

**UNIFIED OR DISTINCT:
AN ANALYSIS OF TWO AFTER-ACTION REPORTS
PUBLISHED BY THE TENNESSEE VALLEY AUTHORITY
FOLLOWING THE 2008 KINGSTON COAL FLY ASH SLURRY SPILL
AT THE KINGSTON FOSSIL PLANT IN KINGSTON, TENNESSEE**

by

Mei Johnson

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Science in Disaster Science and Management

Fall 2015

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LIST OF ACRONYMS

The following table displays the acronyms used through the thesis and its associated meaning.

Acronym	Meaning
AECOM	AECOM Technology Corporation (as of February 2015 known as AECOM)
CEO	Chief Executive Officer
CCR	Coal Combustion Residuals
US EPA	United States Environmental Protection Agency
KFP	Kingston Fossil Plant
MLA	McKenna Long & Aldridge, LLP (as of April 2015 merged with and known as Dentons)
OGC	TVA Office of General Counsel
OIG	TVA Office of Inspector General
RCA	Root Cause Analysis
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority

ABSTRACT

This thesis is a case study comparing narratives presented in the AECOM Root Cause Analysis (RCA) and McKenna Long and Aldridge (MLA) Report addressing the 2008 Kingston Coal Fly Ash Slurry Spill at the Tennessee Valley Authority's (TVA) Kingston Fossil Plant (KFP). Two stages of coding were conducted for each document, and results were compared quantitatively and qualitatively. AECOM RCA is a traditional engineering root cause analysis focused exclusively on the Kingston facility and the 2008 coal fly ash spill with an eye towards avoiding or minimizing potential legal action. The narrative is one of an unexpected, unique and unavoidable act of Nature impacting the KFP, TVA and area residents. The MLA Report follows a report-style structure with an organizational studies approach using lay language as it identifies and recommends lessons learned for all levels of the organization. In contrast to AECOM RCA, the MLA Report narrative depicts the event as predictable, avoidable and by no means unique to TVA's Fossil Fleet or the fossil power industry. Though given the same information about the Spill, KFP's practices and TVA's organization, AECOM RCA and MLA Report investigators draw different conclusions and present distinct narratives of the event. The quantitative and qualitative differences highlight influences of framing on post-event investigations and reports, even when originating from the single responsible organization. A brief discussion on ideality versus reality of the use of the documents by practitioners is also included.

Chapter 1

INTRODUCTION

When a disaster strikes, organizations – particularly those charged with responsibility for the event – often engage in processes of sensemaking and crisis communication by commissioning a disaster investigation and report. These reports constitute written products of the organization’s attempt to create a dominant narrative of what transpired. Though reports are assumed to be objective, scientifically rigorous endeavors, they instead are products resulting from the union of science and rhetoric. Narratives include distinct perspectives (investigator’s voice), plotlines (explanations, justifications and context), blame plots and epiphanies (lessons learned). Each of these components is defined by the investigator’s worldview, assumptions and interpretations of the data (Beamish 2002). Within this post-disaster narrative, statements of “fact” are in actuality subjective creations that have been selected, polished, contextualized and presented as such conclusive by the investigators.

Prior research on post-event investigations and reports typically address four general areas: comparison of types of investigations and reports, conducting public inquiries and post-event investigations, sensemaking and organizational factors and lessons learned. In these studies industry is largely treated as a unified entity with a singular narrative working to counter the contrasting views of external stakeholders, such as environmentalists and regulatory agencies. However, an organization may not always constitute a monolithic entity with a single voice. After a disaster there may be

multiple interpretations within the same organization that compete with or contradict one another (Boudes & Laroche 2009).

In this thesis, I explore how organizations may be comprised of distinct entities that generate distinct narratives, each presenting with high levels of authority and legitimacy. In this study I adopt a social constructivist approach and analyze the narratives presented in two documents commissioned by separate governing bodies within the single Tennessee Valley Authority (TVA) organization. The first document is the AECOM Root Cause Analysis (RCA) commissioned by the Chief Executive Officer (CEO), and the second document is the McKenna Long & Aldridge (MLA) Report commissioned by the Board of Directors. In particular, I examine whether a single narrative emerges across the two documents or, alternatively, if divergent narratives are presented.

The Kingston Coal Fly Ash Slurry Spill of December 22, 2008 is used as a case study. The Spill did not result in human deaths or serious injuries, but its impact on the environment was devastating. The long-term effects for humans, flora, fauna and the surrounding habitat will be felt for decades. Documents produced by the Tennessee Valley Authority (TVA) – the financially independent federal corporation deemed responsible for the Kingston Fossil Plant (KFP) and its failures – are used in the analysis. Focused coding of the reports identified four thematic domains: description of event, description of impact, blame attribution and lessons learned. The second round of focused coding addressed characteristics within each of the four domains. A discussion of the implications of these findings follows.

|Chapter 2

LITERATURE REVIEW

2.1 Disasters: Theories and Definitions

In the scholarship on disasters, there remains a lack of consensus on the causes and definitions of these kinds of events. The classic or functionalist approach, also known as social-systems theory, identifies disaster threats as externally imposed upon the social system, with early research focused almost exclusively on preparedness and response (Phillips et al. 2012; Tierney et al. 2001). This perspective sees nature attacking and interrupting the otherwise functioning and stable social system. In this light, natural disaster events are, ironically, unnatural to the progression of society. As Phillips et al. 2010 explain of this approach, “nature is the cause, the condition, and the propelling force that damages, destroys, and kills. Nature, unharnessed, is to blame” (7). The social system is the focus and organizational preparedness and response are burdened with primary responsibility for addressing, and ideally avoiding, natural hazard disaster events.

In contrast, the natural hazards perspective locates hazard vulnerability at the intersection of natural environment and human society (Tierney et al. 2001). Social groups and processes determine the definition and identification of hazards and disasters, with science and technology attempting to prevent and moderate their presence and effects. Thus, hazards and disasters are the result of combining

“historical conditions and social definitions of physical harm and social disruption at the community or higher level of analysis” (Tierney et al. 2001: 18 quoting Kreps & Drabek 1996: 142). In this analysis, I draw primarily upon the social construction approach to disasters, in which seemingly objective characteristics of a disaster, such as the severity and scope of impact, are instead “the product of social definition” (Tierney et al. 2001: 17).

When a disaster event is impending or has occurred, it is often categorized by its causes, characteristics or impacts. Cause (origin) of a disaster is closely tied with allocation of blame and responsibility. In general there are three categories of event origin: natural, technological, and “natech.” A natural cause is interpreted as an Act of God where nothing can be done to alter the characteristics or effects of the hazard (Phillips, Neal & Webb 2012; Keller & De Vecchio 2012). Technological, or man-made, origins draw a direct cause-effect link between the actions of society and resulting disaster impacts (Gephart 1984). An individual, a company, or humanity may trigger events, and the effects are acted out upon the environment or on fellow humans (Gephart 1984; Keller & De Vecchio 2012; Phillips, Neal & Webb 2012; Turner 1978). A defining characteristic of technological disasters is that they expose more than faults in the industry as well as pointing to failures of regulatory and advocacy agencies (Brown 2004: 30). The third category of causation, natech, deems natural environment and society as co-producers of a disaster. There are multiple permutations, including a natural hazard triggering the failure of a man-made structure, a natural hazard exacerbating an existing technological disaster, or societal actions significantly contributing to a larger environmental issue (Phillips, Neal & Webb 2012). Regardless of origin, hazards and disasters are increasing in both

frequency and severity as types, risks, and human populations increase (Dombrowsy 1998; Phillips, Neal & Webb 2012; Phillips et al. 2010; Tierney et al. 2001).

Characteristics and impacts of disasters are used by scientists and the public to identify and understand the hazard and its interaction with its surroundings.

Characteristics of an earthquake, for example, include tectonic plates, amount of movement, location of the event, depth of earthquake and type of earthquake. An organizational disaster may be characterized by poor management oversight, human error, fear among employees or dismissal of safety policies and procedures. Impacts (i.e. damages) have physical, financial and social dimensions. Identifying and understanding disasters by the hazard's impact is often used to determine the strength and severity of the event. Thus, determination and extent of the event can be highly competitive as stakeholders jostle for position and authority. Following a hurricane, for example, insurance adjusters may have distinctly different assessments of the physical and thus financial impact, while homeowners face the additional emotional and environmental burdens of the event on themselves and their communities. Scientific statements of fact regarding characteristics and impacts often miss the nuances of a disaster event.

Increasingly, researchers are turning their attention towards environmental disasters directly attributable to organizational action or inaction that are hazardous to humans and the environment. The cause-and-effect connection between industry and environmental disasters is well established, as man's industry takes advantage of, alters or destroys the natural environment. In other words, advancements in science and technology come with a price, especially when they are explicitly designed to efficiently mine and consume raw materials with little thought to the back end of

production: excess and waste. Environmental disasters are often viewed as the inevitable outcome of unsustainable development practices, or as Schnaiberg writes, the “treadmill of production” (1980) in which there is increased reliance upon technology for economic outputs and dominance of economic growth concerns. Considering the high potential and risk for large-scale releases of toxic and hazardous materials, such events are relatively rare. When they do take place, however, their infrequency hardly makes up for the severity and longevity of the resulting damages (Tasca 1990).

2.2 Organizational Risk and Crisis Communication

The practice of organizational risk and crisis communication is the art of creating explanatory narratives through the union of science and rhetoric. Traditionally, risk and crisis communication looks externally as organizations generate communications for an external audience such as corporate stakeholders, regulatory agencies and the general public (Coombs 2009). Strategies for crisis communication emphasize timing, cohesiveness, consistency and truthfulness of messaging. Truthfulness, however, should not be equated with objective fact, as these communications are narratives in which information has been digested through multiple layers of subjective selection, interpretation and sanitation (Gusfield 1981, 1984; Heath & O’Hair 2009). Thus instead of objective statements of fact, these documents are rhetorical, subjective interpretations of strategically chosen bits of information. Common conception places science (agent of “true state of things”) and rhetoric (“art of persuasion” (Gusfield 1981: 27)) at opposite ends of the spectrum, as risk and crisis communication reveals that they are in fact more similar than not.

As multiple perspectives exist within an organization during normal (non-crisis) periods, multiple perspectives may also be present during and immediately following a crisis (large-scale, wide-spread disruption to normal functioning). Finance, human resources, and safety and security departments have distinct perspectives and may thus present contrasting accounts of what happened, its impacts and recommendations for moving forward. Though addressing the same event, there will certainly be discrepancies in methods, area of interests and selected data, leading to dissimilar constructed narratives. When there are multiple interpretations, it is assumed that there is one dominant narrative upon which the organization draws for all subsequent external communications with multiple side-narratives that are ignored, minimized or pointedly dismissed (Brown 2004; Gusfield 1981; Peterson & Thompson 2009; Pidgeon 1997; Stallings 1995; Tasca 1990). Dominance of any one narrative can be established through repetition, visibility or prominent individuals who cite, and thus validate, the narrative. Variety is thus pared down to a particular, specific interpretation.

2.3 Post-event Investigations and After-action Reports

Post-event investigations and after-action reports are inevitable follow-ups to environmental disasters. These investigations, whether externally-imposed or internal, are motivated by a desire to re-establish the legitimacy (credibility) and authority of the responsible organization, re-locate the organization's operations and place within society and present and preserve a specific perspective (narrative) of the event (Brown 2000). External investigations are often imposed upon an organization by shareholders or regulatory agencies (external entities), while internal investigations originate from within the organization, usually upper management (Brown 2004). Regardless of their

origin, disaster investigations follow predictable processes and procedures guided by established models. They are also strongly influenced by the culture of the organization and industry that dictate type of investigation, type of data collected, scope of investigation and presentation of the conclusions (Brown 2004; Coombs 2009; Gusfield 1985; Lundberg et al. 2009; Tasca 1990). Though purported to be independent, each investigation is inspired and guided by pressures from without and within the organization.

After-action reports, also referred to as inquiry reports, are formalized post-crisis communications resulting from internal or external investigations. As after-action reports are generated after the event, they are the process and product of post-event sensemaking in which investigators attempt to understand the event, its impacts and lessons learned through crafting an explanatory narrative. In other words, disaster inquiries demonstrate the “retrospective nature of sensemaking” (Brown 2004: 15). Though they are touted as objective, complete, and verifiable, key evidence and witnesses are inevitably inaccessible, missing or incomplete, leading to assumptions or dismissals by the investigators. These same gaps thus appear in the after-action reports. The creative licenses of investigators use rhetoric to persuade the reader that missing or incomplete information is unimportant, tangential to the question at hand, or completely unrelated (out of the scope of the investigation) (Brown 2004; Coombs 2009; Lundberg et al. 2009; Tasca, 1990). Thus, after-action reports are more accurately described as “an invention, not a discovery” resulting from the investigation process that is more akin to a political “craft activity” (Brown 2004: 27) than an objectively definitive accounting of indisputable facts (Gephart 1984).

2.4 Existing Literature and Gaps in the Literature

Research into post-event investigations and reports address four general areas. The first includes literature comparing types of investigations and reports (Elliott & McGuinness 2002; Ferjencik 2011; Skogdalen & Vinnem 2011). The second explores how public inquiries and post-event investigations are conducted (Elliott & McGuinness 2002; Lundberg et al. 2009; Rollenhagen et al. 2010; Sklet 2004). The third analyzes the contents of the reports, specifically language use and bias (Vesel 2012; Wurster 2013), sensemaking (A.D. Brown 2000 & 2004; Boudes & Laroche 2009; Gephart 2007; Gherardi et al. 1998; Kendra 2007; Rossmanith 1996) and organizational factors (Schröder-Hinrichs et al. 2011; Wiig & Heber 2010). The fourth area addresses lessons learned, specifically successes and challenges for their identification and application (Cedergren & Petersen 2011; Deverell 2009; Lundberg et al. 2010 & 2012; Wrigstad et al. 2014; Wua et al. 2010). These studies include analysis of methodology, findings, perspectives, reception and implementation.

Given the research conducted on post-event investigations and reports, important gaps exist. My research seeks to address two of these areas: comparison of perspectives originating within the same and from the responsible organization. In the literature, comparison of reports and perspectives look only at conflicts among internal versus external or external versus external entities. Internal versus external literature compare perspective of the responsible organization with that of an independent external investigation, such as a regulatory agency, public inquiry board or concerned citizen groups. External versus external studies remove the responsible organization from the equation and compare investigations and reports of the external organizations. Internal versus internal research focuses on cases in which there are multiple responsible organizations, each seeking to lay blame at the others' feet. In my

research the investigations and reports were commissioned by the single responsible organization (TVA) and conducted by third-party contractors answerable to TVA. Though presented with the same information, differences between the reports are to be expected due to, among other factors, document templates, methodology, professional background of investigators and the audience (i.e. the commissioning body who is paying for the investigators' services). Despite these differences, it may be expected for the reports to have similarities in their general conclusions and identified lessons learned, as they draw upon the same sources, report to the same over-arching organization and know their reports are available to the general public.

Chapter 3

METHODS

This research explored sensemaking and presentation in after-action reports commissioned by the single responsible organization after an environmental disaster. The research question is as follows: following a man-made environmental disaster after which the responsible organization produces multiple official post-event explanatory reports, do the documents present a unified narrative? In order to look at this topic, I looked at three sub-questions: what narrative is presented in each document, how is the narrative presented and what are the similarities or differences between the documents. I conducted a single-case study of the Tennessee Valley Authority's Kingston Fossil Plant and its 2008 coal fly ash spill through analysis of the two primary source after-action report documents. I approached the case study using the social constructivism paradigm, as I qualitatively coded across four domains, numerous sub-domains and compared the findings.

3.1 Tennessee Valley Authority and the Kingston Fossil Plant

3.1.1 Coal Fly Ash: Hazard and Disposal

According to the EPA, coal combustion residual (CCR) is one of the US's top generated waste streams (EPA 2015). Generated primarily from coal-fired utility plants, CCRs include bottom ash, boiler slag and fly ash (EPA 2015). Fly ash composes the vast majority of CCR, while bottom ash (coarser ash particles too large to become airborne) makes up approximately 10% of CCR, and boiler slag (molten

bottom ash) is 2%. Because of its extremely fine grain, fly ash is easily airborne and thus attempts are made to capture it via stack scrubber filters before it can escape into the atmosphere (AECOM 2009; Adriano et al. 1980; Openshaw 1992; EPA 2014: Boiler Slag). Coal fly ash's hazard potential stems from highly toxic and radioactive elements, such as uranium, thorium, potassium, and radium that become concentrated through the combustion process. These elements are a serious concern, especially considering the rate of accumulation, but the EPA does not currently classify fly ash as a hazardous material, thus exempting it from the Resource Conservation and Recovery Act regulations (Openshaw 1992).

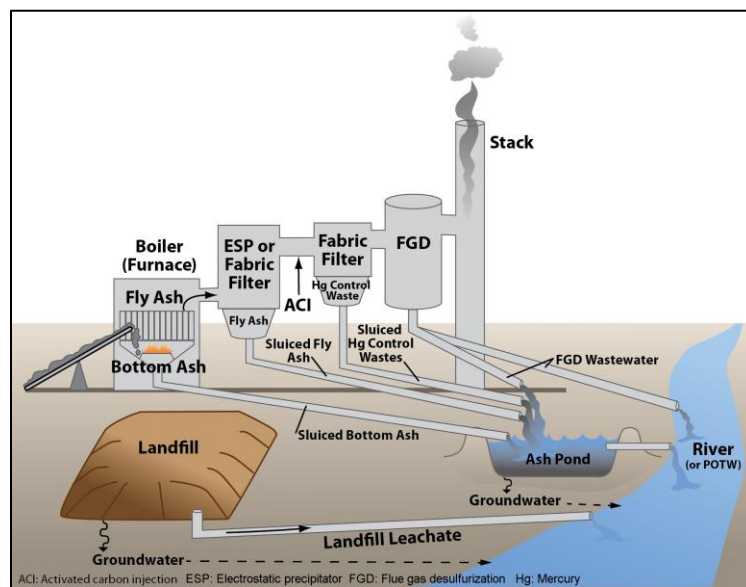


Figure 1: Diagram of disposal of waste from coal-fired plants. Image courtesy of US EPA Steam Electric Power Generating Effluent Guidelines - 2015 Final Rule: <http://www2.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-2015-final-rule> (2015).

In 2012 in the US alone, more than 470 coal-fired facilities produced approximately 110 million tons of CCR (EPA 2015). The coal fly ash portion of CCR is either transported off-site for industrial use or disposal or stored onsite in “landfills and surface impoundments” (EPA 2015). There are two methods for on-site fly ash storage: dry and wet. In the dry storage method, dried fly ash is collected in silos and is both costly and significantly less prevalent throughout the fossil fuel power industry. The wet storage method is the far more common storage practice in which fly ash slurry is wet-slucied through a series of on-site impoundments designed to encourage fly ash particles to settle out to the bottom of the ponds (Adriano et al. 1980). Benefits of this method, when compared with dry storage, are reduced management and transportation costs, fewer personnel requirements, and increased convenience as the site is in closer proximity to power plant. There are, however, numerous drawbacks. The first concern is that the water in the ash slurry makes the material unstable, weak and highly leachable. A second concern is the amount of space required for these on-site storage facilities; on average, wet storage requires approximately ten times more space than a dry landfill approach (Openshaw 1992). Whether using dry or wet storage, management of CCR waste should be a high priority for the industry, regulators and general public.

3.1.2 History and Context: TVA & the Kingston Fossil Plant

The Tennessee Valley Authority (TVA) is a federally owned corporation established by the TVA Act of 1933 to provide flood control, cheap electricity and boost agricultural and economic development across the Tennessee River Valley in the Southeastern United States. TVA's initial electricity production came exclusively from hydroelectric dams, but in 1959 they added coal-fired fossil plant operations (their Fossil Fleet). Currently, TVA boasts more than 50 dams, 11 fossil plants, several nuclear plants and numerous solar energy sites throughout 80,000 square miles in Tennessee and portions of Alabama, Georgia, Kentucky, Mississippi, North Carolina and Virginia (Ezzell 2015; Encyclopaedia Britannica 2014; TVA 2012). TVA is the largest public provider of power in the U.S. (Ezzell 2015), and it is the sole supplier of power in its power service jurisdiction.

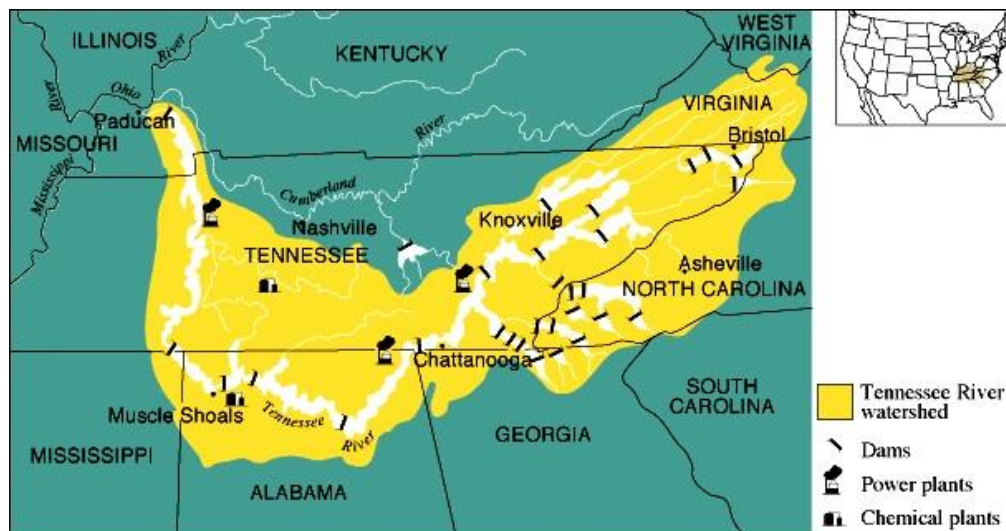


Figure 2: Tennessee Valley Authority Operations. Image courtesy of HistoryTimeline.com: <http://historytimeline.8m.com/1930-1939.html> (unknown date).

The Kingston Fossil Plant (KFP), site of the December 22, 2008 spill, is one of eight fossil plant facilities within the state of Tennessee. KFP opened in 1956 on the shores of Watts Bar Reservoir where Swan Pond Creek flows into the Emory River. With nine generating units running at full capacity, KFP has the capacity to consume up to 14,000 tons of coal per day, generating 1,000 tons of coal combustion ash waste per day (MLA 2009; OIG 2009). TVA implements the wet storage method in on-site waste facilities known as holding or settling ponds, and these storage facilities developed over time as capacity was needed (MLA 2009). The waste materials are wet-slucied to a series of on-site ponds where ash materials settle as liquid rises to the top (Openshaw 1992). Historical standard practice at KFP dictated that as a pond reached its holding capacity, the settled ash materials were dredged and used to add height to the holding pond's dikes to increase capacity. At the time of the failure in December 2008, KFP's on-site storage involved an initial ash cell, an ash collection pond, two dredge cells and an emergency cell.

3.1.3 December 22, 2008: the Kingston Coal Fly Ash Slurry Spill

On Monday, December 22, 2008 just before 1:00 in the morning, the northwest corner of Dredge Cell 2 experienced a catastrophic failure, triggering further structural failures and resulting release of a massive quantity of fly ash slurry. Within an hour more than 2/3 of the combined volume of Dredge Cells 1 and 2, totaling 5.4 million cubic yards of fly ash slurry and dike debris, flooded the Swan Pond Creek embayment, the Emory River, and Watts Bar Reservoir. As the material rushed into waterways, contaminated water, mud, and debris washed ashore in a 40+ foot high wave, covering approximately 300 acres (including 50 acres of privately-owned land). Roads, the rail line, and homes were inundated, with some areas receiving as much as

12 feet of toxic piling of ash, mud and debris. Fortunately, land immediately surrounding KFP is largely undeveloped and sparsely populated during the winter, and there were no human injuries or fatalities directly resulting from the failure event. The Spill's effects on surrounding land, watershed, flora and fauna, however, were devastating. The corporate structure of TVA follows that of any other corporation, with the President / Chief Executive Officer (CEO) and appointed Board of Directors operating in a checks-and-balances system of governance. Immediately following the Spill, TVA's CEO and Board of Directors commissioned separate investigations, a separation mirroring TVA's governance. The Spill cast a brilliant light on multiple failures by TVA, and it continues to be a long-lasting black eye for TVA, the fossil fuel electric industry (specifically coal-fired) and the Environmental Protection Agency.



Figure 3: Pre- and post-conditions at the Fly Ash Slurry Storage Dredge Cells. Images courtesy of US EPA TVA Kingston Fossil Fuel Plant Release Site: <http://www.epakingstontva.com/default.aspx> (2014).

3.2 Social Constructivism Paradigm

The Social Constructivism Paradigm informed the approach to this study as it facilitates inquiry of interpretation, narratives and construction of those narratives (Patton 2002). The social constructivism paradigm is a sociological theory in which subjective meanings of individuals' worlds and experiences are created through their interactions. These constructed meanings are used to help make sense of environments, positions within that environment, and placement of other actors, and they are strongly influenced by the historical and cultural contexts in which they exist. Instead of a worldview being dictated to individuals, they create their own, leading to a wide variety of views and meanings existing and influencing simultaneously (Creswell 2007; Gergen 1985; Patton 2002; Stallings 1995). Thus, the narratives

presented within the after-action reports are subjective constructions responding to biases and influences from both within and without the investigation.

3.3 Kingston Coal Fly Ash Spill as a Case Study

3.4 Data: Report Documents

After the Spill, TVA immediately began the process of investigating what happened. Instead of commissioning a single investigation, however, the TVA CEO and the TVA Board of Directors each commissioned its own separate investigation. The TVA CEO's request was addressed by the TVA Office of General Counsel (OGC) contracting with the engineering firm AECOM Technology Corporation to conduct a Root Cause Analysis (RCA) to begin in January 2009 and finalize in June 2009. A root cause analysis is a mainstay in the engineering field (Ferjencik 2011). The TVA Board of Directors asked law firm McKenna Long & Aldridge, LLP to conduct an investigation into the organizational practices of TVA. This report was also commissioned in January 2009 and was published in July, a full month after the AECOM RCA. Requests for these investigations came from within the organization (internal investigation), though they were carried out by a third party. Each of the documents is written from the perspective of quite different disciplines (engineering and law), so it is not surprising that they contain a distinct writing style and perspective. What is remarkable, however, is that, given access to the same information and comparatively similar resources, they differ greatly in determination of causation, blame, lessons learned and overall narrative. These differences are even more surprising, as TVA does not have the luxury of having "strictly internal" after-action documents since it is a federally owned corporation. The assumption is that

such a large, visible organization would ensure a single narrative is presented, but the differences between the narratives lie in stark contrast.

3.5 Coding

I conducted two stages of coding (Hsieh & Shannon 2005; Lundberg et al. 2009; Smith 2000). The documents are the text unit, and the four themes are the coding unit (Smith 2000). The first coding stage involves coding of a priori categories (themes): description of event, description of impact, blame attribution and lessons learned. A priori, in contrast to empirical, coding categories are defined and operationalized before coding of the documents begins. Once the documents were coded for themes, I conducted a second round of coding within the thematic areas with sub-codes specific to each theme. Some sub-codes were identified before the second round of coding while others were identified during the coding process. I then compared the four themes across the two documents (AECOM RCA and MLA Report). The coding manual is included as Appendix A (Smith 2000: 32).

Chapter 4

RESULTS

I conducted two rounds of qualitative coding of the documents, and I compared the results across the documents. The first round of coding was by thematic domain: Event Description, Impact Description, Blame and Lessons Learned. The second level of coding used multiple sub-codes within each thematic domain. I compared the coding results across the AECOM RCA and MLA Report documents. The coding results are summarized in this chapter.

4.1 Event Description

The event description thematic domain contains seven sub-codes exploring ways in which the document describes the Spill.

Table 1: Event Description

	AECOM	MLA
Event descriptors	9 descriptors	4 descriptors
Event timeline begin	3 reference points	1 reference point
Triggering event / primary agent	5 agents	None.
Sequence of events	Yes.	Yes.
Event duration	One hour	None.
Causation / causative factors	5 factors	5 factors
Non-causative factors	14 factors	None.

4.1.1 Event Descriptor

“Event descriptor” sub-code identifies ways in which the document refers to the event. AECOM RCA uses nine unique descriptors versus the MLA Report which uses only four. Both AECOM RCA and MLA Report use the descriptors “failure” and highlight the nature of the event, but they identify and locate “failure” in differing ways. AECOM RCA failure descriptor points to failures of ash materials, built structures and a general failure tied to the site. For example, AECOM RCA took core samples to determine the subsurface profile of the failed dredge cell. They identified the thickness of, profile depth of and characterized each layer. Figure 4 provides an example of their findings.

TABLE ES_T1: Typical Subsurface Profile at top of North Dredge Cell 2

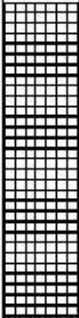


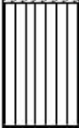

Log	Thickness (ft)	Profile Depth (ft)	Description
	0-90	90	Loose Ash Fill
	< 0.5	90	Slimes
	0 to 15	90 to 105	Clay and Silt Alluvium
	10 to 20	110 to 125	Silty Sand and Silt Alluvium
	Greater than 50 feet	125+	Conasauga Shale

Figure 4: Example: AECOM RCA Table ES_T1: Typical Subsurface Profile at top of North Dredge Cell 2. Table courtesy of AECOM RCA (2009).

In contrast, MLA predominantly cites organizational “system failings” (MLA 2009: 4), though there are a few references to the failed structure. Examples of organizational system failures include “silos of responsibility that failed to collaborate effectively” (MLA 2009: 21), “Culture Flaws that Caused or Contributed to an Incident” (MLA 2009: 24) and failure of employees to “observe the events that were

going on outside of TVA” and failure to “appreciate the seriousness” of those events (MLA 2009: 24). Structurally, MLA refers to the dike and associated structures as “storage facility that failed” (MLA 2009: 7) and failure of “aging byproduct impoundments” (MLA 2009: 30).

Describing the suddenness of the event, AECOM RCA uses “sudden” in the same way as “surprise” (no foresight) whereas MLA emphasizes that this event was neither sudden nor surprising. For example, AECOM refers to the “sudden loss in stiffness, leading to sudden and large creep deformation” (2009: 50), “an unstable system that was on the verge of failure and did so in a sudden way without warning or visible pre-failure symptoms” (AECOM 2009: 80), the “sudden and dramatic manner” of the failure (2009: 4) and “Failure of the Kingston dredge cells was sudden and complex in nature” (AECOM 2009: 5). The authors conclude “the dredge cell impoundment was on the verge of failure with no visible signs of distress reported that would have indicated that a deep-seated failure was about to occur (AECOM 2009: 81). In contrast, MLA reiterates the foreseeable and preventable nature of the event. Specifically, the authors write:

In addition to the foregoing incidents at Kingston as potential red flags, there were many other incidents over time suggesting a deeper root cause analysis of risks to the ash ponds in the Fossil Fleet. In reality, there were a number of opportunities to leverage problems with a single facility into a thorough investigation of the Fossil Fleet (MLA 2009: 26).

AECOM RCA maintains the failure and causes were unexpected or beyond the imagination, in stark contrast to MLA findings that it was predictable and potentially avoidable event.

4.1.2 Event Timeline Begins

“Event timeline begins” is the point in time at which the document places the triggering event / primary agent that began the sequence of events. MLA Report does not include a timeline beginning, stating simply the date of the event (“On December 22, 2008” (MLA 2009: 2)). AECOM RCA does include a timeline and uses three frames in establishing the beginning of the event timeline ranging from a specific time (1:00 a.m. EST) to a general part of the day (“Early in the morning on December 22, 2008” (AECOM 2009: 81)) to not identifiable. This third frame is used in reference to creeping of the alluvial clay deposits (slimes) layer underlying the failed dike structure, as the ash was slimes were initiated in the 1950s and 60s. Phrases modifying each of these AECOM RCA frames indicate varying degrees of uncertainty with phrases such as “around,” “just after,” “at” and a reference to the event occurring “before 1:00 a.m. EST” (AECOM 2009).

4.1.3 Triggering event / primary agent

The “triggering event / primary agent” sub-code is inspired by Barry A. Turner’s “Stage III: Precipitating event” in his *Man-made Disaster Model* (1978: 382). Turner’s precipitating event “arouses attention because of its immediate characteristics” that illuminate the inevitability of “the process of transforming the ill-structured problem into a well-structured problem” (Turner 1978: 382). I define the triggering event / primary agent as the first instance in the sequence of events that

make up the disaster. This is the event to which the “timeline begin” sub-code is tied. The MLA Report does not identify a triggering event / primary agent, but AECOM RCA proposes five possible triggering events / primary agents. The agents are associated with the ash material itself, the slimes below the dike structure, practices of loading the dredge cells and the sudden failure of the northwest corner of the dike structure.

4.1.4 Sequence of Events

The “sequence of events” sub-code is also inspired by part of Turner’s Man-made Disaster Model, specifically “Stage IV: Onset” (1978: 382). Turner defines onset as the “direct and unanticipated consequences of the [initial] failure” (1976: 382). Actions and activities included in the sequence as well as where they fall along the timeline of the event are aspects of how the document describes the disaster. MLA Report contains a basic sequence of events, but AECOM RCA’s sequence is extremely detailed.

In MLA Report the only allusion to a sequence of events is the opening line of the document. The investigators simply state there was a release of material that affected adjacent property and the Emory River. “On December 22, 2008, the Tennessee Valley Authority (‘TVA’) experienced an environmental spill at its Kingston Fossil Plant, releasing 5.4 million cubic yards of fly ash sludge onto adjacent property and into the Emory River (the ‘Kingston Spill’ or the ‘Spill’” (MLA 2009: 2). This is a barebones presentation of a sequence of events.

The AECOM RCA contains a comprehensive and detailed sequence of events. Given the room for error presented in the “event timeline begin” and “precipitating event / primary agent” sub-codes, the sequence of events is surprisingly precise, using

the failure of the northwest corner of the containment dike of Dredge Cell 2 as the precipitating event occurring around 1:00 a.m. EST. This initial failure led to the failure of the north and west dike walls. The ash material began to sequentially fail backwards deeper into Dredge Cell 2 due to liquefaction of the ash. With each successive failure, increasing volumes of ash were released, triggering additional progressive failures that moved from north to south, including loss of an upper portion of the Phase 1 Emergency Dredge Cell. The sequence of failures into the dredge cell was halted by the Cell 1 Divider Dike. The contents of Dredge Cell 2 slid across the 200-foot setback buffer zone and into Perimeter Dike C, which also failed. Once outside of the dike system of the waste management facility, a 47-foot high seiche (flood wave, surge of water in the form of a wave) preceded the debris and ash, flowing upstream (north and northwest) and downstream (southeast and south). The ash and debris swept into the slough 1, the tail water and Watts Bar Reservoir (the Emory River), up sloughs 2 and 3 and across numerous acres of TVA and privately-owned land. A seiche also ripped across the Emory River channel where it damaged privately-owned docks on the eastern shore of Watts Bar Reservoir directly across from the waste management facility.

4.1.5 Event Duration

“Event duration” is the length of time for the sequence of events from the precipitating event / primary agent up to but not including response efforts. MLA Report does not identify event duration, but AECOM RCA explicitly states two options. As AECOM RCA identifies two potential triggering events / primary agents, there are two possible durations for the disaster. If the creep of the slimes is used as the primary agent, the event duration spans decades from when the slimes were first

sluiced into place in the 1950s and 60s until the ash and debris came to rest (approximately one hour after the failure of Dike C). If, however, the primary agent is the failure of the northwestern corner of Dike C, then event duration is identified as approximately one hour.

4.1.6 Causation / Causative Factor(s)

“Causation / causative factor(s)” sub-code is based on the concept of an “incubation period” during which factors are unnoticed, misunderstood, or dismissed (Turner 1978). In retrospect, these factors are identified as underlying or direct contributors to the development and triggering of the disaster. While both AECOM and MLA emphasize the necessity of concurrent factors working together to result in disaster, there are significant differences in the identification of those factors. AECOM’s report looks solely at the Kingston facility. Factors focus on facility and site operations, construction and engineering at the site, and the failed structures. Specifically,

Active loading, cell location, high water level, dike geometry, loose ash fill, and creep sensitive foundation slime material provided an unstable system that was on the verge of failure and did so in a sudden way without warning or visible pre-failure symptoms” (AECOM 2009: 80).

The authors are careful, however, to note that no single factor could have fostered conditions and then triggered the spill (AECOM 2009: 80).

While MLA acknowledges the findings of the AECOM report, they conclude that it did not ask the fundamental question: “did system and culture failures allow such conditions to occur and remain undetected or unaddressed” (MLA 2009: 2).

MLA identifies organizational factors at the Kingston site and throughout the TVA organization. These include: management and oversight, policies and procedures, operations and operational and organizational cultures. Findings focus on if, which and how “system and culture failures allow[ed] such conditions to occur and remain undetected or unaddressed” (MLA 2009: 2). For example, MLA identifies an absence of controls, checks and balances in the absence of a meaningful quality assurance plan. The lack of regular supervision by the specially trained engineers created an atmosphere in which employees “devised ways to do their jobs better, not recognizing the potential negative consequences of their actions” (MLA 2009: 17). A specific situation was one in which a member of the Heavy Equipment Division (HED) “built the dikes ‘better than the drawings’ by extending the dike’s width to better accommodate the ash handling equipment’s size” (MLA 2009: 17). The site plans were not updated accordingly, and the addition of four feet in width of the top of the dike (from the called-for 14-feet to 20-feet) potentially further destabilized the dike structure. A second example comes from the finding that siloed responsibilities and poor communication (due to informational and organizational silos) were strong features of the TVA culture. The informational silo manifested as employees reliance upon unofficial, personal networking (friendships) within the organization if they had a questions or encountered an issue. They “relied heavily on personal relationships, indicating ‘I knew who to call’ or ‘they would call me directly, which my supervisors didn’t like” (MLA 2009: 22). Unfortunately, the individual contacted was often not the most knowledgeable or best equipped to handle the issue. MLA states that “the dependence on personal relationships prevented TVA from most efficiently utilizing its resources” (MLA 2009: 22). Thus, pervasive and persistent blind spots and

shortcomings in the TVA organizational culture contributed to a “failure to look for the pervasive cause of systems failure or culture flaws that caused or contributed to an incident” (MLA 2009: 26).

4.1.7 Non-causation / Non-causative Factor(s)

“Non-causation / non-causative factors” identify events, structures and conditions presented then dismissed as having a role in the sequence of events. These events are deemed as completely unconnected or inconsequential to the disaster event. MLA Report does not reference any non-causation / non-causative factors; the report only includes relevant information to support its narrative. AECOM, in contrast, introduces and dismisses six non-causation / non-causative factors in a hypothesis testing structure. “AECOM identified twelve potential failure modes and then reviewed their likelihood individually and in concert with each other based on observations, measurements and testing” (AECOM 2009: 69), and they found that six were non-causative: structural features of the failed structure, nearby structures, loading and related operations at the site, geologic features of the site and region, ash slurry material itself and climatology.

4.2 Impact Description

There are five sub-codes within the impact description thematic domain. These sub-codes identify the effects of the event.

Table 2: Impact Description

	AECOM	MLA
“Victim”	None.	Environment
Economic impact	None.	None.
Geographical extent	Waterways TVA / Kingston property Privately-owned land / property Items / Landmarks Infrastructure	Adjacent property (not specified if TVA or private)
Damages	Humans Privately-owned land / property Waterways TVA / Kingston property Railroad / tracks & Sawn Pond Road: Dike remnants North hillside Items / Landmarks	None.
Timeline for recovery	None.	None.

4.2.1 “Victim”

The “victim” sub-code identifies animate and inanimate entities stated to be directly and singularly negatively affected by the disaster event. MLA Report specifically cites the environment as being negatively affected, calling the event “an environmental spill” (MLA 2009: 2). AECOM RCA does not, however, include reference to either human or environmental victims.

4.2.2 Geographical Extent

“Geographical extent” sub-code focuses on the geographical area affected by the Spill. MLA Report contains one reference to geographical extent: “adjacent property” (MLA 2009: 2). This property is not specified as either TVA or privately-owned land. AECOM RCA identifies five categories to demonstrate geographical extent of the Spill: waterways, TVA/Kingston property, privately owned land and items identified as “relics” (AECOM 2009: 18) that moved with the liquefied ash / debris flow. Relics, for example, were tracked for distance and direction from their pre-failure location to estimate “movement of water and ash during the course of the failure” (AECOM 2009: 18). Some relics only moved a few feet while others, like the cattails, originally located at the base of the failed dike structure, traveled more than 3,300 feet northeast up the slough (AECOM 2009: 19).

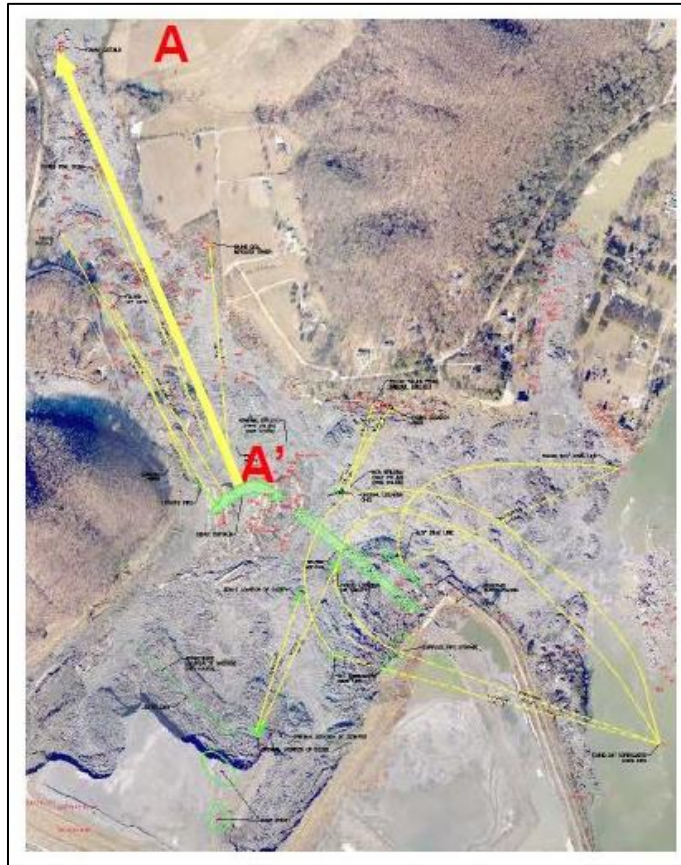


Figure 5: Example: Relic Survey Summary. Image courtesy of AECOM Dredge Cell Failure Presentation (2009).

4.2.3 Damages

The “damages” sub-code captures the impact of the event on humans, property, infrastructure and the environment. Beyond stating that the event is “an environmental spill” (MLA 2009: 2), the MLA Report does not reference additional damages or provide additional details. AECOM RCA identifies eight categories of items that were damaged by the event, many of which overlap with items included in the geographical extent sub-code. These categories are: humans, privately-owned property, waterways,

infrastructure, dike remnants, TVA/Kingston property, the north hillside opposite the first failed dike and items identified as “landmarks” that moved with the failed material. The spill, for example, altered the flow of the Emory River, forcing it eastward, and a seiche “traveled across the Watts Barr Reservoir” where it damaged docks on the eastern shore (AECOM 2009: 20). In addition, the intake for the water to be converted into steam in the electricity generation process was completely plugged with the ash slurry and debris (AECOM 2009: 29) and the railroad tracks, on which coal is brought to the facility, were buried under 10 to 20 feet of ash and debris at various points along the track (AECOM 2009: 16).

4.2.4 Economic Impact

“Economic impact” identifies the financial and economic impact of the event for the facility and for area residents. Neither MLA Report nor AECOM RCA includes reference to economic impact, and neither quantify damages monetarily or provide a projection of monetary impact for the company, plant or community.

4.2.5 Timeline for Recovery

“Timeline for recovery” is the timeline associated with recovery from the impacts of the event. Neither MLA Report nor AECOM RCA reference a timeline for recovery of the organization, environment or area residents.

4.3 Blame

The blame thematic domain is divided into two sub-codes: blame plot and blame attribution. These sub-codes identify various aspects of the ways in which blame for the event is addressed and attributed in the reports.

Table 3: Blame

	AECOM	MLA
Blame Plot	Fate plot	System collapse plot
Micro-level (Organizational attribution)	Individual actions	Individual actions
Meso-level (Organizational attribution)	KFP management & construction practices (past and current)	Organizational lack of adequate systems, controls and procedures Ineffective management of facility employee activities Lack of subject matter expertise in leadership at facility level
Macro-level (Organizational attribution)	None.	TVA leadership Regulatory agencies

4.3.1 Blame Plot

Use of the “blame plot” sub-code comes from Boudes & Laroche’s four blame plots: fate plot, human factor plot, bureaucratic hydra plot and system collapse plot (2009). MLA Report and AECOM RCA align with the system collapse plot and fate plot, respectively. MLA Report identifies with the system collapse blame plot, as it points to the cultural mindset in the TVA organization, identifying numerous red flags / warning signs that could (and should) have been addressed. For example, processes and procedures varied in rigor and quality with the individual performing the inspection and those executing and monitoring operations are also found to be at fault. Though it acknowledges the AECOM RCA’s engineering and structural deficiencies findings, MLA Report focuses instead at TVA and regulatory entities. No single

Kingston plant employee or manager is identified, and Mother Nature is not ascribed guilt for any component of the failure. The authors specify:

‘Too high,’ ‘too wet,’ ‘Foundation, Geometry, Material, Load’ and similar characterizations seeking to explain the Kingston Spill miss the fundamental question, which is: did system and culture failures allow such conditions to occur and remain undetected or unaddressed (MLA 2009: 2).

The authors note TVA’s history of limiting their lessons learned and implementation of fixes to “specific, isolated remediation” without thinking proactively or expansively (MLA 2009: 28) to “leverage the lessons learned across the Fossil Fleet” (MLA 2009: 4). The actions of individuals are noted, but they are contextualized within the larger cultural issues within the organization. For example, following an interior dike failure at the Kingston facility in the 1980s, an employee attempted to encourage his fellow employees to talk about what had happened, to little avail. According to the authors, fault lies not with the individual or his fellow employees, but with the overall failure of the organization to take advantage of these learning opportunities.

AECOM RCA adheres strictly to the fate plot. The overall message of the RCA is that the event was rare, unusual and site-specific (Kingston facility, that particular dredge cell because of its construction). They point to contributing factors working in concert to trigger and intensify the event (i.e. no single factor and no single individual are entirely to blame). The authors take great pains to quote Dr. George Sowers, a geotechnical engineer, on his philosophy regarding slope failures. Their direct quote is as follows:

In most cases, several ‘causes’ exist simultaneously; therefore, attempting to decide which one finally produced failure is not only difficult but also technically incorrect. Often the final factor is nothing more than a trigger that sets a body in motion that was already on the verge of failure. Calling the final factor the cause is like calling the match that lit the fuse that detonated the dynamite that destroyed the building the cause of the disaster (AECOM 2009: 83 citing Sowers 1979).

As mentioned earlier the authors continuously emphasize the surprise nature of the event. The history of initial construction and operations at the site are also cited to support the conclusion that many factors were beyond the control of current or recent past management. “It is likely that most failures are site specific and set in motion by decisions made decades ago” (AECOM 2009: 83).

4.3.2 Organizational Blame Attribution

The “organizational blame attribution” sub-code comes from Cedergren & Petersen’s (2011) three organizational levels addressing scope of attributed event causation at the macro-, meso- and micro-levels. AECOM RCA and MLA Report engage in organizational attribution at micro- and meso-levels, but only MLA Report identifies failures at the macro-level. At the micro-level, AECOM RCA attributes actions to individuals, specifically employees in the operations department at the Kingston facility. Individual actions include the siting and design of the cells and their active loading with the ash slurry material. At the micro-level, MLA Report attributes

focuses on the actions of individual inspectors throughout the history of the Kingston facility and other facilities in the TVA Fossil Fleet. At the meso-level, AECOM RCA spreads the blame among construction practices, historic plant management and management at the plant immediately before and during the disaster. MLA Report, however, lays blame upon the organization (TVA) and the organization's overall Fossil Fleet management (includes all TVA fossil fuel facilities). At the macro-level, AECOM RCA does not attribute blame to any entity, but MLA Report identifies failure in leadership by TVA as an organization, at individual plants within the Fossil Fleet and even regulatory agencies.

4.4 Lessons Learned

The lessons learned thematic domain contains six sub-codes that identify which and how lessons learned are treated in the documents.

Table 4: Lessons Learned

	AECOM	MLA
Previous failure – Kingston facility	7 types of failures	4 types of failures
Previous failure – other fossil fuel facility	None.	6 types of failure
Failure to learn past lesson / missed opportunity	4 areas of failure	5 areas of failure
Recommended hierarchical level of learning	Industry Organizational Plant	Organizational Plant Unit
Implementation plan for lessons learned	Yes.	Yes.
Prescribed corrector / prescribed implementer of lesson learned	3 correctors	10 correctors
Kingston specific or Non-Kingston specific?	Majority site-specific Majority geologic specific	Majority non-site specific Majority organization specific

4.4.1 Previous Failure at Kingston Facility

“Previous failure at Kingston facility” sub-code identifies structural failures at the Kingston facility taking place before the Spill. Both MLA Report and AECOM RCA identify seepages, slope failures and shallow surface slides (sloughing), dike failures and mismanagement of inspections and resulting reports. MLA, for example, highlights what happened when there were two seep incidents, three years apart, at the Kingston facility within 100 feet of one another. Though TVA called in experts to workshop and develop a solution, they did not think proactively to “view these incidents as possible warnings of other or deeper issues with the dikes either at

Kingston or at its other plants” (MLA 2009: 25). In addition, as mentioned earlier, after the 1980s interior dike failure, few employees wanted to discuss the incident and the potential for similar and worse events in the future (MLA 2009: 26). AECOM focuses only on previous events at the Kingston facility, to the exclusion of those within the TVA Fossil Fleet, the fuel industry in general or related industries.

4.4.2 Previous Failure at Other Fossil Fuel Facility

“Previous failure not at Kingston facility” sub-code applies to structural failures taking place before the 2008 Spill at other facilities associated with the fossil fuel industry. AECOM RCA does not identify any failures outside of the Kingston facility, as its scope is exclusively restricted to the Kingston facility. The MLA Report, in stark contrast, identifies numerous incidents occurring at multiple TVA and non-TVA facilities. These incidents include incidents that are similar to the Kingston Spill as well as those that simply deal with the same material under different containment (and different failure) conditions. MLA Report states that these lessons could (and should) have been applied within the TVA Fossil Fleet and across the fossil fuel industry. Incidents include weir failures at the TVA Widows Creek facility, breached plug in an ash settling pond in Pennsylvania, issues with gypsum pond management and breaches at the TVA Cumberland Fossil Plant, the 1972 Buffalo Creek impoundment dam failure and sludge spills in Martin County in Kentucky. The authors lament, “there is no indication that TVA utilized the misfortune of another power utility as a catalyst to assess the safety and integrity of its own facilities” (MLA 2009: 25).

4.4.3 Failure to Learn Lessons from the Past

The “failure to learn lessons from the past” sub-code addresses failures at TVA and non-TVA facilities that were unnoticed, misunderstood or dismissed. This sub-code is inspired by events highlighted in Turner’s Incubation Period (Turner 1976). Failure to learn lessons from the past can be seen as one of the main themes throughout the MLA Report. In the MLA Report, six areas of failure to learn from past incidents are cultural, operational and come from the Kingston site, sites within the TVA Fossil Fleet, the fossil fuel and associated industries. AECOM RCA only identifies four areas of failure, which are site-specific (Kingston) and primarily operations-related. For example, MLA points to an incident in Pennsylvania in August 2005 in which 100 million gallons of fly ash material spilled into the Delaware River due to a breached plug in one of the facility’s ash settling ponds. This event did not cue a review by TVA of its own ash ponds and any potential risks associated with them (MLA 2009: 25). In contrast, AECOM RCA states, “It is likely that most failures are site specific” (2009: 83).

4.4.4 Recommended Hierarchical Level of Learning

The “recommended hierarchical level of learning” sub-code comes from Cantley & Sahal’s discussion of hierarchical levels of organizational learning in socio-technical systems (1980): unit, plant, organizational or company, industry and societal (as discussed by Shrivastava 1983). MLA Report makes recommendations at all hierarchical levels, versus AECOM RCA which identifies lessons learned at the plant, organizational and industry levels. At the unit level, MLA Report encourages a culture of accountability for the employees where they are empowered to complete outstanding maintenance items and take initiative in doing so. At the plant (Kingston

and all similar facilities) and organizational levels, MLA Report recommends development and implementation of an inspector training program to ensure consistency of inspections and standards. At the organizational, industry and societal levels MLA Report strongly advocates for double loop learning, to think and act proactively. In contrast, AECOM RCA lessons learned are geared towards the plant (the Kingston Facility only), organization (TVA) and industries using impoundment ponds. Their primary message to convey is that some things are beyond the imagination, beyond man's efforts to control. The implication is that the plant, organization and industry should monitor their impoundment ponds and consider this particular event, but the unique and unpredictable nature of the event mean that disasters such as these can and certainly will happen again regardless of precautions taken at the plant, organizational or industry level.

4.4.5 Implementation Plan

The "implementation plan" sub-code seeks information related to a plan for implementing lessons learned. MLA Report highlights seven areas for specific attention with recommendations for actionable items along with entities to implement these items. AECOM RCA does not provide a specific implementation plan like the MLA Report provides. This is due to the strict restrictions placed upon AECOM by the TVA OGC (commissioning entity) to avoid discussion of "design of remedial construction measures to clean-up and restore the Kingston site," "implement the restoration program" or "to institute performance monitoring to ensure effectiveness of the restoration/cleanup program" (AECOM 2009: 2).

4.4.6 Prescribed Corrector / Prescribed Implementer of Lesson Learned

The “prescribed corrector / prescribed implementer of lesson(s) learned” sub-code identifies the group or authority figure within the organization who is given the responsibility for implementation of lessons learned. As mentioned above, MLA Report provides an extensive list of actionable items and entities responsible for implementation of these items. These prescribed correctors extend from site personnel to newly created management groups to TVA higher management and third party experts in ash handling. AECOM RCA’s lineup of prescribed correctors is limited to on-site staff in operations, construction, maintenance and inspection. Specific tasks, however, are not assigned. The authors justify the absence:

It was not AECOM’s charge to implement the restoration program nor was it to institute performance monitoring to ensure effectiveness of the restoration/cleanup program. This work was and will be performed by TVA or by consultants and contractors retained by TVA (AECOM 2009: 2).

In contrast, MLA Report assigns activities and goals to ten entities ranging from plant site employees and management to dedicated division managers to Fossil Power Group to any industry using impoundment ponds. For example, at the organizational level, the Fossil Power Group is tasked with “successfully installing best practices, with standards, training, controls and consistent processes, and, as a result, the risks of another Kingston Spill should be significantly reduced” (MLA 2009: 32). Another example is at the unit level regarding corrections in training in and implementation of the pond inspection program. In this “revamped” program, inspections are performed by both TVA employees and outside entities. Trainings will be provided by Stantec to

the on-site employees for completion of daily and quarterly inspections. Thus, each inspection will be standardized with continuity across inspections and inspectors (MLA 2009: 31).

4.4.7 MLA Lessons Learned

Table 5: MLA Lessons Learned

Aspect of Presentation of Lessons Learned	Number of Lessons Learned
Total # of lessons learned	18
# of single-loop lessons # of double-loop lessons	Single-loop: 2 Double-loop: 16
Hierarchical level of learning	Unit: 5 Plant: 9 Organization: 9 Industry: 1
Prescribed corrector	Operators and engineers: 4 Plant management: 2 TVA management: 9 TVA oversight group: 3 Board of Directors: 1 Outside group: 2
Scope of implementation	Site-specific: 1 Fossil fleet: 7 TVA enterprise / TVA: 8

As a follow up to the lessons learned thematic domain, I conducted a more detailed analysis of the MLA Report's lessons learned. I was interested in specific characteristics for each lesson to be learned: single vs. double-loop learning, hierarchical level of learning, prescribed corrector and the scope of implementation. Two of the eighteen lessons learned are single-loop, while the other sixteen are

double-loop. For example, the MLA Report identifies conclusion of the MLA Report is that

In terms of hierarchical level of learning, five lessons are placed at the unit level, nine at the plant level, nine at the organizational level and one at the industry level. There are twenty-four hierarchical levels given responsibility, which is more than the original eighteen lessons as several of the lessons addressed learning at multiple levels. There was a wide variety of entities given responsibility of prescribed corrector: four with operators and engineers, two with plant management, nine with TVA management, three with TVA oversight group, one with the TVA Board of Directors and two third party (external) groups with specific expertise. Implementation timelines are either unspecified or identified as “ongoing.” In terms of scope of implementation, one is site-specific (not the Kingston site), seven span the fossil fleet and eight apply across the TVA enterprise. The MLA Report is greatly concerned with double-loop learning, hence the heavy allocation of responsibility for implementation of lessons learned to upper plant and organization management.

4.5 Summary of Findings

Table 6: Summary of Findings

	AECOM RCA	MLA Report
Event Description	<ul style="list-style-type: none"> • Act of God • Unpredictable 	<ul style="list-style-type: none"> • Man-made • Predictable
Impact Description	<ul style="list-style-type: none"> • TVA victim of Mother Nature 	<ul style="list-style-type: none"> • TVA victim of own actions • Mother Nature victim of TVA
Blame	<ul style="list-style-type: none"> • Fate Plot • Micro & meso-levels 	<ul style="list-style-type: none"> • System Collapse Plot • Micro, meso & macro-levels
Lessons Learned	<ul style="list-style-type: none"> • Engineering • Kingston & TVA Fossil Fleet operations • Single-loop 	<ul style="list-style-type: none"> • Engineering & organizational • TVA & industry operations & culture • Double-loop

Thematic domains of event description, impact description, blame and lessons learned reveal critical differences between AECOM RCA and MLA Report. AECOM RCA is a traditional scientific paper format using hypothesis testing as written by an engineering firm focused exclusively on the Kingston facility and the 2008 coal fly ash spill with an eye towards avoiding or minimizing potential legal action. The MLA Report uses lay language as it takes a macro-level organizational and industry approach in identification of causative factors and lessons learned to question and improve TVA and the fossil fuel power industry. AECOM RCA provides greater detail, whether relevant or not (see results regarding non-causative factors), when compared to MLA Report. In addition, there is a clear distinction between the operational / cultural emphasis of the MLA Report and the engineering / construction approach of AECOM RCA. While AECOM RCA focuses almost exclusively on site-

specific (Kingston Fossil Plant) issues and solutions, MLA Report is much more expansive as it includes other facilities within TVA and industries using impoundment ponds for waste storage. These differences lead to questions regarding post-event scientific writing, crafting of a narrative and narrative authority.

|Chapter 5 DISCUSSION

5.1 Theoretical Approaches and Biases of AECOM RCA and MLA Report

AECOM RCA and MLA Report follow the functionalist / social systems theory and the natural hazards approach, respectively (Tierney et al. 2001). There are numerous characteristics of the AECOM RCA that follow the functionalist / social systems theory. The Spill is described as sudden and unpredictable, an abnormal event disrupting normal operations of the facility and life for area residents. In adherence with the fate plot, blame is laid squarely upon forces of Nature, and TVA is depicted as an innocent, unwitting victim whose engineering efforts failed in a unique fashion (Boudes & Laroche 2009). “Nature, unharnessed, is to blame” (Phillips et al. 2010: 7), or rather, nature, despite being harnessed, is to blame. TVA is presented as an objective party investigating what happened and attempting to make right the wrongs.

The MLA Report adopts the natural hazards perspective. The event is labeled a man-made environmental spill, pointing the finger at TVA and presenting Nature as the victim of man’s failed engineering attempts to contain his industry waste. Using the system collapse blame plot (Boudes & Laroche 2009), investigators ascribe blame to both TVA culture and individual employees (direct and contracted). Conditions for this failure were created and furthered through failures in management, oversight, policies and procedures and repeated failures to learn from similar events at Kingston and across the industry. These causative factors are touted as predictable and could

have been addressed if management had put in the time and effort to take systematic (throughout the TVA organization) corrective action.

Determination of scope of the investigation is an example of the way in which biases affect the investigation and resulting content of the reports. The scope of AECOM's investigation is externally imposed by the TVA Office of General Council. AECOM could not comment upon TVA standards of practice for the Kingston site's design and construction, movement of contaminants into the environment due to the ash slurry, TVA's response and recovery efforts, or operations at other TVA sites. In contrast, MLA's scope was self-determined based upon a request by the TVA Board of Directors to "improve TVA's governance, systems and controls to reduce the likelihood of similar or other harmful incidents" (MLA 2009: 2). They were not restricted in the type, breadth or source of information or its applicability. Instead of steeling itself for litigation as in the AECOM report, MLA took a more self-reflective approach more akin to an internal review.

Though not consciously chosen, as would be the case in scholarly research, the investigations and resulting reports certainly approached the Spill with a specific lens. As Lundberg et al. write, "Investigation manuals necessarily embody or represent an accident model, i.e., a set of assumptions about how accidents happen and what the important factors are" (Lundberg et al. 2009: 1297). The conclusions and lessons learned are thus also dictated by the "model" and the investigator's biases (Ferjencik 2011 citing Hollnagel 2009; Lundberg et al. 2009).

5.2 AECOM RCA and MLA Report as TVA's Post-event Crisis Communications

Organizational risk and crisis communication is the art of storytelling, a product of the union of science and rhetoric. Specifically chosen information is strategically presented as a narrative whose goal is to engage and convince an audience. After action reports act in three capacities: depoliticize the disaster event and justify the response, restore trust and legitimacy of the institution and reduce anxiety (Boude & Laroche 2009). As a crisis communication document, AECOM RCA actively works to depoliticize the Spill, justify past policies and procedures at the Kingston facility, restore trust in and legitimacy of TVA and reduce anxiety of regulators and the general public about the potential for future similar events. Ferjencik writes that the primary role of root cause determination is “identification of multiple causes which are considered to be underlying system-related ones” (2011: 887). Content focuses on causal factors, including but then dismissing a small number of contextual and minor contributory factors. Investigators used engineering, chemical, geologic and highly technical findings from field research and lab testing to support their conclusions. Thresholds, acceptable Factor of Safety measurements and frequency counts are heavily used. The report reads as a textbook root cause analysis, and is a verbatim accounting of the Spill offering several potential causes at the Kingston facility.

The MLA Report takes a different approach from AECOM RCA. MLA investigators accept the inevitability of politicization of the Spill, loss of trust and legitimacy of TVA and increased anxieties. They turn their attention to organizational factors that created conditions conducive for this type of Spill in the TVA Fossil Fleet and across the industry. MLA Report reads like an organizational qualitative case

study. Instead of doubling down on the sudden nature of the failure of the dikes, MLA points to the easily identifiable organizational cultural issues, failure to take seriously lapses in policies and procedures, and the avoidable nature of the organizational causative factors. While acknowledging the technical engineering findings of AECOM RCA, MLA Report intentionally moves further to address failings at the higher organizational levels. They write:

“Too high,” “too wet,” “Foundation, Geometry, Material, Load” and similar characterizations seeking to explain the Kingston Spill miss the fundamental question, which is: did system and culture failures allow such conditions to occur and remain undetected or unaddressed (MLA 2009: 2).

Investigators are taking an in-depth look at TVA and its Fossil Fleet to identify meso- and macro-level areas in need of reworking.

AECOM RCA engages in external-facing organizational sensemaking by crafting a narrative in which TVA attempts to regain its legitimacy and boost its morale (Brown 2000). The RCA uses the typical root cause analysis style, engaging in a form of hypothesis testing (specifically in sections addressing non-causative factors) and using professional verbiage from engineering (Factor of Safety), geology (rock characteristics, soil chemistry), hydrology (slurry chemistry), geography (seismic zones) and the industry (handling and management permits).

Table 1.5.1_T1 Summary of Void Ratios in Ash

Material Type	Void Ratio						
	Arithmetic Mean	Median	Mode	Standard Deviation	% Void Ratios > 0.8	Maximum	Minimum
Failed Ash	0.83	0.81	0.73	0.23	48.4	1.78	0.25
Unfailed Ash	0.88	0.84	0.79	0.24	58.1	2.19	0.39

Notes: 1) Void ratios were calculated from water contents and $G_s = 2.37$
2) Unfailed Ash in 300- and 600- Series, MACTEC 2004 data, and 09-400 and 09-402 borings of the 400-Series
3) Failed Ash in 100-, 200-, and 500-Series, and 09-404, 09-406, and 09-408 borings of the 400-Series

Figure 6: Example: AECOM RCA’s Table 1.5.1_T1 Summary of Void Ratios in Ash. Image courtesy of AECOM RCA (2009).

The TVA OGC, oversight and regulatory agencies (Federal and State) and any potentially litigious members of the public are the target audience. Lessons learned adhere strictly to single-loop learning in which adjustments occur strictly within the existing systems and frameworks, which themselves remain unchanged (Shrivastava 1983 citing Argyris & Schön 1978). Lessons learned are not expanded to higher organizational (meso-) or industry (macro-) levels, as investigators focus on design, engineering, maintenance and inspection procedures exclusively at the Kingston site. The characterization of the ash, slurry (ash and water), and the geologic characteristics of the area are front and center, with the general attitude of “we did the best we could” and “we can’t go back and change history, so let’s just move forward” regarding past facility waste management practices.

Since TVA is a Federally-owned corporation, there are very high stakes in terms of the how findings will be interpreted and used by regulatory oversight groups

and the public. As a Federal entity, TVA is encouraged to be a leader in innovation and accountability. This responsibility opens the door for additional regulation of waste material, its management and the waste industry (Committee on Environment and Public Works 2009; Subcommittee on Water Resources and Environment 2009a& 2009b). Given these external and internal pressures, it is not surprising that the TVA OGC severely limited the scope of AECOM RCA to the Kingston facility. Conclusions and lessons learned fail to climb beyond Kingston plant's employees and site management who act as the scapegoats (Boudes & Laroche 2009).

The MLA Report also recognizes the significance of TVA in the industry, but it takes a different approach to be proactive as opposed to defensive. Instead of engaging in organizational sensemaking, the Report more accurately reflects inquiry sensemaking which identifies the "broad social implications" with high-level lessons learned (Brown 2000: 32). Written for both internal (TVA Board of Directors) and external (Federal and State regulatory entities, industry and the public) audiences, investigators used a rhetorical writing style that minimized the amount of law and scientific jargon. In broadening the scope of the investigation, lessons learned and recommended corrective action were made applicable to the TVA organization as a whole and others in the fossil fuel industry. MLA Report engaged in double loop learning by challenging organizational cultural norms and frameworks (Shrivastava 1983 citing Argyris & Schön 1978). Employing the "failing policy makers configuration" in which higher-level organizational actors receive blame (Boudes & Laroche 2009 citing Brändström & Kuipers), TVA Board of Directors, Fossil Power Group, newly established Fossil Fleet Group and independent third party experts are among top management receiving marching orders. When compared to one another,

AECOM RCA and MLA Report use different methods, cite alternate information and draw contrasting conclusions. Each tells a story, but in a different way and with different outcomes.

5.3 Framing the Narrative: AECOM RCA and MLA Report's Campaign for Authority

When multiple narratives exist, they often compete to be the most cited, trusted or authoritative (Boudes & Laroche 2009). If viewed as *the* authority on a given situation, future reports and members of the industry will point to that document and future legislation will confidently quote from it. With authority comes prominence and dominance over the other narratives. One of the most obvious and effective strategies in the effort to be the authority is intentional selection (or omission) of data to be interpreted. As a reader, the information and how it is used reveal biases of the investigator and commissioning entity (Boudes & Laroche 2009; Brown 2004; Ferjencik 2011 citing Hollnagel 2009; Lundberg et al. 2009). AECOM RCA restricts its investigation to data from the Kingston facility, while MLA Report adds organizational data from the TVA organization and event data from other fossil fuel industry facilities. The interpretation of the data is another method. AECOM RCA uses the functionalist / social systems theory lens through which to interpret the field observations and lab test results, leading them to the conclusion that the Spill was a unique, unpredictable and singular event that should not be viewed as a warning sign. The MLA Report investigators, however, used the natural hazards approach to their data, labelling TVA (man) the aggressor and environment (nature) the victim. The TVA organization's lack of insight, foresight and proactive action created a climate in which management, policies and procedures and responsibilities at all levels

prioritized electricity production significantly more than waste management practices. The causative factors were predictable, by no means unique to the TVA organization or the fossil fuel power industry and they could certainly have been avoided had management made the effort to be proactive.

As it is clear that the two reports do not present a unified narrative, the question now becomes: which of these documents is perceived to present the most relevant and most important information regarding the Spill? There is no easy answer, as ultimately neither AECOM RCA nor MLA Report is the absolute authority. For engineers and operators within the fossil fuel industry, scientists in academic research, and regulatory entities, AECOM RCA is the most accessible and thus most likely to be referenced. The format (root cause analysis), language (specific to engineering, geological and hydrological scientists), presentation of information (hypothesis testing and the use of thresholds) and conclusions (site-specific engineered and individual action recommendations) of the report are familiar and easier to understand for these groups. Boards of Directors, organizational scientists and general oversight entities, however, gravitate to the MLA Report. For these entities, the format (case study), language (lay, no jargon), presentation of information (only relevant information included) and conclusions (meso- and macro-level organizational failures and widespread recommendations at all levels) are approachable and digestible.

The following is an example of the changing perception of authority given to the AECOM RCA and MLA Report. In the seven months following the Spill, the Federal government, in the form of three legislative committees, referenced both the AECOM RCA and MLA Report in different capacities and at different points in time. During the January 8, 2009 and March 31, 2009 hearings before the Committee on

Environment and Public Works and Committee on Transportation and Infrastructure, respectively, AECOM RCA is only mentioned three times: once in the January 8 hearing and twice in the March 31 hearing. Both mentions are extremely brief, noting simply that the investigation is in process and the report may be available by summer of 2009. The lack of reference is interesting, as the AECOM field team was commissioned within a few weeks after the Spill, and their first visit to the Kingston site was on January 8 – the day of the first committee hearing. Also of note, neither hearing recognizes the MLA Report, though it was commissioned in January 2009 and was conducted over similar time period to the AECOM RCA.

There is a distinct shift in the third hearing on July 28, 2009 before the Subcommittee on Water Resources and Environment. At this hearing, Subcommittee members were more interested in MLA Report findings and recommendations for the fossil fuel industry than in the site-specific construction (engineering) and operation issues identified in AECOM RCA. The hearing concludes with Subcommittee members calling for organization- and industry-wide recommendations at the meso- and macro-levels, as opposed to structure-specific engineered solutions (Subcommittee on Water Resources and Environment 2009). As this was the last hearing addressing the Spill, the ultimate takeaway is that this oversight committee preferred to emphasize meso- and macro-level learning from the Spill (MLA Report) over site- and component-specific fixes (AECOM RCA).

|Chapter 6

CONCLUSION

6.1 Distinct Narratives

Though given access to the same information about the Spill, Kingston’s waste management practices and TVA organization, investigators of the AECOM RCA and MLA Report present distinctly different narratives. AECOM places blame in nature with a dash of man-made influence, engaging in both “Act of God” mentality and “scapegoating.” MLA points to organizational culture, lax policies and procedures and lapses in management and oversight at all levels of the organization. Consciously or unconsciously, each investigative team’s professional background, scope of inquiry and target audience adhere to disaster theories that further dictate framing of the narrative. Lingering questions remain, however, as to who is the authority, who determines that authority and how is it maintained. If we consider the Congressional oversight committees to confer authority, then the MLA Report is the dominant document as it is mentioned most frequently and cited most often. If, however, we turn to operational and engineering experts in the field of waste management, impoundment ponds and fossil power industry the AECOM RCA is designated to be the authority. Other entities, such as the TVA OIG and TDEC cite both, but there is a noticeable imbalance in those citations. Given these influences, this case study supports past research positing the impossibility of completely objective investigations, reports, science and their interpretation.

6.2 Interdisciplinary Versus Multi-disciplinary Approaches to Post-disaster Investigations

Given the subjectivity of rhetorical scientific writing, an important question arises regarding the interdisciplinary versus multi-disciplinary approach to disaster investigations. Is it better to have multiple perspectives presented independently or a single narrative that cuts across all relevant disciplines? In other words, is it better to work within or across silos of expertise? The interdisciplinary approach asks representatives from multiple disciplines to work together in a combined effort of a single investigation that produces a single report. In the multi-disciplinary approach, each discipline assembles its own team to conduct an investigation and report, guided by the theories and frameworks of that discipline. As there are multiple teams, the result is multiple, independent investigations and reports from a wide variety of professional perspectives with potential for equally varied conclusions.

TVA engaged in the multi-disciplinary approach, whether consciously or unconsciously, by commissioning two post-event investigations. The benefit of having both AECOM RCA and MLA Report, as opposed to only one or the other, is that a more complete picture emerges of the event, causation and organizational (and industry) environment. AECOM RCA is written by and appeals to engineers and site operators, whereas MLA Report is more accessible for upper-level management, oversight entities and the general public. When an investigation stops at the analysis of “preventable causes,” as opposed to conditions conducive to their development into a disaster event, there is the potential to “limit the usefulness of using investigations to get a view on the ‘big picture’ of causes of accidents as a basis for further remedial action” (Lundberg et al. 2010: 2132). True to this assertion, organizational context and the “big picture view” are excluded from the AECOM RCA, just as in-depth technical

findings are missing from the MLA Report. Together the two documents (AECOM RCA and MLA Report) present a more comprehensive narrative of the Spill and TVA's responsibilities moving forward than if either had been the sole narrative. Those seeking a more accurate understanding of and long-term substantive solutions for disaster events such as the Spill should seriously consider adopting the multi-disciplinary approach.

6.3 Reception and Use of Documents: Ideality Versus Reality

The next logical question is what is done with these documents. These documents originate from, exist in and apply to the world of practitioners, and there is often a gap between theory (lessons learned as presented in the documents) and application (implementation of lessons learned). In an ideal world, all lessons learned will be incorporated into the documents, all relevant parties, regardless of discipline or location within organizational structure, will read and internalize these lessons, and application will be both timely and comprehensive. Industry should take the opportunity to look beyond engineered, single-loop "fixes" to long-term, double-loop "changes." In reality however, there are significant hurdles. Specifically relating to TVA and the report documents from the Kingston Spill, these challenges may prove insurmountable due to demonstrated history regarding new initiatives and audience's existing biases. The "legacy culture" within TVA is of particular concern. Whether it be the creation of new organizations, "implementation of new directives," execution of remediation activities of identification and promotion of best practices, TVA has a proven track record of lapsing "into mediocrity" where efforts are "eventually reorganized or disbanded" (MLA 2009: 32). Even if progress is made in one area, it can easily be undermined by resistance from another sector of the organization.

Engineering, structural and design fixes are relatively easy to implement. Progress is quickly and clearly visible, and most can agree on the goals and timelines for updates and construction. Cultural changes, on the other hand, are more nebulous. It is difficult to assess progress, and extremely easy to fall back to the “old ways” of the former culture, especially if employees and management are resistant to the organizational shifts. In summary, it is hard to fight nature especially given TVA’s historical strength to realize the desire of maintaining the status quo.

The second great hurdle for implementation and maintenance of lessons learned is the audience’s pre-existing biases. Disciplines will gravitate towards the format, language and subject matter with which they are most familiar. This bias is also held by the commissioning entities, those with influence at the plant and organizational levels and external regulatory / oversight entities. Taking this a step further, it is entirely possible that neither document will be read outside of the commissioning entities and the Congressional and State oversight groups. Other within the fossil power industry, professionals specializing in impoundment ponds or waste management and general citizens may never read these documents. If they have never read these documents, they are less likely to learn from the event, improve their designs and hold TVA (and the industry as a whole) responsible for advancements and accidents. A further complication is that we are only as safe, protected and ready as our imaginations allow us to be. The mentality that disaster events could seemingly happen without warning is pervasive in the industry, especially as cited by the entity responsible for an environmental disaster. For example, MLA Report authors make a point of identifying “the consistent theme” that emerged from TVA employees: they never thought that an event similar to the Kingston spill as possible, “they always

thought the dike would leak before it would break” (MLA 2009: 24). MLA Report authors conclude that this belief demonstrated the employee and management’s failure to observe and learn from events going on outside of the TVA Fossil Power Group as well as fail to appreciate the seriousness of events within TVA. Warning signs and red flags may be readily identified, but they can easily be, whether consciously or unconsciously, misinterpreted, misapplied or even dismissed.

MLA Report offers several recommendations for moving forward with these documents given the reality of the situation, and I offer several of my own. MLA Report advises that the remediation activities of the newly-created Fossil Power Group will only be sustainable if senior management gets behind the remediation program and takes ownership of it. I strongly suggest that upper management, including the Board of Directors, TVA CEO and TVA OGC, read both AECOM RCA and MLA Report. They should work together to prioritize and tackle lessons learned and associated tasks. In addition, though AECOM states that they were not tasked to develop or follow the implementation of remediation activities, I believe they should, in fact, play some role. AECOM RCA investigators identified engineering and structural problems, and they should be able to take part in assessing and ensuring that the fixes actually address the identified issue. Thus, there must be “an enterprise-wide commitment to, and adoption of, such reforms” (MLA 2009: 32).

I recommend a dual-strategy plan that address short-term “fixes” and long-term “changes.” The first part of the strategy is to address the single-loop constructed / engineered issues identified in the AECOM RCA. These “quick fixes” address the short-term concerns. As mentioned earlier, they are concrete, easier to implement and results are tangible (return on investment is easy to calculate numerically). These

characteristics make the engineered fixes much more palatable for the industry as a whole, despite the potential price tag. MLA Report notes that these types of remediation actions were quickly begun after the event. Within a month after the Spill, TVA contracted with a third party engineering firm, Stantec Consulting Service, Inc., to conduct a comprehensive review of all the waste holding ponds (fly ash slurry, gypsum, coal yard runoff ponds, chemical ponds and “any structure that could discharge into the environment or any structure that could have stability issues” (MLA Report 2009: 26). The second part of my strategy is devoted to the organizational culture, processes and procedures identified in the MLA Report. The proposed double-loop lessons learned will reform TVA and the industry in meaningful and important ways. Addressing interpersonal personnel issues, operational policies and procedures, training and departmental reorganizations are expensive and time consuming. Progress may not be seen for significant amounts of time, and progress can be difficult to measure. These are not easy fixes, and progress may come in fits and starts. Organizational patience, consistency and buy in from all hierarchical levels are required for extended periods of time. This dual-strategy makes adjustments for the reality of setting and maintaining momentum for short-term goals without caving to the challenges of the long-term goals.

6.4 Limitations

This case study addresses a little-explored research area in which multiple post-event inquiry documents are produced by the same responsible entity, but there are key limitations that should be taken into consideration. As TVA is the only federally owned corporation in the United States, it is not possible to conduct a domestic (U.S.-based) multiple-case study. Single-case study designs are often

criticized for their "the uniqueness or artificial conditions surrounding the case" (Yin 2014: 64) which fans the fear of "misrepresentation" (Yin 2014: 53). Types of available contextual documents were limited to those made publicly available through the TVA, U.S. Government Printing Office and general internet search. None of the digital archive contained internal communications discussing these documents and no interviews were conducted. Context and analysis of perceived authority of these documents is thus restricted to their discussion in the Legislative oversight committee hearings.

The case study's methodology imposed certain limitations, as well. No interviews were conducted with investigators, commissioning entities, TVA management or site employees, regulatory and oversight entities or members of the public to examine their perceptions of the documents and their use. The lack of interviews limits determination of context and reception by audiences of the information / ideas presented in the documents. In addition, development and application of the codes were subjective. I did not engage in team coding in which the collaborative effort interpretive convergence adds robustness to the development of code sand coding process (Saldaña 2009). Future research could address these methodological limitations.

6.5 Future Research

Future research can expand upon both content and methodology of this case study. Though differences between AECOM RCA and MLA Report are identified, interviews exploring reasons for and influences of these differences could significantly add to existing research. Future research could also take an in depth look at responses to and uses of these documents within the organization, across the industry, by

regulatory / oversight entities and by the general public. Questions such as perception of import, relevance, trust (authority) and use in regulatory policy debates would be fascinating. A more in-depth view of intra- and inter-industry responses to the Spill and similar events would be beneficial to regulatory agencies, members of the industry and the public. Possible follow-up questions from the lessons learned identified in the AECOM RCA and MLA Report include: which and how are lessons learned adapted throughout the industry; do certain sectors adopt different recommendations at different levels; which entities favor single- over double-loop learning; were there political or policy responses to the Spill and TVA's handling of it; and is there such a thing as "industry peer pressure" in which individual members within the industry feel pressure from their fellow corporations to adopt (or refuse to adopt) policies and procedures. At a macro-level, additional research could delve into the use of interdisciplinary versus multi-disciplinary investigation procedures and reports, specifically how they are received by the target audience. The potential directions for future research are varied and extensive, and their contributions could prove invaluable for the industry and academia.

REFERENCES

- Adriano, D. C., Page, A. L., Elseewi, A. A., Chang, A. C., & Straughan, I. (1980). Utilization and Disposal of Fly Ash and Other Coal Residues in Terrestrial Ecosystems: A Review. *Journal of Environmental Quality*, 9(3), 333–344.
- Beamish, T. D. (2002). *Silent Spill: The Organization of an Industrial Crisis*. Cambridge: The MIT Press.
- Berg, B. L., & Lune, H. (2012). *Qualitative Research Methods for the Social Sciences* (8th Ed.). Boston: Pearson.
- Blanco, J. O., & Ide, R. W. (2009). A Report to the Board of Directors of the Tennessee Valley Authority Regarding Kingston Factual Findings.
- Boudes, T., & Laroche, H. (2009). Taking off the Heat: Narrative Sensemaking in Post-crisis Inquiry Reports. *Organization Studies*, 30(4), 377–396.
<http://doi.org/10.1177/0170840608101141>
- Brown, A. D. (2004). Authoritative sensemaking in a public inquiry report, 95–112.
<http://doi.org/10.1177/0170840604038182>
- Brown, A. D. (2004). Authoritative sensemaking in a public inquiry report. *Organizational Studies*, 25(1), 95–112.
<http://doi.org/10.1177/0170840604038182>
- Cantley, M. F., & Sahal, D. (1980). Who Learns What? A Conceptual Description of Capability and Learning in Technological Systems (Vol. RR-80-42). Luxemburg. Retrieved from
<http://webarchive.iiasa.ac.at/Admin/PUB/Documents/RR-80-042.pdf>
- Cedergren, A., & Petersen, K. (2011). Prerequisites for learning from accident investigations - A cross-country comparison of national accident investigation boards. *Safety Science*, 49(8-9), 1238–1245.
<http://doi.org/10.1016/j.ssci.2011.04.005>
- Chess, C., & Johnson, B. (2009). Risk Communication by Organizations: The Back Story. In R. L. Heath & H. D. O’Hair (Eds.), *Handbook of Risk and Crisis Communication* (pp. 323–342). New York: Routledge.

- Committee on Environment and Public Works. (2009). Oversight Hearing on the Tennessee Valley Authority and the Recent Major Coal Ash Spill. US Government Printing Office.
- Coombs, W. T. (2009). Conceptualizing Crisis Communication. In R. L. Heath & H. D. O'Hair (Eds.), *Handbook of Risk and Crisis Communication* (pp. 99–118). New York: Routledge.
- Creswell, J. W. (2007). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. Thousand Oaks: Sage Publications.
- Dewan, S. (2009, December 30). At Plant in Coal Ash Spill, Toxic Deposits by the Ton. *The New York Times*. New York. Retrieved from http://www.nytimes.com/2008/12/30/us/30sludge.html?_r=0
- Dombrowsky, W. R. (1998). Again and again: Is a disaster what we call a “disaster”? In E. L. Quarantelli (Ed.), *What is a Disaster? Perspectives on the question* (pp. 19–30). New York: Routledge.
- Environmental Protection Agency, U. (2014). Boiler Slag. Retrieved January 1, 2014, from <http://www.epa.gov/osw/conserves/imr/ccps/boilslag.htm>
- Environmental Protection Agency, U. (2015a). Coal Ash Basics On this page: What is coal ash? Regulations What do power plants do with coal ash? How much coal ash is there? Why is coal ash reused? Why does EPA regulate coal ash? Retrieved from <http://www2.epa.gov/coalash/coal-ash-basics>
- Environmental Protection Agency, U. (2015b). Disposal of Coal Combustion Residuals (CCR) from Electric Utilities and Independent Power Producers: Overview of Final Rule Webinar Presentation. Retrieved from <http://www2.epa.gov/coalash/coal-ash-final-rule-webinar-presentation-slides>
- Ferjencik, M. (2011). An integrated approach to the analysis of incident causes. *Safety Science*, 49(6), 886–905. <http://doi.org/10.1016/j.ssci.2011.02.005>
- Gephart, R. P. (1984). Making Sense of Organizationally Based Environmental Disasters. *Journal of Management*, 10(2), 205–225. <http://doi.org/10.1177/014920638401000205>
- Gergen, K. J., & Davis, K. E. (Eds.). (1985). *The Social Construction of the Person*. New York: Springer-Verlag.
- Gusfield, J. R. (1981). *The Culture of Public Problems: Drinking-Driving and the Symbolic Order*. Chicago: The University of Chicago Press.

- Heath, R. L., & O'Hair, H. D. (2009). *Handbook of Risk and Crisis Communication*. (R. L. Heath & H. D. O'Hair, Eds.). New York: Routledge.
- Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(0), 1277–1288. <http://doi.org/10.1177/1049732305276687>
- July, P., & Valle, T. (2009). TVA Board Calls for Comprehensive Organizational Changes In Response to Independent Kingston Report.
- Keller, E. A., & De Vecchio, Duane, E. (2011). *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes* (3rd ed.). Boston: Prentice Hall.
- Kilgore, T. (2009a). Remarks by Tom Kilgore at TVA Board Meeting.
- Kilgore, T. (2009b). Testimony of Tom Kilgore President and Chief Executive Officer, Tennessee Valley Authority, before the U.S. House Committee on Transportation and Infrastructure Subcommittee on Water Resources and Environment March 31, 2009.
- Kilgore, T. (2009c). Tom Kilgore, President and Chief Executive Officer Tennessee Valley Authority Before the U.S. House Committee on Transportation and Infrastructure Subcommittee on Water Resources & Environment.
- Leech, N. L., & Onwuegbuzie, A. J. (2008). Qualitative data analysis: A compendium of techniques and a framework for selection for school psychology research and beyond. *School Psychology Quarterly*, 23(4), 587–604. <http://doi.org/10.1037/1045-3830.23.4.587>
- Lundberg, J., Rollenhagen, C., & Hollnagel, E. (2009). What-You-Look-For-Is-What-You-Find - The consequences of underlying accident models in eight accident investigation manuals. *Safety Science*, 47(10), 1297–1311. <http://doi.org/10.1016/j.ssci.2009.01.004>
- Maitlis, S. (2005). The Social Process of Organizational Sensemaking. *Academy of Management Journal*, 48(1), 21–49. <http://doi.org/10.5465/AMJ.1962.5065118>
- Moore, R. W. (2009). Statement of Richard W. Moore Inspector General, Tennessee Valley Authority before the Subcommittee on Water Resources and Environment of the Committee on Transportation and Infrastructure United States House of Representatives.
- Openshaw, S. C. (1992). *Utilization of Coal Fly Ash*. University of Florida.

- Patton, M. Q. (Ed.). (2002). *Qualitative Research & Evaluation Methods* (3rd ed.). Thousand Oaks: Sage Publications.
- Perrow, C. (2007). *The Next Catastrophe: Reducing Our Vulnerabilities to Natural, Industrial, and Terrorist Disasters*. Princeton: Princeton University Press.
- Peterson, T. R., & Thompson, J. L. (2009). Environmental Risk Communication: Responding to Challenges of Complexity and Uncertainty. In R. L. Heath & H. D. O'Hair (Eds.), *Handbook of Risk and Crisis Communication* (pp. 591–606). New York: Routledge.
- Phillips, B. D., Neal, D. M., & Webb, G. R. (2012). *Introduction to Emergency Management*. Boca Raton: CRC Press.
- Phillips, B. D., Thomas, D. S. K., Fothergill, A., & Blinn-Pike, L. (2010). Social Vulnerability to Disasters. (B. D. Phillips, D. S. K. Thomas, A. Fothergill, & L. Blinn-Pike, Eds.). Boca Raton: CRC Press.
- Pidgeon, N. F. (1997). The Limits to Safety? Culture, Politics, Learning and Man-Made Disasters, 5(1), 1–14. <http://doi.org/10.1111/1468-5973.00032>
- Quarantelli, E. L. (Ed.). (1998). *What is a Disaster? Perspectives on the Question*. New York: Routledge.
- Rivin, G. (2015, June 19). Duke Energy Required to Pay Towns, Cities for Degraded Water. *North Carolina Health News*, pp. 4–7. Retrieved from <http://www.northcarolinahealthnews.org/2015/06/19/duke-energy-required-to-pay-towns-cities-for-degraded-water/>
- Saldaña, J. (2009). An Introduction to Codes and Coding. In *The coding manual for qualitative researchers* (1st ed., pp. 1–31). Thousand Oaks: Sage Publications. <http://doi.org/10.1519/JSC.0b013e3181ddfd0a>
- Schnaiberg, A. (1980). *The Environment: From Surplus to Scarcity*. New York: Oxford University Press.
- Shrivastava, P. (1983). A Typology of Organizational Learning Systems. *Journal of Management Studies*, 20(1), 7–28. <http://doi.org/10.1111/j.1467-6486.1983.tb00195.x>
- Smith, C. P. (2000a). Content Analysis and Narrative Analysis. In H. T. Reis & C. M. Judd (Eds.), *Handbook of Research Methods in Social and Personality Psychology* (1st ed., pp. 313–335). Cambridge: Cambridge University Press.

- Smith, C. P. (2000b). Content analysis and narrative analysis. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology*. (pp. 313–335). Cambridge University Press.
<http://doi.org/10.1093/acprof>
- Springston, J. K., Avery, E. J., & Sallot, L. M. (2009). Influence Theories: Rhetorical, Persuasion and Informational. In *Handbook of Risk and Crisis Communication* (pp. 268–284). New York: Routledge.
- Stallings, R. A. (1995). *Promoting Risk: Constructing the Earthquake Threat*. New York: Walter de Gruyter, Inc.
- Statement, O., Boxer, C., & Inhofe, R. M. (2009). Testimony of Tom Kilgore, President and Chief Executive Officer Tennessee Valley Authority Before the Environment and Public Works Committee.
- Subcommittee on Water Resources and Environment. (2009a). *The Tennessee Valley Authority's Kingston Ash Slide and Potential Water Quality Impacts of Coal Combustion Waste Storage*. US Government Printing Office.
- Subcommittee on Water Resources and Environment. (2009b). *The Tennessee Valley Authority's Kingston Ash Slide: Evaluation of Potential Causes and Updates on Cleanup Efforts*. US Government Publishing Office.
- Tasca, L. L. (1990). *The Social Construction of Human Error*. State University of New York at Stony Brook.
- Tennessee Valley Authority Board of Directors. Resolution (2009).
- Tennessee Valley Authority Office of the Inspector General. (2009). *Inspection Report: Review of the Kingston Fossil Plant Ash Spill Root Cause Study and Observations about Ash Management*.
- Tierney, K. J., Lindell, M. K., & Perry, R. W. (Eds.). (2001). *Facing the Unexpected: Disaster Preparedness and Response in the United States*. Washington, D.C.: John Henry Press.
- Turner, B. A., & Pidgeon, N. F. (1978). *Man-Made Disasters* (2nd ed.). Boston: Butterworth-Heinemann.
- Walton, W. H., & Butler, W. (2009). *Root Cause Analysis of TVA Kingston Dredge Pond Failure on December 22, 2008*. Vernon Hills.

Yin, R. K. (2014). *Case Study Research: Design and Methods* (5th ed.). Los Angeles: Sage Publications.

Appendix A
CODING MANUAL

Thematic Domain	Sub-code	Definition
Event Description**	Event descriptor***	How the event is referred to / labelled in the report.
	Event timeline begin**	Earliest date / time mentioned in the sequence of failure and disaster events up to but not including response activities. May be explicitly stated or an implicit reference.
	Triggering event / primary agent* ¹	An adaptation of Turner's concept of Precipitating Event (1978). Event stated to have led to or started the sequence of events. May be explicitly stated or an implicit reference.
	Sequence of events* ²	An adaptation of Turner's concept of Onset (1978). Events identified along the event timeline, including the triggering event / primary agent but not including response activities.
	Event duration**	Length of time of the event. May be explicitly stated or an implicit reference.
	Causation / causative factor(s)**	Entities explicitly stated to be a cause of the event or creating conditions conducive to the development of the event.
	Non-causation / non-causative factors**	Entities presented then dismissed as having no role or little role in the failure and disaster.
	Impact Description**	Victim**

¹ Turner, B.A. 1978

² Turner, B.A. 1978

		event. May be explicitly stated or an implicit reference.
	Economic impact**	Financial / economic impact attributed to the event. May be explicitly stated or an implicit reference.
	Geographical extent**	Geographical extent of the event. May be explicitly stated or an implicit reference.
	Damages**	Impact of the event on animate and inanimate entities. May be explicitly stated or an implicit reference.
	Timeline for recovery**	Timeline associated with addressing and recovering from the impact of the event.
Blame**	Blame plot* ³	Four typologies of plots for post-crisis inquiry reports as presented by Boudes & Laroche 2009. Fate plot: Human agents and organizations receive little blame. Event is unavoidable or out of human control. Human factor plot: Actions of human agents are central to the causation of the event. Event is avoidable or poorly addressed because of mistakes by human individuals. Bureaucratic hydra plot: Organization receives ultimate blame for the event due to poor management, inertia or negligence. System collapse plot: Both human actions and organizational failure are to blame. Event is a due to the intricate relationship between humans and organizations.
	Organizational attribution* ⁴ : Micro-level	Three organizational levels at which responsibility / blame for causation as presented by Cedergren & Petersen

³ Boudes & Laroche 2009

⁴ Cedergren & Petersen 2011

	Meso-level Macro-level	2011. Micro-level: Lowest organizational level, specifically individual employees and physical processes. Meso-level: Middle organizational level, specifically management issues or inter-organizational factors. Macro-level: Highest organizational level, specifically oversight and regulatory agencies and intra-organizational factors.
Lessons Learned **	Previous failure – Kingston facility***	Actually occurred or potential events similar to the event at the Kingston site.
	Previous failure – other fossil fuel facility***	Actually occurred or potential events similar to the event at other facilities within the TVA Fossil Fleet and in the fossil fuel industry.
	Failure to learn past lesson / Missed opportunity* ⁵	Failure to learn, apply or incomplete application of lessons learned from previous failures at the Kingston or other facility.
	Recommended hierarchical level of learning* ⁶	Five hierarchical levels of organizational learning in socio-technical systems as presented by Cantley and Sahal 1980. Unit level: Single piece of equipment, single-train process plant or product line. Plant level: Single plant, which may contain several unit level entities. Organizational or company level: Multi-plant organization. Industry level: All the organizations / firms within the industry. Societal level: Wider society within which manufacturing and marketing of the goods takes place.
	Implementation plan for	Plan for implementation of the

⁵ Turner, B.A. 1978

⁶ Cantley & Sahal 1980

	lessons learned**	lessons learned. May include scope, timeline and extent of each item. May be explicitly stated or an implicit reference.
	Prescribed corrector / prescribed implementer of lesson learned**	Organizational entities within the recommended hierarchical level of learning who are given responsibility for implementation of lessons learned. May be explicitly stated or an implicit reference.
	Single vs. double loop learning* ⁷	Two typologies of organizational learning as presented by Shrivastava 1983 citing Argyris & Schön 1978. Single-loop learning: Error correction proceeds by changing organizational strategies within a constant framework of norms of performance. Adjustments made in order to keep organizational performance at acceptable levels within static organizational goals and constraints. Double-loop learning: Error correction proceeds by restructuring existing organizational norms of performance. Restructuring of strategies and assumptions associated with those norms involves fundamental changes in the frames of reference or theories in the organization at the time of failure.
	Scope of Implementation***	At what organizational level are actionable items given in the implementation plan. This combines the hierarchical level of learning and prescribed corrector / prescribed implementer of lesson learned. Site-specific Inter-organizational group Organization / intra-organization

⁷ Shrivastava 1983 citing Argyris & Schön 1978

Key	
*	Developed from literature
**	Emergent from initial review of documents
***	Emergent during coding process

Appendix B

EVENT DESCRIPTION RESULTS

	AECOM	MLA
Event descriptors	9 descriptors: <ul style="list-style-type: none"> • Slide, event • Failure, initial failure • Sudden, sudden and dramatic, sudden and complex • Action in slimes • Failure of specific structures • Failure of ash • Sequence, series • Date of failure • Other 	4 descriptors: <ul style="list-style-type: none"> • Environmental spill • Spill • Incident • Preventable / foreseeable
Event timeline begin	3 reference points: <ul style="list-style-type: none"> • 1950s & 60s • 1:00 a.m. • Early in the morning 	1 reference point: <ul style="list-style-type: none"> • December 22, 2008
Triggering event / primary agent	5 agents: <ul style="list-style-type: none"> • Undrained ash • Movement of slimes • Sudden failure of structures • Liquefaction of materials • Loading of cells 	None.
Sequence of events	Yes, extensive.	Yes, limited.
Event duration	One hour	None.
Causation / causative factors	5 factors: <ul style="list-style-type: none"> • Concurrent factors • Geographic setting • Slimes/slimes creep • Instability / weakness of ash / liquefaction of ash 	5 factors: <ul style="list-style-type: none"> • Concurrent factors • Management and oversight • Policies and procedures • Operations • Organizational culture

	<ul style="list-style-type: none"> • Facility practices 	
Non-causation / non-causative factors	<p>14 factors:</p> <ul style="list-style-type: none"> • Northwest Cell 2 section • Artesian conditions • Dry slope instability • Static liquefaction of ash • West slopes • Rainfall • Natural soil under alluvial silty clays • Earthquake • Railroad traffic vibration • Drawdown of Watts Bar Reservoir • Karstic activity in limestone • Bedrock instability • Seepage outbreak around perimeter of dikes 	None.

Appendix C

IMPACT DESCRIPTION RESULTS

	AECOM	MLA
“Victim”	None.	Environment
Economic impact	None.	None.
Geographical extent	<ul style="list-style-type: none"> • Waterways • TVA / Kingston property • Privately-owned land / property • Items / Landmarks • Infrastructure 	<ul style="list-style-type: none"> • Adjacent property (not specified if TVA or private)
Damages	<ul style="list-style-type: none"> • Humans • Privately-owned land / property • Waterways • TVA / Kingston property • Railroad / tracks & Sawn Pond Road: • Dike remnants • North hillside • Items / Landmarks 	None.
Timeline for recovery	None.	None.

Appendix D

BLAME RESULTS

	AECOM	MLA
Blame plot	Fate plot	System collapse plot
Micro-level (Organizational attribution)	Individual actions	Individual actions
Meso-level (Organizational attribution)	<ul style="list-style-type: none"> • KFP management & construction practices (past and current) 	<ul style="list-style-type: none"> • Facility: ineffective management of facility employee activities; lack of subject matter expertise in facility leadership • Organization: Lack of adequate systems, controls and procedures
Macro-level (Organizational attribution)	None.	<ul style="list-style-type: none"> • TVA leadership • Regulatory agencies

Appendix E

LESSONS LEARNED RESULTS

	AECOM	MLA
Previous failure – Kingston facility	7 types of failure: <ul style="list-style-type: none"> • Seepage • Shallow slides • Surface instability • Dike failure • Inspection and inspection report mismanagement • Other • “Beyond the imagination” 	4 types of failure: <ul style="list-style-type: none"> • Seepage • Dike failure • Slope failure • Sloughing
Previous failure – at a non-Kingston facility	None.	6 types of failure: <ul style="list-style-type: none"> • Weir failure • Breached plug in ash settling pond • Reaching capacity • Gypsum: wet sluicing, dikes, ponds • Pipes in plant yard • Impoundment failure
Failure to learn past lesson / missed opportunity	4 areas of failure: <ul style="list-style-type: none"> • Failure of TVA inspections and reports • Thresholds (Factors of Safety) • Computer modeling • Other 	5 areas of failure: <ul style="list-style-type: none"> • Failure to recognize / address warning signs • Failure to follow through with proposed solutions for previous events • Failure due to absence of processes or organizational structures • Failure due to lack of imagination • Failure due to intentional dismissal
Recommended	Industry	Organizational

hierarchical level of learning	Plant	Plant Unit
Implementation plan for lessons learned	Yes. <ul style="list-style-type: none"> • Inspections • Operations& practices 	Yes. <ul style="list-style-type: none"> • Review of structures • Emergency response plans • Systems • Capital planning • Standards and accountability • Culture of accountability • Overall
Prescribed corrector / prescribed implementer of lesson learned	3 correctors: <ul style="list-style-type: none"> • “Nature” • Engineers • KFP construction and maintenance staff 	10 correctors: <ul style="list-style-type: none"> • TVA Management • Dedicated Program Managers (HED, Byproducts Facilities, River Operations) • Fossil Power Group Management • Fossil Fleet Group (newly created post-Kingston spill) • Field supervisors (one supervisor, multiple plants) • TVA Engineers • Plant site management • Plant site employees • Third party engineering firm (Stantec Consulting Service, Inc.) • Third party experts in ash handling (not specified)
Kingston specific or Non-Kingston specific?	<ul style="list-style-type: none"> • Majority site-specific • Majority geologic specific 	<ul style="list-style-type: none"> • Majority non-site specific • Majority organization specific

Appendix F

MCKENNA, LONG & ALDRIDGE, LLP LESSONS LEARNED RESULTS

Aspect of Presentation of Lessons Learned	Number of lessons learned
Total # of lessons learned	18
# of single-loop lessons # of double-loop lessons	Single-loop: 2 Double-loop: 16
Hierarchical level of learning	Unit: 5 Plant: 9 Organization: 9 Industry: 1
Prescribed corrector	Operators and engineers: 4 Plant management: 2 TVA management: 9 TVA oversight group: 3 Board of Directors: 1 Outside group: 2
Scope of implementation	Site-specific: 1 Fossil fleet: 7 TVA enterprise / TVA: 8