During the early years of sluicing ash into large reservoirs, little if any consideration was given for a future need to “close” the reservoir. Even if a possible closure of the impoundment was considered, the current requirements at the time of closure could not have been foreseen. Now as the new federal CCR rules are rolled out to the industry, these impoundments need to be closed within specific engineering guidelines. Obtaining an accurate and detailed topographic survey of the site safely is essential to ensure an insightful closure design.

Over several decades, sluice pipes flooded liquid ash slurry into reservoirs of various sizes, creating ash impoundments. Hollows were dammed up and levees were constructed along rivers to contain the liquid ash. When the dams and levees weren’t high enough to contain the ash, they were typically raised as needed. The result is that there are now roughly 300 ash impoundments in the United States with an average size of 149 acres.
Sluicing commonly occurred in several locations of most impoundments as discharge pipes typically had to be relocated. The length of time the sluicing discharge pipes remained in one location and the volume of sluiced ash discharged through the pipes contributed greatly to how the overall deposit of ash within the impoundment was formed. This procedural sluicing made for changing site conditions with varying deposits of ash. These varying deposits of ash created scenarios where the impoundment was left with water depths ranging from zero to tens of feet. This collection of events, combined with the physical nature of sluiced ash, has left the industry with many large impoundments that are nearly impassible by foot or standard motor vehicle. Many of these ponds pose a risk of drowning or engulfment. All access to these ponds should be controlled. No one should be permitted to walk on the wet ash surface.

Nature seemingly always finds a way to re-vegetate any solid surface. Ash impoundments tend to become quickly vegetated with thick tall grasses and reeds that exceed eight feet in height. Eventually, the vegetated surface gives way to trees and the impoundment becomes hard to differentiate from solid ground. This vegetation, along with the masquerading of the underlying ash surface, presents significant challenges to surveying these impoundments.

Rather than surveying the wet ash impoundment by ground survey, an aerial survey may be suggested. Unfortunately, an aerial survey cannot accurately determine ground elevations in dense vegetation. Similarly, aerial surveying cannot determine subsurface elevations within areas covered by water. Many wet ash impoundments have substantial percentages of the impoundment either under water or within dense vegetation. Only Professional Surveyors experienced in safely collecting accurate points in areas of the impoundment that are located under water or within dense vegetation should be used.

One thing Ash Ponds have in common is that they are all different. Though the surfaces look similar, the materials that lie below the surface vary greatly and thereby their stability varies greatly. R.B. Jergens has been fortunate to have performed surveying work on five wet ash impoundments within the last year alone. Our experience has resulted in a general classification of five different kinds of ash impoundment surfaces:

1. Open Water – Water over 3’ deep
2. Isolated Deep Pools – Water over 3’ deep with no access
3. Shallow water – Water less than 3’ deep (which is usually heavily vegetated)
4. Vegetated ash - Ash surfaces with dense grass, reeds or trees
5. Un-vegetated ash – Ash surfaces above visible water without significant grass, reeds or trees
Each of these surfaces requires a different approach from the Professional Surveyor and very specialized equipment. Safety is the surveyor’s number one concern on ash impoundment surfaces. Construction professionals in the industry have all learned to incorporate safe practices into their regular work tasks. Ash impoundment surveying however, requires additional safety practices to keep personnel and equipment free from harm. Open water presents a clear danger to drowning. In addition, wet ash within the impoundment has a hidden risk. People or equipment can sink into wet ash much like quicksand, but wet ash is very different than wet sand. Due to its ability to hold and release water, wet ash can change from a semi-solid state to a quick or liquid state in seconds. Wet fly ash will typically support small equipment until the movement or vibration of the machinery causes the ash to liquefy. Once the ash liquefies it poses a very real risk of engulfment, as most impoundments are deep enough to completely engulf personnel and equipment. R.B. Jergens has found that the safest solution for surveying on wet ash surfaces is to deploy surveyors in properly equipped Amphibious All-Terrain Vehicles, AATVs. An AATV has the ability to float and propel itself in open water, as well as being able to traverse on solid and semi-solid surfaces. Choosing the best AATV for a specific site is critical to the success of the surveying efforts. R.B. Jergens has performed significant testing of several AATV solutions and has successfully overcome those obstacles presented by the five different ash impoundment surface classifications.

OPEN WATER – WATER OVER 3’ DEEP

Open water surveying is best performed with a small motor boat and hydrographic surveying equipment. The boat must be capable of carrying a survey crew on a steady heading at low speeds and it must be outfitted with the appropriate hydrographic survey equipment.

Bathymetry is the primary hydrographic measurement when surveying the open water of a wet ash impoundment, although wet ash consolidation may also be a consideration. Bathymetry is the measure of the depth of water. Bathymetric surveying requires a combination of sophisticated hardware and software to combine horizontal position, vertical location and depth of water.

Several components make up the required suite of hydrographic survey equipment. These components include a fathometer, transducer, velocity meter, GNSS receiver, antenna and a computer with hydrographic software. A fathometer, also referred to as an echosounder, and the transducer are the primary components to sonar sounding equipment. Depending on the specific hydrographic equipment, single-beam or multi-beam, the fathometer sends from one to over one-hundred simultaneous signals to a transducer to initiate a sound wave. The transducer sends the sound wave. The sound wave continues until it collides with an object. The sound wave then reflects from the
object and the transducer receives the return wave or ‘echo’. The fathometer then processes the return signal from the transducer and determines the time lapse between when the signal was sent and when the signal was returned. The depth of water can then be calculated by using the time-velocity calculation (Distance = Velocity x Time). The fathometer and transducer determine the time variable. The other key variable is the velocity of sound in water. This velocity is best determined with the velocity meter.

A velocity meter, also referred to as a Sound Velocity Profiler, measures the velocity of sound in the water column and records the measured velocity of sound at regular intervals throughout the water column. The velocity meter takes recorded measurements and creates a profile of the velocity of sound for any point within the water column. Velocity of sound in water varies based on several factors. The three key factors include the temperature of the water, the turbidity or suspended and dissolved solids, and pressure. Once the velocity of sound is calculated, the distance or depth of water can be easily calculated.

A GNSS receiver and antenna determine horizontal position and output positional information as the fathometer is calculating depth. Computer software combines the horizontal position from the GNSS receiver with the depth from the fathometer in order to determine a three-dimensional position of each pulse. The resulting three-dimensional point is stored as a sounding. These soundings are taken very frequently, providing a very dense collection of soundings. The density of bathymetric soundings can be up to 100,000 times greater than the density of land topographic survey points. It is common to collect between 2,500 – 3,000 bathymetric soundings per acre of open water in a single-beam application or several million bathymetric soundings per acre of open water in a multi-beam application. A similar area of land topographic survey would only require twenty-five to thirty points per acre. Processing a data set of this size requires a great deal of time as well as a lot of experience and a very powerful processing computer. The entire data set must be closely reviewed and erroneous data points, such as early returns of the sonar signal caused by sub-aquatic vegetation (SAVs), suspended ash particles or submerged debris, must be removed from the overall data set. R.B. Jergens has outfitted a motor boat and AATVs with this equipment and has successfully deployed them on ash impoundments.

ISOLATED DEEP POOLS – WATER OVER 3’ DEEP WITH NO ACCESS

When the initial dams or levees were constructed and the impoundment was created, the lower elevation valleys that drained into the area of the impoundment typically filled with water creating coves or fingers. If ash was not sluiced directly into the tips of these fingers, the ash would effectively dam the
water into these fingers, resulting in isolated and deep pools of water. This scenario creates a deep water pool that is surrounded by forested virgin ground outside the impoundment and unstable ash within the impoundment. These isolated deep pools are typically not accessible by boat, as there is usually no way to launch a traditional surveying boat into these areas. It is not uncommon for these pools to exceed twenty feet in depth. In many cases, these pools are typically long and narrow and filled with trees and other debris that existed prior to the impoundment being created. The area of these pools can easily exceed tens of thousands of square feet in area. Navigating into and through these areas has proven to be difficult. Physical access by canoe is possible; however, this would require carrying the canoe over the forested virgin ground. The large size of these pools also makes mapping by way of canoe very time consuming. R.B. Jergens has successfully customized AATVs by mounting hydrographic surveying hardware to the AATV. These customized AATVs have provided a single solution that has allowed R.B. Jergens to seamlessly collect topography of the ash surface outside these pools and to collect bathymetric data within these pools.

SHALLOW WATER – WATER LESS THAN 3’ DEEP (WHICH IS USUALLY HEAVILY VEGETATED)

Surveying the transition areas from open water to shallow water can prove to be very challenging. Limiting a boat’s draft (depth below water) is critical, as the shallow water zones in many ash impoundments are typically hundreds of horizontal feet from the semi-solid (beach) areas. If the draft of the boat is too great, boat access to the beach areas is not possible. Another option must be considered in order to safely and reliably access this transitional area. Surveying these shallow water areas joins the bathymetric survey to the land surveys on the ash surface. Accurately mapping both the shallow water areas and open water areas of submerged ash is critical to the overall surveying effort and essential for an accurate closure design.

Determining accurate grades of submerged ash in shallow water areas is one of the greatest challenges in ash impoundment surveying. Although the shallow depths of water allow for the surveying measurements to be collected by more traditional land surveying methods, the more challenging component is physically assessing these areas and the maintenance issues the dense vegetation places on the AATVs. The tall grass and reeds growing in the shallow water prevent reasonable passage by AATVs. The bottom is too shallow for the draft of typical motor boats and the dense vegetation chokes the propeller on low draft motor boats. Although very capable of navigating open water and vegetated ash surfaces, AATV’s struggle to overcome the combination of dense vegetation and water depths in excess of two feet. The partial buoyancy of the AATV reduces the traction of the AATV and consequently, reduces the force applied by the AATV to knock down the dense vegetation. This usually results in the AATV literally

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spinning its wheels in an attempt to continue moving forward. Frequently, the AATV becomes stuck and has to be assisted in exiting the shallow water area. With a high risk of the AATV becoming stuck, it is essential that a separate recovery alternative as well as recovery personnel be on stand-by for retrieval. This scenario requires twice the resources (personnel and equipment) than would be typically required. It is also essential that the retrieval equipment not become stuck itself in the attempt to free the AATV that is stuck. Careful consideration for the personnel and equipment must be taken when planning to survey these areas.

R.B. Jergens’ experience is that shallow water surveying is best performed with an airboat, a shallow water jon boat or a canoe. R.B. Jergens has operated various types of equipment on these shallow water surfaces and we have found that these boats provide the best overall performance. We have found that large areas with shallow water and dense vegetation are best surveyed with an airboat. Shallow water areas without the dense vegetation, typically the transition zone between open water and un-vegetated ash surface, are best accessed with a shallow draft boat such as a jon boat or canoe. The shallow water area classification, whether with heavy vegetation or no vegetation, is the most time consuming area to survey. Productivity in this area is far less than that of the open water or the vegetated and non-vegetated semi-solid ash surfaces. The shallow water areas are also the least predictable. Depths of water within the shallow water areas may vary greatly. Transitioning between deep water and very shallow water may occur in a very short horizontal distance. Depending on the draft of the boat, it is very possible for the boat to run aground and to require retrieval.

VEGETATED ASH - ASH SURFACES WITH HEAVY GRASS, REEDS OR TREES

Vegetated ash surfaces are the most common surfaces that will be found in most ash impoundments. Vegetated ash surfaces should be considered the least safe surface of a wet ash impoundment. A false sense of security may be felt while working on this surface as the area appears to be dry and perfectly stable; however, as indicated earlier, wet ash can change from a semi-solid state to a liquid state in a matter of seconds. One area may feel solid but just a couple feet away, a very soft area may exist. That soft area could very easily be deep enough to completely engulf personnel or equipment. Due to the unstable and unpredictable nature of wet ash, vegetated surfaces within ash impoundments should NOT be traversed by foot or by traditional ATV’s. These surfaces can only be traversed safely and effectively with suitably equipped AATVs. RTK GNSS equipment mounted to AATVs make for very cost effective data collection. Similar to the shallow water areas, for safety reasons, AATVs should be worked in pairs as even AATVs routinely get ‘stuck’, requiring winch retrieval of these machines. Pre-job safety planning must consider horizontal distances between pairs of AATVs working in
conjunction with each other for retrieval purposes. Properly planning the surveying efforts and making considerations for equipment and personnel retrieval are critical to the overall success of the surveying efforts.

Surveying vegetated ash areas also requires additional maintenance on the AATVs as the drivetrain of the AATVs routinely get clogged with the grasses and reeds. Maintaining the operating temperature of the AATV is challenging in these areas as well. Seeds from the cattails frequently fill the fins of the hydraulic and water coolers, reducing the ability of the AATV to remain at normal operating temperatures. Overheating is a real concern under these conditions. The fins of the coolers must be cleaned out regularly, as frequently as every five minutes in some situations, throughout the duration of the survey in order to prevent premature failure of the AATV. Survey data from the vegetated ash components of ash impoundments will provide the bulk of the data ensuring accurate ground elevation data is collected and proper earthwork balances are achieved.

UN-VEGETATED ASH – ASH SURFACES WITHOUT HEAVY GRASS, REEDS OR TREES

Un-vegetated ash surfaces usually occur when the pond is active, at recently excavated areas or where water elevations have been recently lowered exposing ash that was previously submerged. These surfaces are likely to be very soft and wet. They may not be able to support AATVs. Un-vegetated ash surfaces should not be traversed with an AATV unless a properly outfitted amphibious hydraulic excavator (or similar retrieval equipment) is on standby to retrieve the crew if they become ‘stuck’ on the semi-solid surface. R. B. Jergens owns various sizes of amphibious hydraulic excavators which can be utilized for safe retrieval. Surveying these surfaces usually completes the contouring of the total ash surface, providing a complete base map model from which the final site design can be prepared.

SUMMARY

During the early years of sluicing ash into large impoundments, little if any consideration was given for a future need to close the impoundment. Sluiced liquid ash slurry was pumped into these ash impoundments for several decades. The results of which created an ash surface that R.B. Jergens has classified as either Open Water, Isolated Deep Pools, Shallow Water, Vegetated ash and Un-vegetated ash. R.B. Jergens has been fortunate to have worked on five wet ash impoundments within the last year. R.B. Jergens has tested and successfully implemented surveying procedures and amphibious equipment to allow for access and data collection within each of these five
surface classifications. Maintaining safety as the paramount consideration, while still focusing on productivity, R.B. Jergens has been able to collect accurate site topography of these ash impoundments at a reasonable cost to the owner.

Construction professionals in the industry have all learned to incorporate safe practices into their regular work tasks. Safety should always be the paramount consideration in any activity. Surveying ash impoundments is no exception. Ash impoundments pose very real and dangerous risks that can be mitigated. These risks can only be mitigated with careful and deliberate planning. Each of the five surface classifications introduces its unique set of risks that require the implementation of a unique set of safety and surveying protocols. Complacency or underestimating the risks posed by a wet ash impoundment can have deadly consequences. Having properly trained personnel is critical to a successful survey of a wet ash pond. Properly equipping surveying personnel is essential to accessing and traversing all areas of a wet ash impoundment. Similarly, having a proper retrieval plan and effective retrieval equipment, in the event the surveying personnel become ‘stuck’ in any area of the wet ash pond is equally essential to a safe and successful survey.

Now, as the new federal CCR rules are rolled out to the industry, many of these impoundments need to be closed, following specific engineering guidelines. Obtaining an accurate and detailed topographic survey of the site is essential to ensure an insightful closure design. Obtaining the accurate and detailed topographic survey requires careful planning, many safety considerations, specialized equipment, properly trained personnel, a firm understanding of the site conditions as well as a respect for the risks associated with collecting the survey data. R.B. Jergens understands the risks associated with surveying ash impoundments as we have successfully surveyed five ash impoundments within the last year alone. Success with safely surveying ash impoundments can be attributed to understanding the site conditions, determining the risks associated with the work, properly training field personnel, properly equipping trained personnel with the proper equipment (AATVs, a variety of boats and hydraulic excavators) pre-planning for equipment and personnel retrieval, re-evaluating the results of field activities and continuing to improve existing safety and work policies and protocols.