

Office of the State Auditor State of Colorado

Performance Evaluation of the Dam Safety Program

Division of Water Resources
Department of Natural Resources

February 2014

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February 25, 2014

Members of the Legislative Audit Committee:

This report contains the results of a performance evaluation of the Dam Safety Program, Division of Water Resources, Department of Natural Resources. The evaluation was conducted pursuant to Section 2-3-103, C.R.S., which authorizes the State Auditor to conduct audits of all departments, institutions, and agencies of state government. The report presents our findings, conclusions, and recommendations, and the responses of the Division of Water Resources.

Sincerely,

A handwritten signature in blue ink that reads 'Fred Brousseau'. The signature is written in a cursive, flowing style.

Fred Brousseau
Project Manager

Table of Contents

1.	Overview of Dam Safety in Colorado	5
2.	Dam Safety Operations	10
	Safety Inspection of High Hazard Dams	10
	Reclassification of Dam Hazard Ratings	22
	Emergency Action Plan Deficiencies	28
	Enforcement Measures.....	38
	Design Review Application Processing Time	45
	Design Review Fees.....	52

DAM SAFETY PROGRAM, DIVISION OF WATER RESOURCES

Performance Evaluation, February 2014

Report Highlights

Division of Water Resources
Department of Natural Resources

PURPOSE

Evaluate the Division's oversight of dam safety in Colorado.

BACKGROUND

- Dams are classified according to the risk posed if they fail. The classifications are high hazard if failure could cause loss of human life, significant hazard if failure could cause significant property damage and low or no public hazard.
- The Division oversees just over 1,800 non-federally owned dams and focuses its regulatory activities on larger and higher hazard dams.
- One of the Division's key responsibilities is to conduct safety inspections of dams and identify actions needed to improve the safe operation of dams and minimize risk. The Division determines how often dams should be inspected based on their hazard classification.
- The Division collects and reviews Emergency Action Plans (EAPs) created by dam owners. EAPs provide critical information for managing dam emergencies, including contact information for those responsible for responding in a dam emergency and those likely to be affected, as well as maps of the streams that would be flooded if the dam failed.
- The Division is responsible for approving plans prior to construction or modification of a dam and approving final construction projects on dams.

OUR RECOMMENDATIONS

- Strengthen processes to ensure that dams are inspected timely and inspection reports are complete.
- Ensure that dam hazard reclassifications are conducted timely.
- Strengthen emergency action planning.
- Seek methods to improve dam owner compliance with statutes and laws.
- Improve the timeliness of design reviews.

The Division agrees with these recommendations.

EVALUATION CONCERN

The Division needs to strengthen controls and enforcement options to further ensure the safe operation of dams in Colorado.

KEY FACTS AND FINDINGS

- Some high hazard dams are not inspected in strict compliance with the Division's annual inspection cycle. For example, 12 dams were more than 6 months past their inspection due dates. Regular inspections help ensure dams are operating safely and identify when a dam's water level should be restricted for safe operation.
- Some hazard reclassification reviews are not conducted timely. Dams' hazard levels need to be reclassified due to changes in their conditions, such as new downstream development. The eight dams reclassified by the Division between November 1, 2012 and October 31, 2013 took a median of 20 months, and one dam took more than 14 years, to be reviewed. Timely reclassifications are important because the frequency of safety inspections and certain dam safety requirements are based on the classification. Delays in reclassifying dams to a higher hazard class could pose a risk to public safety.
- Some dam Emergency Action Plans (EAPs) are not on file with the Division, some are incomplete, and some do not appear to have been updated and tested as required. We found at least 29 of the 686 EAPs that should be filed with the Division were not; 84 percent of the 79 EAPs reviewed were missing at least one important component, such as lists of people and structures at risk in an emergency; and the average age of EAPs on file was 7.5 years, indicating the EAPs were not current. EAPs are intended to provide a basis for the Division to help direct operations in case of a dam emergency.
- The Division lacks efficient mechanisms to motivate dam owners to comply with dam safety rules and statutes. The Division can only charge fines through court proceedings and cannot charge for the additional inspections it conducts when dam reservoir levels are restricted. Our evaluation found some ongoing violations of rules and statutes, such as owners failing to maintain their dams in a timely fashion or conduct certain inspections for which they are responsible.
- There are delays sometimes in the Division's review and approval of dam owners' plans for dam construction, modifications or repairs, and final construction. For example, approximately 29 percent of the plans the Division reviewed between November 1, 2011 and October 31, 2012 took more than nine months to approve.

RECOMMENDATION LOCATOR

Agency Addressed: Department of Natural Resources, Division of Water Resources

Rec. No.	Page No.	Recommendation Summary	Agency Response	Implementation Date
1	20	Strengthen processes to ensure that dams are inspected timely and inspection reports are complete by: (a) implementing mechanisms to track the time required to inspect dams and conduct other work, periodically analyzing time tracking data, and adjusting workload assignments as needed; (b) establishing benchmarks or goals for completing at least high-hazard inspections timely and monitoring against the goals throughout the year; (c) requiring staff to send the Division signed copies of Engineer Inspection Reports and increase the number of reports reviewed by Division management; and (d) modifying the Engineering Inspection Report to include a section to note issues from previous reports.	a. Agree b. Agree c. Agree d. Agree	a. June 30, 2015 b. June 1, 2014 c. June 1, 2014 d. June 30, 2015
2	27	Ensure that dam hazard reclassifications are conducted timely by: (a) developing clear policies that define how quickly reclassification reviews must be completed after a need is first identified; (b) developing and monitoring a centralized system that captures key information on hazard reclassifications including which dams need reclassification reviews, when the need was determined, and other key data; and (c) reallocating reclassification reviews among staff when there are significant backlogs in completing reviews.	a. Agree b. Agree c. Agree	a. Sept. 30, 2014 b. June 30, 2015 c. June 30, 2015

RECOMMENDATION LOCATOR

Agency Addressed: Department of Natural Resources, Division of Water Resources

Rec. No.	Page No.	Recommendation Summary	Agency Response	Implementation Date
3	36	Strengthen Emergency Action Planning (EAP) by: (a) implementing procedures to periodically review the DAMS database to identify dams without EAPs and reconcile DAMS with hard copy EAPs; (b) reviewing all EAPs as part of dam safety inspections to ensure EAPs are on file, complete, and current and follow up with dam owners on any missing, outdated, or incomplete EAPs; (c) implementing a process to regularly report the number of dams for which complete and current EAPs are on file; and (d) implementing additional methods to help ensure that dam owners conduct reviews and testing of their EAPs as required by regulations.	a. Agree b. Agree c. Agree d. Agree	a. Sept. 30, 2014 b. Sept. 30, 2014 c. Sept. 30, 2014 d. Sept. 30, 2014
4	44	Improve enforcement by: (a) evaluating options, including penalties such as direct fining authority and incentives, to motivate dam owners to address violations of dam safety statutes and rules; (b) evaluating the feasibility of statutory changes to allow the Division to charge fees for inspections of restricted dams that are outside the routine inspection schedule; and (c) reporting to the Legislative Audit Committee and the Water Resources Review Committee by December 31, 2014 on options to improve dam owner compliance and pursue statutory changes related to sanctions, incentives, and fees for inspections of restricted dams as appropriate.	a. Agree b. Agree c. Agree	a. December 31, 2014 b. December 31, 2014 c. December 31, 2014

RECOMMENDATION LOCATOR

Agency Addressed: Department of Natural Resources, Division of Water Resources

Rec. No.	Page No.	Recommendation Summary	Agency Response	Implementation Date
5	50	Improve the timely review and approval of dam construction, alteration, and repair plans and of final construction by (a) establishing specific timeliness goals for each step in the Division's design review process; (b) tracking the time it takes Division staff to complete each step in the design review and construction approval processes and using the results to identify solutions to delays that occur within the Division; (c) considering the use of formal pre-application meetings to help dam owners prepare plans that meet the Division's requirements; and (d) tracking causes of delays in final project approvals and taking corrective actions to expedite the approval processes.	a. Agree b. Agree c. Agree d. Agree	a. Sept. 30, 2014 b. June 30, 2015 c. June 1, 2014 d. June 1, 2014
6	56	Evaluate the adequacy of the fees charged for design review including: (a) conducting a cost-benefit analysis of providing design reviews for new dams and modifications to existing dams compared with current fee revenue and determining the appropriateness of statutory changes in the fees; and (b) reporting to the Legislative Audit Committee and the Water Resources Review Committee by December 31, 2014 on the results of the analysis and working with the General Assembly as appropriate on statutory changes to the fees.	a. Agree b. Agree	a. December 31, 2014 b. December 31, 2014

Overview of Dam Safety in Colorado

Chapter 1

Statutory Authority and Program Mission

The Dam Safety Branch, which is responsible for the dam safety functions in the State that are stipulated in Sections 37-87-101 through 37-87-125, C.R.S., is located within the Colorado Department of Natural Resources, Division of Water Resources (Division). The State Engineer, as the director of the Division, is responsible for overseeing the Dam Safety Branch. The Dam Safety Branch's mission is to prevent the loss of life and property damage, determine the safe storage levels of reservoirs, and protect the state's water supplies from the failure of dams through the effective and efficient use of available resources.

The federal government owns and operates some dams in Colorado. The Division has oversight of the more than 1,800 non-federally owned dams in the State and does not carry out any dam safety functions for federal dams. The Division focuses its regulatory activities on dams that are referred to as jurisdictional size dams. Jurisdictional size dams are those that create a reservoir with a capacity of more than 100 acre-feet, have a surface area in excess of 20 acres at the high-water line, or exceed 10 feet in height, according to 2 CCR 402.1, Rule 4.2.5.

All dams are assigned to one of the Division's four hazard classifications shown in Table 1.

High Hazard	Loss of human life is expected to result from failure of the dam. Designated recreational sites located downstream within the bounds of possible inundation should also be evaluated for potential loss of human life.
Significant	Significant damage, but no loss of human life, is expected from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, or public or private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.
Low	Neither loss of human life nor significant damage to structures and public facilities as defined for "Significant Hazard" dams is expected to result from failure of the dam.
No Public Hazard	No loss of human life and damage only to the dam owner's property is expected from failure of the dam.

As indicated in the definition of each classification, these hazard levels are based on the potential damage that would be caused by a failure of the dam, not on the condition of the dam. For example, a dam could be in perfect structural condition, but it would receive a high hazard rating if the downstream environment includes populated areas in which loss of human life would likely result from a breach of the dam.

Table 2 below shows the number of non-federally owned jurisdictional dams in Colorado in Water Years 2010, 2012 and 2013. The water year begins on November 1 and ends on October 31 so Water Year 2013 ran from November 1, 2012 through October 31, 2013. Water Year 2011 was not included because the Division did not produce an annual report for that year and its database of dam inspections does not retain historical information that would allow the Division to provide us with the number of dams under the Division's jurisdiction in Water Year 2011. The number of jurisdictional dams within the Division's purview fluctuates somewhat on a year to year basis due to a number of factors, including the construction of new dams, the breach or abandonment of existing dams, or the modification to the height (i.e., size) of existing dams resulting in their reclassification as a non-jurisdictional dam.

Table 2: Number of Dams Under the Division's Jurisdiction			
Hazard Classification	WY 2010	WY 2012	WY 2013
High	318	332	331
Significant	303	320	303
Low	981	973	973
No Public Hazard	217	226	210
Total	1,819	1,851	1,817
Source: Dam Safety Branch database as of June 29, 2013 and Dam Safety Branch's <i>State Engineer's 26th and 27th Annual Report on Dam Safety</i> .			

Key Responsibilities and Functions

The Division works to fulfill its dam safety mission by conducting two primary functions: (1) reviewing and approving designs for new dams and modifications of existing dams, and (2) periodically inspecting and analyzing dam conditions, including dam owners' emergency planning.

Design Review. In accordance with Section 37-87-105, C.R.S., which requires that the State Engineer approve plans prior to construction or modification of a dam, the Division reviews and approves the design and construction documents for the construction, alteration, modification, or repair of reservoirs or dams. In accordance with Section 37-80-110, C.R.S., the Division collects a fee for each design review ranging from \$100 to \$3,000. According to information from the Division's DAMS database, which contains information about all dams under the Division's jurisdiction, the Division approves roughly 50 to 60 design plans and roughly 40 to 60 construction projects each year.

Safety Inspections. To ensure the safety of the water storage levels, Section 37-87-107, C.R.S., requires that safety inspections be conducted of all dams under the jurisdiction of the Division at a frequency deemed necessary by the State Engineer. Inspections include review of previous inspection reports and site inspection of the dam and associated structures and systems. For each dam inspection, the Division produces an Engineer's Inspection Report which summarizes findings, rates the overall condition of the dam, and identifies any actions that must be taken to improve the safety of the dam. Inspections also include an assessment of the Emergency Action Plan (EAP) for the dam. The Division conducts an average of about 530 dam inspections each year.

One of the following three condition ratings is applied to all dams based on the inspections:

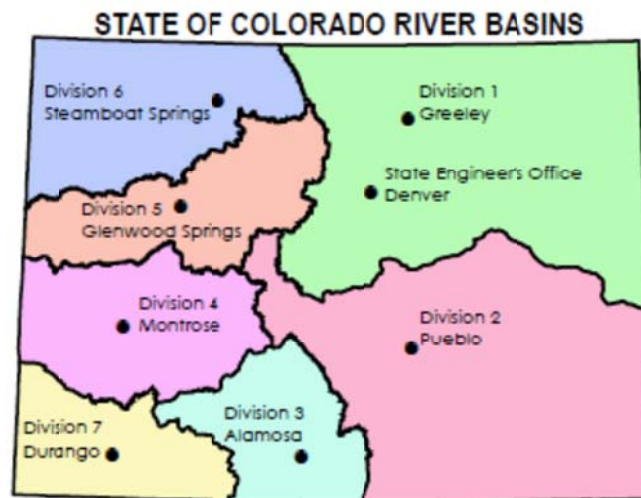
- **Satisfactory** – The safety inspection indicates no conditions that appear to threaten the safety of the dam, and the dam is expected to perform satisfactorily under all design loading conditions. Most of the required monitoring is being performed.
- **Conditionally Satisfactory** – The safety inspection indicates symptoms of structural distress (seepage, evidence of minor displacements, etc.), which, if conditions worsen, could lead to the failure of the dam. Essential monitoring, inspection, and maintenance must be performed as a requirement for continued full storage in the reservoir.
- **Unsatisfactory** – The safety inspection indicates definite signs of structural distress (excessive seepage, cracks, slides, sinkholes, severe deterioration, etc.), which could lead to the failure of the dam if the reservoir is used to full capacity. The dam is judged unsafe for full storage of water.

The Division restricts the water level behind a dam that is deemed unsatisfactory and can seek fines through district court if an owner fails to comply with dam safety laws, regulations, or restriction orders.

Dam Safety Resources

The Division carries out its dam safety duties with a staff of professional engineers located throughout the State. The Division has been allocated 12 full-time equivalent (FTE) positions, all of which are professional engineers. Figure 1 below shows the location of the State Engineer's Office in Denver and the Division's field offices, where most staff are located.

Figure 1



Source: Colorado Division of Water Resources.

The Division's funding for dam safety has averaged about \$1.5 million per year over Fiscal Years 2011 through 2013. General Fund revenues represent about 86 percent of the total funding for the Division's dam safety activities. In addition to state general funds, the Division receives funding from the Federal Emergency Management Agency (FEMA) National Dam Safety Program of about \$163,000 each year, which is used primarily to fund grants to owners of high and significant hazard dams to update their emergency action plans and inundation maps. The Division also collects fees for conducting design reviews, which average about \$44,000 each year.

In September 2013 some areas of the state experienced record rainfall, placing strain on some of Colorado's dams and leading to damage and failure in some cases. According to the Division, 27 dams under its jurisdiction were damaged by the rainfall and related flooding, including 11 high and significant hazard and 16 low hazard dams. The Division indicated that dams sustained damages such as cracking, erosion, and accumulation of debris, and some overflowed as water levels rose above their crests. The Division reported that none of the high or significant hazard dams – those likely to cause loss of human life or significant property damage – failed,

although 9 low hazard dams did breach, contributing to the flooding. The Division roughly estimates that about \$5 million will be needed to make repairs to damaged dams. As a result of the heavy rainfall and flooding, the Division reports it conducted 207 emergency inspections, issued orders to restrict (lower) water levels, and otherwise monitored the condition of threatened dams during and after the rainfall. The Division reports that oversight of dams affected by the flooding continues.

Evaluation Scope

The Office of the State Auditor contracted with Harvey M. Rose Associates, LLC, to complete this evaluation of the State's dam safety program. The evaluation included assessing the Division of Water Resources' policies and processes for:

- Conducting dam safety inspections in accordance with the schedule established by the State Engineer.
- Ensuring dams are properly classified according to their hazard risk.
- Ensuring dam owners maintain complete and current Emergency Action Plans for their dams.
- Implementing sanctions for non-compliance with dam safety laws and regulations.
- Reviewing and approving dam construction, alteration, and repair plans and completed projects.

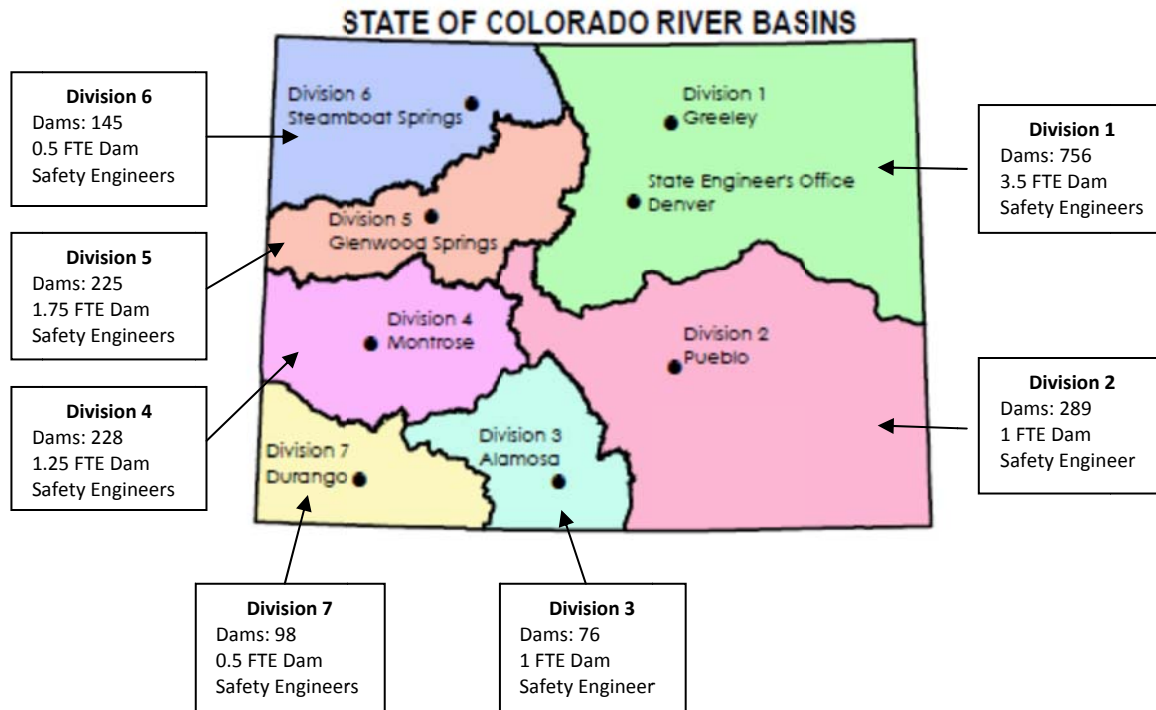
Dam Safety Operations

Chapter 2

As described in Chapter 1, the Division of Water Resources (Division) has two main responsibilities with respect to dam safety in the State: (1) reviewing and approving designs for new dams and modifications of existing dams and (2) conducting inspections of dam conditions and emergency planning. Our evaluation reviewed the Division's key processes with respect to these responsibilities, including conducting inspections, determining hazard classifications, ensuring dams have complete and current Emergency Action Plans (EAPs), and reviewing dam construction, alteration, and repair design plans. Our evaluation identified ways in which the Division could make improvements in these areas, as discussed in this chapter.

Safety Inspection of High Hazard Dams

As discussed in Chapter 1, one of the Division's main responsibilities is to inspect dams to ensure they are maintained and operated in a safe manner. The Division's ten Dam Safety Engineers (9.5 FTEs as one Dam Safety Engineer allocates half of his time to the Design Review function) are dispersed throughout the State among seven Water Divisions. Dam Safety Engineers are responsible for inspecting their assigned dams at a frequency determined by the State Engineer, in accordance with Section 37-87-107, C.R.S., and typically conduct between 500 and 600 dam safety inspections each year. The number and distribution of dams and hazard classifications in each Dam Safety Engineer's region varies based in part on weather conditions and topography, making some inspections more complicated than others. For example, the dams east of the continental divide are easier to access because the terrain is less mountainous and the weather typically permits access year round. Therefore, the Dam Safety Engineers in the eastern divisions are, on average, assigned more dams to inspect than the engineers on the Western Slope, which is more mountainous and has limited seasonal access based on the weather. The number of dams each Dam Safety Engineer is responsible for inspecting ranges from 77 (for the half-time Dam Safety Engineer) to 207.

Figure 2: Allocation of Dams and Dam Safety Engineers by Water Division

Dam Safety Engineers document their dam safety inspections using a standardized form referred to as the Engineer's Inspection Report that guides their routine inspections to ensure that all of the structures that are pertinent to the safety of the dam are inspected. The last page of the inspection report calls for the Dam Safety Engineers to report: (1) the overall condition of the dam, (2) items requiring action by the owner to improve the safety of the dam, (3) the recommended safe water storage level based on the dam's overall condition, and (4) a signature line for the Dam Safety Engineer and the dam owner.

Following their inspections, Dam Safety Engineers keep an electronic copy of the Engineer's Inspection Report and a hard-copy for the dam's paper file. The Dam Safety Engineers either email or mail a copy of the Engineer's Inspection Report to the dam owner, directing them to return a signed copy to the Dam Safety Engineer to keep on record.

What evaluation work was performed and what was the purpose?

The purpose of the evaluation work was to determine: 1) whether the Division is ensuring that high hazard dam safety inspections are being conducted in accordance with the inspection frequency determined by the State Engineer pursuant to Colorado statute (Section 37-87-107, C.R.S.), and 2) whether the inspection reports

documented that required inspection elements were covered in the inspection. This evaluation's focus was on high hazard dams as they put human life at risk in the event of failure; whereas loss of life is not expected if a significant hazard or low hazard dam fails. The *State Engineer's 27th Annual Report on Dam Safety to the Colorado General Assembly Water Years 2010-11 and 2011-12* states that regular inspections are the most effective way to prevent dam failure and should be each Dam Safety Engineer's highest priority.

Evaluation work consisted of a review of a random sample of 32 high hazard dam Engineer's Inspection Reports selected from the 230 high hazard dams inspected in Water Year 2012, which ran from November 1, 2011 to October 31, 2012. We also reviewed inspection dates for all high hazard dams inspected in Water Year 2012 that had risk-based scores indicating they should be inspected that year.

How Were the Results of the Evaluation Work Measured?

Inspection Frequency: We applied the following criteria to our evaluation of the timeliness of the inspections of high hazard dams that took place in Water Year 2012.

- **Dam Safety Branch Policy Memorandum 01-2008: Risk-based Approach to Inspection Frequency:** The State Engineer instituted a pilot program in 2008 that utilized a risk-based approach to determine the inspection frequency of high and significant hazard dams. The Dam Safety Engineers used a software tool developed by the U.S. Bureau of Reclamation, tailored to meet the needs of the Division, to determine a risk-based score for every dam which considered each dam's design, construction, monitoring results, and performance. The risk-based score was then used to determine how often Dam Safety Engineers needed to inspect each dam. Under this policy, dams were required to be inspected as follows:

Risk-Based Score	High Hazard Dams	Significant Hazard Dams	Low Hazard Dams	Restricted Dams (All Hazard Classifications)
>135	Each Year	Each Year	Every Six Years	Each Year
76 to 135	Each Year	Every Two Years	Every Six Years	Each Year
51 to 75	Every Two Years	Every Three Years	Every Six Years	Each Year
0 to 50	Every Three Years	Every Three Years	Every Six Years	Each Year

Source: Department of Natural Resources, Dam Safety Branch Policy Memorandum 01-2008.

We reviewed inspection records for all high hazard dams that were inspected in Water Year 2012 to determine if those dams were inspected consistent with their risk based inspection frequency rating. We also reviewed a sample of 32 inspection files to determine if the inspection reports documented that the inspections had covered the following requirements and guidance:

- **Section 37-87-107, C.R.S.**, requires that inspection activities include, but are not limited to: 1) a review of previous inspections, reports, and drawings, and 2) site inspections of the dams, spillways, outlet facilities, seepage control and measurement systems, and various monitoring devices that measure the performance of the dam. The Federal Emergency Management Agency (FEMA) and the Association of State Dam Safety Officials' (ASDSOs') *The National Dam Safety Program: Model State Dam Safety Program (2007)* recommends that inspection reports should include findings, recommendations, and proposed actions. We reviewed the full Engineer's Inspection Reports for evidence that all these inspection activities had been completed for each inspection. For example, we reviewed to determine whether the Engineer's Inspection Reports documented that the Dam Safety Engineer had reviewed previous inspections.
- **2 CCR 402-1, Rule 15.1 "Outlet Inspection"** requires owners of high and significant hazard dams to conduct a specific type of inspection of their dam outlet facilities which includes the dam's conduits, wells, access ways, and outlet valves at least once every 10 years and submit a written report of the inspection to the State Engineer. The Engineer's Inspection Report form completed by the Division's engineers has a specific area to note the date of the last outlet inspection conducted by the dam owner. We reviewed the sample of Engineer's Inspection Reports to determine when the last outlet inspection was done on each dam. For those dams that had not undergone an

outlet inspection within the last 10 years, we also reviewed whether the Dam Safety Engineer had noted that such an inspection was needed. The Engineer's Inspection Reports contain a section where Dam Safety Engineers document actions that need to be taken by the dam owner to improve the safety of the dam.

- **Division policy** requires that Dam Safety Engineers discuss their inspection findings with the dam owner and ask the owner (or representative) to sign the Engineer's Inspection Report at the time of the discussion. The policy notes that obtaining the owner's signature serves two purposes: (1) To motivate the owner to complete the necessary maintenance before the next inspection; and (2) To demonstrate the Division's attempt to communicate inspection concerns to the owner in the event the dam fails and there are liability issues.

We also obtained information on other state policies and procedures including those from California, Nevada, Oregon, Utah, and Montana to identify dam safety inspection workload and monitoring practices that might serve as models for Colorado's program.

What problem did the performance evaluation work identify?

We identified problems in two areas:

Some Dams Were Not Inspected Timely

We obtained data from the Division on all high hazard dam inspections that occurred in Water Year 2012 and the most recent inspection date prior to the Water Year 2012 inspection to determine whether the Division was in compliance with the risk-based inspection schedule. According to the Division's dam inspection database, the Division had not assigned a risk-based score to 17 of the 230 high hazard dams and therefore had not established an inspection schedule for those dams. As a result, we analyzed inspection frequency data for only the remaining 213 dams that had been assigned an inspection schedule.

We initially evaluated whether dams were inspected in strict compliance with the inspection schedule, in other words, whether dams on the annual inspection schedule were inspected within 12 months of the prior inspection, whether those on the every-two-years schedule were inspected within 24 months of the prior inspection, and whether those on the every-three-years schedule were inspected within 36 months of the prior inspection. As shown in Table 4, we found that 72 of the 213 inspections that took place in Water Year 2012 (34 percent) were not in strict compliance with the risk based inspection frequency schedule.

After we had conducted our analysis, the Division reported that the inspection frequency schedule is not intended to be an exact 12, 24, or 36 month cycle but that the inspection is supposed to occur at some point during the inspection season of the year the inspection is due. For example, an inspection of a dam may be conducted in May of one year to observe the dam in a full reservoir condition and the Division may schedule the next year’s inspection in August to see how the dam is performing at a different time in its yearly cycle which may mean 15-18 months between inspections. Therefore, we identified the number of dams at each inspection frequency that were inspected more than 6 months after their strict inspection date, as also shown in Table 4. The Division reports that Dam Safety Engineers are expected to use their professional judgment when determining which dams to inspect in the event that all dams cannot be inspected in a given inspection cycle.

Table 4: Strict Compliance¹ with Risked Based Dam Inspection Schedule for High Hazard Dam Inspections Completed in Water Year 2012				
Scheduled Inspection Frequency Based on Risk	Number of High Hazard Dams Inspected in WY 2012	Number Inspected in Strict Compliance with Frequency Schedule	Number and Percent Not Inspected in Strict Compliance with Frequency Schedule	Number and Percent Not Inspected Within 6 Months of the Strict Inspection Schedule
Every Year	112	62	50 (45%)	6 (5%)
Every Two Years	43	37	6 (14%)	2 (5%)
Every Three Years	58	42	16 (28%)	4 (7%)
Total	213	141	72 (34%)	12 (6%)
Source: Harvey M. Rose Associates, LLC’s analysis of data provided by the Division. ¹ We evaluated “strict” compliance with the inspection schedule by evaluating whether dams on an annual inspection schedule were inspected within 12 months of the prior inspection, whether those on an every-two-years schedule were inspected within 24 months of the prior inspection, and whether those on an every-three-years schedule were inspected within 36 months of the prior inspection.				

Given the Division’s intent to observe dams during different times of the inspection season, we still found 12 (6 percent) dams that were over six months past their inspection due date. Six of those 12 dams were one year or more past the inspection due date.

In addition to the evaluation of the 213 dam inspections that occurred in Water Year 2012 shown in Table 4, we reviewed all 332 high hazard dams under the Division’s jurisdiction in Water Year 2012 (see Table 2) to determine how many dams were not

inspected that should have been. According to the dams' risk-based scores and previous inspection dates, we found 27 high hazard dams that should have been inspected in Water Year 2012, but were not. 77 percent of these 27 dams, or 21 dams that should have been inspected in Water Year 2012 but were not, were high risk dams (dams with a risk based score of 76 or higher that were supposed to be inspected annually). The others were on a two- or three-year inspection cycle due to their having lower risk scores but Water Year 2012 was the year they were due for an inspection according to their inspection frequency cycles. Moreover, 25 of the 27 high hazard dams that should have been inspected, or 92 percent, were out of compliance with the inspection schedule by more than 6 months.

While the Division applied the risk based approach to determine inspection frequency during the majority of the period we reviewed, the Division changed its inspection approach beginning in July 2013 to a fixed schedule consisting of annual inspections for high hazard dams and dams on restriction, inspections every two years for significant hazard dams and an inspection every six years for low hazard dams ("1-2-6" schedule).

Documentation of Dam Safety Engineer Inspections Is Not Always Complete

We identified three areas where the Division could improve its documentation of the inspections completed by the Dam Safety Engineers:

- **Some Engineer Inspection Reports may be missing owner signatures.** Dam Safety Engineers are required to obtain the dam owner's signature on the Engineer's Inspection Reports to serve as evidence that the dam owners received the report and are aware of any required actions they should take to improve the safety of the dam and for which they will be held accountable. The signatures are important to protect the Division in the event that a dam fails and serves as the basis for enforcement action if the dam owner fails to comply with the required safety improvements. In the sample of 32 Engineer's Inspection Reports we reviewed, none contained owners' signatures. Dam Safety Engineers reported that 24 of the 32 Engineer's Inspection Reports had been signed by the owners but the signed copies are not sent to the Division's main office, so neither we nor Division management could tell from these reports that the inspection results had been provided to the dam owners. In interviews, Dam Safety Engineers indicated that approximately 50 to 75 percent of dam owners sign the Engineer's Inspection Reports acknowledging their receipt of the inspection results and required action items.

- **Some Engineer's Inspection Reports do not include recommendations for dam owners to comply with the outlet inspection requirements.** As noted previously, 2 CCR 402-1, Rule 15.1 requires that owners of high hazard dams conduct an outlet inspection of their dam every 10 years. According to industry best practices, it is the Dam Safety Engineer's responsibility to provide recommendations for all deficiencies found during dam safety inspections. Of our sample of 32 Engineer's Inspection Reports, ten dams were out of compliance with Rule 15.1 as the date of the last outlet inspection, which is documented on the Engineer's Inspection Report, was over 10 years old or there was no record of an outlet inspection ever being conducted. Eight of the Engineer's Inspection Reports from the group of ten dams that were out of compliance with Rule 15.1 included a recommendation by the Dam Safety Engineer to conduct the overdue outlet inspection. Two of the Engineer's Inspection Reports did not contain such recommendations.
- **Some Engineer's Inspection Reports do not document review of past inspection reports.** According to statute, as part of the routine safety inspection, Dam Safety Engineers must review all previous inspection reports. From our sample of 32 Engineer's Inspection Reports, 9 reports did not reference past reports in the written comments. Referencing the past reports and any issues that were identified help Dam Safety Engineers and Division staff determine whether the issues were resolved and documented. It is possible that the Dam Safety Engineers have reviewed past reports even in the instances when their reports make no mention of them but with the current structure of the Engineer's Inspection Reports, this cannot be verified.

Why did the problem occur?

Our performance evaluation work identified two main factors that appear to inhibit the Division's ability to complete all high hazard dam inspections in a timely manner, as follows:

- The Division does not have mechanisms to track the amount of time required to inspect high hazard dams or conduct other work assigned to Dam Safety Engineers such as inspecting lower-hazard dams or completing design reviews. Determining the average time needed for inspections and other activities would allow Division management to evaluate whether staff resources are efficiently assigned and whether additional staff are needed to complete the inspection workload schedule for a given inspection cycle.

- The Division does not have a comprehensive system to monitor Dam Safety Engineers' progress in conducting their inspections. Specifically:
 - The Division has not established any benchmarks or goals for completing high-hazard inspections timely. We found examples of two other states that set inspection goals. The State of Nevada's Dam Safety Program recently instituted workload goals of completing 15 percent of dam inspections in winter, 35 percent in spring, 35 percent in summer and the last 15 percent in fall to help them complete their routine dam safety inspections on time. California's Division of Safety of Dams sets monthly goals for completing inspections. We recognize that it may not be appropriate for Colorado to follow the specific examples of these states in setting goals, due to geography and weather. However, establishing some type of benchmarks for completing inspections is an important part of managing the inspection process.

Tracking and analyzing the resources needed to complete inspections is particularly important in light of additional inspections that have to be performed when lower-hazard dams are on restrictions that require annual, rather than less-frequent, inspections. As discussed later in the report, as a result of having 152 dams on restriction that must be inspected every year, the Dam Safety Engineers must inspect an additional 99 dams per year, or about 15 percent more dams, than if there were no dams on restriction. These additional inspections most likely affect the Division's ability to complete high hazard dam inspections timely.

- The Division performs limited monitoring of the completion of inspections throughout the year. Currently, Division management reports that it reviews the number of inspections that have been completed by each Dam Safety Engineer about mid-way through the annual inspection cycle, which is in July or August. If Dam Safety Engineers appear to be behind schedule to complete all assigned inspections, Division management discusses the situation with the Dam Safety Engineer and assesses whether additional support is needed. In addition, in October each year, largely after the inspection cycle is over, the Dam Safety Engineers report to Division management how many dam inspections were missed. Dam Safety Engineers may get a lower score on their performance evaluations if they continually miss inspections without a reasonable explanation. We learned that the Nevada dam safety program monitors inspections each quarter and California monitors monthly. As with benchmarks, these specific frequencies may not be appropriate in

Colorado, but monitoring more often than once during the inspection season should help the Division ensure more inspections are completed on time.

With regard to dam inspection documentation being incomplete, our work found that the Division does not have comprehensive processes or forms to promote sufficient documentation. First, the Division reports that Dam Safety Engineers do not send the Division the copies of the Engineer's Inspection Reports that are signed by the dam owner and Division management only reviews about one or two reports for each engineer each month. As a result, the Division cannot effectively evaluate the level of compliance with the requirement that Dam Safety Engineers discuss their inspection findings with the dam owner, evidenced by the owner's signature, or take remedial action when the signature is missing. Further, the Division's review of only a few inspection reports each year limits the ability to determine whether the Dam Safety Engineers are consistently providing all the necessary information regarding the condition of the dam. As we noted above, we found instances of information missing from the inspection reports, such as recommendations for overdue interior outlet inspections.

Second, the inspection report form does not include a specific section for engineers to note any issues from previous reports. Although Dam Safety Engineers report that they review past inspection documentation prior to an inspection, it is difficult for other readers, including Division management, to determine if there was an issue with any of the dam appurtenances that may have been identified in a previous inspection and whether the current inspection considered such issues. The U.S. Bureau of Reclamation has sections on its inspection forms to fill out notes and observations from the previous inspection so the reader is aware of what changes were made or new issues arose since the last inspection.

Why does this problem matter?

As noted in the *State Engineer's 27th Annual Report on Dam Safety to the Colorado General Assembly Water Years 2010-11 and 2011-12*, "Dams rarely fail without first showing visible signs of distress, which, when detected by a highly educated and trained eye, can be the difference between a catastrophic failure and prompt corrective action." It is essential that dam inspections occur in accordance with the defined inspection frequency so that the visible signs of distress on a dam that could contribute to failure are not missed.

Completed Engineer's Inspection Reports serve as the basis for assessing and communicating a dam's condition so that the Dam Safety Engineers can adequately

recommend the safe water storage level for the dam or necessary repairs in order to reduce the risk of failure. Engineer's Inspection Reports also serve as evidence that safety recommendations from the inspection were communicated to the dam owner. Incomplete documentation of inspections on the Engineer's Inspection Reports limits the Division's ability to ensure that inspections are comprehensive and compliant with statutes and regulations.

Recommendation No. 1:

The Division of Water Resources should strengthen processes to ensure that dams are inspected timely and that inspection reports are complete by:

- a. Implementing mechanisms to track the amount of time required to inspect dams and conduct other work such as design reviews, periodically analyzing time tracking data, and adjusting workload assignments as needed to ensure that inspections are completed timely.
- b. Establishing benchmarks or goals for completing at least high-hazard inspections timely and monitoring Dam Safety Engineers against the benchmarks or goals on a routine basis throughout the year.
- c. Implementing procedures that require Dam Safety Engineers to send the Division a copy of each Engineer Inspection Report that is signed by the dam owner and increase the number of reports reviewed by Division management during each inspection cycle.
- d. Modifying the Engineer Inspection Report to include a specific section for engineers to note any issues from previous reports.

Division of Water Resources Response:

- a. Agree. Implementation Date: June 30, 2015

We agree that a better system for tracking the times associated with these activities is a good idea. We will work with Department accounting and human resources personnel to get the necessary accounting codes into the State time-reporting system to allow the time associated with the core dam safety activities to be captured and analyzed. We are hopeful that within approximately 6 months (start of next State fiscal year) from now those systems will be able to be in place. After one full year of use and analysis of the results, recommendations to any changes to workload assignments or requests for additional FTE will be able to be made.

b. Agree. Implementation Date: June 1, 2014

We agree that a quarterly tracking and reporting system for dam inspections would benefit the execution, tracking and reporting on our regular dam inspections. We agree to include an annual individual performance objective (goal) for each dam safety engineer to do one of the following: inspect each dam in their assigned area of responsibility in accordance with the frequency established by State Engineer policy or written direction; inform the chief of dam safety regarding dams for which an inspection cannot be accomplished due to workload issues so the inspection responsibility can be reassigned; or, include in the inspection file a written justification why a regularly scheduled inspection was not, in fact, required to accomplish the goals of dam safety. We propose a relatively simple spreadsheet tracking scheme be developed and utilized. The results of this tracking activity will be utilized to support time management/allocation activities the dam safety engineers put toward achieving our annual inspection goals.

c. Agree. Implementation Date: June 1, 2014

We will institute a practice whereby all Engineer's Inspection Reports signed by dam owners are scanned or otherwise uploaded into our Laserfishe digital document management system. Tracking of these dam owners signed documents to determine compliance will be accomplished quarterly, as with the inspection tracking discussed in item 1.b.

d. Agree. Implementation Date: June 30, 2015

We agree that a more comprehensive system of tracking past issues and working toward resolution of those issues should and can be included in the Engineer's Inspection Report process. We will work with dam safety engineers to develop a suitable system for this tracking. Our proposed system will then be submitted as part of a Governor's Office of Information Technology project to modify the coding in the database form. The delay in the projected completion is due to the fact that this development will be part of a currently planned re-development of the DAMS database which we have been told is needed due to coding and software life cycle issues. In the interim we will establish a procedure whereby action items from each section of the previous report are carried forward to the current reports until they have been resolved, at which time they will be removed.

Reclassification of Dam Hazard Ratings

According to 2 CCR 402-1, Rule 4.2.14, the hazard classification of a dam is the placement of a dam into one of four categories based on the dam's hazard potential. The hazard potential is based on an evaluation of the probable damage that could occur in the event the dam fails or is improperly operated. The four classifications are described below:

High Hazard—loss of human life is expected from failure of the dam.

Significant Hazard—significant damage but no loss of human life is expected from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, or public or private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.

Low Hazard—loss of human life is not expected and significant damage to structures and public facilities as defined for a "Significant Hazard" dam is not expected to result from failure of the dam.

No Public Hazard (NPH)—no loss of human life and damage only to the dam owner's property is expected from failure of the dam.

The *Association of State Dam Safety Officials (ASDSO) Guidelines* state that the hazard classification for a dam may change over time. New downstream development, raising of a dam to increase storage, the finding of an endangered or threatened species (plant or animal), revisions to National Weather Service Hydrometeorological Reports, or downstream land use changes could warrant changing the hazard classification of a dam. As a result, it is necessary to periodically review and update the classification of each dam based on the dam's current classification. It is recommended that the hazard potential classification review cycle for each dam correspond to the inspection frequency adopted by the regulatory agency.

Each new or enlarged dam is assigned a hazard classification by the owner which is reviewed and approved by the Division of Water Resources (Division). Over time, conditions around and downstream from a dam may change, necessitating changing the dam's hazard classification. A common occurrence is when a new housing development is built downstream from a lower hazard dam, resulting in a risk of significant loss of property, in which case it would need to be declared a significant

hazard dam, or loss of property and human life, requiring the dam to be reclassified to a high hazard dam.

According to statute, the classification of dams should be reviewed by the Division's Dam Safety Engineers during the periodic dam safety inspection as part of the safe storage level determination (CCR 402-1, Rule 13.3). If a determination is made that the consequences of dam failure have changed due to changes in development within the inundation area, the Division is authorized to assign a new hazard classification to the dam.

Hazard classifications are changed by the Division through a hazard reclassification study conducted by the Dam Safety Engineer and approved by the Division. Upon approval, the Division issues an official memorandum approving the hazard classification change which is sent to the dam owner along with the reclassification study and a change notification letter that describes the impact to the owner for maintenance, monitoring and emergency action planning requirements depending on the new classification. According to statute, the dam must meet the new requirements for the hazard classification within a reasonable period of time (CCR 402-1, Rule 13.3). The dam owner can appeal the decision by hiring an engineer to perform an independent study.

What evaluation work was performed and what was the purpose?

The purpose of the evaluation work was to determine whether the Division is updating the hazard classification of dams in a timely manner in accordance with rules, industry best practices and federal guidelines. The evaluation work consisted of a review of Division policies and processes, and industry best practices guiding hazard reclassifications.

The evaluation work also included review of records for eight of the nine dams that were reclassified by the Division between November 1, 2012 and October 2, 2013 to determine: 1) the amount of time that passed between when the need for a reclassification was identified and when the reclassification took effect, and 2) the change in hazard classification. The records for the remaining dam that was reclassified lacked sufficient documentation to determine when the reclassification need was first identified so we could not evaluate how long the reclassification for that dam took. Information was also collected from telephone and in-person interviews with Dam Safety Engineers.

How were the results of the performance evaluation work measured?

We compared the Division's hazard classification activities to the following rules and best practices:

- **2 CCR 402-1, Rule 13.3** states that as part of the regular inspection determination of a dam's safe storage level, the State Engineer will periodically review the classification of existing dams by evaluating the consequences of failure. If the State Engineer's review indicates the consequences of failure have increased or decreased due to changes in development within the dam failure inundation area, the State Engineer will assign an appropriate new classification and will require that the dam meet the requirements of the rules as they apply to the new classification, within a reasonable period of time.
- **Dam Safety Branch Policy Memorandum No. 01-2013** defines the dam safety inspection frequency which is when the safe storage level is set. The Memorandum states that high hazard dams are to be inspected annually, significant hazard dams are inspected every two years and low hazard dams are inspected every six years. The dam inspection schedule was changed to this schedule from the risk-based system described previously in July 2013.

When the Division identifies the need for a reclassification review, it is important that it complete the review, at a minimum, before the next scheduled inspection would occur at the expected hazard level. For example, if the Division determines that a low hazard dam needs to be reviewed with the expectation that the dam would be reclassified as a high hazard dam, the review should occur within 12 months. This is because the reclassification would place the dam on a yearly inspection schedule.

What problem did the performance evaluation work identify?

We reviewed the Division's practices for reviewing dam hazard classifications and found that it does not complete some hazard reclassification reviews in a timely manner after identifying the need for such reviews.

We found that the eight dams that were reclassified in Water Year 2013 for which records are available took a median of 20 months between the time the need for a reclassification was first identified until the reclassification was finalized. The amount of time for the reclassifications to be completed ranged from a low of 27 days, or approximately one month, to a high of 171 months, or 14 years. The hazard classifications of seven of the eight dams increased to a higher hazard classification. The eighth dam's classification decreased from significant to low hazard. The

reclassifications and elapsed time between the date the need for a reclassification was recorded and the date the hazard reclassification was changed are summarized in Table 5.

Table 5: Elapsed Time to Reclassify Dam Hazard Classifications, Water Year 2013

Dam Name	County	Previous Hazard Class	New Hazard Class	Date Need to Reclass was Initially Recorded	Hazard Class Change Date	Days	Months
Droz Creek Dam	Chaffee	Low	Significant	7/9/1999	7/22/2013	5,127	171
Apishapa Dam	Las Animas	Significant	High	7/1/2010	8/28/2013	1,154	38
DeWeese Dam	Custer	Significant	High	7/1/2011	7/10/2013	740	25
Vouga Dam	Saguache	Significant	High	7/1/2011	7/6/2013	736	25
Wagon Tongue Dam	Park	Low	High	4/27/2012	7/6/2013	435	15
La Joya Dam	Huerfano	No Hazard	Low	12/11/2012	7/7/2013	208	7
Ivanhoe Dam	Pitkin	Low	Significant	12/11/2012	7/7/2013	208	7
Oberon Lake No. 1	Jefferson	Significant	Low	10/9/2012	11/5/2012	27	1
Median						586	20

Source: Harvey M. Rose & Associates based on data provided by the Division of Water Resources

In interviews, most of the Division's Dam Safety Engineers reported a backlog of hazard reclassification studies to conduct. As of October, 2013 the Division had 58 hazard reclassification studies that needed to be conducted ranging from two to 13 reclassification studies for each Dam Safety Engineer. The median number of reclassifications studies in each Dam Safety Engineer's queue was 4.5 studies. The Division is reportedly planning to perform 35 studies in the winter of Water Year 2014, leaving 23 reclassification studies that will need to be performed after the winter. The Division was unable to provide information on how long the 58 dams have been in need of a hazard reclassification.

Why did the problem occur?

The Division allows Dam Safety Engineers to postpone reclassification reviews until after the inspection season, typically during the winter months, but has not established deadlines or expectations for staff on how quickly the reviews should be completed. Deadlines could vary depending on the expected reclassification levels, such that dams expected to be reclassified to high or significant hazard would need to be reviewed more quickly than those expected to be reclassified to lower levels. According to the Division, hazard reclassification reviews are postponed because reclassification studies could interfere with the timely completion of routine dam

inspections as reclassification reviews can reportedly take between two days and four weeks, depending on the complexity of the report.

Some Dam Safety Engineers have more reclassification reviews to conduct than others due to more development occurring in their region of responsibility or neglecting to perform reviews over the years resulting in a large backlog. While five of the Dam Safety Engineers expect to finish all of the needed reclassification reviews in their region in the winter of Water Year 2014, the other five believe they can only complete one-third to one-half of their needed reclassifications reviews during Water Year 2014 as their list is much larger. In recent years, the Division has not reallocated its staff resources among the divisions so that staff with fewer reviews can assist in completing reclassification reviews in divisions with larger backlogs.

The Division does not centrally track dams that have been identified as needing a reclassification review. As a result, management cannot ensure that Dam Safety Engineers are completing reclassification reviews timely and, in the event of staffing changes, that new Dam Safety Engineers are aware of outstanding reclassification review needs. Droz Creek Dam, the dam noted above that did not have its reclassification review done for more than 14 years is an example of the problem that can result from the lack of a tracking process.

According to the reclassification review memorandum for this dam, the delay was due to a variety of factors, including lack of documentation, communication problems, and staff turnover. One of the factors contributing to the delay appears to be that the Dam Safety Engineer who began the review left the Division before completing it and the need for the reclassification study was not communicated to the incoming Dam Safety Engineer who took over the region. Because it was a low hazard dam, six years passed before the next dam safety inspection. Upon reviewing the dam's inspection report records, the new Dam Safety Engineer discovered that the low hazard dam needed to be reclassified to a significant hazard dam which requires a safety inspection every two years. The additional six year delay could have been prevented if a centralized tool was in place to communicate the reclassification need to the new Dam Safety Engineer.

Why does this problem matter?

Dam owners must adhere to certain safety requirements depending on the hazard classification of their dams in order to mitigate the risk of failure. For example, unlike owners of low or no hazard dams, owners of high hazard and significant hazard dams are required to develop an Emergency Action Plan (EAP), conduct more frequent observations of the dam, install additional monitoring instrumentation, and perform

certain specialized inspections. Moreover, the frequency of the Division's dam safety inspections increases when dams are reclassified as high or significant hazard dams.

Delayed hazard reclassifications are a safety risk because these requirements, which are instrumental in preparing for and preventing an emergency, are also delayed. This is especially important for an upward reclassification to high hazard, the classification that covers loss of life in the event of the dam's failure. For the eight hazard reclassifications we reviewed, seven of the dams were reclassified to higher levels that required inspections each year or every two years. However, the more frequent inspections on these dams did not occur because of the delays in completing the hazard reclassification reviews.

Conversely, if a dam is reclassified downward, it would save dam owners the time and resources spent on meeting the additional requirements and also save State resources such that Dam Safety Engineers would not have to inspect those dams as frequently. One of the eight dams whose hazard reclassifications we reviewed was reclassified to a lower hazard classification.

Recommendation No. 2:

The Division of Water Resources should ensure that dam hazard reclassifications are conducted timely by:

- a. Developing clear rules or policies that define how quickly Dam Safety Engineers must complete reclassification reviews from the time a reclassification need is first identified. This could include prioritizing completion of hazard reclassifications reviews for dams that are anticipated to be reclassified as high or significant hazard from a lower hazard classification.
- b. Developing and monitoring a centralized tracking system that captures key information regarding hazard reclassifications including which dams have been flagged for a hazard reclassification review, when the dam was flagged, and other key data for Division management to track to ensure timely completion.
- c. Reallocating reclassification reviews to other Dam Safety Engineers who have capacity when there are significant backlogs in other divisions.

Division of Water Resources Response

- a. Agree. Implementation Date: September 30, 2014

A procedure and policy will be developed that describe the requirements for hazard classification reviews including maximum timelines to accomplish them. Methods and requirements for prioritizing reviews will also be included in the guidance documents.

- b. Agree. Implementation Date: June 30, 2015

We believe we can explore increasing the capabilities of our DAMS database system to include fields for hazard classification reviews. This will allow us to document and track the hazard classification review backlogs statewide. The modifications to the DAMS capabilities will include a means to modify and query those fields to determine the status of reviews at any time. This will require interaction with Governor's Office of Information Technology personnel for the necessary programming and development as well as the dam safety staff for scope, specifications and testing.

- c. Agree. Implementation Date: June 30, 2015

Based on our own internal workload analysis and the obvious differences in east slope versus west slope dam safety engineer's seasonal workload, the Branch has already begun to reallocate workload, especially in the design review area. We propose to also add the hazard classification review component to our current activities that spread the statewide dam safety workload more evenly through the dam safety staff. The modifications described above in item 2.b. will include a description of the engineer assigned to the hazard classification review backlog. Tracking the use of reallocated dam safety engineers from all parts of the state to efficiently complete this work will be able accomplished in this way.

Emergency Action Plan Deficiencies

The Division's Dam Safety and Dam Construction Rules (the rules), codified as 2 CCR 402-1, require that the owners of all high and significant hazard dams file a written Emergency Action Plan (EAP) and any updates with the Division. EAPs are formal documents, prepared by dam owners, describing a detailed plan of action for response to an emergency or unusual event, including alerting and warning

emergency officials in the event of a potential or imminent dam failure or other emergency related to the safety of the dam and public. It is critical that the Division have up-to-date EAPs for all dams so that risk to the public will be minimized in the event of an emergency. The Division uses the EAPs to advise dam owners and local and State emergency managers on technical issues pertaining to dams during an emergency and to notify dam owners when their emergency activities can be terminated.

As described previously, dams are classified into several different hazard classifications to indicate the risks associated with the dam should the dam breach or otherwise fail. These classifications, in order from the most risk that there will be a loss of life to least risk are: high hazard, significant hazard, low hazard, and no public hazard. As of July 2013, the Division's central dam database, called DAMS, had record of 372 high hazard and 314 significant hazard dams. This number of dams is different than the numbers reported in the State Engineer's Annual Reports on Dam Safety, and presented in Table 2 of this report, as they reflect updates to the amounts reported in the annual reports as of July 2013, including any newly constructed dams and reclassifications of dams' hazard classifications.

In 2013, the Division developed and released an updated template for dam owners to use for their EAPs. The comprehensive template includes all of the elements required by regulations, specific document formatting requirements, and guidelines for actions to be taken and duties to be delegated in the event of an emergency.

To assist dam owners in preparing comprehensive EAPs, the Division regularly holds workshops for dam owners to educate them on EAP requirements and other dam safety regulations. In addition, the Division administers a grant program using Federal Emergency Management Agency (FEMA) and Colorado Water Conservation Board funds. Grants are available to owners of high and significant hazard dams to prepare updated professional inundation maps for their EAPs. Such maps are an EAP requirement to graphically depict where damage would occur in the event of a dam's breach.

What performance evaluation work was performed and what was the purpose?

The purpose of the work in this area was to determine whether dam owners are submitting complete and updated EAPs to the Division in accordance with the EAP rules and regulations and whether the Division effectively manages, supports and enforces the EAP development, maintenance, and exercising process with dam owners.

Performance evaluation work included: 1) a review of the regulations, guidelines, templates, and practices related to EAPs; 2) an analysis of the DAMS database to determine if all high and significant hazard dams had EAPs on file with the Division, and review of a sample of 92 EAPs to determine whether the EAP had all of the elements required by the regulations, when the EAP was last updated, and whether there was any documentation of review or testing of the EAP; 3) interviews with Division staff; and 4) interviews with five dam owners.

We selected a random sample of 92 dams from the list of 686 high and significant hazard dams in the DAMS database as of July 2013. The sample comprised 50 high hazard and 42 significant hazard dams. Using the criteria reflected in the EAP template developed by the Division in 2013, we reviewed the sample of EAPs to determine whether each contained all required elements. In addition, we tested five of the EAPs in our sample to determine whether telephone contact information included in the EAPs is up-to-date.

How were the results of the performance evaluation work measured?

2 CCR 402-1, Rule 16 establishes requirements for EAPs, including:

- Owners must submit a copy of their EAPs to the Division as well as to all local and other emergency response coordinators involved in the plan.
- EAPs must contain the following six elements:
 1. Emergency condition detection: identifies conditions and events that comprise an existing or potential emergency.
 2. Emergency level determination: guidance for classifying the extent of the emergency on a scale of 1 to 3, with 3 representing the most imminent dam failure danger.

3. Notification and communication: prioritized notification lists and flowcharts to enable communication and notification of the emergency level to all pertinent parties.
 4. Expected actions: describes actions necessary to prevent a dam failure incident or to help reduce the effects of a dam failure (including identification of equipment, manpower and material available for implementation of the plan).
 5. Inundation mapping: details the streams that will be flooded in the event of an emergency.
 6. Termination: describes the roles and responsibilities for declaring that the incident is terminated.
- Owners must review their EAPs annually. If any revisions are needed, the plan must be updated and provided to the Division and all emergency managers.
 - Owners must test their EAPs, as necessary, to ensure the effectiveness of the EAP, that the EAP is up to date, and to obtain information for revisions or corrections as needed.

The Dam Safety Branch *Activation Guidelines for Emergency Action Plans* (February 20, 2013) contain specific provisions related to the review and exercising of EAPs. These include:

- The EAP minimum annual review by dam owners should include the following:
 - Calling all contacts on the notification charts in the EAP to verify that the phone numbers and persons in the specified positions are current.
 - Contacting the Local Emergency Manager to verify where the EAP is kept and if responsibilities as described in the EAP are understood.
 - Calling the locally available resources to verify that the phone numbers, addresses, and services are current.
 - Reviewing people and structures at risk information for changes in development within the dam failure flood inundation area downstream of the dam.

- The EAP is to be revised if any of the contacts, responsibilities, services or service providers, or people at risk information has changed. When revisions occur, the dam owner should provide the revised pages and a revised Revision Summary Page to all the EAP document holders, including the Division.
- Periodic training and exercises are necessary to help ensure that all responsible personnel are thoroughly familiar with the emergency action plan and their individual roles and responsibilities. EAP exercising can include: Orientations, Phone Drills, Tabletop Exercises, and Functional Exercises. At a minimum, owners of high and significant hazard dams should conduct an orientation and a phone drill yearly. Tabletop and Functional Exercises are typically more complex and are therefore conducted at lower frequencies, on the order of about every 6 years. Key personnel from State dam safety and local emergency management agencies should be invited to participate in any orientation and exercises provided by the dam owner.

What problem did the performance evaluation work identify?

Our review identified problems in three areas: 1) some EAPs are not on file with the Division, 2) some EAPs are incomplete, and 3) dam owners do not appear to be reviewing and testing their EAPS to keep them current.

Some EAPs are missing. We found the Division does not have EAPs on file for at least 29 high and significant hazard dams (at least 4 percent), identified through two processes conducted for this performance evaluation. First, as part of our review of the Division's database of 686 high and significant hazard dams, we found EAPs were not recorded as being on file for 16 dams as of July 2013. Second, the Division could not provide EAPs for another 13 dams included in our sample of 92, even though the Division's database indicated the plans had been submitted for these 13 dams. Because the database does not appear to accurately reflect which dam owners have submitted EAPs, we cannot conclude on the total number of high or significant hazard dams that do not have EAPs on file as required.

Some EAPs are incomplete. Based on our review of 79 EAPs (the 92 selected in our random sample minus the 13 plans the Division did not have), we found that while 13 EAPs were complete, the other 66 (84 percent) were missing one or more of the elements required by regulations, as follows:

- 48 EAPs (61 percent) did not contain a summary of people or structures located downstream at greatest risk in the case of a dam emergency.

- 34 EAPs (43 percent) did not contain an inundation map.
- 25 EAPs (32 percent) did not include prioritized notification flowcharts.
- 19 EAPs (26 percent) did not include sufficient/comprehensive guidance on expected actions in case of emergency.

Some dam owners may not be reviewing or testing EAPs as required. We found several indicators that dam owners do not regularly review or test their EAPs, or make revisions to their EAPs based on reviews to make sure the plans stay up to date.

First, we found that EAPs on file at the Division appear to be outdated. The average age of the EAPs, as recorded in the DAMS database, was 7.5 years, with an average age of 6.1 years for high hazard dams and 8.9 years for significant hazard dams. The oldest high hazard dam EAP hadn't been updated in 31 years and the oldest significant hazard dam hadn't been updated in 24 years.

Table 6 below shows the distribution of the EAPs for high and significant hazard dams, by the length of time since the EAP was updated. As shown, almost two-thirds of the EAPs were more than 3 years old and about one-third were more than 9 years old as of July 2013.

Table 6: Distribution of EAPs by Length of Time Since EAP was Updated (High and Significant Hazard Dams Only) As of July, 2013		
Average Length of Time since EAP was Updated	Number of EAPs	Percentage of Total EAPs
1.0 year or less	38	6%
1.1 – 3.0 years	196	29%
3.1 – 6.0 years	126	19%
6.1 – 9.0 years	91	14%
9.1 – 15.0 years	100	15%
More than 15 years	119	18%
Total	670¹	

Source: Division database of dams as of July 2013.
¹ The database reported a total of 686 high and significant hazard dams but EAPs were reported as not on file for 16 of those 686 dams. Therefore, the length of time since the EAPs were updated could only be assessed for 670 dams (686 total dams in the database less 16 dams for which an EAP was not recoded in the database).

While dam owners are only required to submit updated EAPs when they have changes in content to report, it seems unlikely that that no changes have occurred for an average of 7.5 years for all high and significant hazard dams, or for more than 9

years for one-third of the dams. Changes that should be incorporated into revised plans, and forwarded to the Division, include the names and telephone numbers of those responsible for responding to a dam emergency and those likely to be affected by an emergency. Because of our concerns that some portion of the individuals and their contact information listed in the EAPs is no longer accurate, we attempted to contact the dam owners or other primary contacts for five of the EAPs in our sample that were more than 7 years old. We found that at least some of the contact information for three of the five dams was inaccurate. Specifically, the phone number of the dam owner or other primary contact was disconnected for two EAPs and the alternate contact information for another dam owner was incorrect.

Second, both Division staff and dam owners told us that reviews and exercises are not occurring routinely. Division staff stated that telephone drills, tabletop exercises, and full exercises, as required by the Division rules, are not regularly conducted. Further, all four of the dam owners' representatives interviewed stated that they never conduct drills or exercises related to emergency planning or the EAP.

Finally, 54 of the 79 EAPs we reviewed (68 percent) did not contain a record of revision, which may also indicate that owners are not reviewing or testing the plans routinely.

Why did the problem occur?

The Division does not have a consistent organization-wide approach to tracking and managing EAP compliance. We found the following weaknesses in the Division's processes for ensuring it receives complete, updated EAPs from owners of high and significant hazard dams.

Missing EAPs. The Division did not know why the DAMS database did not reflect EAPs on file for 16 dams or why hard copy EAPs could not be located for 13 of the dams in our sample. We found the Division does not have strong controls to track the submission, retention, and recording of EAPs. Dam owners submit their EAPs to their local Division office and the field Dam Safety Engineers are responsible for reviewing them and recording their receipt in DAMS. The Division does not periodically review the DAMS database to identify and investigate dams for which receipt of EAPs has not been recorded. Further, assurance that EAPs are on file for all high and significant hazard dams is not regularly reported by the Dam Safety Branch to Division management, such as in the Dam Safety Branch's annual report.

In addition, until recently, the Division did not keep copies of EAPs in a central repository. Instead, hard copies of the EAP documents were kept in the respective division field offices. As a result, the Division has not historically had a means of ensuring that all EAP documents filed with the Division remained on file in the field

offices and whether or not the DAMs database records of EAPs on file was accurate. To improve EAP recordkeeping, the Division has been scanning copies of all EAPs on file in the field offices so that electronic copies of the documents will also be maintained in a central repository in Denver. Centrally stored electronic copies of all EAPs will allow the Division to better ensure that all EAPs are filed and recorded in the DAMs database.

Incomplete EAPs. Neither the Dam Safety Engineers nor any other staff within the Division is required to review the content of the EAPs to ensure they include all required elements, either when they are initially submitted or when they are updated. The Dam Safety Engineers do verify that an EAP has been completed as part of their regular dam safety inspections, but they do not have a standardized protocol in place to check the EAP for its completeness or whether or not it is current. Thus, the Division has no systematic mechanism in place to ensure EAPs are complete.

Outdated EAPs. The three dam owners we called to test whether contact information in their EAPs was current stated that they were not aware that the EAPs needed to be updated. Division staff told us they are undertaking efforts to improve EAP documents, such as offering regular Division-sponsored dam owner training. The Division also indicated that it is planning additional efforts to improve emergency action planning, including providing more support and organization for dam owners around the exercising component of emergency preparedness.

Currently, the Division does not require that dam owners submit documentation, or attest to the Division, that they have conducted their required annual reviews or periodic testing of their EAPs. Such a requirement could help the division better ensure that EAPs are being reviewed, tested and updated regularly.

Why does the problem matter?

It is critical that the Division have up to date EAPs for all dams so that risk to the public will be minimized in the event of an emergency. The Division needs up-to-date EAPs to fulfill its role advising dam owners and local and State emergency managers on technical issues pertaining to dams during an emergency. Absent, incomplete, or outdated EAPs pose a risk to dam owners and the human life and property that surround the dams. Without a current emergency action plan that is accessible to relevant parties and regularly reviewed and exercised, dam owners may be unprepared to respond in case of a dam emergency.

During the flooding in September 2013, Division staff found that two dams, one high hazard and one significant hazard, had not updated their EAPs since 2006 and 2000, respectively. Division management report that the outdated EAPs caused lost response time as there was confusion regarding how the dams and spillways operated.

This could have potentially led to unnecessary damage if the dams had failed though, fortunately, neither of them did.

The absence of some required components in some EAPs create specific risks. For example:

- Prioritized notification flowcharts identify and provide contact information for responsible officials and at-risk parties in various levels of emergency. Without these flowcharts, it may be difficult to mobilize appropriate action and move at-risk parties to safety. The Division stated that the notification flowcharts are one of the two most important components of the EAP.
- Inundation maps are necessary and relied upon heavily during an emergency to ensure that the Division and all responders are aware of the areas of risk to human life and property. The Division stated that the inundation map is one of the two most important components of the EAP.
- Guidance about response options and decision-making during an emergency is needed so that dam owners and other responsible parties are prepared to take effective action.

Recommendation No. 3:

The Division of Water Resources (Division) should strengthen the Emergency Action Planning (EAP) process by:

- a. Implementing procedures to periodically review the DAMS database to identify any dams that do not have an EAP recorded and reconcile the DAMS database records with hard copy EAPs on file to help ensure all required EAPs are filed and DAMS is accurate.
- b. Implementing a process for Division staff to review all EAPs in conjunction with the regular dam safety inspection process to determine if the documents are still on file, complete, and current and to follow up with dam owners to obtain copies of any missing documents and for dam owners to revise any EAPs that are incomplete or not current. The Division should also develop written policies and procedures requiring Division staff to review new or updated EAPs submitted in the future for all required elements and attributes upon receipt and to follow up with dam owners to obtain complete EAPs when elements are missing.

- c. Implementing a process for the Dam Safety Branch to regularly report to Division management on the number of dams for which the Branch has verified that EAPs are on file, contain all required elements, and are current.
- d. Implement additional methods to help ensure that owners of high and significant hazard dams conduct annual reviews and periodic testing of their EAPs as required by regulations. This could include asking dam owners to provide periodic documentation or attestations that the reviews and testing were completed.

Division of Water Resources Response

- a. Agree. Implementation Date: September 30, 2014

The Division has embraced electronic document management and storage, which means our “hard copy” documents are not paper. This change significantly improves the ability to monitor the currency of the documents and enable them to be used much more effectively by all members of the emergency management community by being accessible 24/7 from any location. The electronic solution also enables ready notification of the need for updates and dissemination of changes made. Division management will implement a process whereby the information in DAMS regarding whether or not an EAP for the dam is required and the date associated with the most current version of the EAP is consistent with the EAP actually on file. Our initial contemplation is to perform the audit annually for a representative sampling of dams that are required to have an EAP.

- b. Agree. Implementation Date: September 30, 2014

The Division will revise current written policy to make clear that EAP review is a component of the regular dam inspection. The Division has already developed an EAP template that enables ready review of the sufficiency of EAP content. The inspection forms currently used to guide dam safety inspections focus primarily on physical conditions at the dam. The Division will modify the forms so that the inspecting engineer is required to comment on the adequacy and current status of the dam’s EAP and what the owner has done to review or test the EAP as well as document any actions reported to and required by the dam owner or operator to address EAP deficiencies.

c. Agree. Implementation Date: September 30, 2014

We propose to continue to use the Annual Report as our primary means of reporting performance to Division management, elected officials and the general public. We will add documentation regarding EAP status to this report.

d. Agree. Implementation Date: September 30, 2014

Changes described in the response to item 3.b. whereby the forms used to document the inspection are modified to include EAP review and EAP related action items will significantly improve compliance with the EAP regulations. Division management, in coordination with the department director and the department of public safety, will evaluate what additional methods to implement for dam owners who fail to comply with the instructions of the dam safety engineer provided as part of the dam inspection process.

Enforcement Measures

Through the authority of the State Engineer, the Division has two enforcement tools that can be utilized to enforce dam safety statutes and regulations.

First, in accordance with Section 37-87-114, C.R.S., the State Engineer may seek to impose fines on dam owners or operators who fail to follow the reasonable direction of the State Engineer for the construction or safe operation of a dam. According to statute, such dam owners or operators are subject to a fine of not less than \$500 for each offense and each day an offense continues. The fines may only be assessed through civil action in district court. Statute requires that the proceeds of all fines, after paying the cost of the proceedings, be paid into the county treasury for use of the county general fund.

Second, the State Engineer can order a restriction on the amount of water that can be stored in a dam's reservoir, pursuant to 2 CCR 402-1, Rule 13.2, as part of the State Engineer's statutory authority to set the safe storage level of a reservoir (Section 37-87-107, C.R.S.). A storage restriction is used as an interim measure to immediately reduce the possibility of failure and risk to the public until the safety issue can be resolved. Currently, there are 152 dams in Colorado on restriction.

The issues that commonly lead to storage restrictions include inadequate spillways, excessive seepage, or poor conditions, to name a few. These dam safety issues are all

violations of the Colorado Code of Regulations for Dam Safety (2 CCR 402-1). Dam owners are required to adhere to the state regulations regarding the construction and safe operation of dams. These regulations include:

- Requirements for constructing, modifying or repairing dams.
- Requirements for breaching or removing an existing dam.
- Requirements for general maintenance of their dams, ordinary repairs, emergency actions that do not impair the safety of the dams.
- Requirements for maintaining the safe storage level determined by the State Engineer.
- Requirements for Emergency Action Plans for high and significant hazard dams.
- Additional dam owner responsibilities which include general maintenance obligations, monitoring the condition of the dam and conducting outlet inspections for high and significant hazard dams every 10 years.

What performance evaluation work was performed and how were the results measured?

The performance evaluation work was measured using State laws and regulations, Division policies and industry best practices.

The purpose of the performance evaluation work was to determine whether the Division has sufficient and effective enforcement authority to ensure that dam owners comply with State law and regulations concerning dam safety. This was done by reviewing the State's enforcement authority codified in statutes and regulations as well as industry best practices for effective enforcement. Violations of state regulations by dam owners were identified by analyzing our sample of 32 high hazard dam Engineer's Inspection Reports, and three additional Engineer's Inspection Reports outside of our sample that were identified by the Division as reports that included long-standing maintenance issues that had not been addressed by the dam owner and led to restrictions. We also reviewed a sample of 79 Emergency Action Plans (EAPs), and summary level information on the 152 dams with current reservoir storage restrictions. Interviews were conducted with Dam Safety Engineers and Division management.

In addition, we reviewed the enforcement policies of Colorado's Public Utilities Commission, which regulates public utilities in Colorado, the fining authority of five other states' dam safety programs, and guidance provided by FEMA and *ASDSO's Model State Dam Safety Program (2007)*, which recommends that State Dam Safety Programs have a set of appropriate penalties that adequately deter violations.

What problem did the performance evaluation work identify?

Our evaluation work found that dam owners do not always address regulatory violations identified by the Division. Examples of common dam owner violations of State regulations include:

- Dam owners failing to update their dam's Emergency Action Plan (EAP) as required by 2 CCR 402-1, Rule 16. Our finding regarding EAPs found indicators that some dam owners are not reviewing their plans annually, testing them as needed and submitting updated plans to the Division as required by statute. The average age of the EAPs in the Division's DAMS database was 7.5 years as of July 2013.
- Dam owners failing to inspect the interior of a high hazard dam's outlet every 10 years as required by 2 CCR 402-1, Rule 15. Our finding regarding dam inspections found that, of a sample of 32 Engineer's Inspection Reports, ten dams had outdated outlet inspections.
- Dam owners violating one or several of the state regulations regarding the construction and safe operation of dams listed above resulting in 152 storage restrictions. Specific examples of problems include:
 - Dam owners failing to adequately maintain the dam in a timely manner in accordance with 2 CCR 402-1 Rule 15.4. Our review of the three additional Engineer's Inspection Reports outside of our sample found two instances in which the Division identified maintenance issues at a dam that needed to be remedied. In these instances, the dam owners neglected to address the issues for approximately 35 years each and the problems grew worse, eventually leading to a restriction order.
 - Dam owners failing to construct the dam's appurtenant structures in accordance with the regulations (2 CCR 402-1, Rule 5.9.1.3.7). Our review of the three additional Engineer's Inspection Reports outside of our sample found one instance when a dam did not have an appropriate sized spillway to withstand a 100 year flood. The State Engineer directed the dam owner to modify the dam to come into compliance with State regulations. The dam owner did not comply and a restriction order was issued.

Why did the problem occur?

The Division does not have efficient mechanisms to motivate dam owners to comply with dam safety statutes and rules. Specifically:

- Under statute, fines may only be imposed on dam owners by going through district court, which can be a lengthy and costly process. The Division reports that it virtually never seeks fines because the process required to issue orders and eventually impose fines is resource intensive, including the time required to craft enforcement orders, serve the non-compliant dam owner, provide the dam owner an opportunity to comply, document the opportunity, obtain and pay for legal services to craft and file the complaint, and manage the court case. The Division reports that a fine has not been issued for over 20 years and that fines are typically only pursued if a dam owner does not comply with a restriction order. If a dam owner fails to comply with the restriction order, he or she is given notice that non-compliance could result in a fine which is typically enough to gain compliance, according to Division management.

We found an example of another regulatory program in Colorado – the Colorado Public Utilities Commission (PUC) – that does not have to go through the courts to impose fines for noncompliance with laws and regulations. According to statute (Sections 40-7-113 through 117, C.R.S.), fines for violating PUC statutes or rules may be assessed against regulated entities by the Director of the PUC, staff of the PUC, and in some cases other state employees. Violators may appeal any penalty to the Commission. We also found several other states’ dam safety programs including New Jersey, New Hampshire and North Carolina that have statutory authority to directly impose a civil penalty for violations of statute or any other rule or regulation instead of going through the courts.

- The Division does not have the authority to charge dam owners for the additional costs the Division incurs to conduct more frequent inspections on dams that are restricted. As discussed below, many dams remain restricted for years and the Division must conduct more frequent inspections of dams with restrictions.
- The Division has not analyzed other alternatives to motive compliance. The Division reported to us that there may be other options to encourage dam owners to make repairs and otherwise comply with all safety regulations, such as incentivizing dam owners by withholding new construction permits or other permits until repairs are made. To date, the Division has not actively pursued such options.

Why does this problem matter?

Although most regulatory violations do not immediately impair the safety of a dam, if dam owners do not fix deficiencies as directed by the Division and mandated by state regulations, they could have more serious implications over time or in the case of an emergency. An example of this is during the flooding in September 2013 in which two dams, one high hazard and one significant hazard, had not updated their EAPs since 2006 and 2000, respectively. Division management report that the outdated EAPs caused lost response time as there was confusion regarding how the dams and spillways operated. This could have led to unnecessary damage if the dams had failed although neither of them did.

Due to the lack of efficient penalty mechanisms, the Division has used storage restrictions as long term solutions for dam deficiencies. 2 CCR 402-1, Rule 4.2.29 states that storage restrictions limit the amount of water in a reservoir as an *interim* measure to immediately reduce the possibility of dam failure and risk to the public and property. Interim measures are not intended to be long term solutions. However, as shown in Table 7, of the 152 dams with a restriction order as of June 2013, eight (5 percent) have been restricted for over 30 years and 48 dams (32 percent) have been restricted for more than 20 years.

Table 7: Number of Years Restricted Dams Have Been On Restriction as of June 2013				
Time Dam Restricted	High Hazard	Significant Hazard	Low Hazard	Total
30 years or more	1	1	6	8
Between 20 and 29.9 years	4	7	37	48
Between 10 and 19.9 years	8	4	18	30
Between 5 and 10.9 years	3	1	17	21
4.9 years and under	7	13	25	45
Total	23	26	103	152
Source: Table created by Harvey M. Rose & Associates from data provided by the Dam Safety Branch on restricted dams, June 29, 2013.				

There are two main impacts of dams remaining restricted for prolonged periods. First, the conditions that warranted the restriction can potentially worsen over time and become more serious if left unattended. Second, the Division's dam inspection workload increases as the Dam Safety Engineers must conduct annual inspections of all dams on restriction as opposed to every six years for low hazard and every two years for significant hazard dams.

Although dams operating under restriction orders are technically considered safe at the restricted water level, dams that remain on restriction for multiple years impose a significant cost to the Division because the Division must perform additional inspections for those dams. According to the most current inspection frequency schedule established by the State Engineer (Dam Safety Branch Policy Memorandum No. 01-2013), high hazard dams should be inspected every year, significant hazard dams every two years, and low hazard dams every six years. All dams with storage restrictions, however, regardless of hazard classification, must be inspected annually.

Table 8 shows the number of dams, by classification, under the jurisdiction of the Division as of June 29, 2013 as well as the number of inspections that would be expected without water restrictions and the estimated increase in inspection workload due to restrictions.

Table 8: Number of Dams and Inspections Under the Dam Safety Division's Jurisdiction				
Hazard Classification	Number of Dams in Water Year 2013	Number to be Inspected in Water Year 2013 Based on Regular Schedule¹	Number to be Inspected Including Those on Water Restrictions²	Increase in Number of Inspections Due to Water Restrictions
High	331	331	331	0
Significant	303	152	165	13 (9%)
Low	973	162	248	86 (53%)
Total³	1,607	645	744	99 (15%)
Source: Table created by Harvey M. Rose & Associates from data from the DAMS and from data provided by the Dam Safety Branch on restricted dams, June 29, 2013.				
¹ The regular schedule is high hazard dams are inspected annually, significant hazard dams are inspected every 2 years, and low hazard dams are inspected every 6 years.				
² Additional inspections were calculated using the number of dams on restriction per hazard classification and the inspection frequency of each restricted dam according to their hazard classification.				
³ Excludes dams classified as No Public Hazard since they are not inspected.				

As shown in Table 8 above, Dam Safety Engineers were responsible for conducting at least 99 additional inspections in Water Year 2013 due to storage restrictions. The additional 99 inspections cost the Division an estimated \$58,244 in Water Year 2013.

Recommendation No. 4:

The Division of Water Resources should:

- a. Evaluate options to motivate dam owners to address violations of dam safety statutes and regulations related to the construction or safe operation of any reservoir. Such evaluation should include consideration of penalties such as direct fining authority as well as incentives that encourage dam owner compliance.
- b. Evaluate the feasibility of seeking statutory changes to allow the Division to charge inspection fees to dam owners to cover the costs for each inspection that is performed on a restricted dam that is outside the routine dam safety inspection schedule.
- c. Report to the Legislative Audit Committee and to the Water Resources Review Committee no later than December 31, 2014 on options to improve dam owner compliance and pursue statutory changes related to sanctions, incentives, and fees for inspections of restricted dams as appropriate.

Division of Water Resources Response

- a. Agree. Implementation Date: December 31, 2014

Similar to the response to item 4.b., the dam safety branch, in coordination with the state engineer, will evaluate what process the state engineer should follow to obtain compliance with statutes.

- b. Agree. Implementation Date: December 31, 2014

Division management, in coordination with the department director, will evaluate the feasibility of seeking statutory changes to allow the Division to charge inspection fees to cover the additional costs associated with inspecting restricted dams.

- c. Agree. Implementation Date: December 31, 2014

We agree to report to the committees, as recommended.

Design Review Application Processing Time

Under statute (Section 37-87-105, C.R.S.) no jurisdictional-size dam may be constructed in the State before plans and specifications for that dam have been approved by the State Engineer and no work on a dam shall be deemed complete until the State Engineer approves the construction. Further, statute states that no alteration, modification, or repair that will affect the safety of a dam may be made without prior written approval of the State Engineer. To obtain approval for new construction or alteration or repair of a dam, the dam owner must submit an application to the Division that contains the design plans and specifications for the construction project. The Division is responsible for design review (reviewing and approving the application materials) and final inspection (on-site inspection and approval of the construction) of each construction project on a jurisdictional-size dam.

The design review function consists of comprehensive engineering reviews of the design and construction documents and specifications for proposed new or modified dams or dam repairs prepared by registered professional engineers. The reviews determine the adequacy of the dam's design as well as compliance with applicable statutes, regulations, and industry standards. Based on the review, Division engineers often provide comments to the applicant that must be resolved before the application can be approved.

Division engineers also perform periodic inspections during the construction phase of the projects to assure compliance with the approved plans and specifications and to evaluate any proposed change orders, as well as a final inspection once construction is complete. Upon completion of the construction of the projects, Division engineers review project completion filings submitted by the dam owners. These filings are documents required by regulations that contain all of the final specifications, a summary of construction activities, water level details, and monitoring plans. Once the engineers determine that all required documents have been submitted by the owner, they recommend final approval of the projects to the State Engineer. The Division collects a statutory fee for the review of plans and specifications that ranges from \$100 to \$3,000 per project. Under regulations (2 CCR 402-1, Rule 5.8.3) re-submittal of design plans is required if resolution of the design review comments does not occur within three years.

The Division has 1.5 full time equivalent (FTE) Design Review Engineer positions devoted to the design review function. These staff are augmented by the assistance of

the Division's nine Dam Safety Engineers, who reported spending approximately 8 percent of their time, or the equivalent of .58 of a position in Fiscal Year 2013, conducting design reviews. The full-time Design Review Engineer based in Denver acts as the coordinator of all design review functions statewide. The position is also responsible for developing frameworks and procedures for standard documentation of design review activities including accepting and processing applications, entering projects in the DAMS database, and coordinating secondary reviews (referred to as peer reviews) of proposed projects by an engineer other than the staff primarily assigned to the review.

In Water Year 2012, the Division received 49 applications with plans and specifications for new dams or modifications or repairs to existing dams with an aggregate cost of \$22,356,806 and 57 dam projects were completed (meaning the dam construction, repair, or alteration was finished).

What performance evaluation work was performed and how were the results of the work measured?

The test work consisted of an analysis of the elapsed review and approval times relative to statutory requirements for all 57 dam projects completed in Water Year 2012. Specifically, we assessed compliance with the following two requirements of Section 37-87-105, C.R.S.:

- The state engineer shall issue his written decision regarding the approval of plans and specifications [for the construction, alternation, or repair of a dam] within 180 days of submittal [of the plans and specifications] to him.
- The state engineer shall render his written decision regarding acceptance [of the completed construction, alteration, or repair of a dam] within 60 days of written notification by the owner that construction has been completed.

The test work also included review of the 57 design projects completed in Water Year 2012 to evaluate whether the Division adhered to the regulation (2 CCR 402-1, Rule 5.8.3) that states: "Re-submittal of the design [plan] ... shall be required if resolution of the design review comments [provided by the Division] does not occur within three years."

We also obtained some information about the City of Denver's building permit application process. The City of Denver's permitting process is similar to the Division's design review process in that building permit applicants must often submit their plans and specifications to the City's permitting agency which determines if the proposed project is consistent with all zoning and land use regulations. Like the

Division's dam design review process, this often requires several iterations of plans and specifications for review by the permitting agency's staff. We obtained information about Denver's processes to determine if they might serve as models that could be useful to the Division.

The performance evaluation test work also included a review of applicable statutes, regulations, and policies, and interviews with Division staff.

What problem did the performance evaluation work identify?

We found there are sometimes significant delays in the Division's approval of design applications and final construction, alteration, or repair of dams. First, our review of the 57 dam construction projects completed in Water Year 2012 found that the Division did not issue a final approval of construction, alteration, or repair plans and specifications within 180 days of the date the dam owner submitted them for 20 of the projects (35 percent). Of these 20 projects, the average time from submission to final approval of the plans was 436 days. We calculated the range of timeframes for the Division to issue its final decision on the plans as shown in Table 9, below.

Range of Elapsed Time	Number/Percent of Dams
Within 180 days	37 (65%)
181 to 270 days (6 to 9 months)	4 (7%)
271 to 365 days (9 to 12 months)	10 (18%)
More than 365 days (more than 12 months)	6 (11%)
Total	57 (100%)
Source: Analysis of information provided by the Division of Water Resources.	

As shown in Table 9, final approval for six plans took more than a year, or twice as long as the 180 day statutory deadline. For one of these projects, the overall time from the initial submission of the plans to final approval by the Division was 1,635 days, or about 4½ years. For this project the Division did not require the owner to resubmit the plans and specifications in accordance with 2 CCR 402-1, Rule 5.8.3.

We could not determine from the design review files or from the Division's database what caused the delays in approving the plans for the 20 projects, so we asked the Division to provide anecdotal information regarding them. For 18 projects, the Division provided a general explanation that the delays were primarily due to owner's engineers responding slowly to the Division's comments. For the project that took 4½ years to approve, the Division indicated that the project required a hydrology study that was initiated twice under two different owner's engineers which caused

significant delays in moving the project forward. For the final project, the Division was unable to provide any details about why approval did not occur within 180 days.

Second, our review of the 57 projects completed in Water Year 2012 found that 46 (81 percent) were not approved by the Division within 60 days of the owner's notification of completion of construction. We found the average time between notification of construction completion and approval of the construction was 104 days.

As shown in Table 10, final acceptance for 13 plans (nearly a quarter of the total) took more than four months, or twice as long as the 60 day statutory deadline, with 6 of these taking more than 180 days or 6 months. Additionally, 10 projects did not have dates recorded for when the Division accepted the construction.

Range of Elapsed Time	Number/Percent of Dams
Within 60 days	12 (21%)
61 to 120 days (2 to 4 months)	22 (39%)
121 to 180 days (4 to 6 months)	7 (12%)
More than 180 days (more than 6 months)	6 (10%)
Unknown (no date entered in database for final acceptance)	10 (18%)
Total	57 (100%)

Source: Analysis of information provided by the Division of Water Resources.

We could not determine from the design review files or from the Division's database what caused the delays in approving the construction of the 46 projects, so we asked the Division about them. The Division provided general information that the delays were primarily due to dam owners not providing the required documents within 60 days of the final construction inspection, as required under 2 CCR 402-1, Rule 10.2. However, the Division is granting approval in such cases, even though State regulations indicate that projects can only be deemed complete in cases where dam owners have submitted the required documents within 60 days.

Why did the problem occur?

The Division reported that it interprets the 180 day statutory deadline to mean that the Division must review the submitted plans and specifications and provide an initial comment letter to the owner within 180 days of submission. The Division reports it

has followed this interpretation since at least 1994 and likely as far back as 1988. Statutes do not specify that the final approval must occur within 180 days, so this interpretation may be reasonable. However, the Division took more than a year to approve 11 percent of the dam design plans for projects completed in Water Year 2012, which may not be consistent with the apparent intent of the statute to provide dam owners with timely review, feedback, and approval of their plans. We noted that processes that could help the Division better monitor its review and approval process to promote timeliness are lacking. Specifically:

- **Lack of goals and monitoring of steps in the review process.** The Division has not established specific timeliness goals for each step in the review and approval process and therefore does not measure the time it takes Division engineers to complete their reviews. Specifically, the Division has not set goals or expectations for the number of days from receiving an application to the initial review of the plans and specifications and preparation of a comment letter, or for the number of days from receiving any additional documents or revisions to recommending final approval of the plans. In addition, the Division has not established deadlines for dam owners to provide missing documents or revise documents needed to complete the design review.

The Division noted that the design review process involves three parties: the Division, the owner, and the owner's engineer. Setting goals for, and tracking, interim steps in the process would help the Division determine the point(s) in the process where delays are occurring, determine when delays are caused by each of the parties, and develop mechanisms to help address any delays that are the responsibility of the Division.

- **Pre-application meetings are not required.** The Division does not offer formal, required pre-application meetings to assist dam owners with their design plans. The Division reported the quality of applications submitted varies, requiring a significant amount of revision after the initial design plan has been submitted and reviewed by the Division. Offering formal pre-application meetings between Division staff and owners or owners' engineers, especially those who are less experienced, could help ultimately expedite the approval process by helping owners prepare initial design plans that more closely meet the Division's requirements. We learned that, for certain types of building permit applications, the City of Denver requires that applicants have a pre-application meeting with the planning department as a way to assist applicants and streamline the review process. Subsequent to the meeting, the department determines the completeness of the applications but does not

process an application until it is deemed complete. A similar process could help the Division focus its limited design review resources on both helping dam owners prepare acceptable design packets for submission and reviewing only complete design plans, rather than plans that are missing information or need significant revision.

With respect to the timeliness of approving dam construction, the Division's methods for tracking compliance with the 60 day requirement does not report whether approvals occurring after 60 days were due to the dam owners submitting their documents late or due to the Division staff not reviewing the documents and granting approvals timely. We found the Division monitors adherence to the 60-day deadline in the DAMS database based on the date of the final construction inspection rather than on the date when the owner's engineer submits all the necessary documentation to fully notify that construction has been completed.

Why does this problem matter?

The approval of dam construction, alteration, and repair designs, and the approval of actual construction, is required in statute as part of the Division's responsibilities to ensure that dams are built, modified, and repaired to operate in a safe manner. Delays in approving design plans and final construction may result in individuals waiting to build or operate a dam for lengthy periods. Delays in approving the designs or actual construction of alterations or repairs could lead to needed modifications or repairs being postponed, which may affect the safe operation of the dam.

Delays can also have impacts on the public, to the extent the water being stored is used for public purposes, such as by a water utility, and can add to project financing costs for dam owners.

Recommendation No. 5:

The Division of Water Resources should improve the timely review and approval of dam construction, alteration, and repair plans and specifications and of final construction by:

- a. Establishing specific timeliness goals for each step in the design review and approval process under the control of Division staff.
- b. Tracking the time it takes Division staff to complete each step of the overall design review process, as well as each step, and using the results of the tracking to identify solutions to address delays that occur within the Division.

- c. Considering the implementation of formal pre-application meetings to assist dam owners and owners' engineers in preparing plans and specifications that better meet the Division's requirements.
- d. Tracking causes of delays in final project approval to determine if approvals after 60 days are occurring due to dam owners not submitting their required documents timely or due to Division staff not completing the approval process timely, and taking corrective actions to expedite both processes.

Division of Water Resources Response

- a. Agree. Implementation Date: September 30, 2014

We agree that improved tracking of the portions of the design review process for which we are responsible is desirable. We will work to establish timeliness goals for the Division review steps.

- b. Agree. Implementation Date: June 30, 2015

As discussed in item 5.a. we agree to set timeliness goals and strive to improve the tracking of our activities with respect to design review, evaluate shortfalls, and implement methods to consistently meet them.

- c. Agree. Implementation Date: June 1, 2014

We agree with this recommendation and are pleased to say we have implemented this as part of our internal process. We have also added language describing this process to our draft "Design Review Guidelines" document provided to the dam engineering community. We expect that to be finalized in the coming months.

- d. Agree. Implementation Date: June 1, 2014

We agree with this recommendation and are currently tracking these delays and their causes as part of our monthly design review meeting process. Where problems are identified they will be documented, along with the efforts utilized to correct the deficiencies.

Design Review Fees

In accordance with Section 37-80-110, C.R.S., the Division collects fees for the review of plans and specifications. Statute specifies “a filing fee of \$3 per \$1,000 (or fraction thereof) of the [project] cost estimate, limited to a maximum of \$3,000, with a minimum filing fee of \$100.”

As seen in Table 11 below, the Division received a total of 270 design review applications over the last five years from Fiscal Year 2009 through Fiscal Year 2013. Of this number, 256 (95 percent), were for the enlargement, repair, or modification of existing dams while 14 (5 percent) were for the construction of new dams. The total amount collected in fees during this time period was \$221,700 (\$179,485 from applications for existing dams and \$42,215 from applications for new dams). The average collected per year was \$44,340.

Fiscal Year	Number of Dam Construction, Enlargement, Repair or Modification Applications Received	Total Amount of Fees Collected
2009	54	\$44,096
2010	50	\$51,930
2011	67	\$45,718
2012	56	\$30,105
2013	43	\$49,851
Total	270	\$221,700
5-Year Annual Average	54	\$44,340

Source: Division of Water Resources, Dam Safety Branch data from the DAMS database.

What evaluation work was performed and how were the results of the work measured?

The evaluation test work included an analysis of the cost of staff time spent on design review activities in Fiscal Year 2013, based on staff timesheets, compared to revenue for design reviews received by the Division during Fiscal Year 2013. The test work also included a review of the length of time since the previous change in fees and the most recent proposal to change fees. In addition, the test work included a comparison of other western states’ fee schedules with Colorado’s dam safety fees.

The test work also consisted of interviews with Division staff and analysis of statutes, regulations, and Division policies and procedures related to design review.

What problem did the evaluation work identify?

We found that the level of revenue brought in by design review fees is much lower than the cost to conduct the reviews. Specifically, our analysis found that design review fees represent only about 20 percent of the Division's estimated personnel costs to conduct design reviews. As noted above, the Division collected just under \$50,000 in design review fees in Fiscal Year 2013 but we roughly estimate that the Division incurred \$253,000 in personnel related expenses to conduct the reviews. The \$253,000 estimate is most likely understated; it is based on Division staff time records and some staff told us they did not record any hours for design review on the time records we reviewed although they had worked on design review activities during the period evaluated.

We contacted 10 other western states (Washington, California, Wyoming, Idaho, New Mexico, Arizona, Montana, Utah, Oregon, and Nevada) to obtain information about fees related to the dam design review function. We learned that six of the states assess design review fees for construction of new dams or for modifications or repairs and three have higher fees than those allowed in Colorado. Table 12 below summarizes the fee structure for Colorado, Arizona, California, Idaho, New Mexico, Washington and Wyoming. Two of the states – California and Washington – indicated that their fees are specifically intended to cover the costs of the design review function by the State while the others did not. Four of the states we contacted - Montana, Utah, Oregon, and Nevada – do not assess any design review fees.

Table 12: Summary of Design Review Fees for Seven Western States As of November 2013			
State	Fee Description	Fee Range	Notes
Colorado	Review of plans and specifications for new dams or modifications to existing dams that will affect the safety of the structure.	\$100 to \$3,000	Same fee structure applies to new and existing dams.
Arizona	Filing fee for application to construct a new dam or for the enlargement, repair, alteration, or removal of an existing dam.	No Min or Max	Fee is 2 percent of project costs associated with construction of the dam and appurtenant works integral to the design and safe operation of the dam.
California	Review of applications for an alteration, repair, removal, enlargement, or new dam construction.	\$300 to No Max	Fee is applied on a sliding scale based on project cost. For example, a \$1 million project would incur fees of \$15,000 while a \$7 million project would incur a fee of \$85,500.
Idaho	Review of applications for construction of a new dam, enlargement of an existing dam, or increasing the storage capacity of an existing reservoir.	\$210 to \$6,000	Fee is based on a sliding scale according to dam size.
New Mexico	Various fees for: approval of construction and operation of a dam; application for proof of completion of work; extension of time to construct a dam; and altering, repairing, or rehabilitating a dam and reservoir.	\$25+ \$2 per \$1000 of costs. \$25 for proof of completion. \$50 for time extension.	For applications to construct and operate a dam, or alter/repair a dam, or alter/rehabilitate a dam: \$25 plus \$2 per \$1,000 of estimated construction costs. For proof of completion of work: \$25. For extension of construction time: \$50.
Washington	Construction permit fee for new dams or dam modifications.	\$1,977 to \$98,532	New construction fees are based on dam size. Fees for modifications are based on the features to be modified and whether they significantly enlarge storage capacity.
Wyoming	Dam plan reviews for new and existing dams.	\$100 to \$150	\$100 or \$150 fee is assessed based on dam size.
Source: Survey of western states dam safety units conducted by Harvey M. Rose Associates, LLC.			

Division personnel reported that the design review and approval process can be time intensive. Division engineers review submitted designs and provide comments to be addressed by the owner in a resubmission that is considered part of the original application. In addition, Division engineers sometimes meet with the dam owner's engineers early in the process and review preliminary designs for projects before an application is submitted to help ensure applications are complete and consistent with

applicable regulations. Some design applications must be resubmitted more than once, but the Division does not assess additional design review fees for resubmissions unless the Division rejects the application in its entirety. The Division issued its first rejection requiring a new application and fee known to the current staff in August 2013.

Why did the problem occur?

The Branch does not regularly review its fee structure to evaluate the extent to which the fees cover costs and the fees have not been changed since 1990. In 2009 the Department of Natural Resources sought an increase in the fees as part of a strategy to reduce reliance on the General Fund. The 2009 proposal, which was not implemented by the Legislature, would have removed the \$3,000 cap on design review fees and instituted a sliding scale (4% for the first \$100,000 in construction costs, 3% for the next \$400,000 in costs, 2% for the next \$500,000 in costs, and 0.5% of all costs over \$1 million).

Why does this problem matter?

Our analysis indicates that the majority of the Division's design review costs – at least 80 percent, or roughly \$200,000 in Fiscal Year 2013 - are paid for by general taxpayers through the State's General Fund. Taxpayers across the State benefit from the design review function, which helps to ensure that dams are constructed to operate safely. However, dam owners also receive a substantial benefit from the design review services provided by the Division because they must obtain approval of their plans before they can construct, modify, or repair their dams.

The limited revenue from design review fees limits the Division's ability to increase the staff resources it devotes to design review. An increase in revenue could allow the Division to either request additional FTE specifically assigned to the design review function, or contract with outside engineers to assist with design review, thereby freeing up at least some of the time Dam Safety Engineers are currently spending on design review. The amount of time Dam Safety Engineers spend on design review may be impeding their ability to carry out other their duties in a timely manner. As noted previously, the Division is not conducting all dam inspections according to its inspection schedule. Further, Division management stated that the Division is anticipating a significant increase in design review applications as a result of 27 dams sustaining some impact from the September 2013 flooding, which will require additional personnel time to review.

Recommendation No. 6:

The Division of Water Resources should evaluate the adequacy of the fees charged for the design review function. This should include:

- a. Conducting a cost-benefit analysis of current dam safety functions, including a review of the costs of providing design reviews for new dams and modifications to existing dams compared with current fee revenue, and identifying the appropriateness of statutory changes to the design review fees.
- b. Reporting to the Legislative Audit Committee and the Water Resources Review Committee no later than December 31, 2014 on the results of the cost benefit analysis in part “a” and working with the General Assembly as appropriate on statutory changes to the fee structure.

Division of Water Resources Response

- a. Agree. Implementation Date: December 31, 2014

We agree to work with the department budget director to develop this analysis and assess the appropriateness of statutory change.

- b. Agree. Implementation Date: December 31, 2014

The results of the study discussed in 6.a. will be presented to the Legislative Audit and Water Resources Review Committees for their consideration regarding design review fees, and we will work with the General Assembly as appropriate on any statutory changes.

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