

DAM SAFETY QUARTERLY REPORT

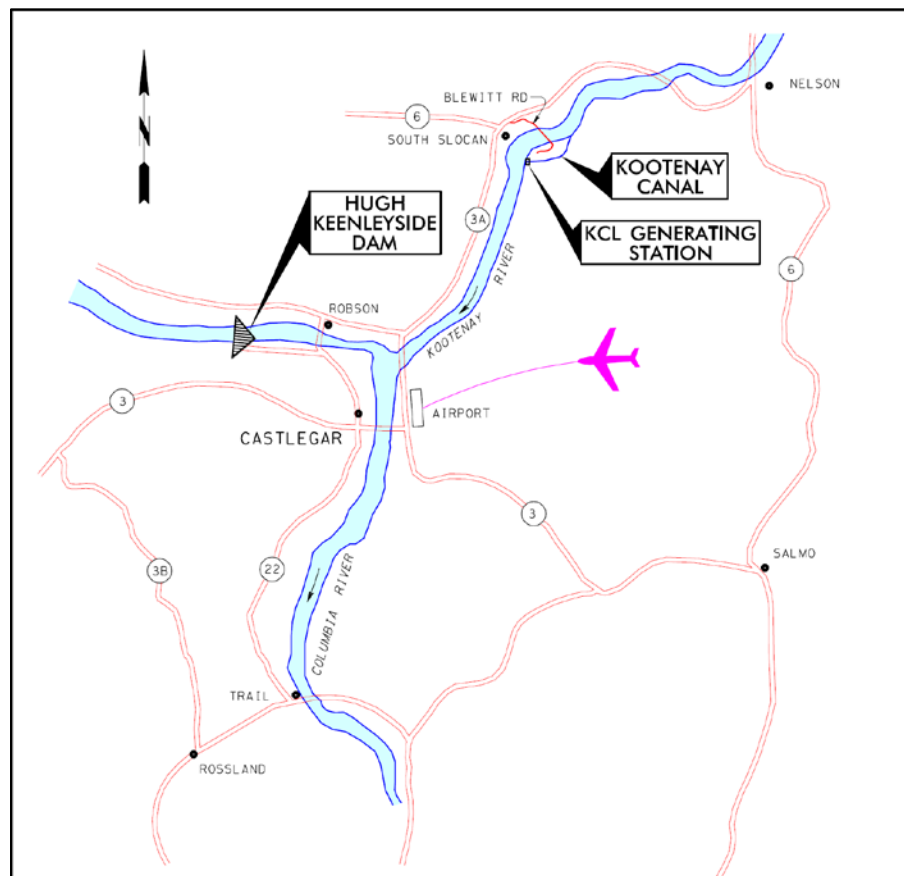
EXECUTIVE SUMMARY

The purpose of this report is to update the Capital Projects Committee of the Board of Directors on key dam risk management activities during the period from April 1, 2015 to June 30, 2015, and to provide reasonable assurance that the safety of dams operated by BC Hydro continues to be managed to the established guidelines and criteria of the Dam Safety program.

The Dam Safety Program has been carried out consistent with its stated objectives throughout the reporting period. The overall Dam Safety risk profile is shown in Figure 1. There is an overall decrease in the risk profile this Quarter due to the completion of a downstream berm at Hugh Keenleyside dam as well as the re-rating of issues at Clowhom Dam and Falls River Dam.

QUARTERLY FEATURED DAMSITES – KOOTENAY CANAL

Kootenay Canal is located on the left (south) bank of the Kootenay River about 20 kilometres upstream of Castlegar and 20 kilometres downstream of Nelson. It was completed in 1975 to take greater advantage of the hydro-electric potential of the Kootenay River, in complement to the five existing hydroelectric plants on this stretch of the river that are owned by other utilities. The Kootenay Canal flow is regulated by the upstream Duncan (BC Hydro) and Libby (US Corps of Engineers) dams as well as the operation of Corra Linn Dam (Fortis), at the upstream end of the canal. An intake gate structure can be used to isolated the canal from the Corra Linn forebay.



Kootenay Canal location

The invert of the entire length of the canal has been excavated down to rock. Along the right side of the canal where the bedrock drops away, the canal is retained by two concrete-faced rockfill dams and one zoned earthfill dam. At the downstream end, the forebay is formed by a 143 metre long main

DAM SAFETY QUARTERLY REPORT

concrete gravity dam with a maximum height of 38 metres and the North forebay concrete-faced embankment. All five dams are reported together in the Risk Profile, and have a Very High consequence classification.

An unlined rock tunnel with concrete inlet and outlet diverts Rover Creek underneath the upstream end of the forebay. The forebay is fully concrete lined. The power intakes are located in the main concrete gravity dam, and four 6.7 metre diameter steel penstocks extend from the Power Intake to a surface powerhouse containing four 125 MW turbine generator units.



Kootenay Canal Development

Kootenay Canal has a history of leakage events originating in 1976, shortly following the first filling of the canal, due to differential settlement of concrete faced slabs in the forebay. Minor repairs to perimeter joints were completed and dive inspections occurred annually through the 1990s. Tolerable leakage ensued until the next major event in 2003.

2003 Canal Leakage

On December 17, 2003, leakage through the toe of the North forebay embankment section, about 75 metres upstream of the Power Intake, inundated the switchyard and powerhouse access roads. The leak resulted from a displaced concrete slab (Slab 579) in the canal lining immediately adjacent to the concrete gravity dam. The displaced concrete slab had settled over 150 millimeters, exposing the underside of the adjacent slab. The leak was stopped by dumping sand, gravel and pumice on top of the displaced slab from the top of the north gravity dam. A temporary weir setup on that day recorded flows on the order of 250 liters/second. No further work was required at that time to reduce the leakage to tolerable levels. It is surmised that ongoing historical leakage in this area caused washing out of fines from underneath the slab. This caused the slab to settle and created a larger opening for water to enter, causing more fines to be washed away. Annual inspections showed no signs of further deterioration until 2006.



2003 Leakage from the toe of the north embankment

2007 Patchwork and 2008 Investigations

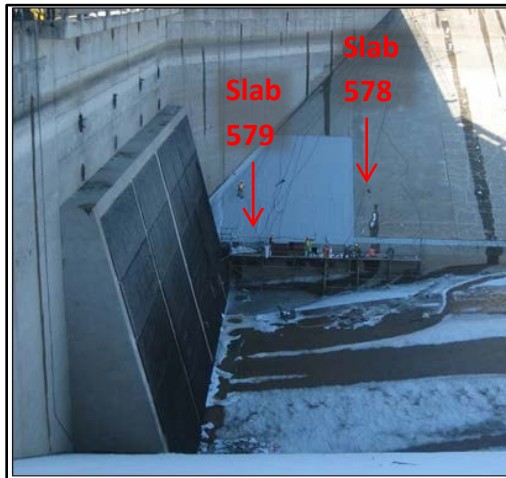
The annual underwater inspection in 2006 noted cracking near the upper end of Slab 579 and two nearby cracks in the adjacent Slab 578. In 2007, the divers found that these latter cracks had greatly increased in length and new cracks had developed in Slab 578. Remediation was completed 3 months later that included installation of a reinforced concrete patch placed underwater, slightly larger than Slab 579 and overlapping Slab 578 by about 1 metre. The overlapping patch was intended to prevent a larger leak resulting from another sudden drop of Slab 579 which could expose the fill underlying the canal liner slabs and cause another leakage event. Dive inspections in early 2008 found no new cracking in Slab 578 and the concrete patch was reported to be in good condition. A late 2008 dive inspection showed signs of vertical offsetting in the cracks in Slab 578 with leaves and twigs protruding from the cracks, indicating major leakage inflows. The slab degradation was assessed to require further remediation as soon as practicable.

2009 Interim Slab Leakage Project and North Forebay Toe Drainage System

The canal was dewatered in March 2009 and CARPI geomembrane was installed over both the 2007 concrete patch as well as most of Slab 578. During the planning for the CARPI work, a 2001 photograph of the dewatered canal was found that showed an area on the opposite side of the forebay with water flowing out of the lower joints of two slabs (Slabs 666 and 667). The scope of work was increased to cover the lower diagonal joints in this area (known as the Chevron area).

In late 2009, a drainage system was installed along the toe of the North Forebay Embankment Dam to manage and measure flows from any future leakage events. The drainage system involved the installation of a 900 millimeter diameter perforated drain pipe to carry flows to a new automated weir. Close monitoring continued, and indicated that further work to reduce leakage would be required, particularly on the south side of the forebay. This was prioritized and a project was initiated in 2014.

DAM SAFETY QUARTERLY REPORT



(Left) 2009 CARPI geomembrane on Slabs 579 and 578; (Right) 2009 CARPI repair on Slabs 666 and 667 on south forebay (left, upstream; right, downstream sides of Chevron)

2014 Forebay Leakage Improvement Project

The main objective of the project was to actively seal sources of leakage through the North and South Forebay Embankments. Priority was given to the South Forebay Embankment due to the higher consequences of a leak event on the south side, including potential flooding of the powerhouse. A weighted filter drain (toe berm) was first constructed at the downstream toe, adjacent to the South Gravity Dam. This was envisioned as an early attention item but would also provide long-term benefits for future seepage. Approximately 9,425 m² of additional CARPI geomembrane was installed on the North and South Forebay Embankment slabs. In addition, roughly 685 linear meters of geomembrane strips were installed over select expansion joints between concrete slabs. The installation areas were primarily focused on slabs and their plinth contact, near the dam face. Since the completion of installation, measured leakage through forebay embankments has been minimal.



2014 Completion of the Forebay CARPI geomembrane and drainage system

DAM SAFETY QUARTERLY REPORT

UPDATE ON OTHER MAJOR DAMSMica Dam

Final piezometer upgrades were completed in Q1, addressing the deficiency in regard to the under-instrumentation of this extreme consequence dam. All new instruments are all commissioned and in-service. Project documentation continued in Q1 and is targeted for completion in Q2.

Revelstoke Dam

Updating of the left bank rock slope geologic model continued in Q1, incorporating the new information obtained from recent drilling. The new geologic and piezometric information will be used for a stability re-assessment.

The instrumentation installation project for the Left Bank slopes, initiated in F2015, is in progress. The field work is targeted for completion this summer.

La Joie Dam

Progress continues to be made to improve the functionality of the water passages. In Q1 most of the work on the North Conduit drain valves were completed. A few small outstanding items remain and will be addressed during the next available outage window. Project document continued in Q1.

Terzaghi Dam

Work is in progress to determine the performance of the dam for the updated seismic hazard. The first phase analyses and reporting has been completed. The scope and funding for the second phase of investigations have been approved in Q1, and work is scheduled to start in Q2. An external Dam Safety Review was completed and is currently under review.

WAC Bennett Dam

There are five ongoing dam safety projects:

Condition of the spillway (deterioration of the spillway chute concrete surface)

As previously noted, the second year of construction has been deferred until next year (2016) due to reservoir conditions.

Spillway gate reliability

The project will upgrade selected electrical and mechanical components of the three spillway gates as the first of a multiple stage program to improve the reliability of gate operations. The project is currently in Definition Phase. Issues with some of the gears have been identified, and an interim risk management plan has been put in place.

Long-term performance of the dam core

The work plan for F2016 was approved in Q1. Work continued on the failure modes assessment and the review of the seismic geophysical data.

Casing Upgrades

This project was initiated to address the leaky open casings in the core, while retaining their usefulness where applicable. This project will be implemented in phases, and the first part

DAM SAFETY QUARTERLY REPORT

includes the grouting of selected observation wells and drill holes. This work is targeted for construction in spring-fall 2015. In Q1, the construction work was awarded to the drilling contractor, and field trials of the proposed injection grouting methodology were successfully completed. The Contractor mobilised to Bennett Dam in June, and the grouting work has been started.

Further work is required to address the remaining drill holes and other instrumentation in the dam core. This assessment will start in F2016, continue for the next year, and any construction/remediation work will be carried out in following years.

Condition of the riprap layer protecting the upstream face of the dam

In Q1, work continued on the preliminary design, including an external review of the cost estimate. Draft procurement strategies for the construction were developed and are under consideration.

Ruskin Dam

Work is progressing with the demolition of the first three existing piers and the construction of new piers. In Q1, the existing piers 2 and 3 have been removed, and the new piers are nearing completion. The new gates 1 and 2 have been mobilized to site and assembling of the gates is in progress.

It was previously identified that the need for further anchoring of the Spillway would not impact the current construction project scope. In Q1, the consultant continued with the development of numerical models.

Campbell River System

Recent and ongoing work at the three sites is as follows:

Strathcona Dam

The project to construct a new Low Level Outlet is in a preliminary 'needs' phase to identify project requirements. A number of decision framework meetings were held in Q1. Based on these meetings, a project plan for the first part of the Identification phase was developed.

Ladore Dam

A first draft of the summary report on investigations to assess the seismic withstand of the dam has been prepared and reviewed. Preliminary results show that some remedial work will be required. Preparation of a second draft of the summary report is in progress.

John Hart Dam

This project was initiated in F2011 to address the seismic deficiencies associated with the dams. In Q1, work continued on the conceptual design of the earthfill dams and planning for the next phase of the project. Also in Q1, the John Hart Dam Advisory Board members were selected, and the first meeting is scheduled for August/September.

NEW ISSUES

No new issues were identified this quarter.

GATE MAINTENANCE AND TESTING

During the period of March to June 2015, 78 scheduled gate tests at 23 sites were carried out. One gate system failed to operate on demand during testing or normal operations. In 11 other cases, gates operated on demand however certain equipment malfunctioned or was found to be in near-fail condition.

As per June 2015, operational restrictions were in place on 5 out of 111 flood discharge gates due to known deficiencies (small change from the previous quarter). In addition, 10 out of 111 flood discharge gates were locked out for construction and operational reasons (no change in the last quarter).

A total of 37 corrective maintenance issues were identified through ongoing testing and maintenance between March and June 2015. A total of 32 new and previous issues were addressed in the same period, for an increase of 5 issues overall in this reporting period. There are now 71 corrective maintenance issues outstanding at the end of June 2015, compared to 45 as of one year ago. The figure has slowly increased over the year, to an unprecedentedly high number since April 2009 when the statistical tracking started. Discussions have been held with Generation Operations, and a review of this situation is underway.

CIVIL MAINTENANCE

The F2016 program is based on a \$4M budget that covers all currently identified items with a Corporate Risk Score of 9.5 and higher. To date 12 of 35 projects are substantially complete. However, planning issues involving environmental and First Nations issues, conflicts with outages or spills have resulted in 3 projects being deferred until next year, and 2 projects being rolled into other ongoing projects. Current spend for the program is just over \$1M. Completed projects are: Bridge River 1 Penstock inspections and tunnel concrete repairs; LaJoie dam face joint repairs; Mica Unit 4 penstock, draft tube and outlet works inspection; Revelstoke Unit 2 penstock and draft tube inspection, Revelstoke 731 Block scaling, walkway repairs and access improvements; Downie Slide helicopter pad repairs; Checkerboard creek road repair; and an underwater inspection of the Falls River Dam face.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

Emergency Preparedness¹

No emergency planning guides were issued in Q1. Updates to the Hugh Keenleyside, Kootenay Canal and Duncan Dam emergency plans are in progress. A Bridge River Generation external agency tabletop will be conducted in July .

Public Safety²

Starting this Quarter, all Public Safety Management Plans (PSMPs) are being reviewed on a 3 yearly basis. The plan in F2016 is to complete 9 PSMPs; 3 were completed in Q1. High risk items identified from the reviews for remediation will be forwarded to Generation Asset Management for consideration and scheduling. A study initiated to document and review the use of warning sirens and strobes downstream from spillways to mitigate high risk items has been completed and is under review.

¹ Emergency Preparedness is managed by the Strategic Emergency Management team. Dam Safety audits the updating of emergency plans for compliance with the BC Dam Safety Regulation.

² Public Safety is managed by the Public Safety team in Safety Engineering. Dam Safety audits Public Safety activities related to dams.

COMPLIANCE WITH PROCESSES AND REGULATION

The Annual Compliance Reports for all dams and the Annual Instrumentation Plan were submitted in June. Approval was requested and granted for the WAC Bennett Dam Core Upgrade project in Q1.

Two Operation, Maintenance and Surveillance Manuals (Site 15A and Valleyview Substation Dike) were submitted in Q1.

A meeting between the Comptroller of Water Rights and the Director of Dam Safety took place in Victoria in April, 2015 to continue discussions on longer-term plans to develop a policy framework for evaluation of risk decisions. The meeting was facilitated by Dr. Ben Ale and also included staff from the Ministry of Transportation and Infrastructure, the Ministry of Energy and Mines and the Ministry of Forest, Lands and Natural Resource Operations. On the basis of these discussions, approval was received from the Comptroller of Water Rights in regards to the risk management strategy for the Jordan River System. This is a significant milestone in the establishment and acceptance of dam safety risk-informed decision making.

Inspections

Overall regulatory expectations were met in Q1 for weekly and monthly dam safety inspections. Three of 403 scheduled inspections for Q1 were not completed, due to staffing conflicts.

Dam Safety Reviews

Dam Safety Reviews are a regulatory requirement carried out at minimum intervals of every five to 10 years at high, very high and extreme consequence dams.

Five external Dam Safety Reviews are in progress for F2016 for Buntzen, Falls River, Elsie, Spillimacheen and Salmon River Diversion Dams. Contracts were awarded in early Q1 and the site visit for the Buntzen Review was carried out. The final reports for La Joie, Terzaghi and Seton were received in Q1. All findings for the F2015 Dam Safety Reviews will be reviewed and entered into the dam safety issues database over the next few Quarters.

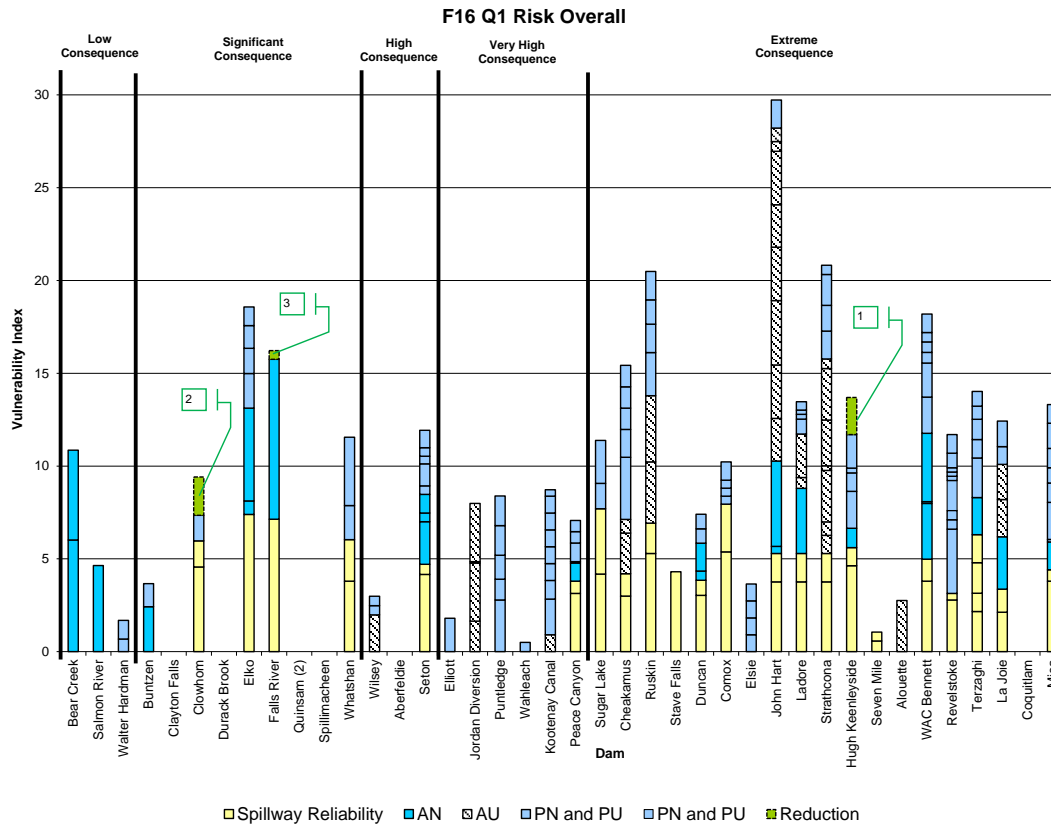
VULNERABILITY INDEX: UPDATE

Changes in Vulnerability Index for actual and potential deficiencies, as outlined in Figure 1, are tracked on a quarterly basis and shown on Figures 2 and 3. This is an indication of the changes in the understanding of the dam safety risk profile.

In Figure 3, the total index is shown (sum of actual and potential deficiencies), as well as separate plots for decreases and increases in the total index. Decreases are due to remediation projects as per the Capital Plan and resolution of issues via Performance Investigations. Increases in the index are due to the recognition of new issues. Existing issues are re-examined on a regular basis, and re-rated as required.

DAM SAFETY QUARTERLY REPORT

FIGURE 1 - DAM SAFETY: OVERALL RISK PROFILE



Legend and Summary of Changes:

Increase in Risk

None

Reduction Risk

- 1. Hugh Keenleyside Dam** – the vulnerability associated with leakage through the right abutment at high water levels has been mitigated by construction of a downstream filter berm
- 2. Clowhom Dam** – derated consequence category due to removal of forestry worker accommodation barge
- 3. Falls River Dam** – issue re-rated on basis of external report regarding acceptability of penstock for operation.

A – Actual deficiencies have been shown to exist.
 P – Potential deficiencies require further investigation.
 N – Normal Load conditions; associated with daily or short-term operations.
 U – Unusual Load conditions: associated with flood and earthquakes

Consequence classifications reflect current BC Dam Safety Regulations.
 Dam order reflects generally increasing downstream consequences

NOTES:

- Vulnerability Index (Rating) is a qualitative assessment of future dam performance from all causes – the higher the rating the higher the likelihood of poor performance.
- 34 dam sites as identified have reportable risk at present
- This Risk Profile represents only currently known and rated issues. Changes do not necessarily indicate a physical change to BC Hydro assets that increase or decrease risk; rather they often represent a change in knowledge and understanding of the risk. Additionally, many known deficiencies (those without a direct impact on potential dam failure) have yet to be rated.

FIGURE 2 – CHANGE IN VULNERABILITY INDEX

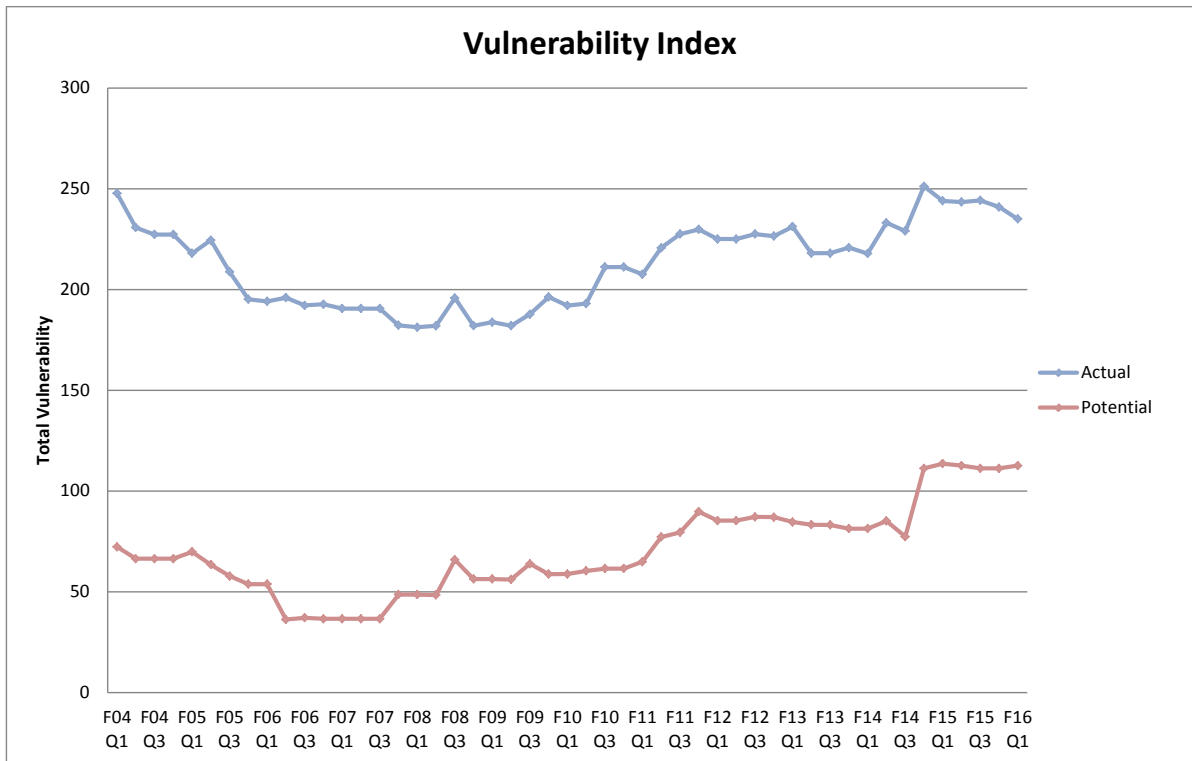


FIGURE 3 – CHANGE IN VULNERABILITY INDEX COMPONENTS

