Geologist Consultation to NRRA at "the slump" **7/29/2023 9:00 AM.** – edited transcript - p 1

Joshua Kilgore, consulting geologist; slump coordinates 39 7.642' -123 29.538'

Bruce Wicinas, Judy Nelson; NRRA board; Doug Nelson and William Seekins, former board members.

Bruce: I forwarded the history of the site, the questions from Tom, various e-mail exchanges and some pictures. I want to show Joshua the extents of the site so he can walk it and make his own observations. (Indicating the holes) Bill inserted a tape into these holes. (Bruce summarizes recent events - the slide above, the 50 truckloads of rock, the surface drains added. This year the slide above stayed put.)

Bill: (indicate the holes) A couple weeks ago the tape went it to 11'. Now it goes only about 3.5'.

Joshua: Does anyone remember, did the landslide originally have the kind of trees we see to either side of the slide?

Doug: It was already transitioning into this stuff. See pistol-butt trees up at the top.

Joshua: I see that. They put in these sorts of surface drains?

Doug: They're just just tarpping sheets, not dug-in.

Joshua: They are not sloped to drain, graded across? Where they were dug in, with a gravel package?

Doug: Very marginal French drains, mostly tarping what's already happening.

Bill: The lowest place where the slug is, it no longer drains. It has settled so there's a perpetual puddle.

Bruce: (Recalls the big grant funding the grants places in 2001. Indicates the nearby culverts above and below the site. Explains about the culvert aiming water into air, the big erosion below the culvert. Mentions the concerns about the consequences of the culverts. Mentions the trenching by AT&T. Indicates the former location of the cross-road rivulet at the upper end of the site, now erased by road correction. Describes the recently drilled well on the parcel above the site.)

Joshua: Give me some time to examine; maybe 15 minutes.

(Bruce hangs chain ladder over the edge; he and Joshua climb down.)

Following site inspection

Joshua: When Bruce sent me the coordinates I found a map from the USGS showing an old landslide at this location. The map was dated in the 1980's. It's indicated by a dot on the map, "too small to be delineated on a USGS quad." We're looking at an old slide path, its upper reaches. Slides have parts. The very top part is the "escarpment" from where the material is removed. Beyond the midpoint and extending to the bottom is a "deposition zone". I see the classic features of this throughout. Up top the slopes get steeper, indicating potentially where the most recent big failure has happened. This material here is likely all slide debris, stuff that moved in the past. You can tell by the big trees that have been removed. If you go down the slope the grade mellows a little bit, and you get this probably big slug from the original movement. You have the "toe" of the slide down there. You see that with the pistol-butting of the trees and the more gradual slope below. I think it's a historical landslide complex which has been moving for a long time.

Doug: The road was built in '49 and it collapsed immediately. We got to know Bill O'brien who worked for the Nashes. The first thing they did after building the road was buy a D4. Starting from Year One, keeping this section clear was a priority. in the historic period there has been a landslide sufficient to block Mill Creek for at least a year's time. As far as I know, at least two houses have slid off this zone. I think this is where Mill Creek cut through the Franciscan but I'm not a geologist. 3:45

Joshua: It's a complex zone. We have a big one here, another little one over there, another one over there -

Doug: Classic Franciscan -

Joshua: Yes, kind of all moving. By the pencil-butting trees you can see all these things have been moving over time.

Joshua: The other thing I see, is over the years you've had a lot of fill. This first steep slope at the edge of the road, could be 10' of material. The thing that activates these slides is moisture - surface and sub-surface water. To design to minimize the chance of an area to move, you minimize the ways that water can get in.

You remove surface water through drains. What that looks like is V-ditches, sloped to drain so no water has a chance to slope or pond and flows off immediately. That goes to an erosion-resistant area, often just a place with cobble or rock where it can dissipate the energy. If you can't make it to an established drainage course, dissipate it where you can, away and downslope from the slide area.

The other way we handle it is through sub-surface drainage. There are a few different styles. During a typical grading process it may be the installation of sub-drains. It's similar to French drains but with one big difference. When people do French drains they typically leave it open on top. We see that as a way to introduce undesired moisture into the subsurface. You're giving it a pathway (6:44) down into the ground. So we stress “separate” - two separate drain designs. You want a surface package which is set to drain as fast as possible. A sub-surface drain package is a gravel drain with pipe sloped to drain that has been sealed off at the top with a foot of clay-y material so no water gets in from above. You are capturing it both places so it does not have a chance to pond and build up hydrostatic pressure.

Another way is de-watering. We see that happening sometimes on very large scale - a big slide you just can't grade out. You install dewatering wells. Those will be set to pump water on floats, and set to pump water as they can. It will be a full-time fix - wells with pumps.

Doug: Vertical not horizontal?

Joshua: Vertical. Horizontal wells are something you see; CalTrans loves them; they are kind of a quick and dirty fix. It's a pretty low-tech thing;

Doug: How effective?

Joshua: They are pretty effective.

Doug: Long term?

Joshua: They may plug at some point. They may make a pathway where the water just goes. Long term, it's a toss-up. CalTrans deploys them shotgun style on 10' intervals.

Bruce: What does it take to drill those? We have assumed that's beyond our capabilities.

Joshua: They're pretty low tech. You have to hire people. When you get into drainage stull, when you talk about the "full package" I highly recommend getting professionals involved. The tech is pretty low; a horizontal drill and a pipe with a screened interval, they do a lot of these without even investigation. They just take a shot, saying "hey, I hope we can break that plane of the water, capture it and maybe that will do it." There have been amazing stories where they deploy to a mess like this and stabilize it.

Bruce: What's the title of the professional who does this type of work?

Joshua: Civil engineer, and somebody like myself. A combo on that. A scientist to inform it and a civil engineer to make sure everything is sloped to drain. That's for de-watering. That's to stabilize it. For the "standard fix" money is no consideration. (Bruce: that's not us!) There's no easy way to stabilize this in a for-sure way without a lot of work. De-watering is a strategy to mitigate. The best is a combination of a geotechnical fix and drainage improvement.

We could do a "grading fix" on this road. ("What does that mean?") Take material away, put it back, rebuild it. (Bruce: “That's what Tom and Bob did on the upper road, 20 years ago.”)

Joshua: We have unknown depths here. You are talking about a big project. The scale is such that you could do a grading fix and preserve access through here, one lane. You start your work down below and build it up. It's the lowest-tech fix but still costly. The other remedies are more engineering-heavy and the cost is a toss-up. Things like: soldier-piles; stitch pier walls. We find the depth of the landslide deposit; then drill piers sub-surface; concrete-cast piers which get support from the underlying material. It can be designed to hold up all this. They are like pilings.

Doug: Our bridge is set on driven pilings. Would it be similar?

Joshua: It would be similar. Either drive them or drill them. They work on the fact that soil has a lot of friction. You would do a sub-surface wall; you would do one here (indicates;) do another six feet away; That would give it enough strength to hold it. I have seen those work very well in situations like this. It’s relatively low invasive.

Doug: Pouring cement is incredibly expensive here.

Joshua: You would pour cement. “Driven” may not work here. I am not sure you could drive deep enough to get into the underlying material. All these sorts of things need to be informed by a geotechnical study. (13:00)

We can talk about some potential mitigations in a minute. I'm giving the rundown on the big picture. If we were to hang our hat on it, "this thing is going to last for 50 years", it entails piers, drainage improvement, all supported by a geotechnical study.

Bruce: What if we move the road farther into the slope. At that bend we could move it in if we relocate the AT&T box.

Joshua: I don't know where you are going to find steady ground. You are not likely to be able cut in and get away from these deposits.

Joshua: This is a good attempt you made on the top (indicates up the slide area.) Those are probably helping a little. But if those plug up you've got empoundment. You might not have much option up there but typically we say "do not impound the water anywhere." Slope it to drain and get it off as fast as possible without adding any more weight to the soil. Regarding this ditch here, you want to make sure you have enough gradient to make it drain effectively. A couple percent tend to make it drain well; if this is moving and sinking on you, it's a moving target and the necessary slope is hard to sustain.

Doug: Would you remove or block these culverts?

Joshua: I would not remove the culverts. These, especially the one up there are keeping water off this area. Ditch maintenance is critical. (16:08) Make sure the entrances to the culvert are clear. That erosion area below is not a huge deal right now but those things can lead to further problems. When you undermine and over-steepen areas you create other parts of weakness. We call them landslide complexes with nested landslides. You cause a failure somewhere, that can weaken another area and cause another one, domino effect. (16:40)

Bruce: Regarding the side ditch, more cracks open up, the water goes in. We've considered impermeable fabric, concrete drains - we're still undecided.

Doug: Half-culverts we could ___ in through, would that be desirable?

Joshua: Yeah, if you have to culvert some of this with a surface drain, make sure you get most of the water. This kind of material, this white pipe (indicates perforated white pipe section lying in the ditch) can move a significant part of the water.

I will tell you, it's gonna be a challenge. All of these are going to be on-going things; this will be your problem child.

Bruce: We were lucky for 15, 20 years.

Joshua: And you're kind of lucky now. Last winter was huge. I saw stuff cut loose which had not moved in a long time. You have good tree cover here; this seems pretty well established; that's worth a lot, to hold stuff in.

Bruce: Is it worth trying to replant trees?

Joshua: I'm a big advocate of planting. Deep-rooted shrubs are really effective. This coyote bush is good.

The bad news is, you guys are sitting on a big landslide that is a big project to fix. To fix it would require a whole cast of characters, and money. You start with a geotech investigation to figure out what's going on. That would guide the design of the fix. You have to have county people involved to get permits, engineers, the whole deal. You may involve FIsh and Game, because of the creek. Because you are pretty far upslope you may be able to avoid Fish and Game.

The positives: you've obtained grants for the dewatering before. There's money available if you can say "this is dumping into the Navarro River watershed; and that's a salmonid creek; if this thing rips it will cause all kinds of problems." (20:10)

Doug: There is presently grant work being done on Little Mill Creek.

Joshua: The interest by the state in Mill Creek is a huge benefit.

Start by characterizing the slide. (21:00) “This is the kind of slide we have.” You have a lot of history compiled; you have geotechnical data. “This is our depth; this is what it's going to cost, or what it's going to take to fix this, and here are some options.” Then, you can start looking for the money and start convincing someone. "We've got this huge problem over here; it's been dumping sediment into the river for who knows how long;" If you have grant funding things can get quite a bit easier.

As far as short-term mitigation you want to concentrate on the drainage stuff. Make sure that this culvert is working well and is sloped to drain. If you have to drop it a little over there that would be good, to establish a consistent drainage over here. Make sure you don't do it too steep, so it cuts in some more. As far as lining it - I think that's unnecessary if you have a good gradient. As far as these cracks - on a piece-meal basis you want to get that water out, away from the cracks.

Where there is sheet flow coming down the road from upslope a kind of rolling dip may be good, to keep water off before it comes to here. Revisit this (Indicates the landslide slope above the road) - but trying to improve it may disturb the terrain and degrade all that you've done. You've got these bushes getting established which are helping; you don't want to destroy these. I'm not a fan of catchment basins but while you have them, make sure they're always functioning and always draining. If those things start plugging up you've got a ton of water up there.

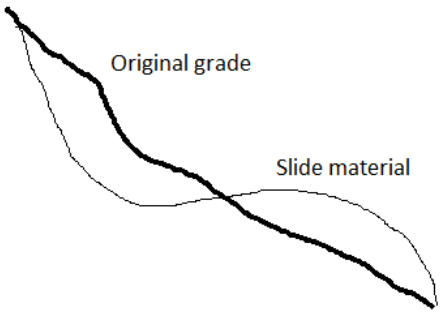
The other things you could play with - I was thinking about on the way up here, but seeing the scale of this it might be less viable. if this is a shallow slide which it may not be, you could try a sub-surface drain to establish some drainage in here. If you have 10' of material and you can dig through it, get some fall, daylight it on the other side of the road, you could catch and drain some of this subsurface water. That would be a "catchment drain." You have a big gravel package with SDR-35 or equivalent, that good white pipe (indicates the piece lying in the ditch) sloped to drain, the gravel sealed at the top so none of this surface water can get into it. Both surface and subsurface systems discharge into erosion-resistant areas. You don't want to start a problem by dumping all the water down there. (25:54)

Doug: How important is it to deal with the water we're already taking across the road? (referring to the existing culverts)

Joshua: Making sure that goes into something that's erosion-resistant is O.K. The erosion you are seeing there at the outflow of the existing culvert is not likely to activate this whole thing. In the scale of that, it's just another piece. I would have someone extend that culvert. I'm not sure what your man is doing down there but you could extend that culvert and discharge it into some cobble - 6"minus cobble into an 8x10 platform. It can be very low-tech.

Another option is to do nothing. You had this record winter. It did not rip on you. Could it rip? - yes. But it makes all those grant things easier to get, when you have active sliding;, "we've got to get this fixed right away." You then have messy pictures.

(Indicating the holes) You say these went down 11'? You've likely got a package of slide deposit, sitting on slide deposits which are moving out.



Bruce: If it “ripped” how much more could go? The angle of repose has become more reasonable.

Joshua: "Angle of repose" goes out the window sometimes. (Joshua draws a section sketch of a typical slide deposit - escarpment, belly, deposition area, toe.) So it's a little hard to say - are we getting close to this thin part? If we can cut off the water going to this part below the thin part, if we can dry out the lower part of this we'll likely stop a lot of this motion. If we can get the moisure out of this top 10'-11' or as deep as you can, it might do quite a bit.

Your options, in brief.

<u>To do nothing</u>, piece it up, keep your drainages as good as possible - if it goes, deal with it in a big way as an emergency situation.

<u>Drainage improvement</u>, the basic stuff we talked about, would be the bare minimum. See what kind of improvements you can do without making this a grading or an engineering project. "can we establish a sub-drain here?" It would be a big deal, and somewhat costly itself, 10-12' deep subterranean drain (beneath the inside ditch), requiring a big excavator. Can we get through all the slide deposits, keep all water that's is upslope to the upslope, and take it off here?

Bruce: Our operator could probably do a lot of this excavation; he's a fast learner.

Joshua: You want to use a "class 2 permeable material" which doesn't require a filtered fabric to cover. It's an engineered fill; it allows everything to drain but it's a combination of bigger and finer grain material that self-filters. You can put a little on the bottom, lay your perforated pipe, then dump the material from the truck. All this would be below your V-ditch or maybe offset from it, and well sealed at the top so there is no chance for surface water to get in there because that would be the worst thing. Sealed 1-2' if you can. These things are amazing.

I'd bet that even now, if I drill a hole here right now, I would get a good indication of where this is moving by the moisture. Often, there would be dry dry deposits, and the I'll hit water. That will be right on the side plane, and frequently there will be a big fat gross clay that's material sheared from above. That would be the first step, to characterize this landslide. This is a big enough project. Even limited to this drainage improvement - you don't want to mess it up. You want to make sure you're doing something right. You don't want to throw a little fix on this. Even if you're doing the subsurface drain you want it to be a little informed. Sometimes a couple of test-pits such as your operator could dig can inform well, can get an idea of the depth of these deposits. The main cost of subsurface drains is labor; the permeable material isn't cheap. You're going to have 150' of it or so. I think you could have pretty good luck with that.

Doug: Would putting clay into these holes be good or bad?

Joshua: The things that activate slides are "hydrostatic pressure." That's the weight of the water. So you don't want to impound the water. There isn't a way to make them behave as you desire. Just cover them with some dirt from the site so they are not a low spot. I wouldn't do anything fancy.

Doug: Build a roof over the whole area (humor.)

Joshua: It's out of the scope of a homeowners association, but CalTrans will often build a bridge over the whole stretch. You need really good support at either end.

Joshua: (response to Judy) Crowning is good, slope to drain. Crowned road is designed to put half the water inside, half to the ourside.

Big changes should be guided by a design. The steps: hire someone like me; do test pits, mainly trying to determine how deep the landslide is. At some point you want to commission a survey of the site.

A geotech investigation would be conducted. If you have some equipment such as a big excavator we dig a few pits. Maybe we can't get to the bottom - sometimes 20' is not enough. But I expect that would probably work. You then get a soils report. Maybe $5000-$6000. In a report like that you would get options for drainage improvement, for grading, and potentially structural improvement. Then you have a document in hand you can shop around to the agencies.

And for the topography survey, I would guess would about the same, $5000-$6000, 1' contour intervals. That is going to be used for anything else. Even for drainage improvements, you would have that plan and you would have a civil engineer draw you a design. (2:10)

The grant might cover the topography survey.