

REDUCING RISK OF LOW HEAD DAM

Reducing the Risk of the Low Head Dam in Elgin, Illinois

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Abstract

The problem was that the Elgin Fire Department had not fully examined the hazards of the low head dam. This had resulted in increased risk to citizens and first responders. The purpose of this applied research project (ARP) was to develop an understanding of the hazards of low head dams and identify potential methods for reducing the hazard to both the public and first responders. The descriptive research method was used to assess the situation as it currently exists. Research questions identified the hazards presented by low head dams, the strategies currently in place in the City of Elgin, other strategies for reducing the hazard of the low head dam to the public, and other strategies for reducing the hazard of the low head dam to first responders. The procedures included a literature review, collection of information and data, personal communications and interviews. The results indicated that there are measures that can be implemented to improve in the three areas of planning, public awareness and emergency response. Recommendations are included for the development of strategies to address each of these areas. The results of this research will also provide the foundation for the later completion of a comprehensive risk assessment utilizing the National Fire Academy's (NFA) Community Risk Reduction model.

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Introduction

In recent years the role of the fire service has expanded beyond the traditional or core services to begin embracing an all hazards approach to planning and response. This broader focus has led communities to examine the potential for other types of natural or manmade hazards. One such hazard that exists in Elgin, Illinois is the low head dam on the Fox River at the northern edge of the downtown area.

The problem is that the Elgin Fire Department has not fully examined the hazards of the low head dam. This has resulted in increased risk to citizens and first responders. The purpose of this applied research project (ARP) is to develop an understanding of the hazards of low head dams and identify potential methods for reducing the hazard to both the public and first responders.

The descriptive method was used to answer the following research questions: 1) what is the hazard presented by low head dams?, 2) what hazard reduction strategies are currently used in the City of Elgin?, 3) what other strategies exist for reducing the hazard of the low head dam to the public?, 4) what other strategies exist for reducing the hazard of the low head dam to first responders?

The results of this research will provide the foundation for the later completion of a comprehensive risk assessment utilizing the National Fire Academy's (NFA) Community Risk Reduction model.

Background and Significance

The City of Elgin, Illinois is a large industrial city located 38 miles northwest of Chicago. In addition to being the headquarters of many national corporations, Elgin is one of the largest cities in the state with a population of 105,568 residents located in 38 square miles (S. M. Olafson, personal communication, January 19, 2010). On the city's near east side is the Fox River which travels north to south through the downtown area. The Fox River flows for 185 miles from southern Wisconsin to central Illinois (Friends of the Fox, 2009). Located along the 115 miles within Illinois are 13 dams, most of them low head dams. Elgin's low head dam is located at the northern edge of the downtown district approximately 150 feet downstream of the Kimball Street Bridge. It is known locally as the Kimball Street Dam.

Elgin was founded along the Fox River in 1854. A primary reason for choosing this location was the ability to harness water power for industrial reasons. Originally the dam provided power for a woolen mill, gristmill and two large flour mills. It also created deeper water levels upstream for approximately two miles. This feature was utilized during the 1800's by ice harvesters (Alft, 1992, p. 25-27). In modern times this provides sufficient depth for the intake system of Elgin's water supply. Over 14 million gallons of water are pumped each day to supply the needs of Elgin and two neighboring communities. For this reason the dam is still considered essential to the city (K.B. Jacobson, personal communication, January 25, 2010). Ownership of the dam was originally vested in private individuals or companies but by 1965 the City of Elgin had become the sole owner ("Landmarks Kimball dam," 1999). The current dam is made of concrete, has a height of 13 feet and spans 330 feet from the east to west shores of the river.

Organized in 1867, the Elgin Fire Department (EFD) is a full service agency providing fire suppression, ALS transport, hazardous materials, water rescue, technical rescue and fire prevention, inspection, and investigation services. These services are provided by 136 personnel located at seven strategically located fire stations. The department has a class 3 rating from the Insurance Services Organization and responded to 10,979 alarms during 2009. On a daily basis personnel staff 13 companies consisting of seven engines, six ambulances, two ladder companies (cross manned by personnel from the ambulance companies), and one shift Battalion Chief. Line personnel are assigned to one of three shifts that work 24 hours on and 48 hours off.

The department's water rescue team began in 1979 and currently has 12 members. The EFD team functions as part of larger area-wide team operated by Illinois's mutual aid organization. Known as the Mutual Aid Box Alarm System (MABAS) this area-wide or Division II team consists of 32 divers representing five fire departments. (B. Lancaster, personal communication, January 25, 2010).

On June 2, 1974, the EFD was dispatched to a report of a boater trapped in the turbulent waters of the Kimball Street Dam. As a dare, a 20 year old male had gone over the dam in a rubber raft. The EFD response included an aluminum row boat with motor. Utilizing this boat, Captain Stanley Balsis and Firefighter Michael Whalen approached while steering the boat to avoid being pulled into the face of the dam. This was the standard tactic at that time. During their efforts to extend a pike pole to the victim, their boat was pulled parallel into the face of the dam and overturned. Numerous attempts were made to rescue the firefighters while they valiantly fought the tumultuous current. For upwards of 45 minutes, Firefighter Whalen and Captain Balsis struggled in the water before succumbing to their injuries. Both firefighters were the first line of duty deaths in the Elgin Fire Department since 1964. The boater who had gone

over the dam survived by holding onto the fire department boat when it broke free of the dam's current (Carr, 2003). The deaths of Captain Balsis and Firefighter Whalen were a tragedy to both the department and the community and have had lasting impact. In May 2003 a memorial was constructed at the Kimball Street Dam to provide remembrance to their selfless sacrifice to the City of Elgin.

Since 1974 there have been other incidents at the Kimball Street Dam. On May 17, 1995 a 28 year old male riding a power ski tried to turn around on the upper portion of the dam, went over the top, and became trapped in the strong current. Although wearing a personal flotation device, witnesses described the victim as being repeatedly pulled under the surface of the water. The EFD and Elgin Police Department were immediately dispatched and on arrival the victim was no longer in the dam and had begun floating downstream. He was immediately removed from the river and advanced life support measures were begun. Unfortunately he did not survive his injuries (Duschene, 1995). A lawsuit was filed against the City of Elgin by the victim's family claiming failure to post and maintain adequate warning. The lawsuit was eventually dismissed (Carr, 2000).

On July 13, 2001 a small fishing boat's engine failed and it began to float toward the dam before being pulled to shore by fire personnel ("Elgin paramedic crew," 2001). On November 11, 2008 an 18 year old woman jumped off the Kimball Street Bridge onto the upper portion of the dam and fortunately was rescued by EFD personnel before going over the dam (Calandriello & Johnson, 2008). These incidents illustrate the hazard presented by the low head dam and the need for a proactive approach to planning, public awareness, and emergency response. With the increasing recreational use of the river, continuing efforts to bring residents to the downtown area, and the experiences of other communities throughout the United States, it is reasonable to

anticipate that there will be future incidents at the low head dam. Equally important is that attempting a low head dam rescue is a low frequency event that places first responders at risk. Every effort should be made to identify means to reduce the occurrence of these types of events in the future.

The establishment of strategies for reducing the hazard of the low head dam directly relates to the United States Fire Administration (USFA) operational directives to “develop a comprehensive multi-hazard risk-reduction plan for 2,500 communities”, “reduce firefighter line-of-duty deaths by 25 percent” and “to appropriately respond in a timely manner to emergent issues”.

The key focus and goal of the Executive Fire Officer Program (EFOP), Executive Analysis of Community Risk Reduction (EACCR) course is to develop leaders and enhance their skills in order to implement and lead community risk reduction initiatives (USFA, 2009, p. 1-7). Course instructor Chief Michael Chiamonte emphasized the responsibility of fire service leaders to become “risk reduction technicians” within their communities. This ARP is a proactive step towards fulfilling that responsibility and will provide the foundation for the completion of a comprehensive risk assessment utilizing the NFA’s Community Risk Reduction model.

This ARP also represents the first time that an assessment has been done of the low head dam hazard beyond emergency response. The results of this research project will be utilized to plan and implement additional strategies for the protection of both the public and first responders. Other organizations seeking to develop a similar program may find value in both the research and recommendations.

Literature Review

The literature review gathered information in the form of texts, newspaper and magazine articles, formal reports, and local materials. There is no single agreed upon definition as to what constitutes a low head dam. During the literature review at least eight different definitions were found. The American Association of State Highway and Transportation Officials defines a low head dam as “having a hydraulic height of less than 25 feet” (Houghtalen & Robinson, n.d., p. 1). Use of this definition helps to differentiate low head dams from larger, more known ones such as the Hoover Dam.

Another term for low head dams, especially those with a hydraulic height of less than 10 feet is “run of river dams”. This term was found in official reports from the state of Illinois. Outside of the United States the term “weir” is frequently used to describe a low head dam.

The exact number of low head dams in the United States is not known. The United States Army Corps of Engineers (USACE) maintains the National Inventory of Dams which numbers approximately 79,000. This however only includes those that have a hydraulic height over 25 feet, which would exclude by definition, low head dams (USACE, 2007). In Illinois alone, the number of dams is estimated to range from 1200-1300 (Illinois Department of Natural Resources [IDNR], n.d.) Locally in the Elgin area, there are four low head dams found along a 16 mile stretch of the Fox River.

Many low head dams were built in the 1800’s as a means of harnessing water power for industry. While many of these dams no longer serve their original purpose, they never the less remain and many are deteriorating. This fact adds to the potential danger of these dams.

One of the primary dangers of a low head dam lies in the action of moving water.

In the article “Dangerous Dams” by Houghtalen & Robinson (n.d., p.1) the physical actions of water moving over a dam are detailed. As water flows over a dam, often into a depression or scour created at the bottom of the face of the dam, it then flows back upstream. This is known as a hydraulic. The water below the hydraulic is very aerated and has a white, foamy appearance that can appear to be “boiling”. This physical feature of the hydraulic is often referred to as the “boil” or “boil line”. It is this re-circulating current that creates one of the deadly features of low head dams. In fact low head dams have been called drowning machines or killing machines. A person trapped in the hydraulic of the dam will suffer a continuous cycle of being pulled under water, frequently to be battered against rocks or debris, brought to the surface momentarily, and then again pulled under. Due to the extreme aeration of the water in the boil, a personal flotation device or life-vest provides little buoyancy.

Additional dangers are in the form of how the dam may appear to an unsuspecting individual. The hydraulic height of many low head dams is only a few feet. This can cause someone unfamiliar with dams to underestimate the strong currents that can be present above and below the dam. This was identified as a contributing factor in several fatalities. The low height that someone in a canoe or kayak sits at can also contribute to not seeing the approaching dam until it is too late (Houghtalen & Robinson, n.d., p. 2).

According to the Centers for Disease Control and Prevention (CDC), in 2005 there were 3,582 incidents of fatal, unintentional drowning (CDC, 2008, p.1). Many of these occurred in recreational water settings including rivers. The sports of canoeing and kayaking have seen steady increases in the number of persons participating. In 2003 the American Canoe Association (ACA) reported that the sport of kayaking was growing faster than any other outdoor

activity (2003, p. 6). As kayaking and canoeing have become more accessible to a growing number of people, those who have little or no experience has increased. This lack of experience, including a lack of knowledge about low head dams, has been a factor in many fatalities. The same report from the ACA identified 27 canoe or kayak fatalities in low head dams during the period of 1996-2000 (p. 21).

The overall number of fatal incidents involving low head dams is not accurately known, a fact mentioned in several reports. Many of the statistics provided were for either a specific state, local dam or anecdotal. For example one article reports twenty-nine people dying in low head dam incidents on the Fox River in a ten year period (Donahue & Earles, n.d., p.2). A report completed by the IDNR's Office of Water Resources (2003, p. i) specific to the Glen Palmer Dam in Yorkville, Illinois references 28 fatalities at that single dam between 1968 and 1993.

In reviewing literature to identify strategies for protecting the public, two incidents in 2006 in Illinois were partly responsible for the most comprehensive study found on low head dams in that state. That incident occurred on May 27, 2006 when a kayaker died after going over the Glen D. Palmer dam in Yorkville, Illinois thirty-six miles south of Elgin (Hetfield, n.d., p.1). Two brothers who attempted to rescue the kayaker also died. In August of that same year there were three additional deaths at the low head dam at Wilmington, Illinois (Illinois Office of the Governor, 2007). The public attention to these incidents was a factor in Illinois Lieutenant Governor Pat Quinn obtaining funding for a comprehensive review of the issue. An outside engineering firm was hired to conduct an assessment of twenty-five publicly owned low head dams located on public waterways (Illinois Office of the Governor, 2006). The study was done under the authority of the Capital Development Board of Illinois (Illinois CDB) and also involved the IDNR. The stated purpose of the study was to document and evaluate existing

safety measures and consider possible additional measures including dam modification or removal (Illinois CDB, 2007, section 1, p.1).

Entitled “Evaluation of Public Safety at Run-of-River Dams”, the study was released in July, 2007. Included in the report was the current status of each dam as well as recommendations for signage, public awareness programs, and both temporary and permanent structural options.

The literature review also included examining methods, training, and procedures available for reducing the hazard to first responders. Information found in magazines as well as water rescue textbooks indicate that low head dam incidents are classified as swiftwater incidents. The textbook, *Technical Rescuer – Water Levels I and II*, by Steve Treinish defines swiftwater as “any water traveling or flowing faster than one knot, or 1.5 miles per hour” (Treinish, 2010, p.134). The dynamics of water moving at that speed along with a lack of knowledge and experience as to the differences between this and other types of water rescue are frequently factors in first responder injury or death. In the Winter 2006 edition of *Technical Rescue* magazine Jim Segerstrom (2006, p. 24) further adds that many untrained rescuers die in swiftwater due to feeling compelled to act even without the proper education, experience, or equipment.

Further guidance is provided through standards developed by the National Fire Protection Association (NFPA). Two particular standards, NFPA 1006, *Standard for Technical Rescuer Professional Qualifications* and NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, address training and preparation for swiftwater incidents. NFPA 1006 focuses on the training and education of individuals involved in technical rescue, including water rescue (NFPA, 2008). More specific information on operations and

response is contained in NFPA 1670 which identifies different levels of preparedness, training and response to a range of technical rescue incidents including swiftwater (NFPA 2009).

In summary, the literature review revealed that the dangers of low head dams are well documented but often underestimated and underappreciated. It also revealed that most of the focus on addressing low head dam issues is at the state or local level. This information was important to the research as it directed the author to seek further information at those levels in terms of strategies for reducing the hazard to the public. The literature review also identified several resources in the areas of planning, public awareness, and emergency response that fire departments can evaluate and implement. This information will provide valuable in the development of recommendations and further risk reduction planning efforts.

Procedures

This applied research paper was formatted and written based on the 5th edition of the American Psychological Association *Publication Manual*. The descriptive research method was used to answer four questions: 1) what is the hazard presented by low head dams?, 2) what strategies are currently in place in the City of Elgin?, 3) what other strategies exist for reducing the hazard of the low head dam to the public?, 4) what other strategies exist for reducing the hazard of the low head dam to first responders?

The research methodology had two main components. The first involved a literature review of texts and articles related to low head dams and the current strategies for reducing risk to the public and first responders. The second involved a review of City of Elgin and Elgin Fire Department documents, personal communication and interviews with City of Elgin personnel and representatives of other agencies. Department information was compared to the accepted national standards and state-level curriculums and the results used in preparing the

recommendations section of this ARP. This information collectively provided the answer to question 2.

Research for part one began at the National Fire Academy located in Emmitsburg, Maryland during May 2009. An electronic search of the resources of the Learning Resource Center (LRC) provided several sources including magazine and newspaper articles. Additional research was conducted at the Gail Borden Public Library located in Elgin, Illinois as well as the researcher's personal library and the reference materials available at the City of Elgin and the Elgin Fire Department. The Gail Borden Public Library was specifically chosen because it maintains a large amount of historical information on the City of Elgin.

Electronic research was conducted via the internet utilizing the Google search engine (www.google.com). The search terms included: low head dam, community risk reduction, low head dam hazard, and water safety.

Utilizing the online card catalog of the LRC (<http://www.lrc.dhs.gov/index.html>) several Applied Research Projects on the general topic of water safety were located and downloaded. The abstract for an ARP on low head dams by Chief Mark Boynton of the Keene, New Hampshire Fire Department was identified and a copy of the full document was obtained from the author in June 2009.

To obtain a copy of the study "Evaluation of Public Safety at Run-of-River Dams" from the Illinois CDB required the submittal of a Freedom of Information Act request in October 2009. Three CD-ROM's containing the report and appendices were later received.

Research for part two focused on personal communications and interviews with personnel from the City of Elgin and other agencies. The individuals interviewed were selected based on their current or historical knowledge of the topic and the interview questions were

specific to the expertise of the individual. Each interview lasted from twenty to sixty minutes and was conducted in person or by phone. Elgin Fire Department and City of Elgin documents including procedures, memos, training outlines, and other internal documents were reviewed.

There were limitations to the research. In utilizing the descriptive method the research was limited to providing an assessment of what currently exists. Because of the specific, unique type of water hazard presented by low head dams the researcher found the predominance of information from articles and textbooks related to the fire service and water rescue disciplines. As a result of the literature review, more emphasis was placed on information and resources available at the state and local level.

The following terms are defined to clarify their meaning:

Exclusion zone: A segment of a river that is intended for limited or no access.

Executive Fire Officer Program: A four year program offered to Chief level officers at the National Fire Academy (NFA) in Emmitsburg, Maryland. Completion of the program requires attendance at the NFA for two weeks each year as well as the completion of an ARP after each course.

Full by-pass channel: An engineered channel that diverts water flow around a dam outside of the dam abutments.

Hydraulic: The water current flowing over the top of a dam that drops down, often into a depression created at the bottom of the face of the dam, and then flows back upstream.

Hydraulic height: The change in elevation from the head or upstream water to the tail or downstream water.

In-stream bypass channel: An engineered channel that diverts water flow around a dam along one of the abutments within the river channel.

Learning Resource Center: The library and resource center located at the National Fire Academy in Emmitsburg, Maryland.

Low head dam: a type of dam having a hydraulic height of less than 25 feet and extending across the entire width of the waterway. Low head dams may also be referred to as run-of-river dams.

National Fire Academy: Part of the United States Fire Administration, the National Fire Academy is a residential campus offering professional development courses to the fire service. The NFA is located in Emmitsburg, Maryland.

National Fire Protection Association: A non-profit world-wide organization and developer of more than 300 consensus standards and codes.

National Fire Protection Association Standard 1006: The professional standard outlining the minimum performance standards for rescue technicians. The standard is revised every five years with the current edition issued in 2008.

National Fire Protection Association Standard 1670: The professional standard identifying and establishing levels of functional capability for conducting operations at technical search and rescue incidents. The standard is revised every five years with the current edition issued in 2009.

Riffle pool: A series of short drops that are created in a river channel through the placement of boulders.

Scour hole: The area below the face of a dam that becomes eroded due to the water current flowing over the dam.

Results

The purpose of this ARP was to research and gain an understanding of the hazards presented by low head dams, the strategies currently in place within the City of Elgin, and other strategies that are available to reduce the hazard to the public and first responders. This section will report the results of information collected for the study.

Research question 1. What is the hazard presented by the low head dam?

Both private and public sector information in the form of books and articles were reviewed. Anticipating that the results of the other three research questions would possibly be more specific to the state of Illinois and the City of Elgin, a focus was placed on national level information. It was found that low head dams present a significant and often underestimated type of water hazard. Research found differing definitions as to what constitutes a low head dam. It was determined that on a nation-wide basis there is not an accurate picture of the overall number of low head dams or the number of fatalities that occur in them. Most statistics in either category were found at either the state or local level. Some of the local level information were estimates or anecdotal. There were however many newspaper articles found relating to local incidents of injury or fatalities at low head dams.

When searching for information on the broader topic of dam safety, much of the information found related to larger dams and issues of dam failure. The Federal Emergency Management Agency's (FEMA) rating system for dams focuses on the potential of a dam collapsing or an unscheduled release of water, not on incidents of someone being trapped in a dam (FEMA, 2004, p. 1).

A valuable rating system for estimating the danger of low head dams was found. The textbook *Swiftwater Rescue* by Slim Ray (1997, p.224) includes a method for rating low head dams based on the degree of rescue difficulty. The rating system includes ten factors:

1. Height of drop
2. Angle of drop from the vertical
3. Volume of water over the dam
4. Distance across the river in feet
5. Access to both sides of the dam
6. Anchors for rope systems and working area
7. Debris accumulating in the hole, % of front of dam obscured
8. Depth of hole from height of boil to lowest visible depression at base of dam
9. Distance from base of dam to boil line in feet
10. Composition of the bottom of the base of dam

Each factor is assigned a value of one to three and the total is used to place the dam into one of four classes: class I – basic, class II – intermediate, class III – more difficult, or class IV – most difficult. With the assistance of Firefighter Wayne Smith of the EFD's Water Rescue Team, the rating system was used to evaluate the Kimball Street Dam. The results rate the dam as a class III or more difficult, requiring advanced skills. Utilizing examples provided in the text, the dam in Binghamton, New York where three firefighters were killed in 1975 is also rated a class III. It should be noted that changes in the volume of water flow, such as during flooding or high water periods could result in the dam at a particular time being rated as a class IV or most difficult.

Research question 2. What risk reduction strategies are currently in place in the City of Elgin?

A review of City of Elgin and Elgin Fire Department documents as well as personal communications and interviews with city personnel and representatives of other agencies provided the information for answering this question. The intent of the interviews was to foster discussion based on their experience, insight, and knowledge of the low head dam issue.

The Kimball Street Dam is located in an area that is of prime importance to the city for both recreational and economic purposes. The City of Elgin's *2010-2014 Strategic Plan* (2009) identifies the "river as a resource" as one of the communities 10 strategic goals. In recent years significant investment has been made to beautify the riverfront and increase the attractiveness to residents for recreational purposes. As part of the city's master plan this has resulted in the construction of a bike path and community park along the river and the elimination of blighted buildings that were replaced by new residential occupancies that overlook the river

A phone interview on January 5, 2010, Mr. Joe Evers, City Engineer for the City of Elgin provided information on city initiated work to improve the Kimball Street Dam. In 1999-2000 the City spent approximately one million dollars to reconstruct parts of the dam. This work including replacing concrete on the face of the dam, pouring a new concrete pad at the base of the dam that extended ten feet from the bottom of the face, and installing new rock for an additional ten feet beyond the pad. One of the objectives of this repair work was to reduce the severity of the dam's hydraulic. In addition, as part of the city's efforts to beautify the shore line of the river, new outlooks and railings were installed along the east side of the dam in 2002. With the assistance of the IDNR the city also installed three large warning signs indicating the

approach to the low head dam on the upstream side of the Kimball Street Bridge. The interview with Mr. Evers provided valuable information and lasted approximately twenty minutes.

In addition to the signs, between May and October the IDNR places a series of buoys on the upstream side of the dam just before the Kimball Street Bridge (A. Geising, personal communication, January 25, 2010).

A review of EFD policies, training outlines, and other documents as well as an interview with Lt. Anthony Bialek on December 8, 2009 provided a historical perspective on the EFD's approach to the low head dam issue. Lt. Bialek has been the team leader of the EFD Water Rescue Team since its inception in 1979. The interview lasted approximately one hour.

Lt. Bialek explained that prior to 1974, the department was not trained for rescues in the low head dam, instead focusing on the other types of water rescue. After the 1979 creation of the water rescue team, the department in 1983 purchased a water craft known as a "ResQDek". The ResQDek consisted of two inflatable rubber pontoons joined together by an aluminum platform, which together resembled the letter "H". The ResQDek was designed to allow firefighters to approach the face of the dam without capsizing as would a standard boat. At that time Elgin was believed to be one of only a few communities in the United States to have this type of water craft.

In the years since the purchase of the ResQDek in 1983, the department's approach to training and response for low head dam incidents has varied. For the first several years, personnel assigned to fire station #1 (where the ResQDek was housed) were trained for rescue attempts in the dam. Over the next several years, this practice gradually diminished and by the early 1990's the philosophy had changed to one of training the entire department to operate the ResQDek. This approach had varied success due to factors including focus on other types of

training, the logistics of training the entire department, and frequent training cancellations due to low water levels.

During the period of 1995 to 2000, there were renewed efforts towards preparation and training for low head dam rescue. This included the 1997 purchase of the next generation of the ResQDek, now called the ResQRaft, from a company in Calgary, Canada. At the time of the purchase, Elgin was the first community in the United States to purchase this water craft. From 2000 until 2009, the department continued its efforts to conduct annual training for all personnel on low head dam rescue, again meeting with mixed results. Also during this period of time additional support equipment for low head dam rescue was purchased.

Research question 3. What other strategies exist for reducing the hazard of the low head dam to the public?

Newspaper and magazine articles, press releases, personal communication, and interviews provided the information for answering this research question. The importance of public education and awareness is a common theme. A variety of public awareness materials were found in both print and electronically on the internet from organizations such as the IDNR, the United States Army Corps of Engineers, and the ACA. The websites for these groups as well as many other local, state, and national associations also included public education messages. The ACA publishes a “*Paddling 101*” handbook (ACA, n.d.) and the United States Canoe Association (USCA) publishes “*Welcome Paddler*” (USCA, n.d.) both of which include discussion of the dangers of low head dams. The Illinois Paddling Council has produced a low head dam safety video that is available for free download from their website (Illinois Paddling Council [IPC], n.d.). This video features a low head dam simulator that can be built for public

awareness purposes. The IDNR has both brochures and posters available for public awareness campaigns.

Another approach to protecting the public is the modification or elimination of low head dams. The non-profit organization American Rivers (1999) reports that this approach is being used in several states including Illinois, Ohio, Pennsylvania, Minnesota and California. These range from basic measures such as installing fencing to the more complex, including temporary and permanent modification. The primary form of temporary modification is the placement of large rocks downstream of the dam face. The intent is for these rocks to prevent or minimize the hydraulic at the dam.

Specific to the Kimball Street Dam the Illinois CDB report (2007,) outlined the following options and feasibility:

- Placement of boulders downstream (temporary modification) – feasible with cost of \$2,680,000 (Executive summary, p. ES-4)
- Full bypass channel – not feasible
- Riffle pool – not feasible
- In-stream by-pass – possible on the left bank of river with an estimated cost of \$1,430,000
- Dam face modification – feasible with an estimated cost of \$4,360,000 (Executive summary, p. ES-7)

The other permanent modification is the elimination of the dam. This has been done in many instances and American Rivers (2009, p. viii) report explains that 435 have been removed nation-wide since 1912. The removal of many of these dams is believed to have both ecological and economic benefits. Removing a dam is not without controversy and in some occasions has

met with public opposition. The reasons for this opposition include historical, sentimental, economic, or recreational. An excellent example of this is the Glen D. Palmer dam in Yorkville, Illinois where several fatalities have occurred. When it was proposed to eliminate the dam it met with considerable public opposition. The path eventually chosen was to modify the face of the dam as opposed to removal (IDNR, Office of Water Resources, 2003, p. iv). Dam removal is also not always feasible due to recreational uses, providing impounded water for water supply as is the case in Elgin, or due to being very expensive. The estimated cost to remove the Kimball Street Dam is \$3,290,000 (Illinois CDB, 2007, Executive summary, p. ES-5).

Another form of public awareness is the use of signage above and below a dam as well as on the shoreline. The Illinois CDB report (2007) provides recommendations for signage to alert both river users and persons on shore. Using guidelines from other state and federal agencies it provides guidance on design, size, and placement. Additional considerations such as community acceptance, property access, maintenance and cost are also important. Specific to the Kimball Street Dam it is estimated that additional signage would cost approximately \$92,000. This does not include the cost of maintenance or replacement. (Executive summary, p. ES-3).

On February 1, 2010 a phone interview was conducted with Mr. Rick Goesch, Chief of Engineering Studies for the IDNR. Mr. Goesch has had significant involvement in the IDNR's dam safety efforts. The interview lasted approximately forty-five minutes and included reviewing information from the Illinois CDB report. Mr. Goesch explained that specific to the state of Illinois, the 2007 signing of public act 95-0020 provided the IDNR with the authority to create guidelines for safety at Illinois' 32 publicly owned dams. In 2008-2009 the IDNR drafted administrative rules to establish exclusion zones above and below dams and establish specifications for signs and other warning devices.

As these proposed rules were submitted for public hearing there was considerable opposition from segments of the water sports community. The opposition believed that the creation of exclusion zones would essentially close many locations along the river from canoes, kayaks, and other watercraft. The opposition was successful and in 2009 the proposed rules were rejected. At the time of this research it has not been determined what the next steps will be in terms of administrative rules or funding for carrying out the provisions of the law. The state of Illinois 2010 budget includes line items for dam safety and dam removal projects but the funding has not yet been secured. Mr. Goesch indicated that IDNR is still working on being able to assist communities with the signage recommended in the report.

Research question 4. What other strategies exist for reducing the hazard of the low head dam to first responders?

Slim Ray's text *Swiftwater Rescue*, (1995) discusses critical differences between swiftwater and other types of water rescue. Key among these is that swiftwater is moving flowing water and those dynamics have a significant impact on water rescue. The importance of pre-planning is stressed as is knowledge and experience. In fact, these two factors are stated to be more important than equipment and gear.

Further guidance regarding training and response were found in two national standards from the NFPA. The first standard is NFPA 1006, *Standard for Technical Rescuer Professional Qualifications*. This standard establishes performance criteria for the various disciplines of technical rescue, including water rescue. Chapter 12 deals with swiftwater rescue and while not specifically addressing low head dams, it does include completing hazard assessments, water search, developing action plans, and rescue methods (NFPA, 2008).

The second standard is NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*. This standard focuses on the operational aspects of technical rescue and establishes different levels of response. Using the three operating levels of awareness, operations, and technician, Chapter 9 covers water rescue including a small section specific to swiftwater. This section also includes references to low head dams and hydraulics. NFPA 1670 also stresses the need for hazard and risk assessment, preplanning and the development of incident action plans for water rescue (NFPA, 2009).

In Illinois, the state agency with responsibility for the certification of fire personnel is the Illinois Office of the State Fire Marshal, Division of Personnel Standards and Education (OSFM). Building upon the NFPA 1006 and 1670 standards, OSFM has developed curriculums and certification programs for the three levels of the water rescue discipline. The first course, Technical Rescue Awareness, is an eight hour program designed to provide a basic awareness of six types of technical rescue, including water rescue. The second level of training is a 40 hour Water Operations program which includes a module on swiftwater rescue and provides basic information regarding low head dams. The third level is Swiftwater Technician certification which is awarded after completion of an OSFM approved course. This level of training includes two, 24 hour courses that incorporate training on low head dam rescue (M. Woodson, personal communication, February 19, 2010).

Two specific initiatives that in part resulted from this research and the research results should be noted. The first involved a change in the EFD's response to low head dam incidents. Concurrent with the gathering of information for the literature review for this ARP, two other factors were occurring. One was an increasing focus within the state of Illinois, MABAS Division II and the EFD Water Rescue Team on the topic of swiftwater rescue.

The other factor was the increasing difficulty in providing sufficient low head dam rescue training to all 136 members of the department.

As a result of these three factors and additional discussions, a department directive was issued in May 2009 ordering that only members of the Water Rescue Team would staff the ResQRAFT during a low head dam rescue attempt. The department's Water Rescue Team developed a training plan for the members of the team as well as training on non-entry, or operations level methods of rescue for the remaining members of the department. This training was conducted between May and July, 2009. Members of the Water Rescue Team also completed specific training on rescues involving entry into the low head dam.

The second initiative influenced by the research was a meeting with three neighboring communities to discuss an area-wide approach to low head dam planning and response. For many years as part of established mutual aid agreements, Elgin has been part of the response plan for low head dam incidents in the villages of Algonquin, Carpentersville, and South Elgin. In November, 2009 representatives of the three other fire departments and the author met to discuss opportunities to jointly address the low head dam issue. This included a review of references located during the research for this ARP. As of the completion date of this ARP these discussions are continuing and show great promise.

In summary, the research provided information that will be important in a complete evaluation using the Community Risk Reduction model. Strategies and resources were identified in the areas of planning, public awareness, and emergency response. This information will be presented to EFD and city personnel for possible implementation.

Discussion

Understanding the hazards presented by low head dams is critical for both the public and first responders. The research for this ARP illustrated that this is a nation-wide problem with a local focus. This was evidenced by the many local articles that were found describing incidents and fatalities at a particular dam or on a specific river. It was also shown that there is a lack of knowledge or lack of appreciation of the risks associated with low head dams by both the public and in some cases first responders. This is further indication for the need for fire departments to thoroughly assess any low head dams in their community. This thorough assessment should include a process such as the NFA's Community Risk Reduction model.

Specific to the Kimball Street Dam, the low head dam rating system found in the text *Swiftwater Rescue* (Ray, 1997, p. 224) provides an objective benchmark that can be used to assess the dam at different water levels.

The research found that the City of Elgin has taken some measures to further protect the public. The reconstruction work completed in 2000, including the installation of railings along the east shore of the river will aid in preventing someone from accidentally falling into the dam. The installation of warning signs upstream and use of buoys during the boating season are also of value.

Strategies for protecting the public can be placed in one of two categories; public awareness or engineering controls. The research identified several resources for public awareness programs at the national, state, and local level. Some of these resources are available in print, via the internet, or both. An item identified in several of the fatality reports was that the victim was not familiar with the local area. This may have led to an increased underestimation of the danger presented by the dam. This is consistent with the authors understanding that this

was a factor in some of the incidents that have occurred at the Kimball Street Dam. This factor of victims not being from the local area needs to be considered in any public awareness efforts planned by a particular community.

Temporary or permanent modifications to dams, including complete removal is becoming more common throughout the United States. A significant factor however is the associated costs of these efforts. The author found that specific to the Kimball Street Dam the estimated costs for some of the modifications that were judged feasible are in the millions of dollars. It was also confirmed that due to the reliance on the dam to provide sufficient depth for the city's water supply, that removal of the dam does not appear to be a feasible option.

There was considerable information found supporting dam removal efforts. Organizations such as American Rivers have produced several publications related to this topic. Local to Elgin, the organization Friends of the Fox was also found to support dam removal efforts. Equal in some cases to this support is the amount of opposition that has been created during some dam modification or removal efforts.

In identifying strategies to protect first responders, the NFPA standards and the OSFM certification programs provide a benchmark and roadmap for use in preparing personnel for swift water rescue. Both NFPA and OSFM indicate the need to provide more formal training at all three levels of awareness, operations, and technician. In addition strategies need to be devised to ensure that the required number of personnel at each training level can be assembled at an incident.

The author's interpretation of the research is that there is an opportunity for the city and the department to improve in the three areas of planning, public awareness, and emergency response. There are some immediate strategies that can possibly be implemented while others,

including using the Community Risk Reduction model to produce a thorough evaluation, will require additional time and resources.

As discussed earlier the City of Elgin and the EFD have initiated some efforts in regard to the low head dam. An opportunity exists now for a coordinated approach between the various city departments that are involved. The changes that have been made, in part due to the research for this ARP, need to be part of an overall assessment and plan for low head dam rescue. The work that has begun with three other communities may present some options for accomplishing this.

The results of this research project and implementing its recommendations will have organizational implications for the EFD. Two key implications or challenges will be time commitment and available financial resources. The time commitment to pursue the recommendations of this research will be considerable. Due to the current economic situation in Elgin, as well as the nation, there have been personnel reductions both within the department and the city. This has resulted in additional workload and responsibilities being placed on the remaining staff. What will be important is to identify strategies and recommendations that can be implemented without a significant time commitment. An example of this would be placing brochures on low head dam safety at public buildings that are adjacent to the river and the Kimball Street Dam. This would include City Hall, the Gail Borden Public Library, the Elgin Police Department, and Hemmens Auditorium.

The financial implications will also be significant. As mentioned previously, the current economic difficulty within the city has resulted in reductions in funds for training courses, overtime associated with training, and equipment purchases. In addition the implementation of strategies identified in the Illinois CDB report (2007), even the installation of additional signage,

would involve significant cost. At the time of completion of this ARP it is unknown what funding might become available at the state level as the state of Illinois is also experiencing severe financial difficulties. The challenge will necessitate working to identify strategies and recommendations that can be implemented at low or no cost. An example would be the use of the city's website to communicate public awareness information on the low head dam, especially during instances of high water levels. Another example would be exploring having additional signs made by the city's public works department. The work that has begun with three other communities may also provide an opportunity to obtain grants or participate in cost sharing.

Recommendations

This ARP provides strategies for the protection of both the public and first responders from the hazards of the low head dam. It also provides a foundation for future application of the Community Risk Reduction model. Several of the recommendations will require additional work in order to determine their feasibility. The immediate recommendation will be for the author to prepare a presentation for the department's senior staff and other members of the city's management team. This will provide an opportunity for other city departments to identify areas where they could contribute to the overall goal of protecting the public and first responders from the low head dam hazard. A second immediate recommendation will be to review this ARP with the representatives of the three other communities that are working with the EFD on the low head dam issue. These two immediate items will help in coordinating further collaboration with the city and with neighboring agencies.

The following additional recommendations are presented for the three areas of planning, public awareness, and emergency response:

Recommendations – planning

1. Complete a thorough assessment of the low head dam using the NFA’s Community Risk Reduction model
2. Continue working jointly with the Algonquin, Carpentersville, and South Elgin fire departments
3. Further evaluate the engineering options presented in the Illinois CDB report

Recommendations – public awareness

1. Utilize and fire department website for public awareness information, including during high water levels
2. Work with local media to publicize low head dam safety each Spring
3. Have public awareness materials available at city facilities, especially those adjacent to the Kimball Street Dam and the Fox River
4. Partner with local recreational water craft organizations and local river-focused organizations to assist in public awareness efforts
5. Evaluate options to increase signage at dam, including having signs in both English and Spanish and having signs made by the public works department

Recommendations – emergency response

1. Provide awareness level training to Elgin Police Department officers
2. Develop plan to train all department personnel to swiftwater awareness and/or operations level
3. Develop plan to train all Water Rescue Team members to swiftwater technician level

Future readers who seek to reduce the hazard from a low head dam in their community are encouraged to utilize the resources identified in this research project. A considerable amount of information on the topic of low head dam modification and removal is available from various organizations. There are also many sources of public awareness materials that can be obtained free or at minimal cost. Guidance in preparing department personnel and protecting their safety is available in the form of NFPA 1006 and NFPA 1670 as well as state-level water rescue curriculums. Researching, evaluating, and then implementing this information will assist other communities in preventing injuries or deaths at their low head dam.

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