Interview with Don Eskridge (Reitz & Jens), July 6, 2007

From Lake Tishomingo:
CH: Clarue Holland
RH: Rich Hirsch
JH: Janet Hirsch
LK: Larry Kimmel

From Reitz & Jens:
DE: Don Eskridge

Previous publications referenced:
PHR – Preliminary History Report, Clarue Holland, Aug 2006
DEI – Don Eskridge Interview, Sep 2006

At the Spillway

RH: How close can boats anchor to the dam without hurting the dam?
DE: Right up to the water's edge.
RH: What about damage to the rip-rap?
DE: I'm not worried about it. I'm not sure how far the riprap extends here, but typically the rip-rap extends about 10 feet down (if slope is 3:1, riprap extends 30 feet out). Primarily for dam-burrowing animals like beaver and otter. It might be wise to set a 50-foot limit, about two boat lengths. The other reason the rip-rap extends 10 feet down is to stop erosion from wind action. If the wind is blowing the length of the lake towards the dam, the water piles up in front of the dam and creates a strong downward current that can erode the dam. Waves created by boats just disturb the surface of the water.
RH: What about planting water willow in front of the dam?
DE: You don't want to plant anything but grass on the dam embankment.
RH: The water willow would be off-shore just in front of the dam. It's recommended by the MO Dept of Cons (MDC) as a fish cover.
DE: I don't think you can control it. I don't think MDC would recommend that it be planted on a dam.

RH: It hasn't rained for sometime and yet there is water on the downstream side of the weir (concrete spillway) *[water is about 12 inches below top of weir – RHH]*. I think there is a slow leak beneath the weir.
DE: Question is, is there water flowing out of here? *[DE walked down the spillway about 200 ft – RHH]* There might be a loss of about 0.25 GPM thru the weir, as you can see moss move with the flow.
There were numerous cuts thru the spillway that were not all repaired well. To make the spillway watertight you would probably have to build a coffer dam and carefully replace the entire weir.
CH: Is there enough riprap? Is there evidence of beaching?
[Slope protection is usually needed to protect the upstream slope against erosion due to wave action. Without proper slope protection, a serious erosion problem known as "beaching" can develop on the upstream slope. The repeated action of waves striking the embankment surface erodes fill material and displaces it farther down the slope, creating a "beach." The amount of erosion depends on the predominant wind direction, the orientation of the dam, the steepness of the slope, water level fluctuations, boating activities, and other factors. Further erosion can lead to cracking and sloughing of the slope which can extend into the crest, reducing its width. When erosion occurs and beaching develops on the upstream slope of a dam, repairs should be made as soon as possible. However, an erosion scarp less than 1 foot high may be stable and not require repair. – RHH]

DE: If the riprap is insufficient you will get slides, and I don't see it here.
DE: An ideal spillway has a gradual slope leading up to it, rather than a wall with a drop-off. You have an efficient spillway approach.

At wet area near the back of the lake property (area is always wet)

DE: My recollection is that the drain pipe on the south side of the dam was daylighted about 2/3s of the way between the toe of the dam and the telephone pole. The drain pipe was on the left (south) side of the pole. The area to the right (north) of the telephone pole was always wet. There was no attempt to drain that area. It may be that this is the original channel of the creek that was dammed to form the lake. The channel was filled, but the fill used was possibly not as water-tight as the surrounding fill.
DE suggested we look at the original dam plans to see if the creek channel was marked on it. *[CH found plans for the dam and the creek does seem to be very close to where "the wet spot" is. See* Figure 1. Dam Profile *at the end of this report – RHH]*
RH: The standing water here has an oily look about it. Why is that?
DE: It is probably due to manganese. The Jefferson City formation has a lot of manganese in it. When you drive down a highway thru an old rock cut you will see several different colors of stain on the rock. One is rust red and that is due to iron. Another color is very black and that is due to manganese.
RH: Last time we were here there were bubbles coming out of the ground.
DE: Some of the bubbles may be from walking on the soil. *[DE demonstrated generating bubbles by stomping on the soggy ground.]* We are far enough away from the dam that the seepage we see here is of no concern for the stability of the dam. Given the size of the area there may be 10 to 15 GPM lost here.
DE: The biggest problem with the wetness in this area is mowing.
CH: Should we try to find the drain pipe and make sure it's not broken?
DE: If you can find the drain pipe, then fix it. Look for an oozing spot. When we installed the drain there was not much water coming out of it. It was just installed as a precaution.
DE: On mowing, if cutting up and down in circles, don't use the same wheel track each time. It is easy to start erosion that way.
CH: From what I've read mowing is supposed to be done horizontally.
DE: But that takes special equipment.

At the leak pool

RH: So what we did was to extend the pipe from the seepage collector so we could make flow rate measurements.
RH: The white fibrous material is present on rocks and leaves in the leak pool when the H_2S smell is present. For most of the year when there is no odor, material coating rocks and leaves in the leak pool is reddish.
DE: It could also be calcium. You should get a hardness test on the water.
RH took a sample of the water and showed it to DE.
DE: Definitely not carrying any mud.

RH: The sulfur smell begins in May.
DE: There's a hunk of asphalt right there.
RH reaches down into the creek bed, gets asphalt all over his hands.
RH: Where do you think the asphalt is from?
DE: Back in the 1960s when they first tried to stop the leak using concrete grouting. That was not effective because the concrete went into a flowing stream and simply washed away. Asphalt grouting was four times more expensive than cement grouting, so they tried cement grouting first. The second time around they used asphalt grouting to try to stop the leak. If asphalt successfully blocks off the water flow the water pressure will slowly cause the asphalt to ooze out. Asphalt grouting only works if enough asphalt is used. Asphalt grouting is still used to seal leaks thru sandstone. In limestone, where cracks open up over time due to dissolution, you can't put a large enough glob of asphalt in it to

successfully seal it off. In hindsight, what they probably should have done was asphalt first, and then concrete over it.

At the original leak pool at the secondary 6” drain

RH: The 6” drain pipe is about 50% full of a tan muck.
DE: That’s iron oxide.
CH: It’s not impervious clay?
DE: No, it’s iron oxide.

At the seepage collector (manhole cover removed)

DE: The collector pipe is not dislodged and there’s no dirt running in at the seals -- that’s good.
RH: It’s surprising that there is not a strong sulfur smell in the collector since there is a strong sulfur smell at the new leak pool.

About 200 ft up the access (haul) road

RH: To the north of the road you can see two casing pipes. I sprayed them with orange paint this morning to help you see them. The pipes are about 2 feet tall and about 4 inches in diameter. There are a total of about five pipes and they run in pretty much of a line up the hill.
DE: Those are probably pipes used in the initial grouting attempts.
RH: So there was a leak over here too?
DE: No. They were trying to seal off a leak in the same area that is leaking now.
DE: The leak you have is not going under the dam – it is going around the dam.
DE: In the process of trying to seal off an abutment leak you normally grout both ways up the abutment trying to fill the channels and they may have done that. Are the pipes filled with concrete?
RH: I don’t know. They have water in them now.
DE: Those are probably grouting pipes where they attempted to grout up into the abutment.

RH: Who would you have do the leak water chemical analysis?
DE: Most testing labs do hardness. You could have it done at St Louis testing, Pittsburg testing, or there is a environmental testing group in Illinois that is inexpensive but requires the sample be brought in frozen. Tell the lab you want the water tested for all phases of hardness. Specifically you want to know the levels of calcium carbonate and magnesium carbonate. Pure limestone is calcium carbonate. *[Dolomite limestone is calcium magnesium carbonate $CaMg(CO_3)_2$. From the PHR: “The lake has been constructed in the Jefferson City dolomite, a firm bedrock formation having some solution enlarged cavities. Typically, the Jefferson City is a thin to medium bedded rock formation with the layers uniform in thickness and lateral persistence. Frequently, very thin shale seams are present between individual dolomite beds.” – RHH]*

At the crest of the dam on the north side

CH: On one of the drawings there was a “monitoring well.” Where is that?
DE: The pipe that was labeled as a monitoring well is really a grout injection pipe.
To locate the pipe find the iron pin and reestablish the baseline. Pipe is probably at the base of the wall (about 4 feet down) and 20 feet in front of wall (lakeside).
RH: If we can find the old grout pipes do we want to drill out the pipes and then regrout the pipes with a better grout material?

DE: You could drill out the old pipes and regrout, The problem is that regrouting will only fill new openings. The old grout in the pipe could prevent finding and filling voids that are blocked by the old grout.
You probably would have to drill new holes for grouting rather than just drilling out and then filling the old grout pipes. In injecting grout you would look for “take” (the ability to inject). If the grout is injected into a void feeding the leak, the

leak rate should drop off in three days or less.
RH: It may take up to three days?
DE: Yes, it can take that long.

RH: So you think the leak is not under the dam, but around the dam?
DE: Yes, when we installed the seepage collector, we exposed the source of the water. It was coming out of a rock wall. There were two bedding planes and water was coming out of each. So we knew where to put the collector.
RH: So that means it's probably not coming from the middle of the lake but from a cove.
DE: That's correct. I'm willing to bet that the entrance is up in that cove*. [DE gestured towards the first cove on the north side of the lake – RHH].*
RH: The only thing is that when I measured the temperature of the leak and then did a temperature profile of the lake, it showed that the leak was between 30 and 40 feet deep, and most of the coves aren't that deep. You have to get out a ways from the cove to get that depth.
DE: I interviewed the old guy that built this lake and he said that when they did the grouting they did lower the lake looking for the leak and they did eventually see a whirlpool in that cove, but they never chased it. So they got close to it.
DE: A whirlpool will close up on itself in about 8 feet. If a leak is more than 8 feet below the surface of the water the vortex will close up.
CH: So we'd have to lower the lake a whole bunch to find the leak *[if the leak is at 30 ft to 40 ft, we'd have to lower the lake about 22 ft to 32 ft. — RHH]*
DE: Yes. That's probably not much further in the cove than the pontoon boat with the white top *[the boat dock at Block I-2]*.
RH: If there was a whirlpool, could you send a diver down to find the leak?
DE: I don't think so. I don't think the flow will be that significant. I don't envision one spot where the water is leaving the lake. I think instead water is leaving through a whole bunch of cracks in the wall.

Wrap up at the Community House

JH: Is there much Karst in this area?
DE: The area can be associated with what is called Karst, but you don't really have the Karst topography. You don't have the series of "bowls" characteristic of Karst topography. You do have the rock formations that have the potential. You don't have the supply of water at these elevations to develop into true Karst.

RH: In the PHR, Figure 1, 1965 Dam drilling, what do the numbers "0+96" and "1+24" mean?
DE: Survey tapes are 100 ft long so the convention is to give lengths as "1+24" which translates to 124 feet. In Figure 1 in the PHR hole #1 and #2 are 28 feet apart, rather than 124 feet apart. It makes no sense to try to grout an abutment using holes located 124 feet apart.
DE: But the real question is, where is the zero point on this drawing? Typically they would put the zero point where there is a break in grade. You should be able to find the pipes with a metal detector. By adding the wall we were attempting to raise the crest of the dam 30 inches. I believe the wall plus foundation is 4 feet deep.

DE: The item on the drawing that is labeled as the "monitoring well" is really one of the grout pipes. It is about 20 feet from the baseline on the lakeside. The problem is that the baseline may not be where the wall is.

RH: Do you think it is important to find the old grout pipes because that would be the starting point for new grouting?
DE: Personally, no. If the grouting contractor wants to find those pipes, let him do it. Personally, I am not in favor of going thru those old grout pipes.
DE: The reason I don't want to go thru an existing pipe is that that pipe was initially filled with grout and may still have much of the grout in place. Drilling thru the old grout will not remove all of the old grout, it will just give us a channel

thru the old grout. Any new grout injected into the pipe will be confined to the channel will not necessarily flow into the leaking zones in the rock.
DE: I don't mind finding the pipes as a place to drill next to, but I don't want to drill down those pipes. I'd drill a new hole perhaps 10 feet away from an old pipe.
DE: Here is what happens with limestone. Let's say you inject grout into two grout holes 20 feet apart and you effectively seal off cavities in the limestone so the leak rate drops from 100 GPM to 2 GPM. You filled just about all of the cavities in the limestone, but there is still a small crack that you did not seal. The water flowing thru that crack will eat away at the limestone and enlarge that crack. H_2S (a weak acid) in the water from decaying vegetation at the bottom of the lake will erode the limestone even more quickly. The erosion is a process you cannot stop. You just have to control it when it becomes a problem. Is it a problem now? No, with one exception, you like to keep a full lake in the summer. Is it a structural or stability problem for the dam or the embankment? No, probably not.

RH: You saw the white fibrous material in the leak water. It's present from June to October and is accompanied by an H_2S odor. What do you think the white material is?
DE: The fact that it is white is a good indication that it contains calcium. I think it's an algae or bacteria that contains calcium, which is from the dissolved limestone.
LK: So the real problem with the leak is with water loss, rather than any degradation of the dam.
DE: Yes.

RH: So if we decided to do something about the leak, how much would it cost and how much can we reduce the flow rate of the leak?
DE: You could probably reduce the flow rate of the leak to practically nothing. The one advantage nowadays is called "plastics." There are plastics, mostly urethanes, that flow very well (when compared to cement) and when they hit water they start to swell. The silicas (waterglass class) can probably not be used here as your flow rate is probably too high. Probably the best material to use in your case would be a urethane as urethanes will react with flowing water to swell up and slow down the rate of flow. The more you can slow down the rate of flow the better chance you have of your plug sealing.
DE: I recommend that you hire Dave Taylor as your grouting contractor.
LK: How critical is it to place the grouting holes?
DE: The holes could be off by about 4 feet and it would not be a problem. If the holes are off by 20 feet that may be a problem.
DE: I think all Dave Taylor will want to know is "What zone did they try to grout and am I still in that zone or well beyond it?"
DE: It is true that if you measure the temperature of the leak water and then do a temperature profile of the lake, you can determine the depth of the leak. Very definitely.
RH: Dave Taylor worked on Lake Chesterfield? Was he effective there?
DE: In the first round they told him what to do and it didn't work. On the second round he said "I'm going to do what I want to do and it's working. Dave knows what he's doing. He's been around."
RH: In our last interview with you in 2006 you recommended that we don't just hire a grouting contractor but that we also get an engineer to act as our agent. Is this still your opinion?
DE: If you like we can represent your interests. I think you've also worked with Greg Hempen (sp?). Greg is now retired from the Army Corp of Engineers, but still works. He's very competent. It may be helpful to have someone work with Dave to represent you and make sure everyone stays on the right path.
CH: The leak is now at 300 GPM and you say that that level is not dangerous. How long do we wait until we do something? What is your gut reaction? How long should we wait?
DE: You will have to react if water starts coming out of the ground, in the area of the manhole or slightly uphill from it. This is an indication that the seepage collector has reached its capacity. In other words the flow of water is too great for the inlet pipe in the seepage collector to handle. So rather than being carried to the toe of the dam by the collector,

excess water will bubble up thru the ground near the collector. (A spring on the face of the dam.)
This condition would not require instant attention, but would definitely need attention in the immediate future.

RH: We have some questions raised by Lake residents that we need answers to:
Q: What if we built a standpipe straight up until the water stops traveling upwards?
A: Well, that hasn't reduced the pressure any, so the water will find a way to flow out somewhere else. All the standpipe does is show you how much pressure the water is under based on the height of the water.
Q: Is there any equipment to help find the leak?
A: Yes, most likely equipment is acoustic emissions. It's an extremely sensitive listening device that is lowering down a hole and measures the noise. Where the noise is the loudest is closest to the zone of the leak. You do that in a triangular pattern so you can triangulate in to where the problem is. There is a possibility that with the flow at 300 GPM that there would be so much noise that the device would be overloaded and not work. Unfortunately it ain't cheap.
Q: What about pumping the leak water back into the lake?
A: Nothing wrong with that. You have power in the area so it would not be difficult getting a drop. To pump 300 GPM, 100 feet of head, you need a 10 Hp pump. If power costs 7.2 cents per Kw, we'd need $0.72 per hr to run that pump = $518.40 per month. But it doesn't fix the leak.
Q: Someone suggested that the current leak is a pressure relief valve and that if we plug this leak by drilling thru the top of the dam and grouting, the dam will just leak somewhere else.
A: By drilling and grouting you are creating a small bathtub wall. And if there's a hole beyond the edge of where we grouted, that the water can eat into and work its way around, it will. The pressure relief valve analogy is not 100 percent accurate.
Q: What would you do if it were your dam?
A: You are going to have to do something. I'd start building a reserve fund for this now. Right now you don't have to do anything. I personally think you have 2 or 3 years before you have to act. The thing that can change the leakage pattern so you would have to react more quickly would be an earthquake.

JH: One problem we have is that the lake is dropping faster than can be accounted for by the leak. The drop in the water level in the lake we've measured to be about 1.5 to 1.8 inches a week. This is about twice the drop we'd expect just based on the leak *[300 GPM = 1" drop in 7.5 days]*.
DE guessed we were losing another 10 to 15 GPM seepage in the field behind the dam.
CH: But even 320 GPM doesn't account for the drop in lake level we've seen for the past two weeks.

DE: Measurements taken at Carlyle Lake where pans of water were set out in the center of the lake indicated an evaporation rate of up to 4.5 inches per week (mid-summer). In the winter they measured 0.5 to 0.75 inches per month.

DE: Let's look at the water balance. Outflow is from evaporation or seepage out of the bottom (assumes no water flows over the spillway). Inflow is rainfall and spring feed. Your valley is so high that there will not be a lot of spring feed from the southwest side of the lake, due to the Big River valley being deeper.

CH: What do you think it would cost to repair the leak?
DE: Two weeks with a three man crew: 240 hr at $60 / hr = $14,400; Drilling rig: $200 / day = $2,000; Grouting material: $10,000. I'd say $35,000 to $40,000. As a nice round number I'd say $50,000.
RH: Dave Taylor in March of 2006 guessed at $60,000 to $100,000; $60,000 if we were really lucky.
DE: It should be in the $50,000 range, I don't think you're in the $100,000 range.
LK: So we could get a $1/foot assessment and pay for that in a year.
DE: As an alternative you could install a supplemental seepage collector for about $15,000.

JH: But we would still have the leak. All we're doing is protecting the back side of the dam.
DE: Right, all we're doing is making sure it doesn't start washing away the face of the dam, which is a very important consideration.
CH: A much better choice for the long term would be to drill and repair the leak.
DE: It will buy you another 20 years.

Installation of siphon drain

DE: It is wise to install the drain into an established channel. How far down do you want to lower the lake?
RH: I believe about 8 feet.
DE: The spillway channel would be an ideal place to lay the pipe, however that long flat slope will make it expensive to install.
RH: Is there a problem installing the pipe in the spillway? Won't that decrease the capacity of the spillway?
DE: It won't make any difference if the pipe is installed in the spillway. That spillway will run 12 feet deep in a storm and a 12 inch pipe in the spillway won't make any difference.
RH: Do we have to contact the Dam Safety people about installing the siphon in the spillway?
DE: You should. You're not modifying the spillway, but they will see the siphon at your next inspection, so you should probably send them a short letter notifying them that you are going to do it.
DE: To make an effective siphon you need the outlet about 10 feet lower than the inlet. So you're going to be using a heck of a lot of pipe to run it in the spillway.
RH: There was also a suggestion to put the siphon at the north end of the dam and bury the pipe where it crosses the crest. This would mean breaking thru the concrete wall and then repairing the wall.
DE: It would be difficult to repair the wall so that it would not leak.
DE: When pipe is buried it is difficult to get a siphon started.
DE: In my experience when you start using a siphon you are going to want to move it around anyway.
DE: Filling a permanent siphon can be difficult. You also need to worry about starting the siphon accidentally if you have a high lake and don't have an air break at the top of the siphon.

LK: In installing pipe to lower the lake we had to go out into the lake about 60 feet in front of the spillway to get a 10 foot drop and we had to go back about 300 feet to get enough drop to run the siphon.

DE: Once you get back a ways in the spillway you could lay the pipe in an existing ditch. If you put the lower end of the pipe at the 10 foot level, you will only be able to lower the lake about 8 feet because you'll be sucking air. A whirlpool will start at that intake and you'll suck enough air to break the siphon. Two to three feet below the surface of the water is necessary to maintain a siphon.

DE: If you make a permanent installation in the spillway you should notify the Dam Safety Committee. If it's a temporary installation, you wouldn't need to notify them.

Rich Hirsch, for the Dam Committee