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July 3, 2013

Ms. Kristi Kita-Rhude
Secretary of the Commission
Arkansas Public Service Commission
1000 Center Street
P.O. Box 400
Little Rock, AR 72203

Re: Docket No. 13-041-U

Dear Ms. Kita-Rhude:

On June 27, 2013, James A. Helwig filed Direct Testimony and exhibits on behalf of the Sims Petitioners in the above-referenced docket. The attached document was inadvertently omitted from the end of his testimony and is submitted for filing to be included with Mr. Helwig's testimony.

We apologize for any inconvenience this omission may have caused. Should you have any questions relative to this matter, please do not hesitate to contact me.

Yours very truly,

CHISENHALL, NESTRUD & JULIAN, P.A.

/s/ Lawrence E. Chisenhall, Jr.

Lawrence E. Chisenhall, Jr.

LEC/am
Attachments
cc : PSC Service List (via EFS)

EXHIBIT CAPTIONS

JAH-1. Aerial overview of Rte 62/86 segments AN and AO. Also shown is the SWEPCO preferred Rte 33. The White River flows from the SW to the NE, i.e. from Spider Creek Resort to the town of Beaver, but in a highly meandering path. The green star is Inspiration Point, the blue dot is Blue Spring, and US Highway 62 and Wolf Ridge are labeled. Note: In the PSC application information distributed to landowners, the SWEPCO Exhibit 1 Route Map did not show the White River at all on segments AN and AO. USDA 2012 photography, width of photo is 6 miles on the ground.

JAH-2. Topographic slope map of the Upper Table Rock Lake Watershed of the White River Valley (WRV) overlain by SWEPCO Rte. 62/86 in pink. The area of this study is the WRV along segments AN and AO of the route. The slopes are color coded: hot colors are very steep slopes, more than 20 degrees; Cool green colors show flatter terrain in the valley bottoms and on the narrow ridgetops; Yellow colors indicate slopes of 11 to 20 degrees. The Chatt Bench (see next Exhibit) is not resolvable on this scale. The steep slopes on the south side of the White River Valley along segment AO are a special source of geological concern, as well as the visual impact of AO construction on the spectacular scenery of the valley and rough terrain seen from Inspiration Point (green star) and Wolf Ridge. Slope map is from University of Arkansas CAST project (see References).

JAH-3. The Chatt Bench on Wolf Ridge, a natural corridor. The topographic bench is underlain by easily eroded shale of the nearly flat-lying Devonian Chattanooga formation, providing a flat spot at a near constant elevation – a contour line. The bench is a flat terrace on the otherwise steeply sloping terrain between the ridge and the White River. The Corridor here is a superb hiking and game trail on my property, and it follows a pioneer trail. Parts of this trail would be cleared by the AO route, which is a much wider corridor than the natural trail. Also note the largest trees grow along this route due to seepages out of the upper karst layer. Photo by Edward C. Robison III.

JAH-4. Aquifers and aquitard in the karstified bedrock strata. Ordovician dolostone, limestone, and clay seams (Jeff City, Cotter and Powell Formations = JCP) with a Devonian sandstone and shale cap exposed in road cut on Rte. 187 south of Beaver Dam. Human for scale (red arrow). Dolostone and limestone are porous carbonate rocks forming 2 regional karst **Aquifers,** the Lower JCP and the Upper Saint Joe. Aquifer means literally a conductor of water. The weathered soil slope above the sandstone ledge covers the Chattanooga Shale, an **Aquitard** that is impermeable to water. St. Joe Limestone at the top here is not well exposed.

JAH-5. Diagram to scale of the stratigraphic succession of the bedrock exposed in the high relief topography of the WRV area. The thickness, geologic age, and names of the rock formations are given in the left-hand column. Graphic symbology represents limestone, dolostone, chert

nodules, shale and sandstone layers. The Early Mississippian-age Boone cherty limestone and St. Joe Limestone (total about 200 feet thick) form the Upper Karst Aquifer, and the Lower Ordovician Jeff City, Cotter and Powell Dolostones (about 250 feet thick) form the Lower Karst Aquifer in the Eureka Springs - Beaver Dam area. These horizons define two distinct karst aquifers and dissolution zones that are separated by the thin impermeable Chattanooga Shale (0 to 15 feet thick). The Chattanooga Shale is 360 Million years old. The bedrock is either exposed or capped locally by red weathering cherty red clay called regolith. Locally some thin Middle Devonian Sylamore Sandstone layers are present at the base of the Chattanooga, e.g. near Inspiration Point and in the previous Exhibit.

JAH-6. Ozark Plateau Geological map, from the 1993 Arkansas State Geological Map. Inset shows Ozark Plateau and location of area of expanded detail map. The flat-lying strata are eroded into a pattern corresponding to the topography and drainage. The map is dominated by 2 colors: beige of the Mb unit: Mississippian Boone +St Joe combined; and pinks of the Ocjc and Op corresponding to the Ordovician JCP horizon of this testimony. The thin brown unit is the Chattanooga Shale and associated local thin beds. See Exhibit JAH-5 for the reference stratigraphic succession. This information should be used in the EIS, which it is not. Later I will show where and why it is important.

JAH-7. Aerial image showing location of proposed Rte 62/86 in the floodplain of the White River. Landmarks include the U.S. Rte 62 highway bridge and Martz Mountain. Note the homes and road of CR 235 on the south side of the river were in the 2008 flood zone when water elevation achieved 940 feet or more (red contour line). The AO route segment is in the high flood zone for over half a mile (green ellipse). Details in text.

JAH-8. Diagrammatic cross section of a typical karst area showing the geological and hydrological features. Vertical scale is exaggerated to show detail. Terminology of karst is adapted from "Living with Karst", American Geological Institute. The **Water Table** is the boundary between the permanently **Saturated Zone** and the overlying **Vadose Zone**. Surface waters enter the karst via percolation recharge, sinkholes, and Losing Streams, often using fractures, fissures or faults. Cave openings and streams develop below or at the water table, or above in some cases (not shown). Springs may be **Ephemeral** (Vadose Zone), **Gravity** (at water table) or **Artesian** springs (rising from depth under pressure). If soils are thin and the vadose zone is broadly permeable, contaminants can rapidly spread through the open hydrologic system of karst, affecting groundwater, wells and surface streams.

JAH-9. **Fissures** are vertical dissolution surfaces and zones in karst bedrock, and they are either filled with soil and rock debris or open to form caves. This new road cut on US 62 southwest of the Leatherwood Creek bridge shows that engineers blocked one such cave. The blocks are huge, averaging 3 ft across. The blasted cliff is 45 feet high, and exposed totally hidden fissures; such fissures, open or filled with Regolith, may be under your proposed construction! Not just a hazard to construction, evidently such fissures can have a huge impact on the

infiltration of surface waters. The bedrock is the Ordovician Cotter Formation. Photo 10/29/2006.

JAH-10. KASM (Karst Area Sensitivity Map) constructed by Ethan Inlander of The Nature Conservancy. Major Highways are shown in black.

The red end of the color spectrum highlights the most karst sensitive areas, e.g. below Beaver Dam on Rte 62/86 segment AN (red ellipse) off of the Beaver Dam road. The sensitivity to land development is scored by multiple parameters, all related to the infiltration and subsurface flow of water, including:

1) Depth to ground water and proximity to streams
2) Recharge characteristics, e.g. Karst rock (limestone or dolostone) at the surface
3) Geology of the aquifer(s): rock type, thickness, structure, permeability
4) Permeability and thickness of the soil zone/ regolith
5) Topography and steepness of slope
6) Permeability of the vadose zone and Presence of fissures
7) Conductivity of the aquifer (rate of flow of water)

We need to use this information in scoring the Rte 62/86 EIS, and also add specific karst features to this map (sinkholes, caves, springs, losing streams) in any area of proposed development, which can only be done by field work. Caves are known to landowners along the AN segment in the Ward Road area, but have not been examined in the present study due to lack of time.

JAH-11. Pre-landslide September image of Wolf Ridge, 9/2/2010 showing outlines of: a. south edge of Chatt Bench (green dashed line); b. cleared riverview corridors (blue) for homes; c. future sites of landslides (fine dashed orange lines.) Grid scale is approximately 500 feet.

Minimum distance from ridge to river is 800 feet, elevation change is 550 feet, so Maximum slope from ridge to river edge is 34 degrees, or average 68% slope! Note that there are major cliffs of St. Joe limestone south of the Chatt Bench, and of Ordovician strata just above the river, creating a shadow. Exhibit 13 will zoom into the area of the green box post-lanslide.

JAH-12. **Ephemeral springs** are active after heavy rain but seldom flow otherwise. This one is on steep slopes above White River on Wolf Ridge and issues out of the Ordovician JCP strata. (Location shown on next Exhibit.) This spring is much above the normal groundwater level (Water Table) and dry more than 95% of the time.

Such springs underscore the holey nature of uplifted karst, and the dramatic manner in which subsurface water can gather and focus into a single exit point, and they vary dramatically in flow

both seasonally and over the years. The gathering area for a spring is called its **Recharge Area**, and of course lies uphill. Since we cannot know the precise geometry of the pores, caverns and fissures in the limestone, and water flow varies greatly with time, *the precise dimensions of a recharge area are always subject to uncertainty, as well as the discharge points*. Therefore, any construction zone can be affected by, or affect, areas well beyond that zone; and such effects may take years to emerge.

JAH-13. Overview of the 4 landslides on Wolf Ridge developed after the storms of May, 2011, showing the location of the AO segment (pink double track) to scale. Image flown 2/24/12, sun casts shadows on NE slopes. The blue arrow is the location of the ephemeral spring shown in Exhibit 12; the green dashed line is the Chatt Bench; Exhibit 14 is located by the green box. The width of the map is 3000 feet, indicating about 4 HVTL towers would have to be emplaced here, and the ROW would expose and disturb a large swath in this east-west trending geological zone of slope intstabililty.

JAH-14. Map of 3 landslides at east end of Wolf Ridge along Rte 62/86 segment AO (pink double line with yellow centerline). The ROW passes across landslides 2 and 3 near east end of Wolf Ridge. The width of the corridor is 150 feet, and the width of the map is 1250 feet. Houses A and C are labeled, B is a shipping container. South edge of Chatt Bench is green dashed line. The average slope in the vicinity of the 2 large landsides, between the Chatt Bench and the lower road, is about 17 degrees. Wintertime image dated 2/24/2012. Dark shadows are from steep slopes, linear dark shadows are tree shadows. Note 250 foot scale bar in lower left; north is to top of image. Construction in this corridor clearly presents a Geohazard risk and increased environmental risk to landowners' property and roads.

JAH-15. Landslide 2. May 25, 2011, looking NE on private road, elevation about 1100 feet. The earth is moving, carrying trees, and crossing the road we are standing on.

JAH-16. Landslide 2, June 8, 2011, viewed from uphill. The slide debris has been bulldozed from the road and the road buttressed by large quarry blocks, at considerable cost. Measurements of the slide, which has continued to move a bit in very wet weather, were made on May 7, 2013.

JAH-17. Landslide 5, Inspiration Point area. The landslide is 560 feet long in map view, a slope of 16 degrees, and has a maximum width of 150 feet. Average width is 120, and multiplied by 550 = 66,000 ft2 or about 1.6 acres for the size of the landslide. Note trees piled up at lower north end of slide (arrow shows movent direction). Note position of abandoned power line ROW, with corridor (red arrows), that may have influenced hydrology of the slide. Martz Mount gate is visible just west of driveway turnoff from U.S. Rte. 62. The Chatt Bench is about 30 yards south, uphill from the upper end of the landslide.

The landslide did not appear on the photography dated 10/13/10 but does appear on this image dated 3/24/2012. Good quality winter imagery is not available. Factors of timing and time of photography affect our ability to properly assess landslide risk.

JAH-18. Contour map and setting of landslide 5. Topo overlay, image rotated to True North up. Green star is Inspiration Point. Yellow-Pink line is segment AO, Rte 62/86. The AO segment of Rte. 62/86 is less than 500 feet from the north end of the landslide. Magenta dot is bald eagle nest. Note the steep cliffs along the river in the lower karst unit.

The landslide is 560 feet long in map view, and the change in elevation from top to base is 160 feet by contours. Angle of slope is then 16 degrees, or a % slope of 28%, which corresponds to measurements in the field (shown on JAH-17). Elevation of Chattanooga Shale is ~ 1260 feet. Martz Mt is in 1400 feet elevation closed contour, so total topographic relief from mountaintop to river is 500 feet.

JAH-19. Photographs illustrating impacts of landslides. Landslide Impact includes effective loss of the forest, loss of land use and value due to instability, and construction/maintenance hazard costs for built systems.

JAH-20. The AN-AO segment is unique in having the only known landslides in the WRV area. This may be due to the geology, as shown from field work and analysis of the geologic map. First, note that the green ellipse encloses the segments AN and AO within an area 4.5 miles long following the PROPOSED route 62/86 (magenta line). The green star is Inspiration Point. The map shows the bedrock geology and routes 62/86, 33, and 91. The green diamond shows the location of an accompanying cross-section of the terrain and geology, shown in the next exhibit, that will help explain the interpreted geology.

The area enclosed in the green ellipse has the following unique *combination* of characteristics:

1. The *route parallels the WRV in a largely east-west direction for 2.7 miles*, from the U.S. 62 bridge past Inspiration Point eastward to the end of Wolf Ridge. This is segment AO.

2. Ignoring meander loops, this E-W topographic trend of the WRV is expressed by hills and cliffs of the St. Joe and Boone limestones (beige color) that parallel the trend of the nearly flat outcrop of the Chatt Bench (brown band, map label MDcp), which gives way to a *general steep north slope towards the river, cutting down into the Ordovician* strata (diagonal pink striped map unit Ocjc).

3. The *5 landslides identified in this study all occur within this zone*, and were activated apparently by the May 2011 torrential rains. These landslides have no known counterparts in the comparable map area outside the zone. But I have not studied these areas, and they are sparsely settled.

Note that all other segments of Rte 62/86 traverse the Chatt Bench in a perpendicular orientation, except that part east of the junction with Rte 33 (yellow line) where it runs concurrently with 33. But in that location the slope is to the south and the depth of the valley is less.

JAH-21. The Cross-Section diagram shows the surface geology and interpreted subsurface of Wolf Ridge featuring 3 major sedimentary rock layers; the vertical scale is exaggerated 3x to show details. A 300 foot wide corridor bracketing the common location of the segment AO corridor is shown in red; it runs perpendicular to this section. The section is a model of the landslide generation process.

Precipitation enters the karst via percolation recharge (at 1a), often using fractures, to develop cavernous flow paths by dissolution. But surface runoff also occurs (1b). The Chattanooga Shale is impermeable, causing small springs and seepages from the upper karst acquifer to emerge at the Chatt Bench (2). Breaks in the shale permit deep groundwater flow through the lower karst, emerging downslope into a zone of clay-rich regolith (3).

The result of this geologic/hydrologic regime is a three-fold input of water into the unstable zone of regolith from 3 sources: runoff at 1b, the upper karst at 2, and the lower karst at 3 - exacerbated by heavy precipitation events, such as those of late May, 2011. This combination of steep slope, regolith, and a triple influx of water due to karst hydrology causes.... landslides.

Note: The width of the Chatt Bench is considerably exaggerated in this diagram.