PUBLIC SAFETY AND SECURITY AT DAMS ARE NOT MUTUALLY EXCLUSIVE

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ABSTRACT

Dams are a popular destination for fisherman, boaters, waders, thrill-seekers, and other visitors. An increase in public visitation creates an ever-greater potential for vandalism and crime, injury, and accidental death that can translate into costly litigation.

Public safety and site security need not be mutually exclusive. A joint approach to evaluating and addressing both concerns can maximize the return on a dam owner's investment. Solutions to address security can also be used for public safety. The steps and information needed to assess the risks associated with public safety and site security are also similar. Solutions to address both issues emphasize the need to provide public warnings, limiting public access to features that create dangerous conditions and/or are critical to the mission of the dam, and effectively monitoring unauthorized activity around the dam.

This paper presents concepts from the authors' experience, on an approach in conducting dam site assessments that address both site security and public safety at dams. An approach is presented for conducting a common site assessment that can be used to simultaneously evaluate security and public safety. Additionally, examples of mitigating strategies that could be used to minimize the risks associated with injury, accidental death, property damage, and related litigation are shown.

1. BACKGROUND

The traditional managerial structure of organizations is to have one department dedicated to safety and another department dedicated to security. In many instances, large organizations require a separation of responsibilities, and when applying this structure of management at a project site such as a dam, the two functions quickly become very disjointed. Without a well thought-out approach to site assessments, an organization's Safety Manager and Security Manager will likely be competing for the same piece of the operational funding pie. In many cases, public safety at dams assumes a secondary role and escapes the responsibility of the organization's Safety Manager, who may be more focused on worker and industrial safety. As a result, public safety is left in the hands of the project management or operational staff. In these cases, project management staff must "borrow" from their shrinking operational budget to allocate funds for public safety. This typical managerial structure used by many dam owners is very inefficient and a recipe for disaster in that operational demands and O&M costs can easily overshadow the needs for an effective public safety program.

As such, there is no unified response to this problem from the start of the design phase through construction and ultimately into operation. Funding for separate projects will be spread among different supervisors; there may be multiple funding requests for similar structures that were conceptualized and designed separately. In the extreme, a death could result that was easily preventable with proper planning.

"$1.8 Million Settlement reached in Deaths of Two Men due to court ruled negligent, careless, and intentional release of water without proper advanced warning." (August 10, 2012 NYInjuryLawBlog.com)

The lack of standards on Public Safety for Dams in the United States is not an excuse for addressing clear and present dangers created by the operation of dams and hydropower facilities. The focus over the past 14 years since the tragic events of 9/11 has shown an incredible focus on security at high hazard dams, but the fact of the matter is that a dam owner is more likely to face an accidental injury or death to the public than experience a tragic event caused maliciously by an outside terrorist organization. The intent of this paper is to bring the dam owner's focus back to what is more likely to occur (and addressing this higher probability event), while at the same time planning for the worst-case event that could potentially occur (either through complementary security features or through contingency planning). A balanced approach needs to be struck between the needs for public safety at dams and the need to protect the project assets through traditional security measures. These two requirements are not mutually exclusive, and with proper planning and coordination, they can be far more mutually supportive than is typically envisioned.

2. PUBLIC SAFETY AND SECURITY

Today, the Federal Energy Regulatory Commission (FERC) manages the adjudication of hydropower licenses for over 1300 utility organizations throughout the United States. Nearly every license contains recreational requirements placed on dam owners to provide adequate recreational use of the dam and hydropower facilities, including the reservoir and the surrounding project lands. These requirements may often funnel public access to the immediate areas near the dam and around potentially dangerous zones. The most common recreational activities include swimming, fishing, and boating activities. From a strict security prospective, these activities can be interpreted as both a pro and a con to the project security.

Pros: public access provides an opportunity for the public to monitor unusual activity and report it to the proper authorities. As well, the presence of "witnesses" to a potential crime, theft, or act of terrorism may serve as an active deterrent. In many cases, project personnel are occupied with other duties, either off site or near the site, and can become distracted from the activities of the public in and around the dam. The benefit of allowing public access is that the dam owner can utilize individuals who use the benefits of the project repeatedly and who have become familiar with others using the facilities. They are quick to identify an individual visiting for the first time, and they are eager to protect the facility that has become important to them.

Cons: a false sense of security could be created with an over-familiarity with public presence, where an adversary may blend within a crowd of innocent recreationalists. Large events could create a crowd mentality where no one reports and/or does nothing to stop the activity of a malicious individual. It also becomes increasingly difficult for dam site security personnel to monitor unusual activity in an area where the presence of the public is common.

Regardless of your views on public access, the public will often develop a sense of entitlement to enter the site, even if it is fenced off or is part of a restricted zone. Water activities are very attractive to people, regardless of the hazards they may present or the measures put in place by the facility owners to protect those people willing to enter. The approach we suggest is that the dam owner embrace the fact that the public will be present and tackle public safety and security as an integrated process. A balanced approach is possible.

2.1 Security Perspective

The fundamental purpose of security is to protect the critical assets at a site. In security, there is a concept called "Protection in Depth" or "Concentric Circle of Defence." Protection in Depth means that to accomplish a goal, an adversary must be required to avoid or defeat a number of protective devices in sequence. For example, an adversary might need to defeat one sensor and penetrate two separate barriers before gaining entry to a process control room or a filing cabinet containing sensitive data. The actions and amount of time required to penetrate each of these layers may not necessarily be equal, and the effectiveness of each layer may be quite different, but each will require a separate and

distinct act by the adversary moving along the path. The effect produced on the adversary is one of uncertainty due to the differing layers of layers of protection reducing their chances of successfully navigate the various security features (ASIS International). The ability to provide Protection in Depth includes identifying zones of concern within different perimeters. An exclusion zone is an area within a perimeter demarcation, such as a fence line or buoy system, that is defined to limit access; an exclusion zone can further be defined inside with restricted zones which are identified areas to be controlled with limited access to only a few permissible cleared individuals. The definition presented here provides identifying exclusion zones and then restricted zones where required within the exclusion zone.

2.2 Public Safety Perspective

The fundamental purpose of public safety is to protect the public, including trespassers, from dangerous situations and hazardous areas. With water retention structures such as dams and hydropower plants, hazardous zones are categorized as either a Danger Zone or a Warning Zone. The Danger Zone is the area of the dam where the hazard is likely to be realized if an individual is exposed to the hazard. In most cases, the Danger Zone is located within a Warning Zone. The Warning Zone is considered that area that is or can be influenced by the Danger Zone (Canadian Dam Association).

As an illustration of this concept, a spillway structure is within a Warning Zone whether the gates are opened or closed. The Danger Zone is the area downstream that is likely to become hazardous if the spillway is opened and water is released. The concept of zoning can additionally be applied upstream of the spillway.

Mutually Supportive: Using the two principles previously mentioned and blending them together, we can begin to see that various zones can be described lending further clarification for Warning Zones to also be described as exclusion zones from a security perspective. This area of exclusion within the defined perimeter of the Warning Zone can provide a buffer area where individuals that venture into this exclusion area do so either at their own risk and/or with a demonstrated intent to cause harm. The Danger Zone from a public safety perspective could be further defined from a security prospective as a restricted zone. Someone entering this zone provides clear demonstration of an intent to initiate malicious activity or to enter an area that may place them in physical harm. The hazard they are exposing themselves to in many cases also provides them access to vulnerable features of the dam creating a security risk. (Such as the spillway, intake structure, outlet works, and dam crest).

2.3 Unified Approach

The following steps provide a structural analytical approach to applying a unified site assessment of a dam site for public safety and security purposes.

2.3.1 Step 1 – Identify and cross reference the critical assets of the project site and hazardous areas.

Table 1 provides an example of how hazardous area information might be captured and defined for critical features and components of a dam. Note that hydrologic analysis in many cases will need to be conducted to determine the area impacted by the feature of the dam.

Table 1. Example of Defining Hazardous Zones

Critical Features of a Dam/Hydropower Plant	Hazardous Area
Spillway	Upstream 40 meters / downstream 100 meters of the Spillway
Hydropower Intake	Upstream 40 meters
Hydropower Outlet	Downstream 30 meters
Switchyard	20 meters around the switchyard (Restricted Area)

2.3.2 Step 2 – Further categorize and identify the hazardous areas as Danger and Warning Zones.

We next identify the Danger and Warning Zones. As an example, we will choose a typical spillway. The Danger Zone is 10 meters upstream and 50 meters downstream. The Warning Zone, however, is 40 meters upstream and 100 meters downstream of the structure.

2.3.3 Step 3 - Compare distance requirements provided by the hazardous zone classification with security detection/assessment and response time requirements.

Make adjustments to the zone classification distances if it is necessary to increase the distance of the Warning Zone area to provide additional response time for emergency or law enforcement responders depending upon how long one would expect them to arrive on site.

2.3.4 Step 4 - Assess current safety and security features in use (if any) and adjust / modify or enhanced these measures to address the newly defined distance hazard zone classification.

Using our same example of the spillway, above, we then make adjustments as necessary, such as:

- Boom currently in place needs to be moved further upstream to restrict access to the Danger Zone;
- Warning signs adjusted to provide early warning before the public enters a zone of impact (or entrapment) from the release of water from the spillway;
- Cameras (if present) need to be replaced and/or adjusted to provide full viewing coverage of the identified zones, with some detection capability integrated with video image to alert the dam operator or security personnel when the public approaches these hazardous zones.

The benefit of this systematic approach is that the dam owner is addressing the needs of both public safety and security at the same time, ensuring that the two programs (often thought of as two separate systems) are complementing each other.

3. MITIGATION APPROACH

The idea of mutually beneficial protective designs may seem like a new concept to the dam and hydropower industry, but the concept has been used for some time. Since 1971, crime prevention through environmental design (CPTED) is an approach to try and influence the behaviour of the public and direct their activities to certain approved areas. It is intended to deter bad behaviour and provide an environment to encourage conforming behaviour from the public. The term CPTED was first used by C. Ray Jeffery (*Crime Prevention through Environmental Design*). Later, Timothy Crowe used it in his book (*Crime Prevention Through Environmental*). The CPTED definition given here is used by the National Crime Prevention Institute and was enhanced by Randall Atlas (*21st Century Security and CPTED*)

3.1 Crime Prevention Through Environmental Design (CPTED)

3.1.1 Management Tools

CPTED is a set of management tools targeting the following (ASIS, *Protection of Assets*):

- Places. Physical environments (such as office buildings, parking garages, parks and public spaces, multifamily apartment buildings, warehouses, schools, houses of worship and shopping centres) designed to produce behavioural effects that reduce the opportunity for certain types of crime and the fear of those crimes;
- Behaviour. Some locations tend to create, promote, or allow criminal activity or unruly behaviour, while other environments elicit compliant and law-abiding conduct;
- Design and use of space. Redesigning a space or using it more effectively can encourage desirable behaviour and discourage crime and related undesirable conduct.

3.1.2 Measures

CPTED is consistent with the security mission of deterring, detecting, and delaying potential offenders, but also effecting public behaviour for the benefit of personal safety. The measures employed through CPTED include:

- Mechanical measures. Also referred to as target hardening, mechanical measures include physical security hardware and technology (such as locks, security screens on windows, fencing and gating, key control systems, intrusion detection, video surveillance, and barriers);
- Human and organizational measures. These include Community Watch, security officer patrols and posts, police officer patrols, and any person or group serving as a capable guardian with the ability to observe, report, and intervene;
- Natural measures. Natural CPTED measures include having a well-defined entrance and arranging work sites, staging areas, and assets for unobstructed lines of sight. Natural measures provide specific guidance for the use of space; examples include architectural landscaping, ditches, berms, bollards, planters, moats, and visibility-enhancing actions such as lighting and shrub and tree trimming. Even when supplied by mechanical equipment (lamps), lighting is classified as a natural surveillance component (ASIS, *Protection of Assets*).

Many of these measures are commonly employed at Dam and Hydropower project sites.

3.1.3 Concepts

The measures are applied with several concepts in mind:

- Natural access control. The idea is to employ both real and symbolic barriers—including doors, fences, and shrubbery—to define and limit access to a building or other space. For example, to deter theft/buglers from entering lower-story windows, one could plant dense, thorny bushes near the windows or install window locking devices or an alarm system;
- Natural surveillance. Increasing visibility by recreational public and casual observers increases the detection of trespassers or misconduct at a facility. For instance, if a high wooden fence blocks the view of a loading dock, the lack of visibility may actually invite thieves. Conversely, the use of chain-link fencing that allows an unobstructed view of the area by workers or passers-by may discourage thieves. Windows, door viewers, mirrors, and other design feature that improve visibility fall under natural surveillance;
- Natural territorial reinforcement. This is the process of establishing a sense of ownership, responsibility, and accountability in property owners, managers, or occupants to increase vigilance in identifying trespassers. For example, the use of small edging shrubbery along sidewalks marks the territory of individually-owned property and discourages trespassers from cutting through. Also, people pay more attention to and defend a particular space if they are provided psychological ownership of it. Territorial reinforcement measures, which may be physical or symbolic, tell people they are in a defined space. Colour, texture, surface variations, signage, and way-finding systems are all part of territoriality and boundary setting. Thus, it is possible, through real barriers (fences, booms, buoys, and walls) and symbolic markers (warning signage, low hedges, and low wood picket fences) to encourage tenants or employees to defend the property from individuals with undesirable intentions. Such reinforcement is termed natural because it results from normal, routine use of the environment.

3.1.4 Approach

In addition to the preceding classic principles, the following concepts are also considered through a CPTED approach:

- Management and maintenance. For spaces to look well-cared for and crime-free, they must be maintained. The “broken windows” theory (Kelling & Wilson, 1982) suggests that leaving broken windows or other decay markers (e.g., graffiti, trash, or abandoned furniture) unattended or unrepaired can lead to the impression of abandonment and increase crime opportunity, as no capable guardian is perceived or observed by the criminal. A parked car left too long with one broken window invites the breakage of additional windows. Maintenance of a building, including lighting, paint, signage, fencing, walkways, and the rapid repair of any broken items, is critical for demonstrating that someone cares about the building and is responsible for the upkeep, and by implication, for its security as well;
- Legitimate activity support. Some places are difficult to protect by the nature of their location or other geographic features. In such instances, legitimate activity support is essential. A “hot” fishing spot within a hazardous waterway below a dam might be eliminated if park rangers

(clearly known by the public to be responsible for keeping the area clear) place a substation in the area, or if maintenance staff persistently patrol (inspect) within view of the area of concern, providing legitimate activity support (ASIS, *Protection of Assets*).

The concepts of CPTED are essentially simple approaches to produce public behaviours that the dam owner would like to see occur, but also allow employees and security staff to quickly identify nonconforming behaviour demonstrated by the public.

3.2 Other Considerations

According to the Canadian Dam Association (CDA website), "…in Canada, more people have died in accidents around dam sites than from structural failure of dams. This is a matter of considerable concern to dam owners, who are seeking guidance on how they can meet their responsibilities to protect public safety." Also stated in the CDA website (Public Safety), "It is worth noting that large or high dams command a respect from members of the public that may be greater than that which exists for low structures. However, low head and small diversion dams can be equally or more hazardous, because many of the hazards associated with these structures are not readily apparent." This is similar to the experience in the United States. A statistic uncovered by research presented by Dr. Bruce Tschantz, professor emeritus of the University of Tennessee, is that during the past 30 years there have been more than four times as many fatalities from drowning at dams than there have been deaths resulting from dam failures (191 reported drownings at dams versus 40 deaths from dam failures) (Tschantz, 2011) . According to the Association of Dam Safety Officials website (Public Safety around Dams), "This year alone [2015], at least 25 people have drowned and at least 10 seriously injured in low-head dam incidents across the U.S." The victims include expert swimmers, rescue workers and other professionals equipped with state-of-the-art life-saving and rescue gear who were aware of the hazards but still succumbed to the lethal hydraulic forces. Low-head dams are often overlooked, especially with respect to public safety, and must be addressed to properly protect the public.

Although the mitigating strategies for improving site security and public safety presented herein are primarily focused on managing access to the site through effective exclusion and monitoring features and procedures, there are cases when structural modifications to the facility can completely eliminate the hazard. This is particularly true for the hazardous conditions at low-head dams and spillway outlets where the hazardous hydraulic roller that can develop can be eliminated by modifications to the downstream face of the dam. Reshaping the downstream face of dams has been one of the most commonly used modification alternatives to address the hazardous hydraulic roller. Details for this modification approach are described in another paper by the authors (Schweiger, 2011).

Effective signage is critical at dams to provide sufficient warning to the public. For further information on this topic, the reader is referred to the FERC report, "Safety Signage at Hydropower Projects, October 2001" (FERC website), and the CDA "Guidelines for Public Safety around Dams (2011)." In addition to guidance on signage, booms, and buoys, the CDA publication provides a managed system approach to public safety, a discussion of the public safety hazards associated with dams, a step-by-step risk assessment methodology and templates, and a description of typical risk treatment or control measures.

Enforcement goes a long way in ensuring that the public obeys signage and restricted zones. When word gets out to the local community that noticeable fines are being issued for trespassing, fewer people will be willing to assume that financial risk. If speeding tickets were never issued, would fewer people obey the posted speeds?

Many dam owners believe it is not cost-effective to expend large security expenditures for protection against a very low-probability terrorist attack. Considering the current threat conditions historically seen within the United States, this belief may possibly be justified. However, the dam owner is cautioned to use proper risk assessment methods to gauge the potential consequences against a level of acceptable risk, both to that of the dam owner and the community where the dam resides, to accurately determine what level of security is needed. However, the basics of security can be implemented and constructed relatively easily at any dam to address the real threat of public safety that confronts all dam owners. This is especially important when considering the needs for liability management. Security procedures and installations for higher-level threats, up to and including the highest threat level reasonably considered, can be planned on an "as needed basis" where phased hardware security additions, more stringent procedures and protocols, temporary closures and

barriers, temporary armed guard contracts, etc. can be added to the basic security features already used onsite to control the public. These actions should be well planned, easily initiated, and well documented in a dam facility site-specific security and public safety plan.

When addressing public safety, most dam owners immediately consider the obvious: spillway or generation (high flow) releases, falling hazards, and switchyard dangers. However, a prudent dam owner should also consider many other issues, such as:

- Fluctuating water levels (both on the reservoir and downstream of the dam);
- Strong currents and under toes;
- Submerged hydraulic jumps or “hydraulic rollers;”
- Strainers and excessive seepage paths that can trap swimmers;
- Open spillways which may not be visible from above the dam;
- Submerged hazards;
- Steep river banks with no exit;
- Improper siting and design of boat launches and portages;
- Winter ice (thin or dangerous reservoir ice and falling ice near structure overhangs);
- Rock-falls along appurtenant structures and access roads;
- Bridges, cables, and transmission lines (boat clearance and/or electrocution);
- Slippery surfaces at or near vertical drops and waterways (notably in high-mist areas);
- Improperly installed boat barriers (sags) that can entrap boats and swimmers due to high flow currents;
- Engineered (and signed) safe havens for the protection of employees and the public in the event of an active shooter or act of domestic violence occurring onsite or in an established recreational facility.

This paper provides a unified approach for two programs that share obvious similarities (namely those of public safety and facility security). It should be noted, however, that a third program should not be neglected; traditional dam safety concerns can also benefit through an integrated design of security and public safety features. Consider how security cameras can not only monitor for the presence of persons of malicious intent and trespassers entering hazardous areas, but that those same cameras can also be utilized for dam safety monitoring and verification of potential or impending dam failure, especially if tied into the monitoring program of identified potential failure modes. Roving patrols can combine efforts in monitoring for security, public safety, and dam safety inspections with a small amount of cross training. Obviously, one profession cannot become an expert in another field, but basic indicators of dam safety distress (unusual seepage, cracks or settlement) can be taught to security patrols. Similarly, dam safety inspectors and operators can be mindful of suspicious activity and public intrusions into hazardous areas. Consider combing frequent operational maintenance checks to include both public safety and security checks, as well as dam safety. In this way, one series of hardware installations, or scheduled patrols, can monitor for three separate programs, thus reducing onsite operational costs.

4. SUMMARY

The approach to managing these two (or possibly three) programs should be considered as complementing programs that provide mutual support from a public safety, security, and perhaps dam safety, perspective. A common assessment approach, assessing public safety needs, dam safety needs, and security needs will provide for a simultaneous optimum design, resulting in one design package rather than multiple ones. Consider mitigation strategies that work to minimize or eliminate risks associated with injury, loss of life, and property damage as well as protecting against a low-probability adversary.

There are many challenges faced by dam owners today regarding public access, public safety, and facility security needs. But the advantage of approaching public safety and security as a unified process is that these programs can complement each other, and that design and construction costs can be combined, and ideally be done only once. The project will be safer for the public and the final design will result in a system that allows dam operators and personnel to more easily and efficiently monitor the activities occurring at and near the site. The result is that the system enables the operations staff to better assess and respond to developing hazardous situations either caused by public negligence, thrill-seekers, criminals and vandals, or by a deliberate malicious attack.

5. REFERENCES

ASIS International, *Protection of Assets*, Alexandria, Virginia, USA; Section 2.1.1

Atlas, Randall (2008) *21st Century Security and CPTED* (Boca Raton, FL: Taylor & Francis Publisher)

Canadian Dam Association, Public Safety Around Dams Workshop 2015.

Crowe, Timothy (1991) *Crime Prevention Through Environmental Design* (Boston: Butterworth-Heinemann,).

Jeffery, Ray (1971) *Crime Prevention through Environmental Design* (Thousand Oaks, CA: Sage Publications, Inc.).

Tschantz, BA, & Wright, KR (2011), *Hidden Dangers and Public Safety at Low Head Dams*, Journal of Dam Safety, ASDSO, Vol. 9, Issue 1

Schweiger, Paul G (2011), *Saving Lives while Improving Fish Passage at Killer Dams*, Journal of Dam Safety, ASDSO, Vol. 9, Issue 2

Kelling, George L. & Wilson, James Q (1982), *Broken Windows*, The Atlantic Online, March, 1982 http://www.theatlantic.com/doc/print/198203/broken-windows.