MAI–2016-7/8

UNITED STATES
DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION
Metal and Nonmetal Mine Safety and Health

REPORT OF INVESTIGATION

Surface Nonmetal Mine
(Sand and Gravel)

Fatal Inundation Accident
June 3, 2016

Harmony Mine & Mill
Green Brothers Gravel Company, Inc.
Crystal Springs, Copiah County, Mississippi
ID No. 22-00650

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OVERVIEW

James "Dee" Hemphill, Dirt Crew Supervisor (age 56), and Emmitt Shorter, Haul Truck Driver (age 24), were killed on June 3, 2016, when the wall of the Johnson Pit failed and inundated the pit with liquefied slurry, engulfing the two miners.

The accident occurred because the mine operator failed to ensure: 1) the impoundment embankment was substantially constructed; 2) that barricades and warning signs were in place to prevent access or continued mining in the hazardous area of the pit; 3) that mining did not ensure wall, bank, or slope stability; and 4) that adequate examinations and corrective actions were implemented to ensure the safety of the miners.

GENERAL

Harmony Mine & Mill is a surface sand and gravel operation owned and operated by Green Brothers Gravel Company, Inc. (Green Brothers), located in Crystal Springs, Copiah County, Mississippi. The principal operating official is Heyward Green, Owner/Vice President. The mine employs approximately twenty one people and operates a twelve-hour shift, five days per week.

Material is mined using a single bench method. The operator mines sand and gravel by using an excavator to extract the material and load haul trucks. The material is hauled to the plant on the mine property where it is processed and sold for construction sand and aggregate.

The Mine Safety and Health Administration (MSHA) completed the last regular inspection at this operation on November 18, 2015

DESCRIPTION OF ACCIDENT

On June 3, 2016, Hemphill and Shorter arrived at the mine around 6:00 a.m. Hemphill was the shift supervisor the day of the accident. He discussed the day's work schedule with the dirt crew and made work assignments. Hemphill assigned Raymond White, Excavator Operator, and Willie Owens, Haul Truck Driver, to excavate and haul waste from the Sojourner Pit, located on the southeast side of the mine property. Hemphill assigned himself, Shorter and Shontavius Norals, Haul Truck Driver, to work in the Johnson Pit, located at the northeast corner of the mine. Hemphill loaded Norals's and Shorter's trucks and they transported the material to the plant or waste dump, as determined load-by-load.

At approximately 11:25 a.m., Hemphill was loading Shorter about 50 feet west of the Johnson Pit wall. Norals was parked to the west of the loading operation waiting to be loaded. Norals observed the east wall of the Johnson Pit begin to break and slurry and tailings (waste sand and clay) material breach the wall. He shifted his truck into reverse and backed up the bank on the west side of the pit, before shifting into a forward gear to exit the pit, as the material engulfed the excavator and haul truck that Hemphill and Shorter were operating. Norals stated that the entire incident occurred in a matter of seconds.

Norals contacted Jackie Mullins, Superintendent, and informed him of the failure. Mullins contacted Ann Moore, Office Manager, who called 911. Copiah County Emergency Management, Sheriff's Deputies, and Fire and Rescue arrived on scene at 11:35 a.m. Rescue workers were unable to gain access to the area where the excavator and haul truck were buried in the liquefied slurry.

Norman Ford, Green Brothers Assistant Vice President, notified MSHA of the accident at 11:52 a.m. Central Time, by telephone call to the Department of Labor's National Contact Center (DOLNCC). The DOLNCC contacted Elwood "Mac" Burriss, Staff

Assistant, South Central District, Dallas, TX, who issued a verbal order under the provisions of Section 103(j) of the Mine Act to ensure the safety of the miners. MSHA modified the order to a Section 103(k) order when the first MSHA inspector arrived on site.

RECOVERY

MSHA enforcement personnel began reviewing plans and requests for modification for the recovery efforts immediately after the accident, including approving the construction of an access road to try to reach the buried equipment. It was determined that miners could not be reached due to the dynamic and unstable ground conditions in the area. MSHA Technical Support dispatched its mobile emergency rescue command trailer and communications trailer as well as personnel to review ground control plans to assist in rescue and recovery efforts. Efforts to gain access to the equipment continued until almost midnight but had to be halted until additional equipment and personnel arrived to ensure safety of the rescue workers.

On June 4, MSHA Technical Support arrived and began evaluating the ground conditions of the constructed roadway and failed impoundment above the recovery operations. A large crane and decking materials arrived at the mine site and personnel began planning and evaluating conditions to set in the pit. The crane then began the process of rigging and lifting the equipment. Crane crews worked through the day to attempt to remove the equipment.

On June 5, rescue workers determined there was too much material in the pit and efforts to pull the buried equipment with the crane stopped. The operator decided to pump the material from the pit. The plan would use onsite pumps, hoses, and pipes in an attempt to pump mud from the flooded pit to another impoundment onsite away from the accident location. Later that same day, the operator decided to not utilize the pumping equipment onsite and decided to bring in other pumps and equipment and personnel to perform the work.

On June 6, additional pumps and crews arrived and began running the pumps. Pumping uncovered a fair portion of the equipment and on June 7, a long reach excavator arrived onsite and was used in combination with the pumping to uncover the top of the cab of the haul truck. Upon reaching the cab, search and rescue teams assisted in the search and possibly recovery of the victims. The search and rescue teams were able to cut and remove the top of the haul unit cab. Teams began digging by hand to make entry into the cab and search for Mr. Shorter. The entire cab was cleared but they were unable to locate Shorter.

On June 8, rescue workers continued using the pumps to lower the material and locate the other known miner's location, the cab of the excavator. Rescue workers located the cab of the excavator around 3:00 p.m. and at approximately 10:00 p.m. that evening Mr. Hemphill was located in the cab of the excavator. On June 9, Mr. Hemphill's body was recovered at 6:56 a.m.

Pumping continued on June 9 and 10 to remove more material from around the machines in an attempt to locate Mr. Shorter. Rescue crews used ground penetrating radar and cadaver dogs on June 10 to locate Mr. Shorter. The use of radar was unsuccessful given the material that had flooded the pit location. Crews continued to wash and pump material in the area of the truck and were able to locate Mr. Shorter at approximately 10:00 p.m. on June 10. At approximately 1:30 a.m. on June 11, MSHA, the state search and rescue team and county officials developed a recovery plan and at approximately 7:00 a.m., workers were able to recover Mr. Shorter and remove him from the pit.

INVESTIGATION OF ACCIDENT

On June 20, 2016, MSHA's accident investigation team traveled to the mine to conduct a physical inspection of the accident scene, interview employees, and review documents and work procedures relevant to the accident. MSHA conducted the investigation with the assistance of mine management and employees, as well as state and local authorities.

DISCUSSION

Location of the Accident

The accident took place at the mine's Johnson Pit near the northeast corner of the mine property (as shown in Figure 1 on page 4). The primary access road into the Johnson Pit enters at the Johnson Pit's southwest corner, near the hopper area of the plant. The Johnson Pit was adjacent to, and immediately west of, an impoundment created in a previously mined pit, referred to as the Krystal Gravel's Ball Pit (as shown in Figure 2 on page 5). There was a fresh water pond used by the mine, also created in an old pit, to the west of the Johnson Pit. The excavator and the truck were positioned near the east pit wall (as shown in Figure 3 on page 6).

Figure 1 – Overview of Harmony Mine Layout and Location Map shown on a satellite image dated December 14, 2015, viewed in Google earth.

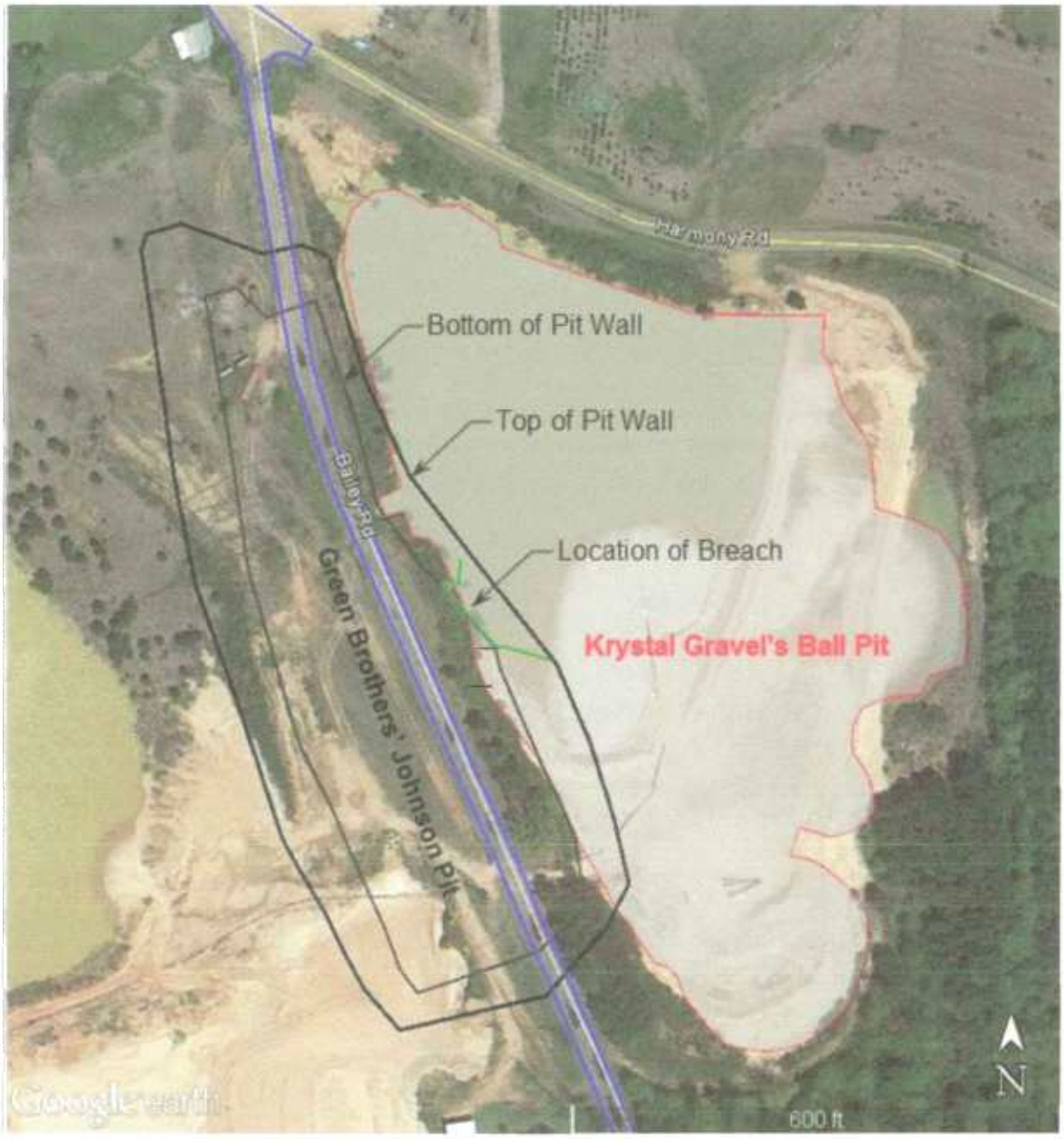

Figure 2 - Outlines the original Ball Pit in relationship to the mining of the Johnson Pit. The area of the Johnson Pit widens where the wall material composition transitions from primarily natural sand and gravel to primarily tailings. The excavator and haul truck were both on the pit bottom near the location of the failure.

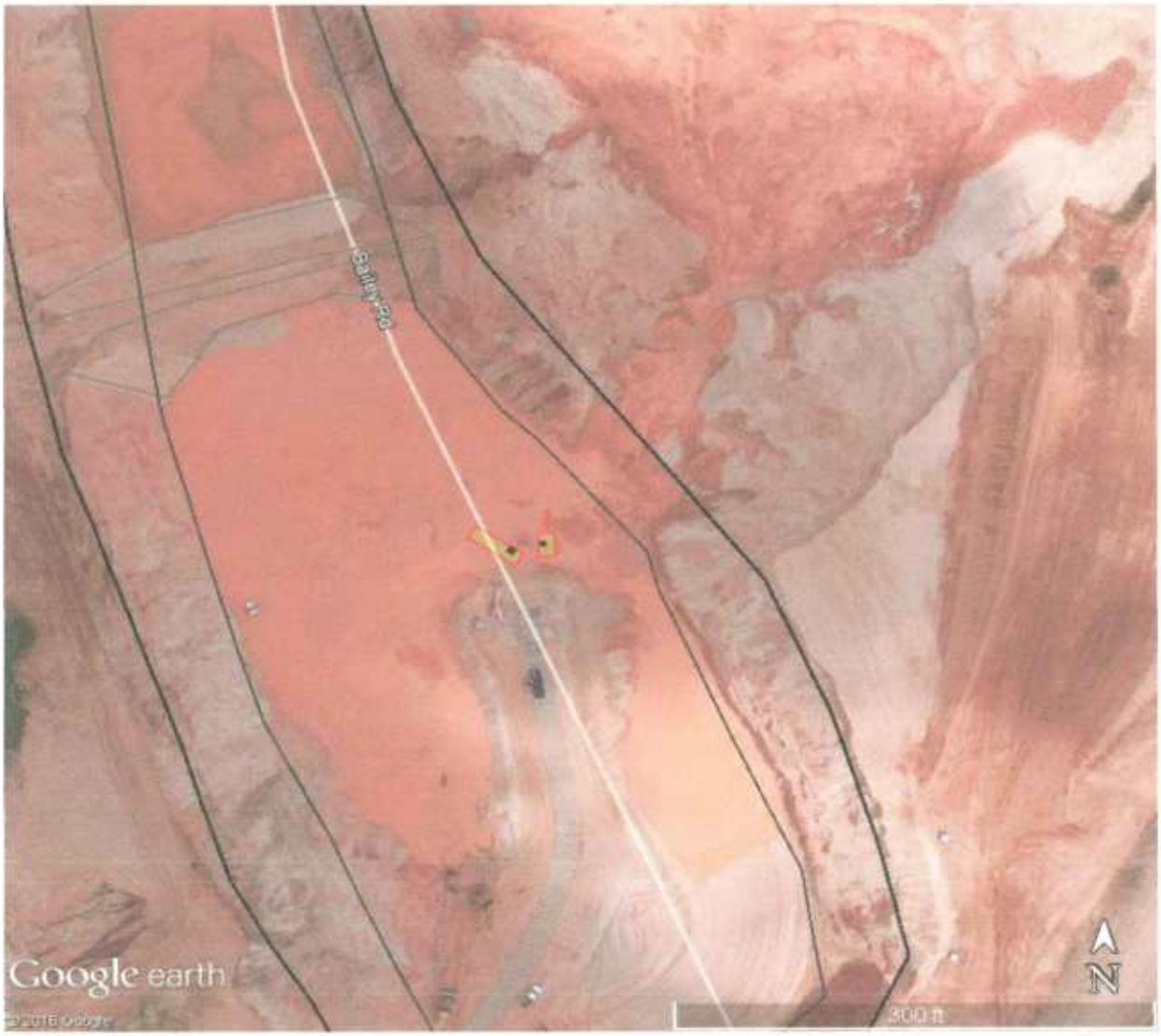

Figure 3 - The excavator was positioned near the east pit wall facing a northern direction at the time of the failure. The truck was on the west side of the excavator, and was facing south to southeast.

The Accident Investigation Team used post-failure pit measurements to estimate that approximately 41,000 cubic yards of material failed into the pit, covering an area of about 2 acres. The failed material was about 16.9 feet deep at the location of the equipment. The failed material came from an area that covered about 2.8 acres of the Ball Pit. The majority of this surface area was occupied by clay tailings.

Development of the Johnson Pit

Green Brothers acquired the Ball Pit from Krystal Gravel in 2008. The Ball Pit covered about 10 acres (Figure 2), and according to mine permits, was mined to a depth of about 50 feet below natural ground. Krystal Gravel completed mining of the Ball Pit prior to 2003 and possibly as early as 1999.

Green Brothers began reclamation of the Ball Pit when they acquired it by filling it with hydraulically placed waste sand and clay from the plant to create a tailings impoundment in the Pit (Figure 3). They pumped water from the impoundment [Ball Pit] via a pipeline under Bailey Road to the fresh water pond, which was adjacent to and west of Bailey Road.

In July 2015, Green Brothers proposed and received permission to relocate Baily Road to the east side of the Ball Pit and mine the material below the "old Baily Road." The permit was amended in August 2015 to mine the material located under the old Bailey Road and would be called the Johnson Pit, which added 1.5 acres and permitted mining to a depth of 80 feet. The permit indicated that the overburden was estimated at 5 to 15 feet deep, sand and gravel product material was estimated to be 60 to 75 feet thick, and groundwater was 110 feet deep. The natural ground elevations in the area of the Johnson Pit range from approximately 460 feet near the southwest corner to about 488 feet near the northeast corner. Most of the natural ground around the Johnson Pit was at or above elevation 480 feet.

Green Brothers paid for the relocation of Bailey Road and employed an engineer to prepare a geotechnical report for construction of the relocated road. An engineering report dated March 26, 2015, presents the results of a subsurface investigation; laboratory testing; and recommendations for site preparation, earthwork construction and pavement design. The mine operator retained another engineering company to prepare a detailed survey of the location of Bailey Road and a map of the survey for conveyance of right-of-way to the county. During construction, compaction testing was performed on the subgrade, laboratory testing of the construction materials was conducted, and compaction testing of the road subbase was performed.

Prior to mining, Green Brothers reportedly stripped about 5 to 6 feet of overburden from the proposed footprint of the Johnson Pit, including old Bailey Road. Most of this overburden material was stockpiled for topsoil cover and the remaining 1 to 2 feet of overburden was pushed into the Ball Pit impoundment along the western shoreline, which was immediately adjacent to and parallel with old Bailey Road. This stripping work removed the pipeline previously used to pump water from the impoundment to the fresh water pond. The footprint of the Johnson Pit during its early development is depicted in Figure 4.

Weather

On the morning of Friday, June 3, weather conditions were clear to partly cloudy with a temperature of about 84 degrees Fahrenheit in the late morning. Average wind speed was 3 to 6 mph. Later that day after the accident, the recorded rainfall for the Jackson area was 0.87 inches. The mine recorded 0.70 inches of rainfall from Friday afternoon through Saturday morning. Leading up to the accident date, on Tuesday, May 31, the mine recorded 0.30 inches of rainfall and on Wednesday, June 1, the mine recorded 1.90 inches of rainfall.

Mining Practice

Green Brothers mined the sand and gravel deposit using excavators. It transported mined material to the hopper in off-road haul trucks and had a permanent plant on mine property to process the sand and gravel.

Typically, miners excavated 4- to 6-foot lifts from the bottom of the pit, working from the north end to the south. The excavator loaded the raw material into off-road haul trucks and sent them to the plant or a waste dumping location depending on the quality of the material. The raw material was stockpiled near the crusher plant where a front-end loader would feed the material into the plant. Conveyors and front-end loaders move the individual sand and gravel products to separate stockpiles and front-end loaders load over-the-road trucks from the sand and gravel product stockpiles.

The mine operator did not have a plan for mining along the east side of the Johnson Pit toward the existing Ball Pit impoundment; however, according to statements made during the accident investigation interviews, they intended to "leave a gravel wall." That is, the operator expected to leave about 20 feet of natural sand and gravel between the pit and the impoundment. The pit was narrower on the north end to "leave a larger barrier where the mud was." The mud refers to the clay tailings in the impoundment. The operator did not conduct any surveys and did not install stakes to determine where the clay tailings were or where the pit wall should have been located to maintain the 20-foot-wide barrier.

Based on interview statements, the mine operator had completed mining in the northern most portion of the Johnson Pit, and about May 1, 2016, installed a levee across the pit to retain excess water and tailings that spilled from the Ball Pit impoundment. At the time of the accident, the operator was draining most of the excess surface water (and some of the clay tailings) from the Ball Pit impoundment via a trench excavated through the embankment crest immediately east of the levee. Storm water that entered the impoundment would drain through this trench and into the northern end of the Johnson Pit. The mine operator stated they had problems with water eroding the embankment and entering the pit so they constructed the levee to retain it in the completed portion of the pit.

Prior to digging the trench, the water seepage had also caused a failure in the upper portion of the pit wall near the northeast corner of the pit. After the levee was constructed and the Ball Pit impoundment was drained of surface water, the mine operator had to install a pump in the northwest corner of the active pit to remove accumulating water. They ran the pump for several hours about every other day when the accumulated water was 3 to 4 feet deep. The mine operator thought that this was groundwater seeping into the pit.

During interviews, investigators determined that the mine operator periodically inspected for undermining of the pit wall, cracks along the top and cracks along the

impoundment and made daily examinations from the pit floor. During the mining cycle in general, sand on the upstream slope would slide into the impoundment pool. Occasionally, additional sand was hauled to the Ball Pit impoundment in trucks and pushed with dozers into the southwestern corner of the Ball Pit impoundment about 4 to 5 feet above the clay tailings in an effort to force the waste material to the north side of the impoundment. There was no compaction equipment used and no sampling or testing of materials.

Along the southeast pit wall, sand tailings that sloughed into Johnson Pit area contained wet clay tailings.

Pit Description and Field Observations After the Accident

The Johnson Pit was about 950 feet long (in the north to south direction) and about 250 to 380 feet wide. The pit was narrower at its northern end than at the southern end. The long axis of the pit runs along the natural ridgeline at an azimuth (a directional measurement) of about 337 degrees from North, which was closely parallel to the old Bailey Road. The Johnson Pit covered about 7 acres and had a perimeter about 2,500 feet. The west pit wall was 160 feet or more east of the fresh water pond. The bottom of the pit sloped downward to the north at a grade of 3 percent. The pit bottom varied in elevation from sea level at about 434 feet at the southeast corner to about 417 feet at the south end. As previously mentioned, the operator constructed a levee across the pit about 200 feet south of the north pit wall and tailings material had flowed from the Ball Pit impoundment into the Johnson Pit area north of that levee covering the final pit bottom. The actual mined pit bottom is estimated to be at 400 feet. The levee had a minimum height of about 17 feet above the tailings on the north side and at least 12 feet above the failed material on the south side. The levee was also located where the pit width began to widen. The western pit wall was relatively straight and uniform. The pit widened along its eastern side. The pit bottom near the failure was estimated to be at about elevation 405 feet and the depth of failed material was about 17 feet. Figure 5 shows the orientation and approximate limits of the pit on a satellite image dated December 14, 2015, viewed in Google earth with an overlay of an aerial image taken on June 6, 2016.

The pit walls varied in height and slope. The pit wall on the western side was excavated in mostly sand from previous pit reclamation. It varied in height from about 15 to 50 feet and had overall slopes between 20 and 40 degrees from horizontal. The slopes were flatter at the southern end of the pit. The pit walls on the northern and southern ends were excavated in the natural sand and gravel. The southern end of the pit had a wall that was up to 40 feet high with a slope of about 55 degrees from horizontal. The northern end of the pit was approximately 55 feet high and deeply eroded. The slopes of the northern pit wall varied and were near vertical in some areas, with localized undercutting from erosion.

The eastern pit wall, the wall where the failure occurred, had the most diverse strata. North of the levee and for a short distance south, the eastern pit wall was primarily excavated in the natural sand and gravel and was deeply eroded. This pit wall was up to 50 feet high above the failed tailings with a slope of about 51 degrees from horizontal. A relatively small failure area was observed along the top of the east pit wall near the northeast corner of the pit. Between the levee and the failure zone, the pit was getting wider, and the eastern pit wall was primarily excavated in the natural sand and gravel, except for the upper portion, which was fill material. The investigation team observed a small failure or large erosion feature near the top of the pit wall, south of the levee, and immediately north of the failure zone (Photo 1). This failure or erosion appeared to be primarily in fill material and had exposed some of the clay tailings under the fill.

The pit wall south of the failure zone was excavated in sand tailings and natural sand and gravel. The upper 40 feet was sand tailings with an average slope of 38 degrees from horizontal. The bottom portion of the pit wall was excavated in natural sand and gravel and was sloped between 56 and 60 degrees from horizontal. Due to the sloped pit floor, the height of the east wall ranged from about 40 feet above pit floor at the southern end to over 50 feet above the failed tailings level adjacent to the failure. The top of the natural sand and gravel strata in the southeast pit wall was nearly horizontal at an elevation of approximately 435 feet.

The failure zone was located between 350 and 500 feet north of the south pit wall. The original failure was likely smaller than the final breach dimensions due to the fact that the breach widened by erosion as material flowed through it. The final breach was about 165 feet wide at the top of pit wall and about 84 feet wide along its bottom (Photo 2). The bottom of the breach, which appears to coincide with the top of the natural sand and gravel deposit, was 35 to 44 feet deep between approximate elevations 428 and 437 feet. Observation of the exposed strata on the northern side of the breach revealed that the east wall contained a relatively thin barrier of natural ground that was estimated to be less than 10 feet wide overlain by a wedge of clay tailings, which was overlain by fill material (Photo 3). Observation of the exposed strata on the southern side of the breach revealed that this portion of the east wall contained natural ground only below the breach bottom, which was overlain mostly by sand tailings except for a few feet of clay tailings near the bottom (Photo 4). On the surface, the sand tailings on the southern side of the breach abruptly transitions to clay tailings on the northern side.

During the investigation and for more than three weeks after the failure, there was a persistent stream of water flowing through the impoundment area and the breach into the pit. The water seepage appeared to originate from the northeast area of the impoundment near the new intersection of Bailey Road and Harmony Road.

It was determined during interviews that wet overburden material was sloughing from the east pit wall, and the operator excavated and hauled it to a supplemental waste dump area, adjacent to the sedimentation and waste pond. This pond was located south of the Johnson Pit and east of the plant. The waste dumping area was a pile situated on the east shore of the sediment pond. Material was dumped in piles by the

trucks and spread out with a dozer. Reportedly, several loads of saturated material was removed from the Johnson Pit and dumped at this pile on the day of the accident. During the investigation, three to four loads were observed on the waste dump. The material characteristics are described in Appendix E.

Recent Satellite Imagery

A satellite image obtained from Terraserver.com dated 02/13/2016 shows signs of erosion or other distress on the pit slope where the failure occurred (Figure 6). At that time, there was a pool of water along the east end of the impoundment, similar to the Google image dated 12/14/2015. However, the more recent satellite image showed more waste sand had been pushed into the southwest corner of the impoundment covering the clay tailings, as reported. This image also shows an erosion gulley near the northern end of the pit prior to the construction of the levee, and water pooling in the pit.

Engineering Assessment

Based on information gathered by the investigation team, namely satellite images from Google Earth and TerraServer, survey measurements of the pit dimensions, drone images of the mine, and other observations and information gathered from the site, it is clear that the failure zone was partially situated within the prior owner Krystal Gravel's Ball Pit and occurred where the sand tailings beach transitioned to clay tailings. The northern side of the failure, where the tailings were predominately clay, may have had a thin barrier of natural sand and gravel. The top of the natural sand and gravel that was observed along the southern portion of the east pit wall is likely the bottom of the Ball Pit.

Failure of the pit wall caused a sudden breach of the impoundment that released saturated clay and sand tailings. The failure occurred due to the mining along the east pit wall that removed most of the natural embankment of medium dense sand and gravel and excavated into the less competent tailings deposit. The thin barrier was further compromised by the steep angle of the wall and the deep erosion gullies in the sand and gravel.

In the immediate area of the failure, the tailings transitioned from sand to clay. The clay can be observed in the upper wedge on the north side of the breach and in the bottom of the south side of the breach. Satellite images over several years of operating the impoundment show that this area was normally upstream of the sand beach. The stripped overburden material that was pushed into the impoundment was an inadequate embankment, failed to displace or retain the clay tailings, and hid the previous pit wall location. The additional waste sand pushed into the southwest corner of the impoundment covered the clay and pushed back the pool water, but it did not stop the seepage, and was inadequate to retain the saturated tailings, and it masked the hazard.

TRAINING AND EXPERIENCE

Mr. Hemphill had approximately 17 years of mining experience; he worked for this mine for 6 years, 51 weeks and 5 days. The accident investigation team conducted an in-depth review of the mine operator's training records including records for Mr. Hemphill. MSHA determined that his required MSHA Part 46 Annual Refresher Training was not in compliance and issued a non-contributory citation under 30 CFR Part 46.

Mr. Shorter had approximately 39 weeks, and 5 days of mining experience, all at this mine. The accident investigation team conducted an in-depth review of the mine operator's training records including records for Mr. Shorter. MSHA determined that his required MSHA Part 46 New Miner Training was not in compliance and issued a non-contributory citation under 30 CFR Part 46.

ROOT CAUSE ANALYSIS

The investigators conducted a root cause analysis of this accident and identified the following root causes and corresponding corrective actions to prevent a recurrence:

Root Cause: The mine operator failed to implement and use proper mining methods to maintain the wall, bank, and slope stability.

Corrective Action: The mine operator established and implemented methods and procedures to maintain wall and slope stability by using proven industry methods. The operator also created and implemented a training program for all miners to identify highwall, bank and slope hazards and a method of reporting hazards to Mine Operator for review and correction.

Root Cause: The mine operator failed to ensure the retaining dam was substantially constructed.

Corrective Action: The mine operator established and implemented methods and procedures to substantially construct dams by using proven industry methods. The operator also created and implemented a training program for all miners to identify a substantially built dam and a method of reporting hazards to competent people for review and correction.

Root Cause: The mine operator failed to install barriers or post warning signs to prevent miners from entering an area that it knew or should have known was hazardous, as exhibited by the operator installing the levee on the north side of the pit, causing water and waste material to enter the excavation area from the impoundment

Corrective Action: The mine operator established and implemented methods and procedures to install barricades and/or warning signs to prevent miners from entering hazardous areas. The operator also created and implemented a training program for all miners to identify hazardous areas and a method of reporting hazards to the operator for review and correction.

Root Cause: The mine operator failed to conduct an adequate workplace examination and to recognize and correct obvious hazardous ground conditions on the east wall of the Johnson Pit and the Ball Pit impoundment.

Corrective Action: The mine operator established and implemented methods and procedures to examine, recognize and correct hazardous ground conditions. They also created and implemented a training program for all miners to identify hazardous areas and a method of reporting hazards to Mine Operator for review and correction.

CONCLUSION

Two victims sustained fatal injuries when they were engulfed in an impoundment wall collapse and inundated the pit with liquefied slurry. The victims were in the process of excavating material too close to a waste disposal pond. MSHA determined the operator failed to maintain the wall, bank and slope stability of the impoundment wall and failed to protect miners from obvious hazards. The operator also failed to conduct an adequate examination to prohibit access to an unsafe area and identify hazards involved in this fatal accident.

ENFORCEMENT ACTIONS

Order No. 8867336- issued under the provisions of Section 103(j) of the Mine Act:

An accident occurred at this operation on 06/03/2016 at approximately 11:00. As rescue and recovery work is necessary, this order is being issued, under section 103(j) of the Federal Mine Safety and Health Act of 1977, to assure the safety of all persons at this operation. This order is also being issued to prevent the destruction of any evidence which would assist in investigating the cause or causes of the accident. It prohibits all activity at the Johnson Pit until MSHA has determined that it is safe to resume normal mining operations in this area. This order applies to all persons engaged in the rescue and recovery operation and any other persons on-site. This order was initially issued orally to the mine operator at 12:15 and now has been reduced to writing.

This order was modified to 103(k) of the Mine Act on 06/03/2016 at 3:57 p.m.

Citation No. 8853033 – Issued under provisions of Section 104(d)(1) of the Mine Act for a violation of 30 CFR 56.3130:

On June 3, 2016, the mine operator did not use proper mining methods to maintain the wall and slope stability of the east pit wall in the Johnson Pit. The east pit wall failed resulting in the death of two miners. The mine operator used excavators and dump trucks to excavate and haul material from the Johnson Pit for processing. This highwall was 65 feet high and the excavator operator was mining the gravel from the bottom portion of the highwall. The composition of the highwall was about 45 feet of sand at the top, underlain by an interbedded sand/clay layer as well as finally a 20 foot thick gravel deposit at the bottom. The sand and clay was material that had been back-filled and the gravel was undisturbed material. The mine operator's mining method was deficient for any of the following reasons: 1. Lack of adequate preplanning or mine plan. 2. No use of engineer support to ensure proper design in slope, stabilization and protection measures. 3. No surveys to define areas to be mined or define the limits of advance. 4. No use of any type of delineation to limit and control the mining advance, for example: stakes, flags, painted marks or cones. 5. No sampling or testing was done to define the areas to be mined or define the limits of advance and 6. Not maintaining a proper angle of repose for the material being mined. A prudent mine operator would have employed any of the above mentioned mining methods to maintain wall and slope stability while mining near a dam. Furthermore, during the mining process there were indications of wall and slope instability. These warning signs included material sloughing off the highwall, persistent water seepage, recent rains of approximately 2 inches, and wet sand and clay dropping out of the highwall. This condition exposed up to six miners to the hazard, including two excavator operators and four haul truck operators working in the Johnson Pit. The miners stated they were concerned for their safety while working in the Johnson Pit. Mine Management engaged in aggravated conduct constituting more than ordinary negligence in that they were aware of the hazards of not using proper mining methods additionally the hazard of mining next to a waste dam. This violation is an unwarrantable failure to comply with a mandatory standard.

Order No. 8853034 – Issued under provisions of Section 104(d)(1) of the Mine Act for a violation of 30 CFR 56.20010:

On June 3, 2016 two miners were killed at this mine when a retaining dam failed next to a pit. The mine operator failed to ensure the retaining dam was substantially constructed. The retaining dam retained water, sand and clay that had been pumped into an abandoned approximately 50–foot-deep excavation that was located next to the Johnson Pit. Prior to mining the Johnson Pit, the mine operator back filled the retaining dam hydraulically with waste and with stripped material and waste sand pushed into the waste dam with a dozer. The mine operator relied on the back fill to displace the wet clay in the dam and to act as an impoundment to allow mining near the dam. The mine operator did not use an engineer to design the dam or the backfill, did not compact the back fill or test for compaction, and did not test to determine the back fill thickness or effectiveness of displacing the clay. The mine operator did not determine the location of or the thickness of the unmined gravel bed below the retaining dam, or the thickness or the stability of the retaining dam. The mine operator did not initially install overflow features such as decant pipes or a spillway. An overtopping event occurred over the crest of the north end of the retaining dam on or about January 2016 which caused material to fall in to the Johnson Pit. As a result, the mine operator installed a levee inside the Johnson Pit and a trench spillway. This trench had no erosion control features. Both this levee and trench were makeshift without engineer design or any construction quality controls. The mine management and miners saw additional water seepage on the retaining dam. On June 3, 2016, a miner observed wet sand and clay being removed from the dam. During the pit excavation, mine management had numerous indications that the retaining dam was not constructed to hold back the water and silt. Further, recent rains of approximately 2 inches should have triggered concern. Management engaged in aggravated conduct constituting more than ordinary negligence by not ensuring the retaining dam was substantially constructed. This violation is an unwarrantable failure to comply with a mandatory standard.

Order No. 8853035 – Issued under provisions of Section 104(d)(1) of the Mine Act for a violation of 30 CFR 56.20011:

On June 3, 2016 two miners were killed at this mine when a retaining dam failed next to a pit. The mine operator was aware that a section of the highwall in the Johnson Pit was endanger of failing adjoining the waste dam. With this knowledge, the mine operator did not install barriers or post warning signs to have miners stay clear of this area in the Johnson Pit. Mine management had indications of a pending failure from continual water seepage, wet sand and clay dropping out of the highwall, and recent rains of approximately 2 inches. Mine management engaged in aggravated conduct constituting more than ordinary negligence by not ensuring barriers or warnings signs were posted in the Johnson Pit. This violation is an unwarrantable failure to comply with a mandatory standard.

Order No. 8853036 – Issued under provisions of Section 104(d)(1) of the Mine Act for a violation of 30 CFR 56.18002(a):

On June 3, 2016 two miners were killed at this mine when a retaining dam failed next to a pit. The person designated by the mine operator to conduct examinations of the Johnson Pit failed to recognize the obvious indications of wall and slope instability on the east wall of the Johnson Pit. These indications were material sloughing off the high wall, continual water seepage, recent rains of approximately 2 inches, and wet sand and clay dropping out of the highwall. A competent person would have recognized the hazards and would have initiated prompt action to correct the conditions; the mine operator failed on both counts. Clearly, the work place examinations of the Johnson Pit highwalls were inadequate. The records of the workplace examinations for the Johnson Pit for the day of the accident and prior make no mention of any safety issues. Mine management engaged in aggravated conduct constituting more than ordinary negligence by not having a competent person who could recognize unsafe conditions and take prompt corrective actions for the Johnson Pit. This violation is an unwarrantable failure to comply with a mandatory standard.

Order No. 8853037 – Issued under provisions of Section 104(d)(1) of the Mine Act for a violation of 30 CFR 56.3401:

On June 3, 2016 two miners were killed at this mine when a retaining dam failed next to a pit. The person designated by the mine operator to conduct examinations of the Johnson Pit failed to recognize the obvious indications of wall and slope instability on the east wall of the Johnson Pit. These indications were material sloughing off the high wall, continual water seepage, recent heavy rains and wet sand and clay dropping out of the highwall. A prudent person familiar with mining would have recognized these hazards and would have tested ground conditions prior to allowing work to commence; the mine operator failed on both counts. Mine management engaged in aggravated conduct constituting more than ordinary negligence by not recognizing the unsafe ground conditions at the Johnson Pit. This violation is an unwarrantable failure to comply with a mandatory standard.

Approved By: _____ Date: 1/3/17

Kevin G. Stricklin
Administrator
Metal and Nonmetal Mine Safety and Health Administration

List of Appendices

APPENDIX A

Persons Participating in the Investigation

Green Brothers Gravel Company, Inc.

Andrew Donahoe	President
Jackie Mullins	Superintendent
Norman Ford	Assistant Vice President
Heyward Green	Vice President
Sarah Korwan	Counsel (Law Office of Adele L. Abrams)

Mine Safety and Health Administration

Christopher Hensler	District Manager, North Central District
Dustan Crelly	Assistant District Manager, Rocky Mountain District
James Peck	Staff Assistant, North Central District
Ryan O'Boyle	Supervisor, MNM Southeast District
Eric Gottheld	Civil Engineer, Technical Support

APPENDIX B

James "Dee" Hemphill Victim Data Information

Accident Investigation Data - Victim Information
Event Number: 6732580

U.S. Department of Labor
Mine Safety and Health Administration

Victim Information: 1

1. Name of Injured/Ill Employee	2. Sex	3. Victim's Age	4. Degree of Injury
James D. Hemphill	M	56	01 Fatal

5. Date(MM/DD/YY) and Time(24 Hr.) Of Death: a. Date: 06/03/2016 b. Time: 11:30

6. Date and Time Started: a. Date: 06/03/2016 b. Time: 6:00

7. Regular Job Title: 149 Dirt Crew Supervisor

8. Work Activity when Injured: 059 Operating excavator, loading trucks

9. Was this work activity part of regular job? Yes X No

10. Experience	Years	Weeks	Days		Years	Weeks	Days		Years	Weeks	Days		Years	Weeks	Days
a. This Work Activity:	17	0	0	b. Regular Job Title:	6	51	5	c. This Mine:	6	51	5	d. Total Mining:	17	0	0

11. What Directly Inflicted Injury or Illness? 094 Slurry Impoundment failure

12. Nature of Injury or Illness: 170 Crushing injuries

13. Training Deficiencies. Hazard: | New/Newly-Employed Experienced Miner: | Annual: | Task:

14. Company of Employment: (If different from production operator) Operator

Independent Contractor ID: (if applicable)

15. On-site Emergency Medical Treatment: Not Applicable: | First-Aid: | CPR: | EMT: | Medical Professional: | None: X

16. Part 50 Document Control Number: (form 7000-1)

17. Union Affiliation of Victim: 9999 None (No Union Affiliation)

APPENDIX C

Emmitt Shorter Victim Data Information

1. Name of Injured/Ill Employee:	2. Sex	3. Victim's Age	4. Degree of Injury
Emmitt A. Shorter	M	*24*	*01 Fatal*

5. Date(MM/DD/YY) and Time(24 Hr) Of Death:
a. Date: 06/03/2016 *b.Time: 11:30*

6. Date and Time Started:
a. Date: 06/03/2016 *b.Time: 6:00*

7. Regular Job Title:
176 Haul Truck Driver

8. Work Activity when Injured:
055 Haul Truck Operator

9. Was this work activity part of regular job?
Yes | X | No |

10. Experience:	Years	Weeks	Days		Years	Weeks	Days		Years	Week	Days		Years	Weeks	Days
a. This Work Activity:	*0*	*39*	*5*	b. Regular Job Title:	*0*	*39*	*5*	c. This Mine:	*0*	*39*	*5*	d. Total Mining:	*0*	*39*	*5*

11. What Directly Inflicted Injury or Illness?
094 Slurry Impoundment Failure

12. Nature of Injury or Illness:
170 Crushing injuries

13. Training Deficiencies:
Hazard: | New/Newly-Employed Experienced Miner: | Annual: | Task: |

14. Company of Employment: (If different from production operator)
Operator

Independent Contractor ID: (if applicable)

15. On-site Emergency Medical Treatment:
Not Applicable: | First-Aid: | CPR: | EMT: | Medical Professional: | None:

16. Part 50 Document Control Number: (form 7000-1)

17. Union Affiliation of Victim: *9999* *None (No Union Affiliation)*

APPENDIX D

Figures and Photos

Figure 1 – Overview of Harmony Mine Layout and Location Map shown on a satellite image dated December 14, 2015, viewed in Google earth.

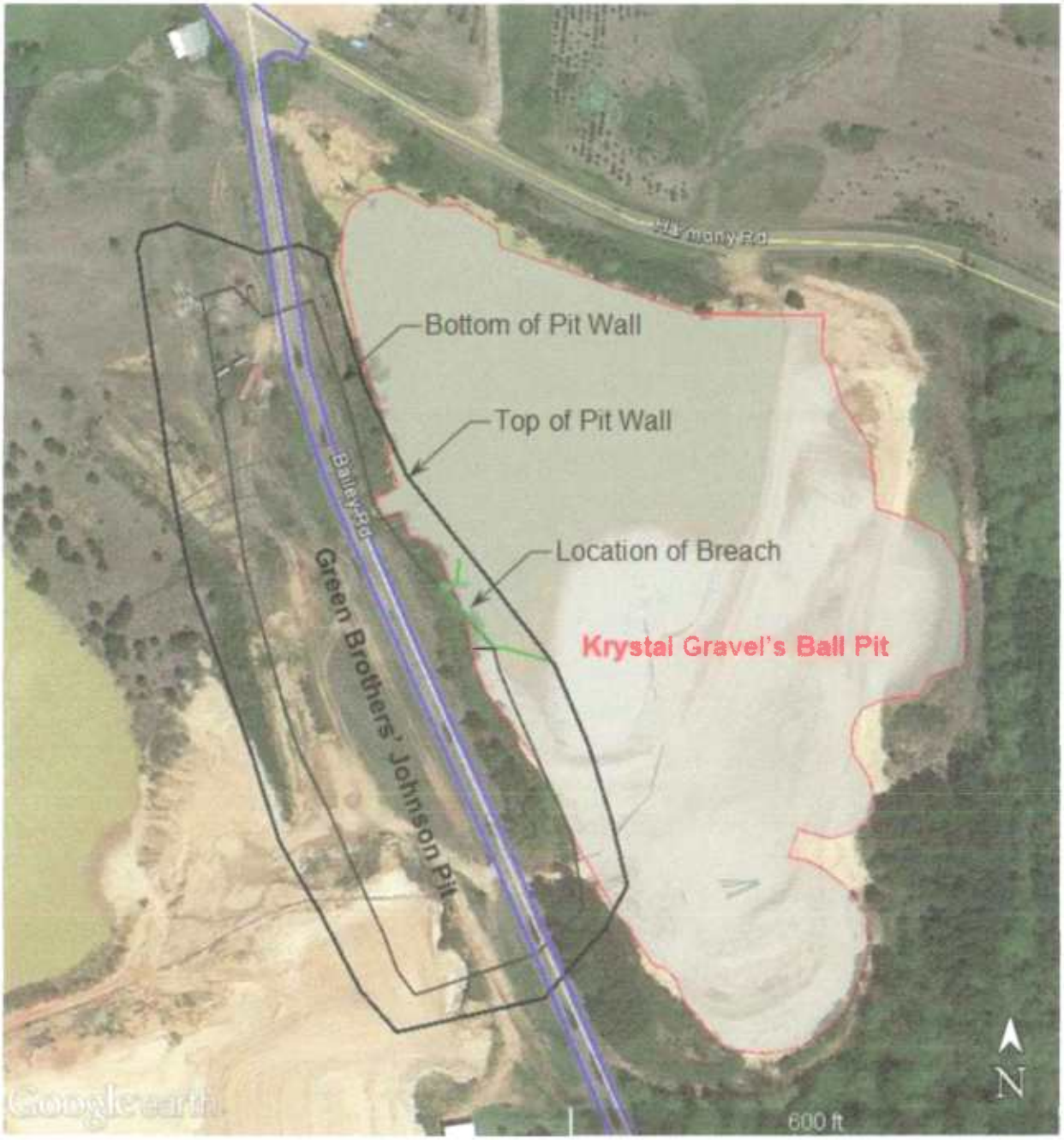

Figure 2 – Location of the Johnson Pit and the breach relative to the Ball Pit as shown on a satellite image dated April 9, 2014, viewed in Google earth.

Figure 3 - The excavator was positioned near the east pit wall facing a northern direction at the time of the failure. The truck was on the west side of the excavator, and was facing south to southeast.

Figure 4 – Location of Krystal Gravel's Ball Pit and old Bailey Road shown on a satellite image dated November 4, 2004, viewed in Google earth.

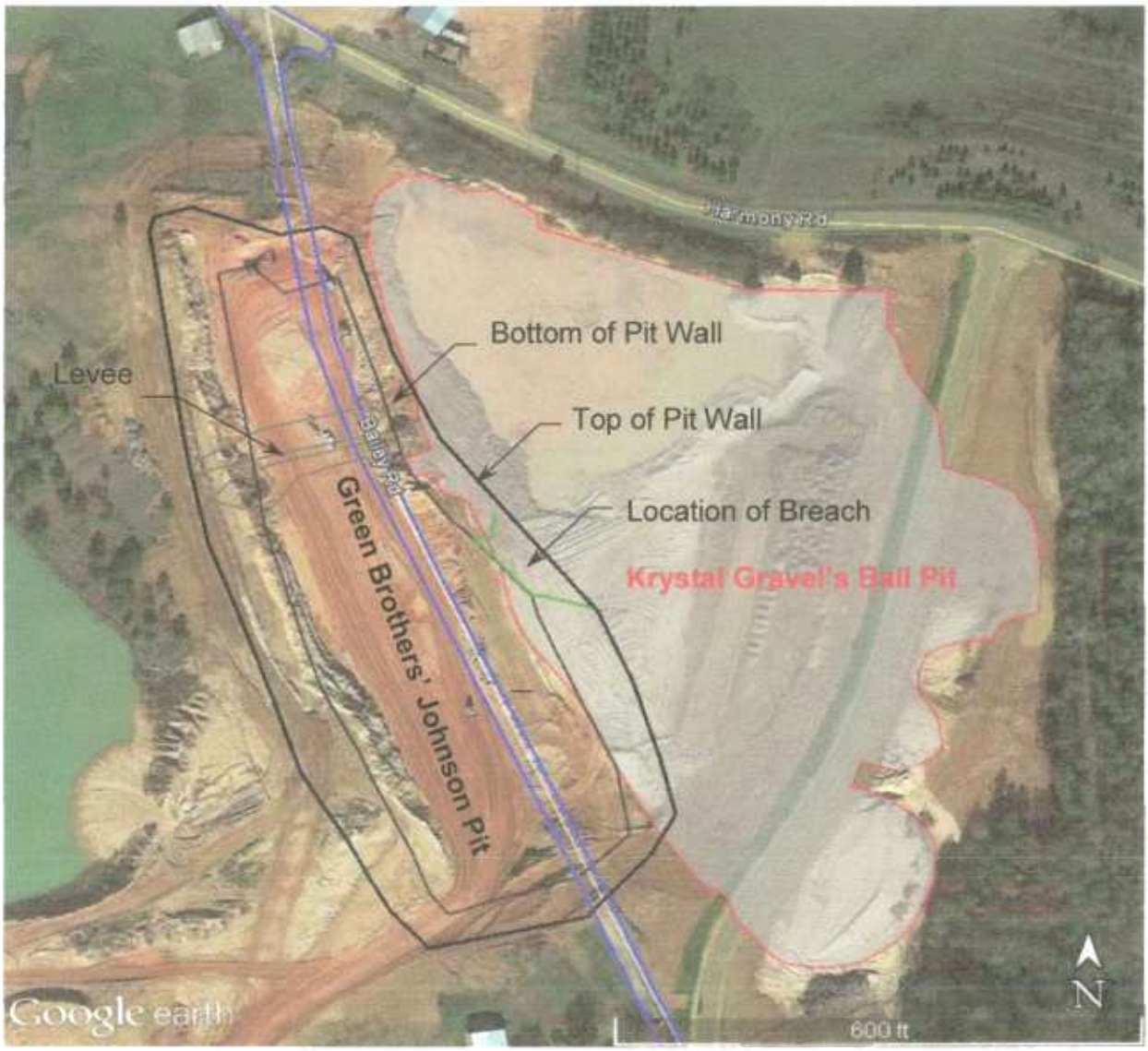

Figure 5 – Location of the Johnson Pit, the breach, and the previous Ball Pit shown on a satellite image dated December 14, 2015, viewed in Google earth.

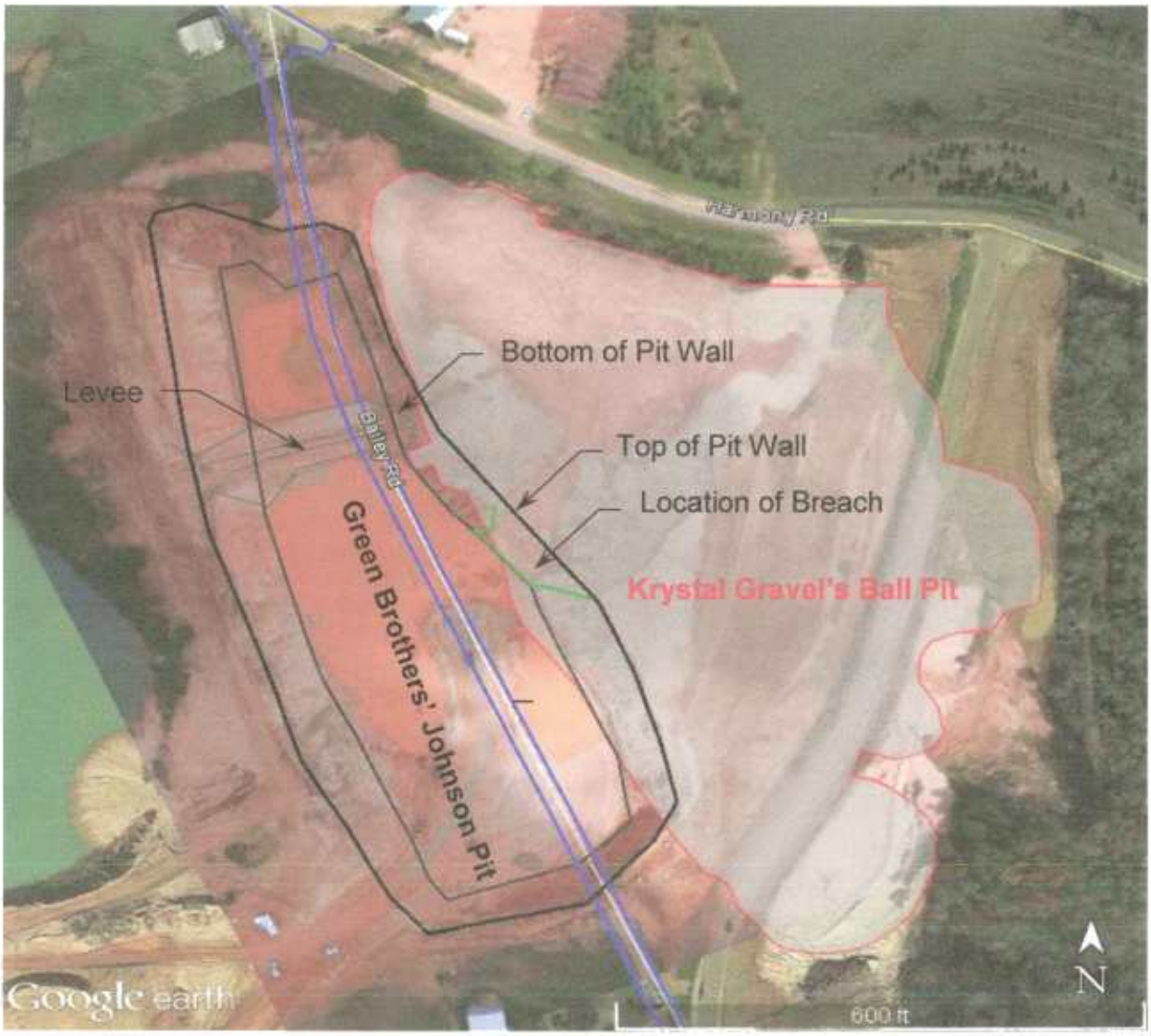

Figure 6 – Overlay of an aerial image taken by drone on June 6, 2016, on the satellite image dated December 14, 2015, viewed in Google earth.

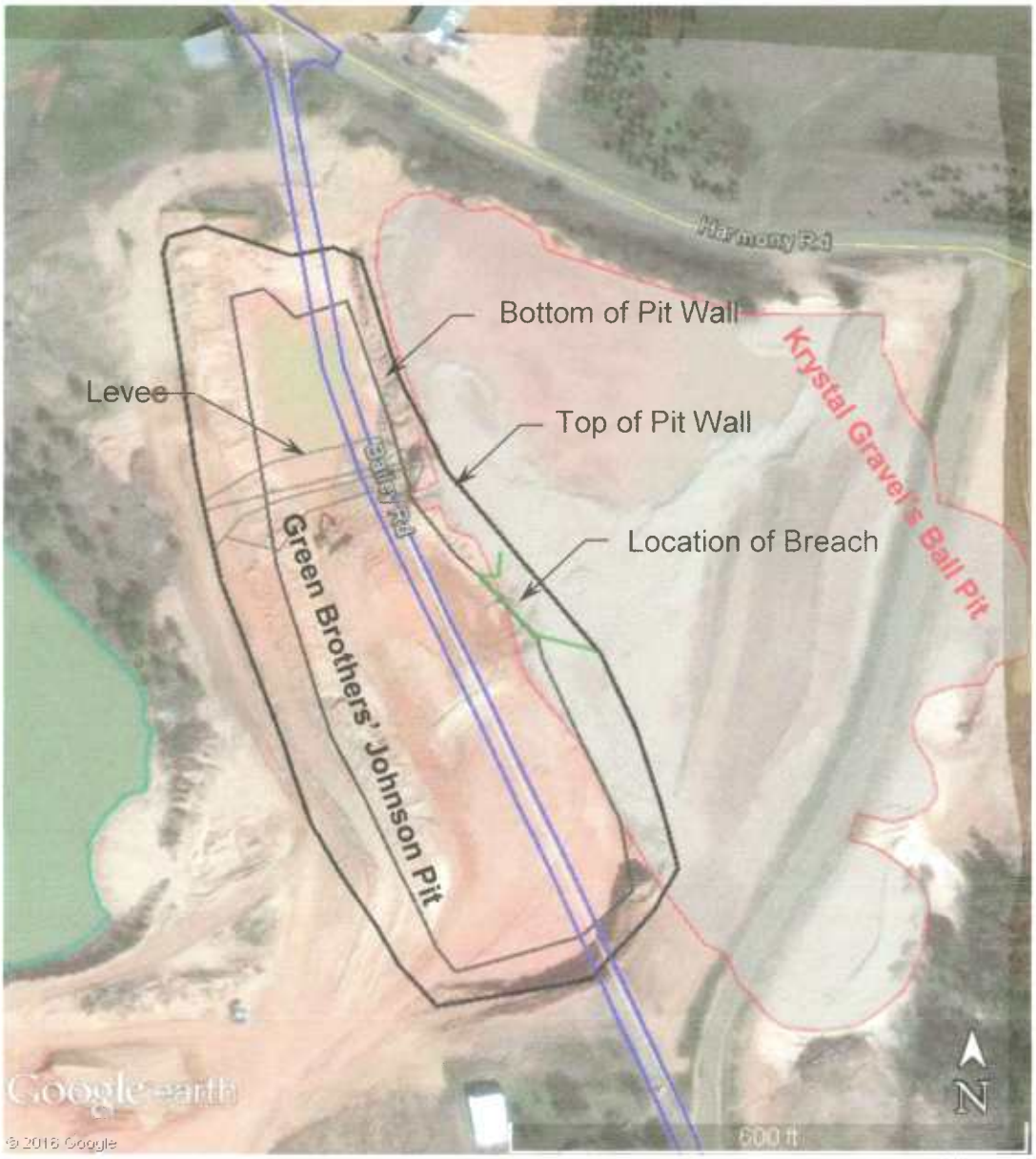

Figure 7 – Overlay of an aerial image from TerraServer date February 13, 2016, on the satellite image dated December 14, 2015, viewed in Google earth.

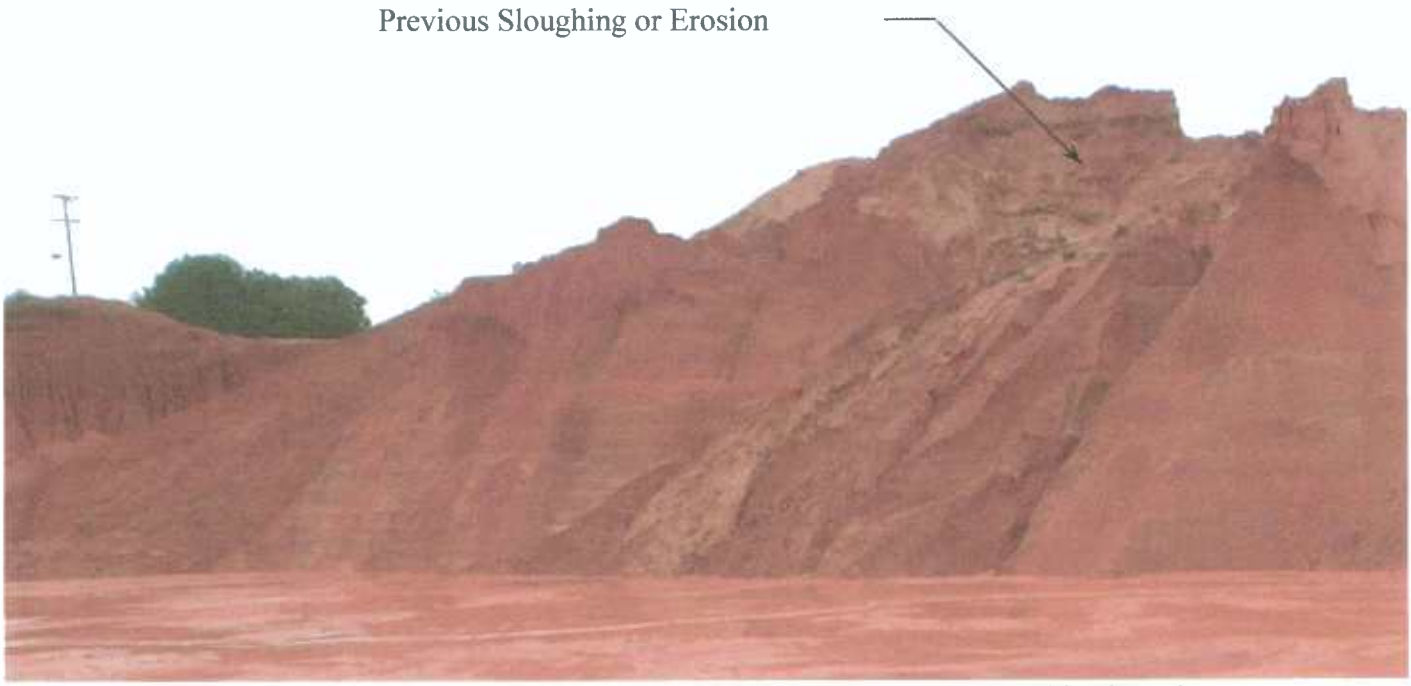

Photo 1 - View of the pit wall on the north side of the failure looking northeast. This view also depicts some previous erosion and sloughing adjacent to the failure.

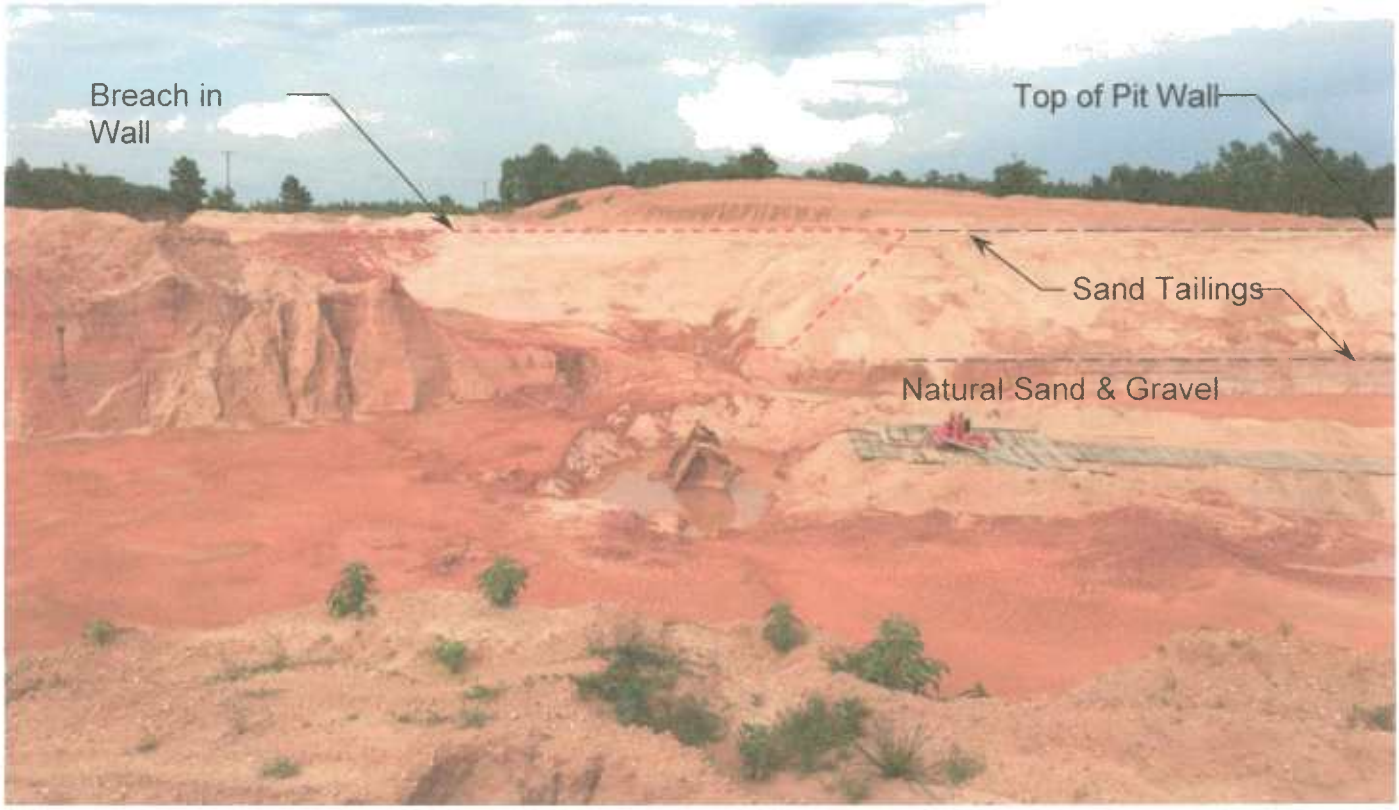

Photo 2 – View of the failure area and breach looking easterly from the west side of the pit.

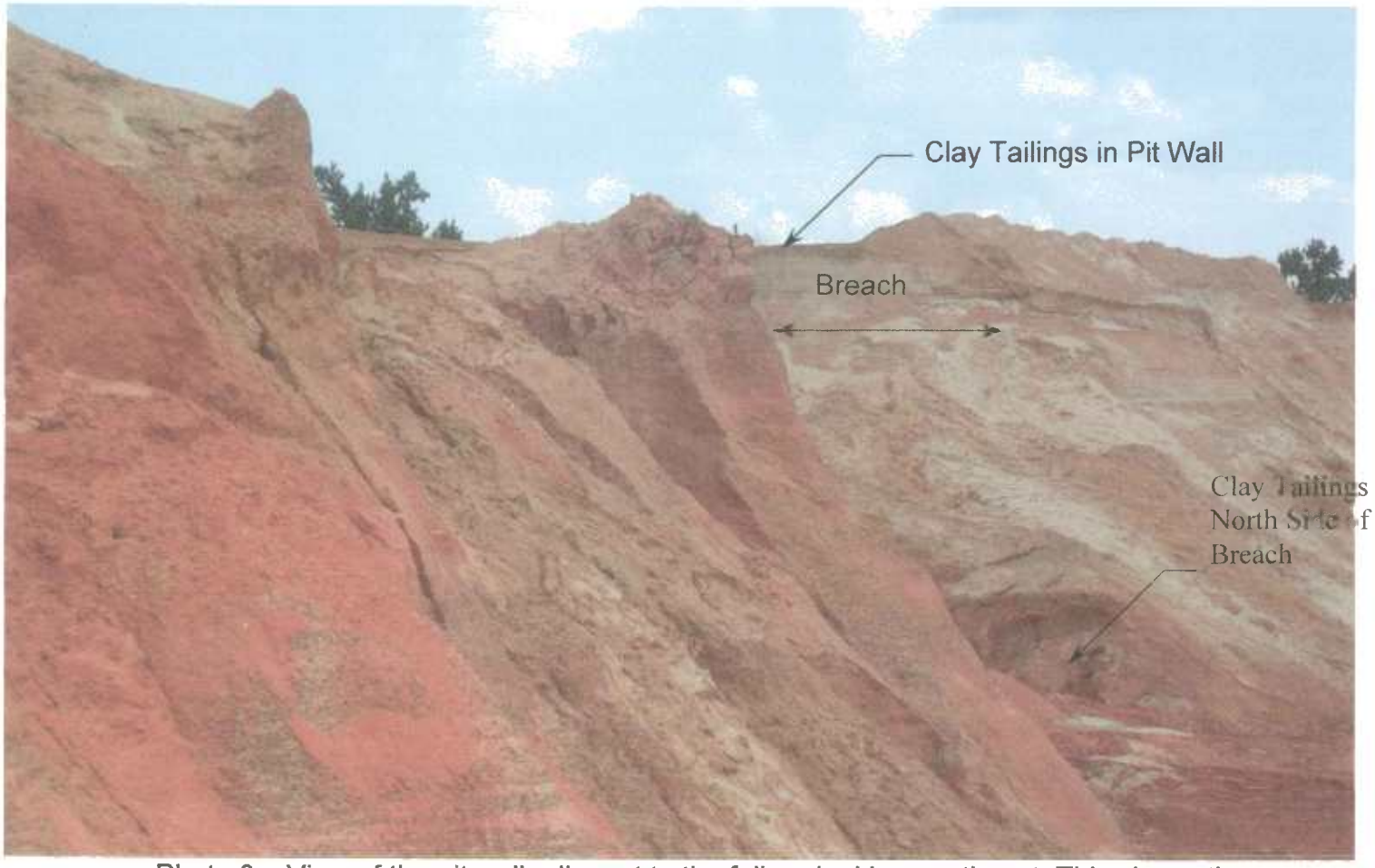

Photo 3 – View of the pit wall adjacent to the failure looking southeast. This shows the clay tailings overlying the natural sand and gravel near the top of the pit wall. It also depists clay tailings in the lower part of the pit wall on the southern side of the breach.

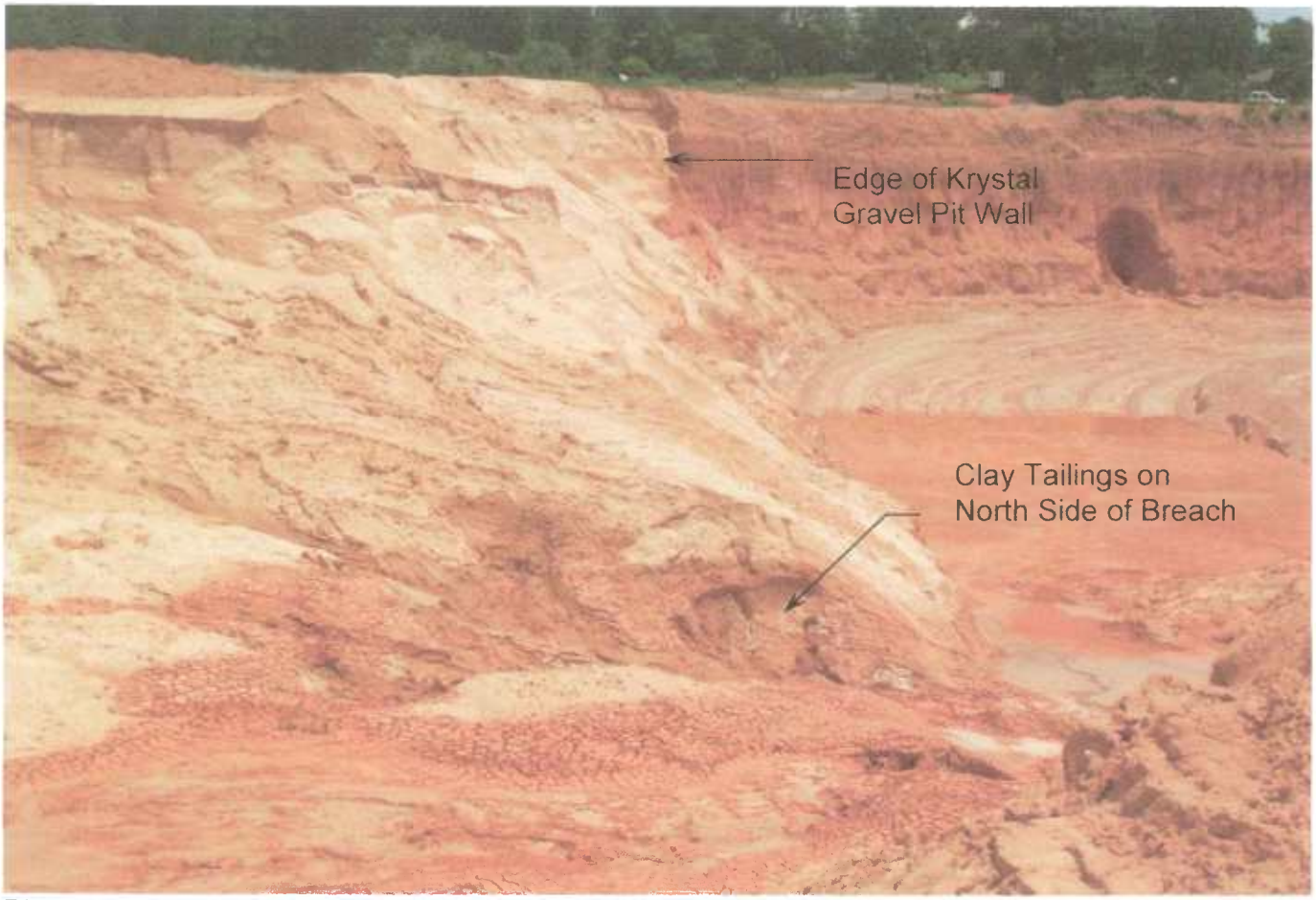

Photo 4 – View of the breach area and the eastern pit wall looking south. This view depists clay tailings in the lower part of the pit wall on the southern side of the breach and the inside edge of the western wall of Krystal Gravel's Ball Pit in the background.

APPENDIX E
Material Description

Along the southeast pit wall, sand tailings that sloughed into the pit area may have contained 10 to 25 percent clay tailings. The tailings were wet, but not soupy.

The sand and gravel material being mined was from the Citronelle Formation and consisted of medium dense to dense sand and gravel with some silt and clay. The gravel portion was generally hard, rounded, and pea size to 3-inch size. The sand portion was fine to coarse grained. The natural material was dry to moist in situ, and overall reddish brown in color. The dense sand and gravel appeared to exhibit some mild cohesion, or bonding, which allowed portions of the pit wall to stand near vertical. However, when the sand and gravel is excavated and dumped, it performs like a typical cohesionless, granular material that forms a pile with side slopes indicative of its angle of repose. Although there were traces ofsome silt and clay in the sand and gravel, there were also discontinuous lenses of red clay a few inches to one foot thick. The natural red clay had dry to moist in situ moisture. When excavated it would also break up and when dumped, it formed a pile.

The Citronelle Formation occurs along the ridges in Copiah County and its base occurs around elevation 400 feet. Reportedly, this formation has higher gravel content in the northern portion of Copiah County. This formation can also have significantly more silt and red clay mixed throughout at other mining locations; making the material at this mine a relatively high-quality deposit.

In the immediate area south of the failure, the sand and gravel material being mined was overlain by about 40 feet of fine sand tailings with some clay tailings. The sand was fine grained and light tan to white with traces of red silt and clay. Clean, dry sand is a cohesionless material. However, moist sand can exhibit an apparent cohesion due to surface tension and negative capillary pore water pressure, which will allow the sand bank to stand steeper than its angle of repose. However, this strength is moisture sensitive and transitory. Dry sand and saturated sand lose all apparent cohesion. The sand tailings appeared to exhibit these moisture sensitive qualities. In its moist condition, the sand tailings exhibited slopes as steep as 65 degrees along the southeast pit wall. As the sand tailings dried, it lost its apparent cohesive strength and sloughed off to an average slope of about 35 degrees in the pit. The dry, loose sand in a stock pile had an angle of repose of about 31 to 33 degrees.

As previously mentioned, Green Brothers pumped and hydraulically deposited sand and clay waste materials (tailings) into the impoundment located in Krystal Gravel's Ball Pit. During the settling process, the tailings separate by grain size as the slurry (tailings mixed with water) is pumped into the impoundment. The coarser material (light colored sand) settles out near the place deposited and the fines (reddish colored silts and clay) remain in suspension longer and settle upstream of the sand in the pool area. The sand builds a beach and excess water drains from the sand that is built up above the pool

level. The clay tailings, even when the pool is dewatered, typically retain water longer, but should drain slowly into the sand and natural sand and gravel.

During the investigation, the sand beach in the impoundment area was relatively dry and built up to at least elevation 472, which was 5 to 10 feet above the clay. A sample of sand tailings was collected from the beach area of the failure for laboratory testing and classification. The sand tailings were composed of almost 99 percent sand-sized material with 1.3 percent silt and clay and had an in situ moisture content of about 3 percent. The surface of the clay tailings deposit in the impoundment area was also relatively dry and heavily desiccated in the upper 4 to 12 inches. The consistency of the clay crust was hard. The clay appeared drier and more heavily desiccated around the perimeter of the impoundment. There was vegetation growing over a small area of the clay crust, and although the surface of the clay had dropped down several feet, the crust did not appear to have exhibited any major lateral movement except near the failure.

The clay tailings were primarily clay with some sand. The strength of the clay tailings is very moisture sensitive. The strength increases with decreasing moisture content. Initially, when the clay tailings are deposited, they have very high moisture content and very little to no strength. As the clay loses moisture, its cohesive strength increases and it shrinks. As the clay dries, it will also begin to crack and become more brittle such that shear failure through the material results in the sudden loss of its cohesive strength. The clay that flowed from under the crust is an example of its behavior at very low strength with high moisture content.

The investigation team collected a sample of the failed tailings from the pit area (southeast of the failure) for laboratory testing and classification. The consistency of the failed tailings was that of a wet, flowable mud. During sampling, the tailings flowed from the approximately 1.5-inch-diameter holes in the excavator bucket. The failed tailings had a very high moisture content of about 115 percent and were composed of 81 percent silt and clay with less than 19 percent sand-sized material. The cracked crust on the top of the impoundment is an example of hard but brittle clay with low moisture. The investigation team also collected a sample of the clay tailings from the surface of the impoundment area (east of the failure) for visual classification, but did not send it to the laboratory for testing. Pocket penetrometer testing on the sample exhibited an unconfined compressive strength greater than 4 tons per square foot, which gives it a consistency classification of hard.

The waste material observed in piles at the dump site had dried enough to form a hard crust on the surface of the piles. The surface was lumpy with a texture characteristic of material that was particularly wet when dumped and later dried. The piles appeared to contain sand and gravel with large clumps of clay. The clay clumps on the surface had deep desiccation cracks, were hard and dry on the outside but moist and stiff on the inside; these characteristics were like the desiccated clay tailings in the impoundment. The middle pile was considerably flatter than the others suggesting that this material was weaker than the other piles. This pile appeared to be primarily sand and gravel.

The northern pile appeared to be mostly moist sand with clumps of dried clay on the surface. The last pile south appeared to be sand with considerable clay and some gravel. Two samples were collected from the inner portion of the middle and southern piles. Both samples were wet. A sample of wet, red, mottled with lighter stripes, clay was removed from the southern pile that primarily contained material that was like the clay and sand tailings material. The clay had a very soft consistency, which is a characteristic of wet tailings. Laboratory tests indicated that this material had a moisture content of about 55 percent and contained 78 percent silt and clay with about 18 percent sand and less than 5 percent pea-sized gravel material. The finer fraction of this material had a plastic limit of 29 percent and liquid limit of 61 percent moisture content, which produces a Unified Soil Classification System classification of CH for fat clay. Another sample was collected from the middle pile that contained primarily sand and gravel. The sample had excess water and was visually classified as wet. Laboratory tests indicated that this material had a moisture content of about 20 percent and contained about 27 percent gravel, about 61 percent sand, and about 12 percent silt- and clay-size material. For comparison, the sand and gravel material that was sampled and tested in an engineering report produced for the relocation of Bailey Road had 12 to 48 percent silt- and clay-size material and natural moisture contents between 8 and 14 percent, which is why 20 percent moisture is considered wet.