A Major Landslide on Greers Ferry Lake

by
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Early on the morning of March 28, 2005, after two days of rain, a significant landslide occurred on the north side of Stevens Point on the south shore of Greers Ferry Lake. The slide collided, in part, with a house owned by Shirley Bradford, crushing the garage (Figure 1) on the south side of the house and tearing a small room off the west side (Figure 2). The slide ultimately involved an area extending from a sandstone ledge over one hundred feet in elevation above the house down to and into the lake over one hundred feet in elevation below the house and extending to either side of the house.

Figure 1. Bradford garage.

Figure 2. West side of Bradford house.

The bedrock sequence on the hillside seems to be in the lower Atoka Formation. It consists of a thick sequence of shale interrupted by thinner intervals of siltstones and sandstones. The slope is compound and in profile somewhat typical slope and bench. Two significant sandstone intervals were noted on the slope, one just below the 600-foot contour and the other near the 720-foot contour. These resistant units produce ledges that crop out incipiently. The sandstone ledges exhibit fairly frequent joint sets trending subparallel to the slope face and into the slope face at about north 10 to 20 degrees west. The hillside is draped with a thin to thick soil of residuum and colluvium derived from the weathered bedrock and is covered by a mature forest, except where disturbed by fairly recent cultural modifications. The slope averages about 20 degrees in the vicinity of the slide, but varies locally from near vertical to nearly level.

The slide area is over 700 feet long crown scarp to toe and 300 to 500 feet wide (Plate 1). The slide is divided in two major portions by the sequence of sandstones forming a significant ledge about midway down the slide area (just below the 600-foot contour). It

also has some incipient marginal displacements extending laterally from the main slide area. The main crown scarp is developed just below the 720-foot contour sandstone ledge and the lowest toe development is in the lake. At the time of the slide the lake level as reported by the Corps of Engineers was 463 feet above mean sea level. Both the upper and lower portions of the slide are similar in that they have a steep upper section and flatten out to near level in their lower section. The upper sections have completely failed and display near vertical scarps in places. The lower sections are a jumble of trees, soil, rock, and other debris displaced and fallen from above. Pressure ridges are common along the toes of each section, forming from subsurface flow of the soils and small lobe thrusts. Rock falls, mud/debris flows, and translational and rotational slumping are all evident in various places in the slide area (Figures 3-10).

Figure 3. Slide area from Greers Ferry Lake. The upper portion of the slide is partially hidden by foliage still standing on the 600-foot contour ledge. (Photo courtesy of U.S. Army Corps of Engineers)

Figure 4. A view looking east north east at the upper portion of the slide area.

Figure 5. Rotational Slumping.

Figure 6 (above). Translational slumping.

Figure 7 (below). Lower portion of slide area.

The small toe thrusts, noted in the lower reaches of each portion of the slide as lobes of debris, overran one another and stacked en echelon. These lobes were better developed on the lower portion of the slide near and in the lake. Some portions of the hillside apparently failed and were displaced somewhat intact. Groups of trees were transported laterally or slightly downslope with little disruption. Both rotational and translational slumping were noted on the west side of the 600-foot contour sandstone interval. However, most of the slide's failure seemed to be via debris flow and rafting

Figure 8. A pressure ridge extending into Greers Ferry Lake.

Figure 9 (left). A pressure ridge developed beneath the garage floor of the Bradford house.

Figure 10 (above). Pressure ridge formed at lakeside.

Displacements and cracked ground were noted adjacent to the main area of failure (Figures 11-13). These slide margin displacements tended to be shallow slips of just a few feet. Often their expression is presented via a low crown scarp dying out with distance from the main slide area. The toes of these marginal displacements are somewhat indeterminate due to the natural roughness of the slope and a thick forest-litter cover. These marginal slides extended up to a few tens of feet, reaching over a hundred feet in at least two cases, from the main slide track.

Figure 11. Slippage marginal to main slide.

Figure 12. Incipient ground cracking due to minor slippage marginal to main slide. Note water in crack.

Figure 13. Ground displacement and subsidence east of the Bradford house.

The March 28 events were preceded by two days of rain. On the day of the slide water was still running off the slope in several streams. Two of these streams formed small waterfalls over the main crown scarp (see figure 14). This water was mostly absorbed by the upper slide mass and did not result in overland flow much below the upper slide area. However, water was copiously seeping from the lower developing scarp formed by the 600-foot ledge. A week later the 600-foot contour ledge had more fully developed into a secondary crown scarp which displayed persistent flow from a joint in the sandstones several feet below the overlying surface. Observations around the slide area suggested that upslope runoff water was focused into this portion of the hillside. Open joints on the sandstone and siltstone outcroppings offered conduits for direct injection of water to the regolith/bedrock interface, promoting lubrication and instability.

Figure 14. Crown scarp March 28, 2005. Note water flowing freely over scarp surface.

Although most of the movement on the slide occurred the morning of March 28, the slide continued to creep for several days. Trees, rocks, building debris, and soil continued to migrate to the edge of the 600-foot ledge and fall to the steeper slope below (Figure 15). The lower part of the slide (that is the part below the 600-foot contour ledge) continued to flow and creep toward the lake. Pressure ridges at the lake margin continued to inflate (Figures 8, 10). Trees that were initially only tilted fell. Experience has shown that this level of creep will continue for many months with slowing magnitude.

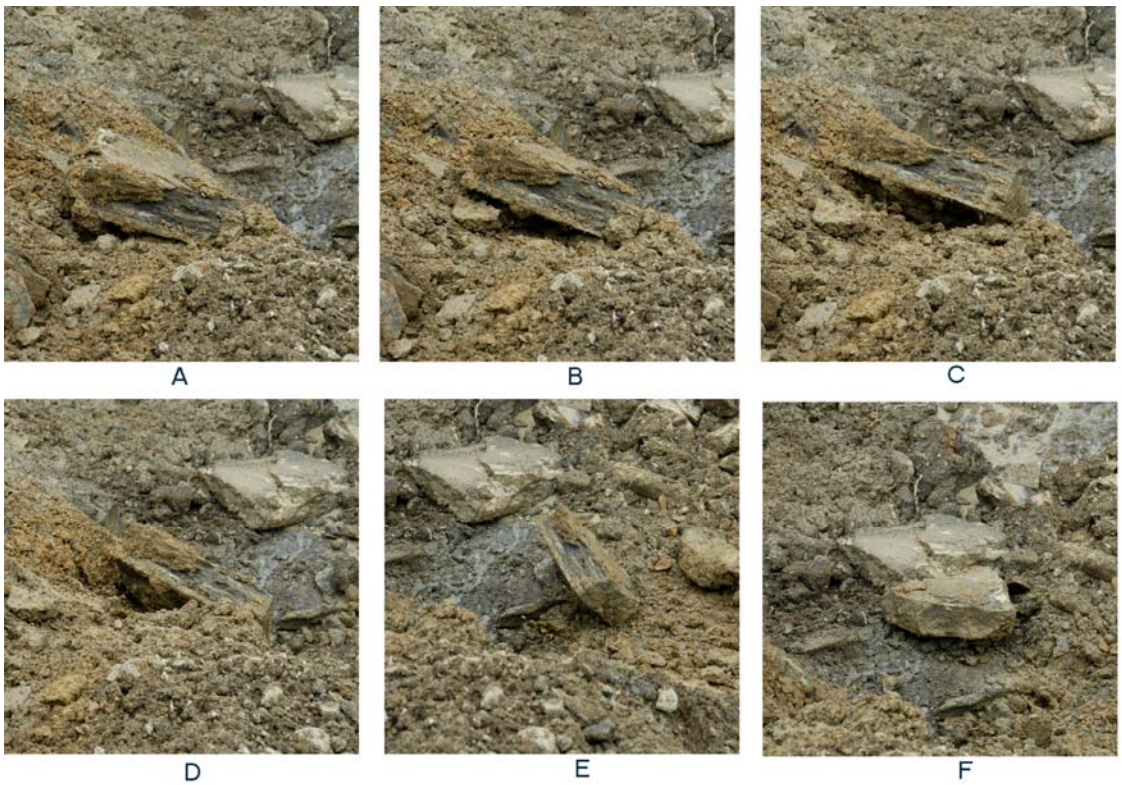

Figure 15. April 12, 2005. Rock fall due to continuing landslide creep

Adjacent to the top of the crown scarp we observed separation of the residuum from the base of the outcrop of the 720-foot contour sandstones as revealed by a shallow ditch in that location (Figure 16). Most of the separation appeared to have occurred well prior of the March 28 slide. We also noted that the poison ivy vines along a portion of the 720-foot contour outcrop adjacent to the slide were dead due to the roots being pulled apart and broken off. The condition of these vines suggested that the separation that unrooted these vines occurred last Fall or during the Winter (Figure 17). These observations suggest that the movement of the slope initiated well before the events of March 28. This prior movement might have also opened cracks in the soils providing a conduit for water.


Figure 17. Poison ivy killed by root separation.

Figure 16. Trench at base of 720-foot contour ledge.

The main part of the slide developed on the footprint of an ancient landslide. Judging by the trees growing in the main slide area it appears that the slide area had been relatively stable for well over a century. Outside the main slide area we noted traces of smaller slumps and slides similar to other recent landslides in the area. These traces registered themselves as anomalous slight upslope depressions with downslope bulges, low relief scalloping, and hummocky slopes. Boulders traceable to the 720-foot contour sandstone were noted displaced down to the 600-foot contour ledge. These smaller slide traces suggested incipient failure of the hillside is not uncommon, but does not occur under ambient conditions on a regular basis. The evidence we recognized indicated that decades might pass between slips as long as the hillside is undisturbed. Based on the estimated ages and trunk form of the trees growing on these old slide tracks suggest that they may have resulted during initial tree harvesting of the hillside in the late nineteenth and/or early twentieth century. It is evident that the static stability of the hillside is in a critical state where any disturbance will likely destabilize the local slope and potentially result in a landslide.

The Bradford family indicated that the house was built around 1996. They stated that they had had no problems with landslides up to the present slide. They told us that they had built a road around the house and down to the lake where they planned to install a boat dock. They said the road cut the forested hillside behind and up slope from the house, made a switchback to the west of the house, and passed downslope and in front of the house ending near the Corps of Engineers Greers Ferry property line directly downslope from the house. It is likely that this road construction was the principle destabilizing influence on the slope. The road cut reduced the slopes resistance to an increase in shearing stresses along the potential slide surface. Reduction of soil cohesion and shearing resistance due to rainfall completed the job resulting in slope failure. The road's construction also undoubtedly changed the natural runoff paths and may have redirected water so that more of it infiltered. Runoff from rainfall was able to penetrate along joints in bedrock exposures as well as direct infiltration thereby adding both weight and lubrication. Once slippage had initiated (during the past winter) new openings in the soil would provide additional routes for water infiltration.

The Bradford house, except for the crushed garage and lost west wing seems to be relatively stable at the time of this report. We noted that the walls were still plumb and straight. The brick was generally undisturbed. In our initial examination of the house we noted one small old crack in the brick at the top corner of one window on the front of the house unrelated to the present activity. A visit to the site a month after the initial slide revealed a small fresh crack in the brick at the base of the front wall of the house. The ground surface to the south and east of the house has subsided several inches to a few feet leaving the footing exposed (Figure 18). This subsidence has compromised the underground utilities leading to and from the house. The house itself seems to be foundationed on or shortly above the 600-foot contour sandstone beds providing an island of stability. Whether this condition will persist, only time will tell. At the time of this report we have not yet had a period of protracted rainfall to test the stability of these features.

Figure 18. Surface subsidence on the east side of the Bradford house revealing its foundation.

Figure 19. Phone and power boxes displaying effects of subsidence and displacement marginal to main slide area.

We noted 11 smaller landslides along the road leading to the Bradford house. We have no doubt that these slides were the direct result of the recent road building activity and the associated clearing of the forest to either side of the roadway. These slumps ranged from about 25 feet to 250 feet wide and about 20 feet to 100 feet toe to crown scarp (Figure 20). All of these unintendedly induced slumps were on the uphill side of the road. However, we did note that some cultural features normally expected to be level and or plumb deviated from the expectation downslope of the road suggesting wide spread slope instability (Figure 19). This hillside averages slightly less slope than the Bradford property, about 15 to 20 degrees. This area is under development at the present time. It is highly probable that additional modification or construction efforts on this hillside will induce more slope failure that will need to be addressed in non-traditional and creative constructional methodologies to be successful.

Figure 20. Small landslides on Platinum Peaks development along road leading to Bradford house.

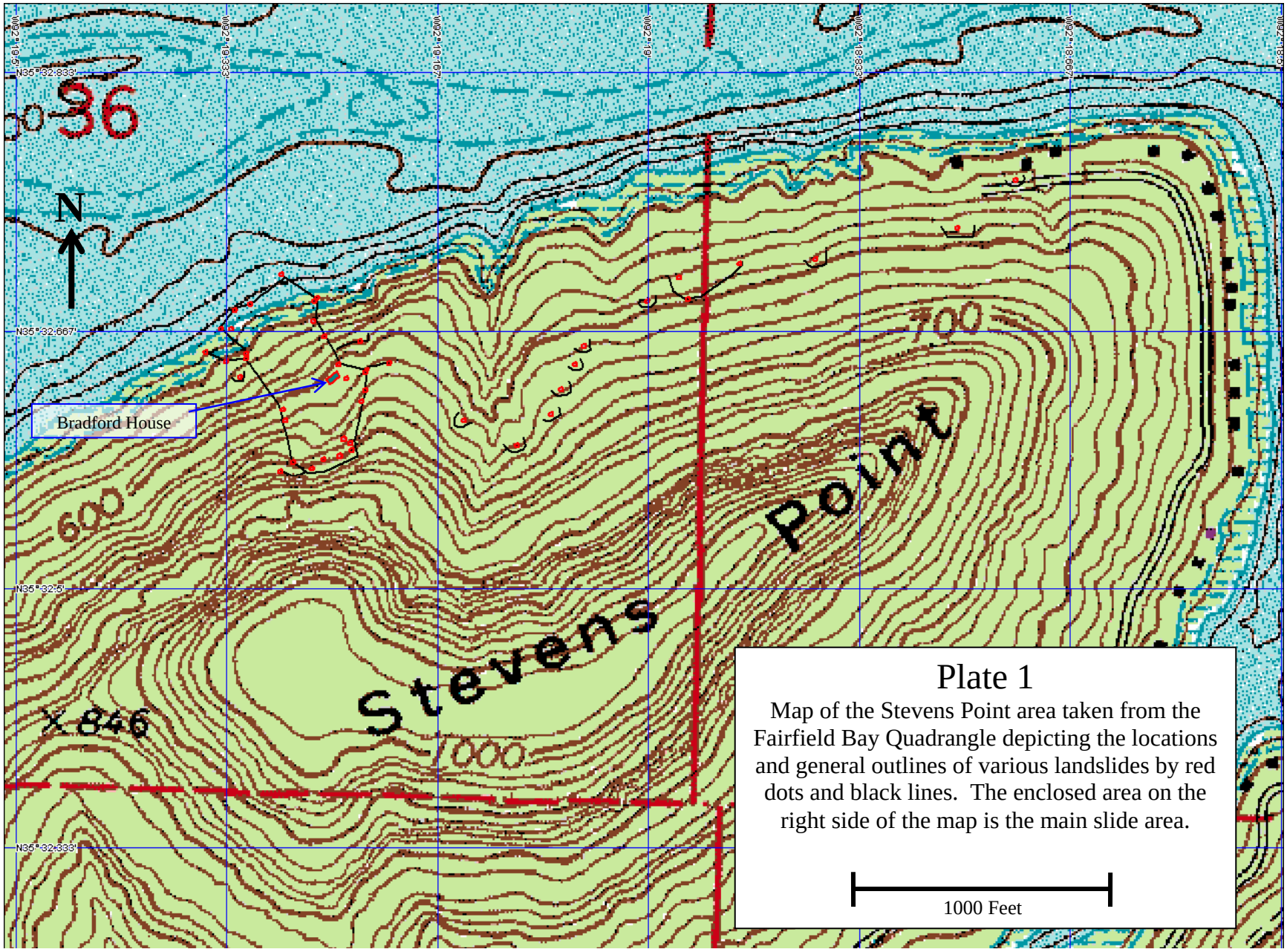

Plate 1

Map of the Stevens Point area taken from the Fairfield Bay Quadrangle depicting the locations and general outlines of various landslides by red dots and black lines. The enclosed area on the right side of the map is the main slide area.

March 28, 2005 Greers Ferry Landslide GPS Locations

Collected by John David McFarland April 5, 2005
Arkansas Geological Commission

Perimeter of main slide

Lat	Long	Notes:
35d 32.641m	92d 19.221m	Start of loop around main slide area, near Bradford house
35d 32.628m	92d 19.223m	
35d 32.621m	92d 19.226m	
35d 32.593m	92d 19.234m	
35d 32.589m	92d 19.233m	point just below & west of east side of crown scarp about 5-10 feet
35d 32.597m	92d 19.241m	point just below & west of east side of crown scarp about 5-10 feet
35d 32.586m	92d 19.244m	point just below crown scarp and southern-most edge about 10-20 feet
35d 32.584m	92d 19.257m	point just below crown scarp and southern-most edge about 10-20 feet
35d 32.578m	92d 19.266m	point just below crown scarp and southern-most edge about 10-20 feet
35d 32.582m	92d 19.281m	
35d 32.609m	92d 19.287m	
35d 32.616m	92d 19.289m	
35d 32.652m	92d 19.318m	
35d 32.649m	92d 19.318m	
35d 32.668m	92d 19.338m	
35d 32.668m	92d 19.330m	
35d 32.680m	92d 19.327m	
35d 32.684m	92d 19.315m	
35d 32.703m	92d 19.290m	
35d 32.688m	92d 19.262m	
35d 32.686m	92d 19.264m	
35d 32.673m	92d 19.265m	
35d 32.663m	92d 19.256m	
35d 32.645m	92d 19.245m	
35d 32.640m	92d 19.224m	end of loop around main slide

Spurs to main slide area, not directly part of main slide

35d 32.647m	92d 19.334m	A. extension of thin crack leading to lake, off ancient slide area (OASA)
35d 32.653m	92d 19.350m	B. extension of same thin crack as above leading to lake
35d 32.646m	92d 19.205m	east end of cracks marking subsidence of driveway, etc east of house
35d 32.576m	92d 19.291m	end of open crack extending off west end of crown scarp, OASA
35d 32.637m	92d 19.323m	location of small separate slide above road switchback off west side of main slide, OASA
35d 32.660	92d 19.228	near the middle of the crown scarp of a slide down slope and east of Bradford house (not observed on March 28), OASA, (Apr 12, '05)

March 28, 2005 Greers Ferry Landslide GPS Locations

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Small landslides above road through Platinum Peaks Development, east of Bradford house

35d 32.609m	92d 19.146m	western most slide
35d 32.593m	92d 19.104m	
35d 32.613m	92d 19.077m	
35d 32.629m	92d 19.069m	
35d 32.645m	92d 19.058m	
35d 32.657m	92d 19.051m	
35d 32.686m	92d 19.001m	
35d 32.701m	92d 18.976m	A. west end of 250 foot wide slide
35d 32.687m	92d 18.969m	B. crown scarp of 250 foot wide slide
35d 32.710m	92d 18.928m	C. east end of 250 foot wide slide
35d 32.713m	92d 18.868m	
35d 32.733m	92d 18.756m	
35d 32.764m	92d 18.710m	eastern most roadside slump, near east end of Platinum Peaks new road (Apr 21, '05)

Miscellaneous

35d 32.636	92d 19.239	point near southeast corner of Bradford house (Apr 12, '05)