8TRm018eBoLcRF-VDn9SxY-1j-Hjqd1h2tJ0pDV4ZXAX0A26wpT215wAJ4LWqf702DALyUxp3XUasHMjfb5H_tMtI?loadFrom=DocumentDeeplink&ts=595.65)):

That's right. And so when we talk about sanitation, we really are talking about separating people from their wastes to protect public health. And we also want to protect the environment.

([10:14](https://www.rev.com/transcript-editor/shared/heMF_ymmM1GpZLXIgOfNFSNGXKsg6x1N1uqOVG5Pmu4ZyjIvFIInBQNwL7c8gCOF_W_SoPjfwxrg2YpejmdW8Wggwss?loadFrom=DocumentDeeplink&ts=614.76)):

So they're tightly interlinked, right? We want to keep our waters clean so people can use it for drinking, for bathing, for recreation. In a lot of the cities, people who have traveled overseas, you can see the city rivers are usually black. They're not flowing, they're smelly. And those are all signs that it's polluted.

([10:38](https://www.rev.com/transcript-editor/shared/e48uyFMcAF1HFhJDSblCWXiPr3R1anJCTtia8tsha1dxQlJWmHmT2AN301L1VqDO2Bm4TweE2miZwHFD6JsEB5oea4Q?loadFrom=DocumentDeeplink&ts=638.76)):

And it's because of, again, a lot of the wastewater from both domestic and industrial, from industries, are not treated well before they're discharged. So that is an issue, yeah.

Tracey Peake ([11:01](https://www.rev.com/transcript-editor/shared/1qrDOillNBkFxTAD54aYr3UHnXYvV0tSA0ppytu75dFCEB0YQ7HiID4Ab63ggdsO46B2y_AJrMdgQN8ynuD6iK-0kVg?loadFrom=DocumentDeeplink&ts=661.95)):

So I know that a lot of what you and your lab works on is solutions to some of these basic problems. So can you tell us a little bit about what you have worked on to help with poop management in some of these developing nations?

Francis De Los Reyes ([11:16](https://www.rev.com/transcript-editor/shared/ZO8WqO9KJH-r78bxFI-H712VATVGkcrg2AnkUMG3LhLam0CvyzvpCgCjlliq8zAGPPFJVlzC6_BAzsfuoSVQOyQ4wnY?loadFrom=DocumentDeeplink&ts=676.62)):

Yeah, yeah. So we've looked at it again as a system, and this chain of things that all have to happen. We feel like most people think about the toilet, and then that's it. Provide people with toilets, and then the problem solved. It's really not that. There's a whole chain again, of collection, transport, treatment. That all has to happen. And all of these things have to work.

([11:41](https://www.rev.com/transcript-editor/shared/navvQ8gEAnYfyi-KkKb1wgGyUZX5oR1C5Zq1PmZyE69Vra_UxSUoiRNTREGPxc6eAzfoF9QdGhe9GUvURtubbirz5d4?loadFrom=DocumentDeeplink&ts=701.1)):

And so if stepping back, if you think about why it doesn't really work in a lot of these countries, there are actually a variety of reasons. The first one is what we call the enabling environment, which is this universe of laws. So regulations, and rules, and policies, and implementation. These are not strong enough in some of these countries.

([12:12](https://www.rev.com/transcript-editor/shared/kHUVNeDw1UPcJx4XNlLLO4ODJ7QKDc574IA2o69qWVKTH9pG5iB4D2xAiRV-ex41Dv3plJJl_pKLw3hP8EKTnwPlE9o?loadFrom=DocumentDeeplink&ts=732)):

In other words, they don't have the equivalent of, for example, an EPA that says, these are the standards, and we got to do this. And maybe sometimes they might have the laws in the books, but it's really not implementable. Or there's really no way to enforce it. And that has to do with a lot of different things; incentives, and costs, and corruption, and weakness of the institutions, basically.

([12:43](https://www.rev.com/transcript-editor/shared/yDsm9gPRI3TYxI8mM_hnFLV-p89wz2j_1GwMPK4D_aUiYsDR1U2xiR3umYeVOtTxU1PNE69d8OQpOYB3tYEwx0CPtDc?loadFrom=DocumentDeeplink&ts=763.26)):

So that's one thing.

([12:56](https://www.rev.com/transcript-editor/shared/tfjsktrlJerqzPWGX6uX5FHmVSrTQTSYovqbtj2qS9b4eXmxGfm0YjgrT6YOWRv2MmhlV9yha1SbWwAYPLIbnbPCv08?loadFrom=DocumentDeeplink&ts=776.28)):

The second thing is technologies. We know that the technologies that we have here, in developed countries, may not be applicable to all of these other situations. They may not have water for flushing, and their soils might not be right for a septic tank, for example. There are concerns about costs, and there are concerns about culture.

([13:23](https://www.rev.com/transcript-editor/shared/-bvF7cu5n42oePGafBTSgz-F8z4umcSm4QKnN52ceRKTiQIbIfJYH2So09A34he2xySLDhF3awgEOiYO-QQ3NwrC6_E?loadFrom=DocumentDeeplink&ts=803.91)):

So all of these things all add up so that it's not a one-size-fits-all, and there's not one single technology solution that can be used.

([13:37](https://www.rev.com/transcript-editor/shared/u_K5DAAJGNcoCERc2aXXnGgIEnfrPhaDwiZcu4BDiI4brQUSQqSGU15kP7MD90W-5YbSTKJQ-lSvliheYbfctWzgPEw?loadFrom=DocumentDeeplink&ts=817.47)):

And then the third thing is that we need to make sure that it all, it makes sense economically and financially. Somebody's got to carry the burden, financially, for these things. Like any infrastructure.

Tracey Peake ([13:54](https://www.rev.com/transcript-editor/shared/6_wz1d2J6bFeG-9UurwNBe5-ZS7XdI1MHGTCtS5b8KG7lipEZY3DXFhunRB7-KOvysp0qxnteLJcq01sEGH-axuzUXk?loadFrom=DocumentDeeplink&ts=834.69)):

Right. We couldn't just swoop in there, install a bunch of sewer lines.

Francis De Los Reyes ([13:58](https://www.rev.com/transcript-editor/shared/vJCUbSrckcciTh3TV_tMP0_cDjwht3Hr7H4dbOHndaGGtIwpwZhGE4cN97HgCAtiEixVyJ9T7yYsjcxkxxv-zEraj0o?loadFrom=DocumentDeeplink&ts=838.47)):

Right, exactly.

Tracey Peake ([13:59](https://www.rev.com/transcript-editor/shared/zE1cdkVP0e1kCAvsH317F5HO6OZ-XNhe7kzPnwvXSDaMw4yi632IAfr62qhKlgqXCx4yC-SQT99_iLN5M_6BX-hjODw?loadFrom=DocumentDeeplink&ts=839.13)):

And then if they don't have the money or the resources to keep it running after you're gone, you've just thrown that money literally down the toilet.

Francis De Los Reyes ([14:05](https://www.rev.com/transcript-editor/shared/0bNEtJUH3enNSewgjI_dVrNMDEftVo7OpB2FQDUap_GNFR13CRZv0jVRUirL7pc1BzuU3brZmfZgLpV7W47BC9tcv58?loadFrom=DocumentDeeplink&ts=845.34)):

Right, right. And it's part of infrastructure, so it's like roads or hospitals.

([14:28](https://www.rev.com/transcript-editor/shared/v8b9vIPcqAaDKd_BNcU3KijEVCk8bwIVEplIqkw0bzdvjSp727QTBpMnDh5okesJH5rYFszuh-LICFkZ6gSks_5NfXo?loadFrom=DocumentDeeplink&ts=868.68)):

And then, who's going to pay for that? And then, given the limited resources, sometimes sanitation is, it's hidden. It's an afterthought. Between drinking water, for example, and toilets and sewer lines. And rightly so, right? It's the priority. Or between, let's say opening up a new bridge or a fancy highway. If I'm a politician in that country, that's more visible. Nobody wants to talk about toilets and wastewater treatment plants. So that's an issue.

([15:06](https://www.rev.com/transcript-editor/shared/nA_o67WqsQkkzh5kEvsEpk-0hQMzrzJk-w4R7BfbQ5Qtx_WG5FEga-JhPXi6aO8CqH1jGshsbZj7IGY6uL6630RgzBo?loadFrom=DocumentDeeplink&ts=906.06)):

And then finally, there are cultural things that we have to think about. So, education is one issue. We here in the US, we are flushers and we are wipers, and we are sitters, typically. You know what I mean?

Tracey Peake ([15:26](https://www.rev.com/transcript-editor/shared/2vWt6tRU3MXlSJMns_11ksKVib80ZSwsfc2WevcJyaZ-tmsn-QuuIMPESvP2RhZdpAy5Zo0mMf3Pu8n9X_lZuxrLlxk?loadFrom=DocumentDeeplink&ts=926.79)):

Yes, we know what you mean.

Francis De Los Reyes ([15:29](https://www.rev.com/transcript-editor/shared/o7IUAg_rD3zTr9QHHP1V_N-jOgYnCDPSo9akJHCEOa9QGFdiDyolgtz5a18x7yPhZY57VodKfBzZC37LgZW2nKyO15c?loadFrom=DocumentDeeplink&ts=929.19)):

But in some countries, they're squatters. So they squat, they don't sit, the hole is flush to the ground. They may be washers, they use water for anal cleansing. And so that changes a lot of the technologies that we can use.

([15:46](https://www.rev.com/transcript-editor/shared/y9qXCL4B3phWCMh1oNSvTAwzl04UkJ-gB1vlWkvSdw_wxj_nL7DANZHCn6ehasWitL4GpOA8zWj3eP0fGOLflrPGbS4?loadFrom=DocumentDeeplink&ts=946.35)):

So context matters. Culture and context, wherever people are, we had to have a different solution.

Tracey Peake ([16:19](https://www.rev.com/transcript-editor/shared/NQXKgKI2zE0dGt1GqmxwePA2g4rHPkRou-Z9mHbwimtvqhb-AktG5VUQatjYRF0vwlnPYPtAQMWNIPyVJlTQ_hqKQ_c?loadFrom=DocumentDeeplink&ts=979.2)):

It's a very complicated problem. It's not like you could just walk in and be like, here is the solution to all of your problems.

Francis De Los Reyes ([16:23](https://www.rev.com/transcript-editor/shared/LCk-IAyFonh2qdaz_TMcL0LuWLZWEU5W6peHoDJ11fvaToWCLqQlyA-OptH0Sf7X0W6fe0-FVRkE01eLGZ9TP5tiFeo?loadFrom=DocumentDeeplink&ts=983.16)):

Right, right. And that's what we have tried to avoid as engineers in saying, okay, here it is. But also we're engineers, and so we start with, okay, what can we do with technologies that we think will apply in these contexts?

([16:38](https://www.rev.com/transcript-editor/shared/QXK6oIVof9Z9sNIHvRQtX6ggzPpJf1jpTPRlGpOptbn6JOpL4qTAlBGIkXkoNtnM9aTTMoB6-HUoR0hbN8DUqtEPHzs?loadFrom=DocumentDeeplink&ts=998.58)):

So for example, we've developed this technology which is a way of taking the fecal material out of a pit latrine without the operator having to go down there and doing it manually.

Tracey Peake ([16:56](https://www.rev.com/transcript-editor/shared/ATv7Ce45kZ_bdm4UNGab6QQDQTFmBzVh4SVZLgX24gSiaS-SDDcfRUF-P1IOxq5QJHd5_s_kzC44DLdmSlxBWrekVak?loadFrom=DocumentDeeplink&ts=1016.46)):

That's great.

Francis De Los Reyes ([16:57](https://www.rev.com/transcript-editor/shared/wAvhpouBSj4X_KqY36soNTYlUru1rouD41QpZMcTvOTO4Nx0Go-C-v5F68oXtcYH8oJRWgx_xbjkRD7RIRP2CT5Qkss?loadFrom=DocumentDeeplink&ts=1017.15)):

Yeah. So it's a technology that's been developed over 10 years with the Gates Foundation, and we've traveled to different places to test it out. And it's out there, and some groups are using it, but it really doesn't have a huge market.

([17:17](https://www.rev.com/transcript-editor/shared/Ot5jUVyYCpRp6IElpjtBmW58kXN-6hnTPLcieIKzLTpuqLEMztKAqgpvJ9ebyeVgUBWjbKIzHy3KOgcjzrjaiCcjeew?loadFrom=DocumentDeeplink&ts=1037.4)):

Again, because of a whole set of issues with funding, and finding partners who can take it to scale and commercialize it. It's not a huge money-making area.

Tracey Peake ([17:31](https://www.rev.com/transcript-editor/shared/vDwQRHm8sxOzV04Kz3tKqmL62CNDtO9eQn8UkQvM6vqrcy9025LBi_S_rRauUwMRYMgK5p4VyB0WRzCLQ2hu_Vfn4ys?loadFrom=DocumentDeeplink&ts=1051.89)):

Right, right. But I bet it's great for those people who would otherwise have to go and clean those latrines by hand, holy cow.

Francis De Los Reyes ([17:38](https://www.rev.com/transcript-editor/shared/hCIkRmI-zfkBwMRgukGIZYmGzTcLTgZE_yD131Y3Rd6sOMrXz6WUMMq1dyJow6SkxI-2ekHwThme9XiaQA9IJe3GR7I?loadFrom=DocumentDeeplink&ts=1058.61)):

So we look at that. And then on the other hand, we also look at treatment technologies. Like, what can we do now with the fecal waste? So there's the emptying part.

([17:48](https://www.rev.com/transcript-editor/shared/nae2I53jpBG4eyt_pHr4DIE5wvrcGuLeLkdR9WW5eeRLQuFzaSX1CGbSaXQ37h-KHJ4woW13jKzCr9WWl58IggSh4TU?loadFrom=DocumentDeeplink&ts=1068.18)):

We think about, how do we treat this with biological processes? For example, anaerobic digestion, so we can create energy out of it, like biogas can be used. So, resource recovery, we work on that. Both on the wastewater side, as well as on fecal sludge.

([18:06](https://www.rev.com/transcript-editor/shared/uylQLqsMBzEYg8sOtl4joDYgJgOD-Z8do-8X8GFvKi2N8rQrZm2qDzKw-nZVRnx0LGgQsbCvCGJGdBBI1J4sdJuJL1o?loadFrom=DocumentDeeplink&ts=1086.27)):

And then on the transport side, we think about risks. What are the risks when you are emptying and you're transporting, what's the exposure to the pit-emptiers to the community, to the workers? So that's all kind of looking at it from the different portions of the sanitation chain.

Tracey Peake ([18:26](https://www.rev.com/transcript-editor/shared/r21QW1t-q6ZMxJrdhwP9LJFZcKSYug3VtGkg_4f194N2W6SwQAzkGhSGebOp2mz7E8X3s8rjA08s06yB7XJTDAmKmw4?loadFrom=DocumentDeeplink&ts=1106.49)):

So that leads me to another question. Because talking about all of these treatment options. Particularly for liquid waste, sure, but mainly for poop. For the solid waste. And we can't just import eighty-gabillion dung beetles in here to handle it. So is there money to be made from poop?

Francis De Los Reyes ([18:45](https://www.rev.com/transcript-editor/shared/ZoNwZbTYi0FXfVXqNI2szMYzEYQ0WouipnjhNdUEjresiv5Qt9eqhWaVZy0fhcEC_vdziVj6blrsY53herl0wVFCg4o?loadFrom=DocumentDeeplink&ts=1125.3)):

The short answer is yes, there is money to be made. Again, the key is what works in a particular context. So depending on where you are, depending on things like the market for fertilizers, for example, or the market for energy, and then the cost of collection, the labor force and what people are willing to pay, and what regulations are in place, all of these things have to come together. And if they all do come together, then yes, there's money to be made.

([19:22](https://www.rev.com/transcript-editor/shared/xw-jHcasSTz0ppQRPRv8N9kIScgYtDzQxWYyRoLA8po1Xz-ciiH2fnCmZrUmKY3_cfIePUqgNJzjMtreQrdzRHvg4B0?loadFrom=DocumentDeeplink&ts=1162.17)):

So for example, pit-emptiers, there are companies or small businesses, local businesses, that actually thrive. And they make money, it's a living. And then on the other side, there are NGOs, for example, that take that fecal material, convert that to energy, maybe fertilizer, maybe compost, maybe biogas energy.

([19:47](https://www.rev.com/transcript-editor/shared/-tKKxpYm1sU7HMzjGMZrmY54HIKAMH7_JmELneOqtDYNqyb4cWczTPpqT3kLhByJ226WRGYLrqozAuPFEKdb8rTr6Ek?loadFrom=DocumentDeeplink&ts=1187.82)):

And there's some unique things, too. For example, there's something called the black soldier fly. So it's a fly, and it eats the waste. And then the larvae, the larvae are actually high in protein. So they're collected, they're dried, and they're used as animal feed.

Tracey Peake ([20:07](https://www.rev.com/transcript-editor/shared/77WLzMOBQhLECllybpm_NaWhepmhLF550eMAgd57U6XjpzrZKj_WJsIpdZVlzjwTQ9bx9KYGvbG-sOhD1Biq_wUhCsw?loadFrom=DocumentDeeplink&ts=1207.62)):

I have heard about this just recently. Yeah, the black soldier fly. They were like, yeah, we use black soldier fly larvae for protein. And I'm like, aren't those the flies that eat poop?

Francis De Los Reyes ([20:18](https://www.rev.com/transcript-editor/shared/F47phRpeELCxRKaLwfgAph-2AmHvws7gEhgUR3Jz6J1opFFerJ2CvnEHMyiO66WMHhYEyUWru_NBPgtiUZ6riclZWSM?loadFrom=DocumentDeeplink&ts=1218.03)):

Yep.

Tracey Peake ([20:18](https://www.rev.com/transcript-editor/shared/jPsHjuytaSubO5AKqEpyD81Do6KJHBnmDsnFT7nphAkyIwAgQSHao5cfNGzqgtsCRn5Mrj8auaKZoWsvydUQxtDeBkU?loadFrom=DocumentDeeplink&ts=1218.42)):

Yeah, okay. So it's sort of adjacent to the dung beetle idea.

Francis De Los Reyes ([20:22](https://www.rev.com/transcript-editor/shared/QttSpsTCs4XhhFhvVoCijKfB39X8BGUxXVRNDzqs_s9AiaDvRB4DAz8FMrZi_B9nX8pM2OdbEo25Sc4h_Zu8cEnAGsI?loadFrom=DocumentDeeplink&ts=1222.71)):

Yes, yes. And there are, vermin composting is another one. You use worms that actually create this high-value compost that's 10-times more expensive than the regular compost. And then you can buy it and sell it. So there are ways to make money out of it if you think of it not as waste, but as a resource that you can convert to energy, you can convert to other things.

Tracey Peake ([20:51](https://www.rev.com/transcript-editor/shared/_ne24oJOMbA4qe-p0sK1mgcRc6d35cTlk4tOq_8UMj3ymBIaVJF4BYRjFcqwW0Rx0Ke102yLzVxh3PPk8YoDaHw6Ar0?loadFrom=DocumentDeeplink&ts=1251.3)):

So that's sort of an educational barrier, I guess. If it's just easier, and what you've always done is dump it in the river, you have to change a lot of minds.

Francis De Los Reyes ([20:58](https://www.rev.com/transcript-editor/shared/IpoMdgv9N5R9vLGWRCKZakKo4jparwmoEwIChALrFaT6F545iJBFV6hxj2SCS5QTTnBML9zSspusVUU9AVISzP9bAuA?loadFrom=DocumentDeeplink&ts=1258.65)):

Right, yeah.

Tracey Peake ([20:59](https://www.rev.com/transcript-editor/shared/uiLNC6IOxbeNWJzN6OfHa5kD9z3ZQtDdqfBrsjLZHOAHiv5zXIzlbYhGdXr_Z61YQ3rEIFee6A5HQU_8XT1CrrWkZRE?loadFrom=DocumentDeeplink&ts=1259.79)):

Do you have any statistics on how many people, or a ballpark of how many people are probably affected adversely by these practices?

Francis De Los Reyes ([21:10](https://www.rev.com/transcript-editor/shared/x7ZckSOFI1vBzj16w04pJuXmHAo_fFH8NtBRA8hXoUo1NRjeWH4AhJaozQJ5S-4Zo8lT8Ifm7ssp_F1Nbt-eQSYQot0?loadFrom=DocumentDeeplink&ts=1270.14)):

Yeah, yeah. So the UN, the United Nations, tracks these numbers as part of the sustainable development goals. So one number is the number of people who don't have access to toilets in their house, or basic service. And so that's about 1.92 billion people.

([21:34](https://www.rev.com/transcript-editor/shared/5fZ6NrDbV7dFnYiKlT3MKd02Yfk962tyXbWy0EoJfhnivSybGkMCzdcN0rrkcN5arykd-kkbR4kS7NU0QLrEi19qeHM?loadFrom=DocumentDeeplink&ts=1294.8)):

So if you think about it, it's about one fourth, almost more than one fourth of the people. And then another number is a larger number, these are all the people who don't actually have what we call safely-managed services. Meaning they might have a toilet at home, but then it actually just goes to their backyard or goes to a pit, and it's not treated properly. And that is a bigger number. That's about 3.6 billion. So a little bit less than half of all the people in the world.

Tracey Peake ([22:08](https://www.rev.com/transcript-editor/shared/7ERwvbqL3eHsFFec4Poz1bNHoKdfd0hnT8R1iNbzJH1DOqBHzqLq1uxt3y3ICd472JmftI1Hs_F_RtRzFtNqqEoX3as?loadFrom=DocumentDeeplink&ts=1328.91)):

Okay.

Francis De Los Reyes ([22:09](https://www.rev.com/transcript-editor/shared/t-SXr2aqrkrArNQWkyLZqVaJnXqMna-VPhEvl-nwb4Qd5I6xGA_B5gJvOLCz6AF59zYbyrQll5DYoSkp27YBHH7XSK4?loadFrom=DocumentDeeplink&ts=1329.84)):

Yeah.

Tracey Peake ([22:10](https://www.rev.com/transcript-editor/shared/nRzZRWYoybv2x19aPLRtCoJmK92XIkfxM-a0PWsNzXALfxeuRZUA-pCHA7v5NGiPtySgKDs-4q_JwbT2g2Y6vr9Z3sM?loadFrom=DocumentDeeplink&ts=1330.62)):

Wow, that's terrible. And then that's not to, you probably couldn't get a one-to-one correlation on disease, could you? Or how many people are dying of disease from...

Francis De Los Reyes ([22:20](https://www.rev.com/transcript-editor/shared/O1rAwJIj8UIuTKqP0kKxtBoqIEZ6nYYfaHycjunsIDYidCMPhSsUxJP7aMKhRhy3wFj6jnyBJCqqgIM2RKUBhwHX8m4?loadFrom=DocumentDeeplink&ts=1340.16)):

Well, yeah. I mean, you actually can.

Tracey Peake ([22:22](https://www.rev.com/transcript-editor/shared/_mmx9C1GlKjibspl3b-xpGjJHZ3SPWcIVEqnULkZdjMeeu60IJPRaDI6Fidwc2S8lf2ZdqbNn3hWJXDgRyS91xCbelA?loadFrom=DocumentDeeplink&ts=1342.47)):

Oh, okay.

Francis De Los Reyes ([22:22](https://www.rev.com/transcript-editor/shared/3T742RHqoECFZsKYENT9Wwwo1q3BIAlKBUSnB8hAX8mDq-XN_DuFCHtxgo-p41EKwulHPEOLjubg0sHtyyJoktq-DnY?loadFrom=DocumentDeeplink&ts=1342.8)):

And again, there are direct impacts and then indirect impacts. So the direct impacts are infections, for example. Because of these fecal-oral transmitted diseases. And then you have indirect impacts. For example, malnutrition.

([22:41](https://www.rev.com/transcript-editor/shared/r1DG6guOFlR8loJUBWwKo0dwhiBUJWIh7Vng5jYpRhBXnUnzlac34ohNjRqKoyRZuxHkq-Rgif_ASbznKbfZHEeTWiw?loadFrom=DocumentDeeplink&ts=1361.85)):

So the direct would be people will get sick, diarrhea, and all of that. And then you have the indirect impacts, subsequent malnutrition or stunting of growth because their mothers were malnourished, or exposed to these unsanitary conditions. Or kids who miss school because maybe they're young girls and they don't want to go to school and they have their menstrual period, because there are no facilities at school.

([23:17](https://www.rev.com/transcript-editor/shared/eYT8nY7wUiCxYMabrdvUIGtg46sS2X1D0S9jOtzQe0fBBc1-27PF9Z2xuQDOWsMtWyCb3RvtJctWK47z2vxUCuYESzE?loadFrom=DocumentDeeplink&ts=1397.28)):

When you add it all up, sometimes it's 2%, 3% of the GDP of a whole nation. All of those economic impacts, medical costs, and so on.

([23:44](https://www.rev.com/transcript-editor/shared/WGy6YleuPUR6cUowHN9S9N-Rumm03PrmmkO03ecAE5hF-Woc9dy-2UZrxqdWC98VEsEtXntxdexhHJ4Tp7nwpI5UqSg?loadFrom=DocumentDeeplink&ts=1424.55)):

What's interesting is, we're talking about low and medium-income countries. This is also actually an issue in the US. There are 2 million people in the US who don't have access to basic water and sanitation. And an organization called DIGDEEP did a study last year, and they quantified the impact of the US economy as about $8.6 billion per year.

Tracey Peake ([24:11](https://www.rev.com/transcript-editor/shared/HFFk-x7qMQs1TYmna6vb7xGt-ORuij_wg9MIkV2-su6q8m-2Uy3dQ7lsFqUjTB8knsOjRAbvgagqm7MhQuVJqjMPvpI?loadFrom=DocumentDeeplink&ts=1451.37)):

Wow.

Francis De Los Reyes ([24:12](https://www.rev.com/transcript-editor/shared/g5HlLZYYQZz8aFmUG2yEehg3t0bB_SF_GMaln2z5wjJ2xnX0n25-8AgS_35e349LgkEN69sK_KsR0AEgF1wgg2CPK2Y?loadFrom=DocumentDeeplink&ts=1452.93)):

Direct impacts of these 2 million people who don't have access to water and basic sanitation.

([24:22](https://www.rev.com/transcript-editor/shared/SAxZnmtvzNefL3lUIaNntTELJfGT1nmuXCKloGrYfOKBvPWD3l5ysuIYs9-8Iiv_M-JWc09GwuQ3oRR1etpxFSqu-sw?loadFrom=DocumentDeeplink&ts=1462.29)):

So it's not just something that is happening in low and medium-income countries, it's also happening in the US. Even though it's a small percentage of our population, there are people left behind, communities that are underserved.

Tracey Peake ([24:36](https://www.rev.com/transcript-editor/shared/F7xetRsKciZWhx2CEQXjT9ZTAiwvCb35GR8_koTx1gvCxfQXygGLPzsUC-x8q7q2WfkEgg5L3LiorBwpd4LgYolyafY?loadFrom=DocumentDeeplink&ts=1476.63)):

Well, it's amazing to me how something that, like I said, we don't even think about has such an amazing impact economically, in terms of health, across the boardAnd this leads me to sort of my final question for you, first of all, how did you get into poop? And secondly, what is the most interesting thing or the coolest thing that you've learned while doing this work?

Francis De Los Reyes ([25:03](https://www.rev.com/transcript-editor/shared/dAfSeihnuYjz9pahxKbyIOJ73mfk4KEC5VWizn-XzLdaFacnI_BaJQRTXfCPClDlkCSRG1kQsVWZCGTKn3Pe5iFOxMw?loadFrom=DocumentDeeplink&ts=1503.21)):

I was trained as an environmental engineer. But I'm originally from the Philippines, so I've seen underserved communities in formal settlements. People whose housing situation, and maybe basic water and sanitation situation is not ideal. So when I will train in the US in these big, giant wastewater treatment plants and biological chemical processes, I always knew that this really does not apply to half of the world.

([25:50](https://www.rev.com/transcript-editor/shared/IIXgBN6WP_C47Nf8GFRdkvnsPqaXhRqF6o7HFetsdIiuUyua9HidikeceWUnfdFzOi2shCXMfeiVhBErFdhcPY_r198?loadFrom=DocumentDeeplink&ts=1550.7)):

I started with, I would say, traditional wastewater treatment technologies. I did a lot of microbiology and biotechnology. And I wondered, how can I apply that to what I think is this problem that affects a lot of people around the world? And so I kind of went back to my roots, if you will, and started thinking about this problem.

([26:22](https://www.rev.com/transcript-editor/shared/ZQ5P-LQnbMZzyb4XpN4Nf8CyfosT91ulq4ZGf2IwiqNfvsLsr8OwHvViBZVCt7nuldfR9bP-BjT34BqUcyf9szSVFBo?loadFrom=DocumentDeeplink&ts=1582.89)):

And so that's how it really started, which is interesting. I guess the second part of your question is that when you get into it, you realize that the coolest thing is that you're not alone. There's a bunch of people in the US, colleagues at different universities and all over the world. Maybe they're in NGOs, maybe they're in government agencies, research institutions all over the world. Both in developed countries and in these low and medium-income countries who are actually passionate about this issue, and understand that it's a great challenge, but it's also a great injustice.

([27:11](https://www.rev.com/transcript-editor/shared/xknn1RUefsdarDPE0VDFxfDM6vxPhU5VjfcaDvvTwl4Tr94-Ey8olwiGiBa7dnsdLZuRfYO2GcJZP23p6jNmQmS12mY?loadFrom=DocumentDeeplink&ts=1631.19)):

([27:46](https://www.rev.com/transcript-editor/shared/o7pGSuYViQ2T7uCYKqyDhxwDPKqldHjzlNEXIa4Lv7RGLYBx-0EOs5hSMxE27pGxF9IHcX6HcB1gq2DEXmVRkWQUiFQ?loadFrom=DocumentDeeplink&ts=1666.41)):

So that's the coolest thing, is the people always are always thinking and getting to think beyond what they usually think about. Like you said, it's a hidden problem. And I hope we continue trying to expose this issue and challenge our young people to address this, because it is complicated. So that's one of the coolest things, maybe. Yeah.

Tracey Peake ([28:13](https://www.rev.com/transcript-editor/shared/YWOm0mgFEo1wfJQMG_5J0mtgEPoDUZa3h37j1HtLBI2nSGQr2_Db6i7c776FVibd7jdZfvV8YbLhlmitIpI8RC-pfvg?loadFrom=DocumentDeeplink&ts=1693.92)):

Well, that is a cool thing. And it's interesting, again, it's something you take for granted.

([28:34](https://www.rev.com/transcript-editor/shared/WRhxPy9cshOdL7I2zLQHY1e1ja0ytXNLTth8oSvjqdbLGzznKK_gHcS3uP_Oih7e5NaoLk5fXYk5SlMq6do5QUE2xCQ?loadFrom=DocumentDeeplink&ts=1714.14)):

So it's good to come back and think about these things that are hidden problems that have impacts far beyond just, what do you do with your poop? So thank you so much for being here today, Francis. This has been great.

Francis De Los Reyes ([28:47](https://www.rev.com/transcript-editor/shared/eXQnYMR154L-yLNSOoRCd_zXYv9uxCq-VM0CbnGhTMeZEfO8-lPCer0cBVMG3AmqeMp9LpxT1PnqGn1QzUgiwU7f8jI?loadFrom=DocumentDeeplink&ts=1727.94)):

Well, thank you, Tracy. Yeah, I really appreciate the chance to talk about something I'm passionate about.

([29:02](https://www.rev.com/transcript-editor/shared/Ip_Vg0kMxNK_ZWGTvrw3jBdE3B4rzcLkSLhztzHH5xsBnXEYvbhWNo2wI9PVpQ610MGzysMed58h8QmxVI-oWzjtW5E?loadFrom=DocumentDeeplink&ts=1742.55)):

We've been speaking today with Francis De Los Reyes, professor of Civil Construction and Environmental Engineering. This has been Audio Abstract. I'm your host, Tracey Peake. Thank you so much for listening.