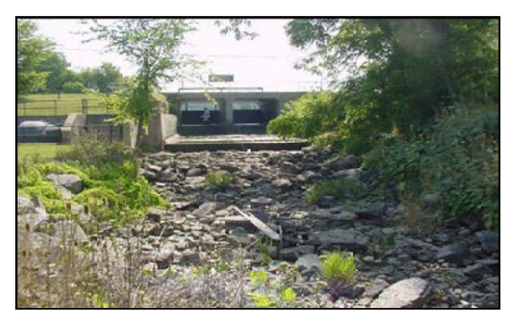
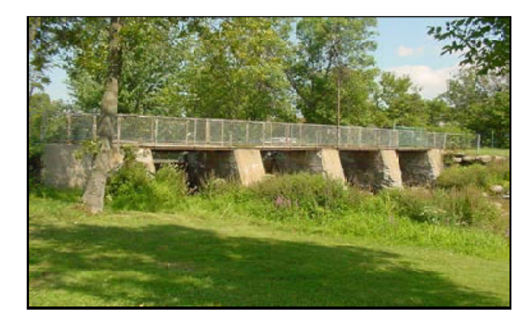
Safety & Maintenance Assessment Study
For Water Control Structures

CATARAQUI REGION
CONSERVATION AUTHORITY



Safety & Maintenance Assessment Study for Water Control Structures





Trow

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EXECUTIVE SUMMARY

To arrive at rehabilitation requirements for the eleven studied water control structures within the Cataraqui Region Conservation Authority (CRCA), an office review of existing data and a field site inspection were conducted. Ten of the sites are owned and operated by the CRCA with the other owned and operated by a municipality (Loyalist Township).

Of the eleven sites, two are channelizations that convey storm water runoff within an urban development in a manmade channel. Another site is described as a dry stormwater detention pond. The remaining eight sites are dams with typical functions of flood control, recreation, wetlands and wildlife preservation, and flow augmentation. The municipal dam site creates a head pond for a grist mill structure. The mill still functions, on occasion, as a tourist site. Several sites are in the same watershed and on the same watercourse.

The site inspections confirmed the structural elements of each structure only as related to the design drawings where these drawings were available. From communications with CRCA staff, their historical inspection reports and the site inspection conducted as part of the work program for this study, deficiencies were noted and are presented in Section 3 of this report.

Section 4 describes the hydrotechnical requirements to be able to prepare a Site Operations Plan. Such plans define the operations at each dam, not only the typical seasonal procedures, but during events having significant runoff. The inflow design flood (IDF) also has to be determined. An Emergency Preparedness Plan can be produced from the Operations Plan. This Emergency Preparedness Plan provides a protocol of notification of key personnel and operational requirements to mitigate and/or minimize loss of life and reduce property damages for storm events having a greater return period frequency.

Section 5, Geotechnical Investigations, references the draft 1999 Ontario Dam Safety Guidelines (ODSG) and the criteria used for evaluating structural stability for concrete structures and earth embankments. Geological information along with the type, material composition and size of the physical structure are assessed. The pressures exerted on this structure by the water in the reservoir including ice, wave action and earthquake conditions are estimated. The stability of the structure is calculated in order to determine if the dam meets the safety factors set in the ODSG.

The Hazard Classification is described in the Dam Safety Inspection Forms of the Authority. This designation takes into account the evaluation taken under the ODSG and considers loss of life and property damage with reference to reservoir size. Section 6 has summarized the Hazard Potential Classification of each site. Four of the sites have a rating of high, two of significant (one a channelization) with the balance being low or no rating provided.

Section 7, Rehabilitation, identifies measures to be undertaken to address deficiencies including Operations, Materials and Maintenance, and Safety of both the public and operator. Where there is a lack of information to be able to conduct a stability analysis per the ODSG, data gaps are noted.

CRCA has asked that the deficiencies be prioritized and that a ranking for undertaking this work be provided. A two-part program has been suggested. Firstly, each site should be ranked according to its hazard classification. Where the classification is rated significant to high, the necessary studies and data collection should be undertaken to determine the stability of the dam along with any remedial measures, both short and long term. The existing operation plans for the dam sites would need to be amended and updated to meet current guidelines as part of this program. Implementation of remedial measures including reconstruction would be ranked accordingly. Secondly, deficiencies would be evaluated related to operations, maintenance and materials, and operator and public safety. Safety should have the greatest priority. Operations that impact on the ability to pass floods at the dam relate to the ability of the operator to access the site and to remove logs safely and expeditiously. Operational deficiencies of this nature should be given a high priority. Maintenance of the dam should only be undertaken should the structural integrity of the dam be deemed adequate. Areas showing signs of potential failure such as stability need to be properly evaluated before undertaking remedial measures. A physical assessment of existing dam materials may need to be undertaken. Maintenance to facilitate operations would have a higher priority.

Safety can be improved at many of the sites. Noteworthy is the condition of the Babcock Mill Dam. This dam is considered to be in such a serious state of disrepair that operations should be discontinued to protect both the public and operator. Safety measures that could be readily implemented at other sites are increased signage with better visibility, provision of operator safety clothing, having two staff at each site during operations, additional fencing and barricades, and a fall protection system for operators when they are on the control structure deck.

Operational Plans exist for nine of the eleven sites. However they require changes to meet current standards and guidelines. The majority of watercourses have stream gauges, but four of the structures are located on watercourses without gauges. Many low flow valves are not operated. The need for these valves should be assessed at each dam. Measures can be implemented to provide for easier operation and reduced maintenance at these valves. Removal of stop logs at periods of high flow is considered to be problematic. A few sites use pulleys to raise the logs. These should be replaced with a winch system. Where there is more than one bay and several logs per bay, and where logs are manipulated frequently, an alternative method of stop log adjustment should be considered. The Ministry of Natural Resources is using a gantry system in these instances. Staff gauges are typically imperial, generally set to geodetic and at a location where the water level would be influenced by the drawdown at the control structure. New metric gauges placed at a suitable location away from the flow should be installed at all dams.

Typically, the older the dam, the greater are the material deficiencies. Facilities constructed in the 1970’s to date showed little deterioration of the concrete. Structural repairs need to be undertaken where the cracking is pervasive and deterioration consisting of spalling and drummy concrete is evident. The method of repair, including materials, needs to be determined. Experienced workmen need to undertake these repairs. Other areas of deterioration should be monitored regularly.

Significant seepage was noted at two sites, each where the road embankment acts as a dam. There may be other sites where seepage was not readily apparent. There are no visual signs of embankment stress. Vegetation did not permit ease of viewing. A detailed site inspection should be undertaken when vegetation has been maintained or is at a state where the ground surface can be seen. Where seepage is evident or suspected, geotechnical investigations should be undertaken, remedial measures identified and a rehabilitation program implemented.

The CRCA should implement a program of completing the detailed dam safety assessments including programs of data collection (site topography, structure confirmation), office studies (geological, hydrotechnical), determination of dam stability, confirmation of Hazard Potential, conduct dam break analysis where warranted, and prepare the respective reports including Operations and Emergency Preparedness Plans. Additional field programs may include a geotechnical evaluation of structure materials and soil/bedrock conditions along with instrumentation as necessary, and underwater inspections to determine material conditions, and seepage at foundations and within the structure.

Section 8 summarizes the recommended work programs required to complete the dam safety assessment in accordance to the draft ODSG and Occupational Health and Safety Act.

1.0 INTRODUCTION

1.1 GENERAL

In July 2003, the Cataraqui Region Conservation Authority (CRCA) retained Trow Associates to undertake a Dam Safety and Maintenance Assessment for the ten water control structures owned and operated by the CRCA, and one additional structure owned and operated by Loyalist Township.

The Assessment involved:

1. Collection and Review of Background Information
2. Site Reconnaissance, Field Surveys and Inspections
3. Preparation of a Report Documenting the Project Procedures, Assumptions, Findings and Recommendations to assist in the Implementation of the Rehabilitation of the Dams.

1.2 WATERSHEDS

The eleven structures are scattered across six watersheds (Figure 1.1):

- Sydenham Lake Dam, Millhaven Dam, and Babcock Mill Dam are located within the Millhaven Creek Watershed.
- Highgate Creek Channelization is found within in the Highgate Creek Watershed.
- Little Cataraqui Creek Dam is located in the Little Cataraqui Creek Watershed.
- Temperance Lake Dam and Marsh Bridge Dam are located within the Leaders Creek (tributary of Gananoque River) Watershed.
- Fred Grant Dam is located within the Lyn Creek Watershed.
- Broome-Runciman Dam, Buells Creek Detention Basin, and Booth Falls Channelization are located in the Buells Creek Watershed.

1.2.1 Millhaven Creek Watershed

The Millhaven Creek Watershed drains in a generally southwest direction through three municipalities (South Frontenac Township, City of Kingston and Loyalist Township) toward Lake Ontario. The headwaters of Millhaven Creek are located at Gould Lake and then it flows into Sydenham Lake, which is controlled by the Sydenham Lake Dam. The creek continues through the Town of Sydenham and into a large Provincially Significant Wetland (PSW) complex, controlled by the Millhaven Dam. The creek next flows past the Millhaven Dam, over Potters Dam (just upstream of Highway 2), and then past the Babcock Mill Dam (south of Highway 2).

The drainage area of Millhaven Creek at the Sydenham Lake Dam, the Millhaven Dam and the Babcock Mill Dam are approximately 59 km^2, 123 km^2 and 127 km^2, respectively.

The headwaters of the watershed are located within the Canadian Shield rock formation and drains into the Napanee Limestone Plain. Soils within the watershed are generally fine silt and clay with some glacial till.

1.2.2 Highgate Creek Watershed

The Highgate Creek Watershed drains in a generally southwest direction within the City of Kingston and empties into Collins Bay. The watershed starts just south of Highway 401 in two branches (East and West). The East branch has been mostly enclosed, while the West branch remains aboveground. The two branches converge just downstream of Highway 2.

The watershed has been highly developed with a lack of stormwater controls, resulting in flooding and erosion problems downstream. The Channelization, between Carmil Boulevard and Prince Charles Drive, was an attempt to minimize the flooding problems in a particular two-block section.

The drainage area of the creek upstream of the Channelization is approximately 3.7 km^2.

The watershed is situated on the Napanee Limestone Plain with soils comprised of glacial till.

1.2.3 Little Cataraqui Creek Watershed

The Little Cataraqui Creek Watershed drains in a generally south direction through the City of Kingston. There are three identified branches; East, Main and West. The East branch starts just northwest of Highway 401 and Perth Road (Division Street), and drains southwest to join with the Main branch at Counter Street. The Main branch starts near Montreal Street and flows southwest through the Little Cataraqui Creek Conservation Area, passing the Little Cataraqui Creek Dam. The West branch starts southeast of Highway 401 and Gardiners Road. It drains generally south, then curves northeast to join the Main branch north of Bath Road.

The drainage area of the watershed at the Little Cataraqui Creek Dam is approximately 20 km^2.

Bedrock within the watershed consists of the Napanee Limestone Plain. Surficial soils include silty sand and lacustrine deposits.

1.2.4 Leaders Creek Watershed

Leaders Creek is a tributary of the Gananoque River Watershed and generally drains in a southwest direction through the townships of Athens, Front of Yonge and Leeds & the Thousand Islands. The headwaters of the creek drain to Temperance Lake. Flows from Temperance Lake pass the Temperance Lake Dam into Centre Lake. The Marsh Bridge Dam forms the divide between Centre Lake and Graham Lake. There is another outlet from Centre Lake that has been used in the past to divert water from the lake to Lees Pond on the Lyn Creek Watershed. Water then flows over the Graham Lake Dam (owned by the Ministry of Natural Resources) into Leaders Creek and then into Charleston Lake. Water then eventually empties into the Gananoque River.

The drainage area of Leaders Creek at the Temperance Lake Dam is approximately 7 km^2, while the drainage area upstream of the Marsh Bridge Dam is approximately 21 km^2.

Geology within the watershed belongs to either the Napanee Limestone Plain or Canadian Shield formation. Some ground moraines are found within the Plain.

1.2.5 Lyn Creek Watershed

The Lyn Creek Watershed drains in a generally southeast direction from Lees Pond in Elizabethtown-Kitley Township, past the Fred Grant Dam and through the Town of Lyn where it joins with Golden Creek.

The drainage area of Lyn Creek at the Fred Grant Dam is approximately 15 km^2.

Bedrock geology for the Lyn Creek watershed belongs to the Napanee Limestone Plain and the Canadian Shield. The overburden consists of lacustrine, beach and silty deposits.

1.2.6 Buells Creek Watershed

The Buells Creek Watershed drains in a generally south direction from the City of Brockville/Elizabethtown-Kitley Township boundary through the City of Brockville.

The headwaters of Buell Creek start within the Mac Johnson Wildlife Area and drain into the reservoir formed by the Broome-Runciman Dam. The creek then flows south to Laurier Boulevard and through the Brockville Memorial Centre Sports Area, which contains the Buell Creek Detention Basin. The main outlet of the Detention Basin has redirected the water south through the main outlet structure to Parkdale Avenue. The original creek path to the west that passes through the basin itself is maintained and empties through an auxiliary outlet structure under Magedomo Boulevard. However, this is where major flows from the storm sewer network enter the basin. The auxiliary outlet backs flow into the basin for storage and slow release. Flow from the auxiliary outlet crosses the St. Lawrence College property and joins flow from the main structure outlet just upstream of Parkdale Avenue. At this point the creek flows south and eventually passes under Central Avenue. The creek is then directed straight south to the Booth Falls Diversion. The Diversion was cut to allow floodwaters to flow straight instead of having to turn 90 degrees to the left and then 180 degrees to the right.

The drainage area of the Buell Creek Watershed at the Broome-Runciman Dam, Buell Creek Detention Basin and the Booth Falls Channelization are approximately 8 km^2, 13.4 km^2, and 16.8 km^2, respectively.

The Napanee Limestone Plain forms the geology of the Buell Creek watershed. The surficial deposits are a mix of lacustrine, beach and outwash deposits.

2.0 SITE RECONNAISSANCE AND BACKGROUND INFORMATION

2.1 SITE RECONNAISSANCE

2.1.1 General

In August 2003, CRCA and Trow personnel carried out a site reconnaissance of each of the eleven structures.

The site reconnaissance was undertaken to inspect and digitally photograph each structure (pertinent photographs of the structures are included in Appendix A) and surroundings to establish requirements for safety, maintenance, and operations, as well as any future safety assessment requirements.

The location and directions to reach each structure are given below:

2.1.1.1 Sydenham Lake Dam

The dam is located in South Frontenac Township (former Loughborough Township). It can be reached from Kingston by travelling north on Sydenham Road to Rutledge Road (Country Road 5). Proceed west to Wheatley Street and then turn right onto George Street and travel 0.2 km to the dam.

2.1.1.2 Millhaven Dam & Reservoir

The Millhaven Dam is located in Loyalist Township (former Ernestown Township). It can be reached from Kingston by travelling west on Highway 401 to the Town of Odessa. Take the Wilton Road exit and travel 0.5 km north to the dam.

2.1.1.3 Babcock Mill Dam & Diversion

The dam is located in Loyalist Township (former Ernestown Township). The dam can be reached from Kingston by travelling west on Highway 401 to the Town of Odessa. Take the Wilton Road exit and travel south to Main Street. Turn right on Main Street and then left on Bridge Street and travel 0.5 km to the park on the left-hand side.

2.1.1.4 Highgate Creek Channelization

The Highgate Creek Channelization is located within the City of Kingston (former Kingston Township). The start of the Channelization is at Carmil Boulevard, 0.7 km from Collins Bay Road. The channel ends at Prince Charles Drive near Brookside Drive.

2.1.1.5 Little Cataraqui Creek Dam

The dam is located in the southeast section of Little Cataraqui Creek Conservation Area in the City of Kingston (former Kingston Township). Access to the Conservation Area is via Perth Road, 2 km north of Highway 401, and access to the dam can be made via a service road past the main office for the Conservation Area.

2.1.1.6 Temperance Lake Dam

The Temperance Lake Dam is located in Athens Township (former Rear of Young and Escott Township). The dam can be reached from Brockville by travelling northwest on Country Road 29 to Temperance Lake Road (Country Road 28). Turn west on Temperance Lake Road and travel 5.5 km.

2.1.1.7 Marsh Bridge Dam

The dam is located in Front of Yonge Township. It can be reached from Brockville by travelling northwest on Country Road 29 to Graham Lake Road, then head west on Graham Lake Road for 2.5 km.

2.1.1.8 Fred Grant Dam

The Fred Grant Dam is located in Elizabethtown-Kitley Township (former Elizabethtown Township). It can be reached from Brockville by travelling northwest on Country Road 29 to Graham Lake Road, then proceeding west until the intersection of Graham Lake and County Road 46.

2.1.1.9 Broome-Runciman Dam

The Broome-Runciman Dam is located in the City of Brockville. It is an integral part of Centennial Road and is located 2.6 km west of Stewart Boulevard.

2.1.1.10 Buells Creek Detention Basin

The basin is located in the City of Brockville. It can be reached by travelling 1.4 km immediately downstream of the Broome-Runciman Dam or by travelling 0.6 km north of Parkdale Avenue at the CPR crossing.

2.1.1.11 Booth Falls Channelization

The Booth Falls Channelization is located within the City of Brockville. It can be accessed through the park near the intersection of Stewart Boulevard and Central Avenue.

2.1.2 Dams

2.1.2.1 Sydenham Lake Dam

The Sydenham Lake Dam is a reinforced concrete gravity structure with an earth embankment. The dam structure also doubles as a road embankment. The dam consists of one control structure with two stop log bays, each containing three permanent logs and 2 logs that are placed and removed seasonally using winch structures.

The dam was constructed in the upstream portion of the watershed to provide water for a mill. The head at the dam is over 3 m and any downstream obstructions are not expected to affect dam discharge.

The recreational lake is located upstream of the dam and provides paddling and fishing opportunities, as well as creating habitat for fish and waterfowl. There are numerous cottages around the lake, which may be affected by dam failure. Downstream of the structure, there are residential developments and road crossings, which may also be affected if the structure should fail.

Access to the dam is along the sidewalk from the parking area. The sidewalk over the dam is not plowed during winter and can be slippery.

There is signage warning of fast moving water. There are also handrails at the control structure and along the headwall.

2.1.2.2 Millhaven Dam & Reservoir

The Millhaven Lake Dam is a reinforced concrete structure consisting of four steel gates and an aluminum plate low flow valve, and two overflow weirs. The gates are used solely in the summer months and are raised for the winter. The low flow valve is used for augmenting downstream flows during the summer months. The gates are raised and lowered by winch structures and the low flow valve is operated with a threaded rod and wheel.

The dam is situated within the lower one-third of the watershed. There are occasional downstream beaver dams and other obstructions that could create backwater affects, possibly affecting dam discharge.

A recreational Conservation Area is located upstream of the dam and provides paddling opportunities, as well as creating habitat for fish and waterfowl. Downstream of the structure, there are residential developments and road crossings, which could be affected if the structure should fail.

Access to the dam is along the road embankment and stepping over the guide rail. The access is open to traffic and can be slippery during winter conditions. There is a set of concrete steps down the embankment to access the north overflow weir and staff gauge.

There is signage warning of fast moving water. There are also handrails around the control structure.

2.1.2.3 Babcock Mill Dam & Diversion

Information is not available.

2.1.2.4 Highgate Creek Channelization

The Highgate Creek Channelization is a channel excavated down to bedrock with reinforced concrete walls. It has been sized sufficiently to provide capacity for high flow events.

The diversion channel was constructed in the lower portion of the watershed to reduce flood risk in the area. There are residential and road crossings in the area that could be affected should the structure fail.

Access to the channel is over the guide rails and into the channel. There are no steps into or out of the structure.

There is no signage along the structure.

2.1.2.5 Little Cataraqui Creek Dam

The Little Cataraqui Creek Dam is a combination steel sheet pile weir and earth embankment structure. There is also a low flow valve and 24 inch diameter pipe with a steel plate operated by a threaded rod.

The dam was constructed in the upper half of the watershed to create a recreational lake in the Little Cataraqui Creek Conservation Area. The fall across the dam is over 2 m, and while there are occasional downstream beaver dams, they are not expected to affect discharge at the dam.

There is a trail bridge downstream as well as a Highway 401 crossing, which may be affected if the dam fails.

Access to the control structure is across a landscaped area and down a hill. The embankment is accessed across a trail bridge, downstream of the dam structure proper.

There is signage warning of fast moving water. There are also handrails around the control structure.

2.1.2.6 Temperance Lake Dam

The Temperance Lake Dam is a reinforced concrete gravity structure and an earth embankment. The control structure consists of one stop log bay, containing six permanent stop logs and two stop logs that can be placed and removed on a seasonal basis using Jeamar winch structures.

Public Works Canada constructed the dam in the upper part of the watershed for recreation, flood control and habitat. Sometimes there are beaver dams downstream, but they are not anticipated to affect discharge at the dam.

There are no structures downstream of the dam that would be affected should the dam fail.

Access to the dam is along a trail from the parking area. The trail can be slippery during wet conditions.

There is signage warning of fast moving water. There are also handrails on portions of the control structure.

2.1.2.7 Marsh Bridge Dam

The Marsh Bridge Dam is primarily an earth embankment with a reinforced concrete spillway. There is also an 18 inch diameter low flow valve operated by a wheel and threaded rod. However, the valve is currently inoperable as the inlet area is filled with stone.

The dam was constructed in the centre of an existing lake to provide augmentation water for the mills downstream on Leaders and Lyn Creeks. There is also a bypass channel from Centre Lake to Lees Pond during periods of high water.

The outlet of the spillway is situated near some trailers in the park, which could be affected by high flows.

Access to the dam is along the park road, with parking beside the dam. Alternatively, access to the dam can be made down a narrow walking trail, which can be muddy and slippery, with a steep portion near the parking area.

There is signage warning of fast moving water. There are also handrails on either side of the weir.

2.1.2.8 Fred Grant Dam

The Fred Grant Dam is an earth-and-rock fill embankment gravity structure with a rock spillway. The dam has a control structure with two stop log bays, each containing a maximum of two stop logs placed and removed by a set of winches similar to those used on boat trailers. There is also a 12 inch diameter low flow outlet. An older low flow outlet has been sealed with clay and is inoperable.

The dam was constructed in the upper portion of the Lyn Creek watershed to provide augmentation flow to mills downstream in the Hamlet of Lyn. The reservoir for the dam is currently used as a fishing and hunting club.

There are some road crossings and residential areas downstream of the dam. The fall across the spillway is around 3 m, and there is no expected backwater affect.

Access to the dam is along a farm lane. The road is also used for access to cattle pasture land.

There is signage warning of fast moving water. Handrails exist at the control structure. There is no railing along the embankment.

2.1.2.9 Broome-Runciman Dam

The Broome-Runciman Dam is a reinforced concrete gravity structure combined with an earth fill embankment. The dam structure also doubles as a road embankment. The control structure consists of two stop log bays, each containing a maximum of nine stop logs that are placed and removed using winch structures.

The dam was constructed at the top of the Buells Creek watershed, upstream of an old mill dam. Occasionally there are downstream beaver dams and other obstructions that could create a backwater effect on the structure.

A recreational Conservation Area is located upstream of the dam and provides paddling opportunities, as well as creating a habitat for fish and waterfowl. Downstream of the structure, there are residential developments and road crossings, which could be affected during a dam failure.

Access to the dam is along the road embankment and over the guide rail. The access is open to public traffic and can be slippery during winter conditions.

There is signage warning of fast moving water. Handrails exist around the control structure.

2.1.2.10 Buells Creek Detention Basin

The Buells Creek Detention Basin is generally an excavated earth structure. There are two outlet structures. The main outlet consists of a 1350 mm diameter culvert with a steel plate (operated by a threaded rod) and a small 450 mm diameter low flow culvert. The auxiliary outlet is a 750 mm diameter culvert under Magedomo Boulevard. The plate for this outlet is operated via a wheel on top of a threaded rod.

The basin was constructed upstream of flood damage centres in the City of Brockville to help control stormwater runoff from city developments. There are major residential, institutional and commercial structures downstream, as well as road crossings, which could be affected if the structure failed.

Access to the structure is along an access road from Parkdale Avenue with parking beside the wheel and rod structure, or from Laurier Avenue in the park parking lot and a walk to the structure. The main inlet structure is accessed through the gate in the fence, and down a set of rock-and-concrete steps with a handrail. The main outlet structure is accessed through the gate and down the embankment. There are no steps or handrail. The auxiliary outlet is accessed down the embankment from Magedomo Boulevard. There is a catwalk structure, which can be used in times of high water to unblock the culvert inlet.

There is signage warning of fast moving water. There is fencing around the main outlet structure.

2.1.2.11 Booth Falls Channelization

The Booth Falls Channelization was constructed in 1980 as an excavated rock channel providing a straight connection across a natural meander in Buell Creek.

Access to the channel from the parking area is along a City of Brockville walkway and down the stream bank. The bank is steep, but there are some areas where the limestone is stepped allowing easier access.

There is no signage along the structure.

2.2 BACKGROUND INFORMATION

2.2.1 General

During the course of conducting the study and the reconnaissance survey of the dams, CRCA staff forwarded the following background information on the structures to Trow:

1. Hard copy drawings illustrating plans, profiles and sections of the dams. In some cases the drawings are not in final form or are missing details.

2. General information regarding water levels, operations, dam elevations and dam operation plans (a summary of the operations are available in Table 2.1).

3. Yearly inspection reports for the structures.

2.2.1.1 Sydenham Lake Dam

The original dam at the outlet of Sydenham Lake (originally Sloats Lake) was constructed in the mid-nineteenth century to provide power for a local mill. The mill burnt down near the end of the century and was rebuilt in the early 1900s, but burnt again in the late 1940s. The CRCA purchased the dam in 1976 and rebuilt it in 1978.

The dam was reconstructed as a reinforced concrete structure with stop log bays. There are two stop log bays, each having a 3.63 m effective width. The logs are 0.22 m (9 in) square and 3.35 m (11 ft) long. The sill elevation for each bay is 129.85 m GSC (426.00 ft). There is a 450-mm (18 in diameter low flow valve located at the sill of the north stop log bay.

There is an Ontario Ministry of Natural Resources (MNR) benchmark located on the southwest corner of the deck of the structure. The benchmark, number V010915713, was installed in 1991 and is set at an elevation of 132.244 m GSC.

Records identify the operation of the Sydenham Lake Dam as follows:

	Gauge Reading - feet	GSC – metres	GSC – feet
Maximum Acceptable Level	4.0	131.06	430.00
Minimum Level	2.5	130.61	428.50
Normal Level - Summer	3.5	130.91	429.50

Fall / Winter Operation

As winter approaches, generally late-August or early-September, stop logs are removed from each bay such that only three logs are left. The low flow valve is also closed for the winter. The timing depends on the water level of the lake and the downstream water level. The water level should be adjusted to 130.61 m (428.51 ft) to provide flood storage for fall storms and spring runoff.

Spring Operation

Three stop logs are generally left in each bay for the spring freshet. However, if the lake level reaches critical levels and there is opportunity to release greater flow downstream, stop logs can be removed or raised and left hanging thereby alleviating upstream pressure. As the lake water levels start to fall, stop logs are added to each bay to maintain levels for the summer.

Summer Operation

The dam is generally untouched throughout the summer season (4.5 stop logs in each bay). The stop logs are "jacked down" in the bays using lumber to minimize leakage and vandalism of the structure. When necessary, stop logs can be raised or lowered to maintain the summer water level of 130.91 m (429.50 ft). There is a low flow valve that can be operated; however it is currently plugged with sediment and is considered inoperable.

Records of stop log settings and lake water levels, as well as any other relevant operational notes, are being maintained.

2.2.1.2 Millhaven Dam & Reservoir

The Millhaven Dam was constructed in 1975 to assist the Town of Odessa's Water Treatment and Sewage Treatment Plants. These two plants were constructed in 1970. It was found that the creek was prone to drying up in the fall and could not meet the demands of the plants. The dam was built to store water from the spring freshet and augment flows through the drier months.

The dam is a reinforced concrete structure with 4 steel gates (width 4.57 m) and a 1.22 m (4 ft) wide by 1.83 m (6 ft) high aluminum plate low flow valve. The sill elevation for the gates is 122.83 m GSC (403.00 ft). There are also two auxiliary spillways (4.17 and 9.14 m long) on either side of the structure, set at an elevation of 124.36 m (408.00 ft) and 124.34 m (407.94 ft).

Records identify the operation of the Millhaven Dam as follows:

	Gauge Reading – feet	GSC - metres	GSC – feet
Maximum Acceptable Level	3.5	124.82	409.50
Minimum Level	0.3	123.84	406.30
Normal Level - Summer	2.0	124.36	408.00

Fall Operation

As winter approaches, generally late-September to mid-October, the four main gates and low flow gate are raised over the course of a few weeks to equalize the water elevation on either side of the dam. The timing depends on the water level of the lake. However, the process should be completed by the end of November.

Spring Operation

As the lake level rises during the spring freshet, the gates are lowered (again over the course of days or weeks) to obtain a lake water level at 124.36 m GSC (408.00 ft) by May 1st.

Summer Operation

There is a requirement for a minimum flow downstream of the dam over the summer months to provide dilution for the sewage treatment plant outfall. Generally the low flow valve is used to provide this flow. It is opened once the lake level reaches 124.39 m (408.10 ft) to provide a flow of 170 L/s. Depending on the year, the amount of rain, evaporation, and the lake levels, more than this minimum amount may be provided.

There has been a problem with beaver dam debris collecting in the low flow valve, reducing the outflow from the dam. During the summer months, a visit once or twice a week is needed to completely open the low flow valve, flush the debris, and re-set the valve.

Dam stop log settings and lake water levels, as well as any other relevant operational notes are recorded.

2.2.1.3 Babcock Mill Dam & Diversion

Information is not available.

2.2.1.4 Highgate Creek Channelization

The Highgate Creek Channelization was built in 1980 to provide a channel to pass floodwaters through a residential neighbourhood. Before the channel was built, local properties had the potential for flooding.

The channelization consists of two reinforced concrete walls founded on excavated bedrock and is about two blocks in length.

As the structure is solely used for flood control, there is no operation of the structure.

2.2.1.5 Little Cataraqui Creek Dam

The Little Cataraqui Creek Dam was constructed in 1970 to provide a reservoir, wildlife habitat, and flood protection in a new Conservation Area. The reservoir area was excavated and headlands at the eastern end were created. The dam itself was constructed as an earth-fill embankment (elevation 82.30 m GSC) on the west side and a sheet steel wall with limestone armour rock-fill on either side to the east. A low flow valve was constructed on the east side of the structure. In 1972, a movement in the dam crest (elevation 81.23 m) was observed. A relief well system was installed at that time to reduce pore water pressures in the embankment.

There is a MNR benchmark located on the south-east corner of the low flow valve concrete structure. The benchmark, number V010905201, was installed in the early 1990s and is set at an elevation of 82.30 m GSC.

The structure is not operated, except for occasional use of the 0.6-m (24 in) diameter low flow valve. The normal water surface elevation is 81.23 m.

Lake water levels are recorded, as well as any other relevant operational notes.

2.2.1.6 Temperance Lake Dam

The original dam for Temperance Lake was constructed in 1952 by Public Works Canada to stabilize lake levels, act as a reservoir for headwater storage, improve wildlife habitat and for recreational purposes. The CRCA purchased the structure in 1978 and refurbished it by raising the deck and capping the wingwalls with concrete at either side of the stop log bay.

The dam is reinforced concrete with a single stop log bay. The logs are 254-mm (10 in) square and 2.44 m (8 ft) long. The sill elevation is 112.33 m GSC (368.55 ft).

The elevation of the abutment of the control structure is 114.6 m GSC.

Records identify the operation of the Temperance Lake Dam as follows:

	Gauge Reading – feet	GSC - metres	GSC – feet
Maximum Level	2.10	114.61	376.00
Minimum Level	0.47	114.11	374.37
Normal Level - Optimum	1.30	114.36	375.20

Fall Operation

On September 1st, the 8th stop log is removed (There are 6 permanent and 2 removable stop logs). This allows the lake drawdown to occur before muskrat and fish have established their winter habitat.

Spring Operation

Seven stop logs are generally left in the bay for the spring freshet. However, if the lake level reaches critical levels, the two removable stop logs can be removed or raised and left hanging to alleviate the upstream pressure. As the water levels start to fall, the 8th stop log is added to the bay to maintain levels for the summer.

Summer Operation

The dam is generally untouched throughout the summer season (8 stop logs in the bay). When necessary, the two removable stop logs can be raised or lowered to maintain the summer water level.

Records of stop log settings and lake water levels as well as any other relevant operational notes, are being maintained.

2.2.1.7 Marsh Bridge Dam

The original dam between Graham and Centre (Stump) Lakes was built in 1858 to divert water to Lees Pond to produce power at a mill. The CRCA purchased the dam in 1973 and refurbished it in 1974.

The dam was constructed as an earth-fill embankment, with an overflow weir. The embankment is 275 m long, and the weir is 17.4 m long. As a result of the refurbishment, the weir was relocated and constructed of concrete over clear stone. An 450-mm (18 in) diameter low flow valve was also added. The sill elevation is 107.72 m GSC.

This structure is generally non-operational. However the low flow valve could be used during periods of low water, but it is currently filled with stones and is inoperable.

The high water level is 108.04 m, with a maximum level of 108.7 m, and a regulated water level of 107.72 m.

Lake water levels and any other relevant operational notes are being recorded.

2.2.1.8 Fred Grant Dam

The original dam at Lees Pond was constructed in the late eighteenth century to provide power for mills downstream in the Hamlet of Lyn. A low flow valve was added to the centre of the structure in the 1960s. The CRCA purchased the dam in 1976 and built a spillway at the eastern end of the dam. This spillway was modified in 1993 and a stop log control structure was added at that time. The structure has two bays, each holding two 3.14 m (10.3 ft) long, 152-mm (6 in) square logs. A new 305-mm (12 in) diameter low flow valve was also added.

The original dam was constructed as an earth-and-rock fill dam. The 1960s low flow valve was constructed of concrete with a steel gate operated by threaded rod. It is currently inoperable as it is plugged at the upstream end. The spillway structure is concrete and steel with wooden stop logs. The low flow valve is a steel gate valve in PVC pipe.

The elevation of the deck of the control structure is 108.61 m GSC. The sill of the dam is at elevation 107.62 m GSC, and the low flow valve invert is 107.02 m GSC.

Records identify the operation of the Fred Grant Dam as follows:

	Gauge Reading – feet	GSC – metres	GSC – feet
Maximum Level		108.27	355.22
Minimum Level		107.60	353.02
Normal Level - Optimum		107.90	354.00

Fall Operation

On September 1st, the stop logs in each bay are removed over a two or three week period to bring the water level to 107.60 m (353.02 ft).

Spring Operation

No stop logs are left in the bays for the spring freshet. As the lake water level starts to fall, two stop logs are added to each bay to maintain the lake water level for the summer.

Summer Operation

The dam is generally untouched throughout the summer season (2 stop logs in each bay). The stop logs are locked in place to minimize vandalism of the structure. When necessary, stop logs can be raised or lowered to maintain the summer water level. There is a low flow valve that can be operated, however it is generally not used and appears partially plugged with sediment.

Dam stop log settings and lake water levels, as well as any other relevant operational notes, are recorded.

2.2.1.9 Broome-Runciman Dam

The original dam at the outlet of Buells Creek Reservoir (locally known as the Back Pond) was constructed in the mid-nineteenth century to provide power for a mill. The CRCA constructed a new dam upstream of the old structure in 1966.

The dam was rebuilt as a reinforced concrete structure with two stop log bays and is an integral part of a road culvert. The sill elevation is 100.59 m GSC (330.00 ft). The low flow valve is a 406-mm (16 in) diameter pipe. It is currently inoperable, as it is plugged with sediment.

There is a Geodetic Survey of Canada (GSC) benchmark located on the southwest corner of the deck of the structure. The benchmark, number 70U523, was installed in 1971, and is set at an elevation of 103.922 m GSC.

Records identify the operation of the Broome-Runciman Dam as follows:

	Gauge Reading – feet	GSC - metres	GSC - feet
Maximum Level	6.5	102.56	336.50
Minimum Level	4.0	101.80	334.00
Normal Level - Optimum	6.0	102.41	336.00

Fall Operation

As winter approaches, generally late-September to mid-October, three stop logs in each bay are removed. The timing depends on the water level of the lake and the downstream water level.

Spring Operation

Six stop logs (6.5 recently) are generally left in each bay for the spring freshet. However, if the lake level reaches critical levels and there is opportunity to release greater flow downstream, stop logs can be removed or raised and left hanging to alleviate the upstream pressure. As the water levels start to fall, three stop logs are added to the bays to maintain levels for the summer.

Summer Operation

The dam is generally untouched throughout the summer season (9 stop logs in each bay). When necessary, stop logs can be raised or lowered to maintain the summer water level. There is a low flow valve that can be operated. However, it is currently plugged with sediment and considered inoperable.

Dam stop log settings and lake water levels, as well as any other relevant operational notes, are recorded.

2.2.1.10 Buells Creek Detention Basin

The detention basin was constructed in 1980 to alleviate flooding downstream and provide stormwater quantity control for a developing part of the City of Brockville. The basin was excavated and a dual control structure was constructed. The main structure consists of two culverts, the larger consisting of a steel gate in the centre and the smaller acting as a low flow culvert. The auxiliary outlet is also small, and conveys water from the storm sewer outlet upstream of the basin.

The maximum water level in the basin is 98.70 m.

Fall Operation

As the ground freezes, mid November to early December, the steel gate is raised to minimize restriction of water flow. The basin was designed to provide storage for rain water, not snowmelt, and could cause flooding during a snowmelt event.

Spring Operation

The steel gate is left open until all snow has melted and the ground has thawed. If the gate has been lowered and snow falls, the gate is generally opened to store less water.

Summer Operation

The gate is left closed through the summer rain season. If needed, the gate can be opened while the basin is full to reduce water levels, but careful operation is necessary as not to cause downstream flooding.

Gate settings and water levels, as well as any other relevant operational notes, are recorded.

2.2.1.11 Booth Falls Channelization

The Booth Falls Channelization was built in 1980 to provide a channel to pass flood waters through a residential neighbourhood and schoolyard. Before the channel was built, the local properties had the potential for being flooded.

The diversion channel bottom is excavated in bedrock, and a stone retaining wall holds the soil back on the west side of the channel.

There is no operation of the structure.

2.3 GEOLOGY

2.3.1 Sydenham Lake Dam

Geological mapping indicates that the Sydenham Lake Dam site is underlain by the Gull River limestone formation, member A. Soils at the site are either Guelph loam or a shallow phase of Bondhead loam.

2.3.2 Millhaven Dam & Reservoir

Geological mapping indicates this site is also underlain by the Gull River limestone formation, belonging to members B, C, and D. Soils mapping shows that the soils are either Farmington loam, Lincoln clay or Renfrew clay.

2.3.3 Babcock Mill Dam & Diversion

Similar conditions exist for the Babcock Mill Dam as it does for the Millhaven Dam (i.e. Gull River limestone formation, Farmington loam, Lincoln clay and Renfrew clay).

2.3.4 Highgate Creek Channelization

Geological mapping for the channelization site indicates that the main geological formation is the Gull River limestone formation, member A. Soils at the site are a mixture of clays: Lincoln clay, Renfrew clay, Lansdowne clay and Napanee clay.

2.3.5 Little Cataraqui Creek Dam

The Gull River limestone formation, member A, underlies the dam site and the surficial soils are Lincoln clay, Renfrew clay or a Gananoque/Napanee clay complex.

2.3.6 Temperance Lake Dam

Geological mapping indicates that the Temperance Lake Dam site is underlain by Precambrian granite of the Algoman, Frontenac and Rockport formations. Soils mapping shows the site has soils belonging to either Monteagle sandy loam or Grenville loam.

2.3.7 Marsh Bridge Dam

Sandstone belonging to either the Cambrian, Nepean or Potsdam formations underlie the dam site and soils are a mixture of Monteagle sandy loam, Farmington sandy loam and Grenville loam, shallow phase.

2.3.8 Fred Grant Dam

The Cambrian and Potsdam sandstone formations as well as the March and Oxford dolomite formations underlie the dam site. Soils mapping for the site shows that both Monteagle sandy loam and Grenville loam, shallow phase, are located at the site.

2.3.9 Broome-Runciman Dam

Geological mapping for the Broome-Runciman Dam site indicates that rock from the Black River limestone and the March and Oxford sandstone-dolomite formations underlie the site. Farmington loam and muck are the local soils.

2.3.10 Buells Creek Detention Basin

Rock from the Cambrian sandstone and March and Oxford dolomite formations are found at the site as indicated by geological mapping. Local soils encompass Farmington loam, muck and Napanee clay.

2.3.11 Booth Falls Channelization

The Cambrian and Potsdam sandstone formations, and the March and Oxford dolomite formations underlie the dam site. Soils mapping for the site shows that Farmington loam, muck and Napanee clay are located at the site.

Table 2.1

3.0 FIELD SURVEYS, DRAWINGS, INSPECTIONS AND DEFICIENCIES

3.1 FIELD SURVEYS AND DRAWINGS

Field surveys need to be conducted to:

1. Provide North American Datum 1983 (NAD83) UTM coordinates (X, Y) at the dam.
2. Provide a Geodetic Survey of Canada (GSC) 1928 vertical coordinate (Z) at the dam site if unknown.
3. Verify dam dimensions and elevations.
4. Obtain sufficient horizontal and vertical data to supplement existing site plans.

Global Positioning System (GPS) technology can be used to establish the NAD83 UTM coordinates at the centre of the dam. Typically, two dual frequency receivers and associated software should be used to derive the UTM coordinates of the dam and the GSC vertical control elevation. The coordinates of any point established on the control structure can be determined by measuring the vectors from selected points in the Provincial database (COSINE) with known X, Y and Z. Similarly, an orthometric (Mean Sea Level; - (MSL)) elevation can be transferred from known vertical points in the Provincial database (COSINE) to the point on the control structure. Elevations are to be related to the GSC 1928 vertical datum.

The GPS system specifications for Static mode should be capable of achieving accuracy of horizontal: 25 mm and vertical: 30 mm.

After GPS derived data has been established at reference sites at the dam, conventional total station survey technology can be used to obtain horizontal and vertical data of the site and surroundings. The survey data along with relevant information from the original existing drawings can be used to prepare appropriate scaled digital metric drawings for the site. These drawings should include border-titled drawings and illustrate a plan of the site, upstream and downstream profiles, section details and text notes for clarification. These new drawings can be reduced for reporting and field usage.

The dam drawings on file at the Conservation Authority are hard copy and should be transferred to a digital format. As noted in Section 2, there is only one dam that has an as-built record.

3.2 DAM INSPECTIONS

3.2.1 Operations

The dam should be operated with knowledge of the stage-discharge-storage relationships. The dam should also have a “rule curve” for the operation of the structure.

An Operations Plan should be available with written protocol that can be used by all staff. It should contain information on the sequence of operation depending on the level of the reservoir as well as upstream and downstream conditions. It should address operations during flood conditions. According to the draft Ontario Dam Safety Guidelines (ODSG), the Operations plan should also contain information on the maintenance of minimum flows and water levels within specified limits during certain times of the year.

The staff gauge for the dam should be metric and set to a geodetic datum. It should be located at a sufficient distance that its readings are not impacted by drawdown at the dam.

Adequate records should be kept at each dam utilizing current digital drawing and management systems.

3.2.2 Maintenance and Materials

The draft ODSG requires that the dam be maintained in a safe and fully operable condition. A good maintenance program will protect against deterioration and prolong the dam's life span. Inspections at concrete structures and earth embankments should look for the following deficiencies.

3.2.2.1 Concrete Structures

Concrete Cracks

Cracking in a concrete dam occurs when tensile stresses exceed the tensile strength of the concrete. These stresses may occur because of imposed loads on the dam or because of volumetric changes in the concrete.

There are several types of cracking. The direction or orientation of a crack can be described using one of the following terms:

Longitudinal: A longitudinal crack runs parallel to the crest of the dam
Transverse: A transverse crack runs perpendicular to the crest of the dam
Horizontal: A horizontal crack runs along the same elevation of the dam
Vertical: A vertical crack runs up and down the face of the dam
Diagonal: A diagonal crack runs on an inclined plain between horizontal and vertical

Cracking in concrete dams generally falls into the following categories:

1. Structural
2. Cracks along joints
3. Shrinkage
4. Thermal
5. Pattern
6. D-cracking

Structural cracks are the most serious and are related to some feature of the dam where stress concentrations occur. In appearance, a structural crack may be:

1. Diagonal with abrupt changes in direction
2. Traverse extending from upstream to downstream
3. Wide with a tendency to increase in width
4. Adjacent to concrete that is noticeably displaced

Cracks along joints are typically construction joint cracks or cracks at places where new concrete has been placed against old concrete.

Shrinkage cracks due to drying of the concrete are fine and show no evidence of movement.

Thermal cracking is usually rectangular or blocky. Thermal-induced cracks result from tensile stresses exceeding the tensile strength of the concrete and are deeper than shrinkage cracks.

Pattern Cracking is indicated by openings on concrete surfaces in the form of a pattern. Pattern cracking results from a decrease in volume of the material near the surface or increase in volume of the material below the surface or both. Pattern cracks are an indication that a problem associated with freeze-thaw or some type of chemical reaction is occurring in the concrete.

D-cracking results from using sub-standard concrete aggregates, which absorb water then crack under freezing conditions. The cracked aggregates then cause cracking in the surrounding concrete.

Concrete Deterioration

Although cracks are a form of concrete deterioration, the following is generally considered the most common types of concrete deterioration:

1. Disintegration
2. Spalling
3. Efflorescence
4. Drummy Concrete
5. Popout
6. Pitting
7. Scaling

Disintegration is concrete crumbling into small particles.

Spalling is the loss of pieces or chunks of concrete because of compression, impact or abrasion. Although spalls are confined to the surface of the concrete and thus may not be a serious problem, spalling can lead to exposed reinforcement, create a seepage path around waterstops at joints, create an offset along the flow surface, or develop into a point of structural weakness.

Efflorescence is the leaching of calcium compounds from within the concrete and deposition on the surface due to water leaking through the joints, cracks, or the concrete itself. As calcium is leached from the concrete, cracks become wider leading to increase leakage and faster deterioration.

Drummy concrete is concrete that has a void, separation or other weakness within the concrete and can be identified by striking the dam and listening for a hollow sound. Drummy concrete has a diminished strength and is susceptible to further deterioration.

Popouts are small areas of the concrete surface that break away. Popouts are caused by expansion of deleterious coarse aggregate particles due to wetting/freezing. Popouts leave a shallow conical depression, which is subject to further deterioration.

Pitting are small cavities in the concrete caused by localized disintegration and are susceptible to further deterioration.

Scaling is flaking or peeling away of concrete or mortar surfaces and these areas are subject to further deterioration.

Causes of Concrete Deterioration

Shrinkage, thermal stress and freeze-thaw actions are causes of cracking and can also cause concrete deterioration. Other common causes of concrete deterioration are:

1. Faulty Concrete Mixes

2. Chemical Attack
    a) Sulphate
    b) Acid
    c) Alkali-Aggregate

3. Erosion

Faulty concrete mixes can result from improperly graded mixes, improper cement or water content and a lack of or improper degree of entrained air. Even good concrete mixes can become faulty if there is improper use of additives or inadequate mixing, placing, or curing procedures and equipment.

Although **chemical attacks** are very slow processes, they are undesirable reactions that occur over the entire lifetime of the structure requiring ongoing observation and maintenance.

A **sulphate attack** is a chemical reaction between sulphates in soil or ground water and concrete. The reaction causes expansion of the concrete that leads to further deterioration. Mix designs before 1930 did not consider sulphate attack and are prone to this chemical reaction. Symptoms of sulphate attack include cracking, spalling, scaling and staining.

An **acid attack** is a bacterial action on the calcium hydroxide found in hydrated Portland cement, limestone, or dolomite aggregates. This type of reaction results in leaching away of water-soluble compounds. Symptoms of an acid attack include cracking, efflorescence, spalling and color change.

An **alkali-aggregate attack** is a chemical reaction between the soluble alkali in the cement and the aggregate. A concrete mix of low alkali cements and marine sediments or shale from river gravels containing cherts is a good recipe to create an alkali-aggregate chemical attack. This type of reaction causes the expansion of concrete resulting in pervasive pattern cracking. Indicators of alkali-aggregate attack include pattern cracking, efflorescence, incrustation and white rings around aggregate particles. Dams that were built prior to 1940 of low-alkali cements or where designers failed to recognize reactive aggregate are prone to this type of reaction.

Physical Erosion can occur on spillways, aprons, piers or any other part of a dam that experiences fast flowing water containing abrasive materials. Dams located downstream of riverbeds of gravel and rocks with moderate to steep gradients are subject to abrasion erosion.

3.2.2.2 Embankments – Crest and Slopes

Embankments can be constructed of homogeneous materials (select earth fill) or a combination of materials (select earth fill and rock fill). The design of the embankment typically takes into account available materials for construction, dam operations, foundation conditions and siting. Most dam embankments are generally homogeneous. In addition, measures may be installed to enhance structural stability by controlling seepage and erosion. These measures may include cutoff walls (clay, concrete or sheet pile), toe drains and relief wells, and riprap. Dam operation can impact stability should water levels in the reservoir be drawn down quickly.

Visual signs of material stress at an embankment include cracking, slumping / bulging and settlement. Signs of seepage include visible flow at the toe, standing water or wet soil conditions and lush vegetation compared to the surrounding area. Other concerns are erosion gullies, excessive or deep-rooted vegetation and animal burrows. Riprap that is improperly sized (mass and gradation) or its placement (thickness and extent) can increase the erosion potential.

Most of the dam sites have earth embankments associated with a control structure. Several of these sites have municipal roads and public trails built on the embankment.

3.2.3 Safety

Both operator and public safety is important at a dam site. However, a higher level of safety should be considered for a dam site that is situated at or near a public area.

Danger and warning signs should be located at each site. These signs typically have red letters on a white background and are reflective in appearance noting any hazards. Danger signs identify areas of fast flowing water and changes in depth of flow and should be visible from a minimum distance of 50 m of the dam. Warning signs identify areas of no trespassing, no boating, no swimming etc. Consideration should also be given to installing buoys and warning signage with a boom in areas of boating and swimming.

According to the Occupational Health and Safety Act (OHSA), where a worker is exposed to a fall into water with the risk of drowning, a life jacket should be worn and equipment available to ensure the worker's rescue from the water.

A fall protection system is required under OHSA for a worker exposed to a fall height of 3 m or greater. There are degrees of protection to be provided. The hierarchy is as follows: avoidance, travel restrict, travel restraint, fall restrict, fall arrest and a safety net. Travel restrict is provided through a barrier such as a handrail. Travel restraint according to the OHSA definition is a harness or safety belt attached by a lifeline/lanyard to a fixed support that prevents access to any hazard/fall areas. A fall restrict system is a system that is attached to a fixed support that limits a worker's free fall. A fall arrest system consists of a full body harness and lanyard equipped with a shock absorber attached to a fixed point.

Handrails that are acting as a safety barrier should be continuous and visible. They should be securely anchored and of sufficient height, typically taken as 1.07 m.

3.2.4 Visual Dam Inspection

In August 2003, TROW undertook a detailed dam inspection to:

1. Obtain a digital photographic record of the dam, material deficiencies and important features found at the site.

2. Identify, locate and measure the material deficiencies.

3. Review operation and safety features.

The visual inspection of the upstream face of the dam was generally at the summer water level. The downstream inspection of the stop log bays was undertaken although there was slight to moderate leakage through the stop logs of the various dams. Observations at some of the structures were reduced due to vegetation.

The digital photographs taken during the dam inspection are presented in Appendix A. The photographs identify the site and the location / view.

Depth of water and aquatic vegetation restricted the visibility of the upstream face at several of the structures. Where concrete deterioration and / or seepage is a concern, a further investigation in the form of a geotechnical program of concrete coring and laboratory testing, and drilling / coring of the founding materials with instrumentation should be undertaken. In addition, an underwater inspection with video could provide greater detail of the dam condition, define areas of seepage and establish the level of sediment. Similarly at embankments where stability and/or seepage issues are probable, a geotechnical investigation should be conducted.

Material and operational deficiencies and issues are described below for each site. These deficiencies are summarized along with rehabilitation measures on Table 7-1 in Section 7, Rehabilitation. The CRCA dam inspection summary forms are presented in Appendix B. The sites have been grouped per area (west to east) and their order of listing does not reflect the structure condition or any operational issues.

3.2.4.1 Sydenham Lake Dam

<u>General</u>

Sydenham Lake Dam is located within the Community of Sydenham in South Frontenac Township (former Loughborough Township). The dam is on Millhaven Creek and is part of a bridge crossing of George Street. Millhaven Creek flows westward at this site. There are two stop log bays and extensive dam segments on either side of the control structure extending to the lake shoreline. A low flow valve is situated in the raised sill of Bay 1. The control structure is integral with the bridge. The bridge is maintained by the Township. There are sidewalks on either side of the paved road. The outlet channel from the bridge has a concrete wingwall on the north and an embankment on the south that has been erosion proofed with concrete interlocking block. The bed of the channel has this same block. The channel has a vertical drop mid-way along this lined section. At the end of the structure, there is another drop to the creek bed. The river channel is lined with large stone or riprap (up to 0.25 cubic metres). Bedrock is evident at the creek bed.

Sydenham Lake

At the north shoreline (view left looking upstream), a gabion wall one basket high has been installed from the dam segment approximately 20 metres upstream. There is minor deterioration of the gabion basket consisting of settlement of the stone and bulging of the outside face in a few areas. Two boat docks have been installed by the adjoining businesses at the limit of the wall to encourage shopping at their stores. There is a residence at the south shoreline with a boat dock 30 metres upstream from the dam. At the water edge, a stone wall has been constructed. The wall height is nominal. There does not appear to be any settlement behind the wall.

Further upstream on the lake, the Town has constructed a beach area. Sand has been imported. CRCA speculate that there may be some sediment transport from the beach into the lake and towards the dam. Due to the relatively shallow depth at the dam, there is significant growth of aquatic vegetation. It was not possible to view the extent of sediment at the dam nor were probes taken of the lakebed.

Millhaven Creek Channel

The creek channel immediately downstream of the bridge has been erosion-proofed. The bed and south bank are lined with a concrete interlocking block. The north bank consists of a concrete wall. There are two drops in this segment of channel, mid-way and at the downstream limit. Repairs to the erosion mat at the bed closest to the bridge were undertaken as portions of this mat failed. Failure of the terrafix blocks was due to oxidation of the connecting wires. Concrete was placed over portions of the mat. This repair appears to be working. However, should the failure be a result of high flow, these or other areas of the erosion block on the bed may fail again.

The creek channel continues westward for a short reach and then turns in a southerly direction. There is a relatively steep gradient for a 30-metre distance downstream. Much of this reach has been lined with riprap. There are no signs of settlement or failure of the bank in this reach. CRCA staff believes there has been some shifting of the riprap at the bed immediately downstream of the lined channel. Additional riprap should be placed to fill any depressions caused by shifting of the existing material since the riprap on the bed is used for energy dissipation and protection of the toe of the lined channel. Further downstream, a large tree has fallen across the channel. There is sufficient grade differential between the structure and the bed at the tree that there is no backwater under low flow conditions. However, under higher flows, this could result in a higher river stage and impact the riprap and soil on the bank.

Material Deficiencies and Issues

Concrete

All dams experience cracking associated with shrinkage, joint deterioration and tensile stresses. The majority of cracks are not deemed serious unless they are considered pervasive or structural.

The control structure and abutment do not exhibit diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns. There are a few minor cracks on the deck extending from the upstream face to the corner of the east side of the gain at Bay 1. This may be due to jacking of the stop logs against the underside of the deck.

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence (leaching of calcium compounds). Testing with the Schmitt hammer on the bridge abutments and walls and downstream wingwall indicates the concrete was of the same relative strength throughout. Testing with the steel hammer showed there are no delamination or hollow areas. It is noted that the downstream wingwall has incorporated a concrete remnant of the mill structure. Literally, this older piece of concrete was capped.

The expansion joint between the control structure and the dam segment at the upstream face has sealant present. There is also a joint between the dam segment and abutting sidewalk. This joint has a cementitious sealant and is in good condition.

The bridge is owned and maintained by the Township and consists of two concrete cast-in-place box culverts. As a general observation, the concrete displays no signs of stress. There is no abrasion due to flowing water or freeze-thaw. There is a storm sewer outlet near the downstream end of the west bay.

A seepage investigation has been conducted to determine the source of the flow that discharges downstream of the mill structure at the north bank. Settlement of the surface of the downstream west embankment continues to occur. Several metres of concrete were pumped into the foundation at the area of the turbine. This had limited impact on the amount of seepage. A drain (0.5-m diameter) has been constructed from the mill structure to outlet ten metres downstream. The estimated flow is 0.5 to 1.0 litres per second. CRCA staff was not sure whether the source of this seepage was defined with this study. It was noted, at the time of inspection, that there is an indication of seepage approximately two metres downstream of the outlet channel structure near the north side of the riverbed at the old concrete wall of the mill. Flow in the stone of the riverbed did not appear to continue downstream. Confirmation of seepage was not undertaken nor was the rate of seepage able to be measured.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There were 5 logs in each stop log bay, 4 full logs (9 inches) and 1 half log (4.5 inches). These logs are set on a raised sill. The upper log is held in place with a wood brace extending to the under side of the deck. There was water flowing over the stop logs at Bay 1 while Bay 2 was dry. The main logs have a gasket (plastic tubing) at the top of each log to assist in sealing. Possibly, some of these logs have lost this sealant. There was little sign of seepage through the logs or at the gain. The lifting clips on these logs are different from the MNR standard. Slotted steel plates are mounted to and extend above the log. The hook from the winch attaches to the plate. The base of the stop log is perforated to allow the steel plate to be inserted. CRCA did not express any concern with this design.

The winches are manufactured by Jeamar, are in good condition, and have covers that are locked. CRCA staff indicated that logs could be removed by either one or two operators.

The steel gains show little deterioration or rust at the waterline. The steel in the gains does not extend to the deck.

The gain covers are diamond-grid steel plates with lockdown straps. These plates are painted. A single operator can raise the cover.

The low flow valve is mounted to the raised sill of Bay 1 with the operating shaft extending to the top of the control structure. The wheel is chained to a post of the handrail. The valve is difficult to operate as a result of sediment build-up at the entry and the location of the operating wheel.

The staff gauge is situated on the south side of Bay 2 and is directly mounted to the dam segment. Recently, CRCA staff added a second gauge with it set perpendicular to the wall to facilitate reading of the gauge. Both gauges are imperial and are set to a geodetic datum. There is a MNR survey benchmark on the dam.

Signage, Gate, and Handrails

There is warning signage mounted to the handrail at the control structure identifying `Dam Ahead, Stay Back'. There is no other warning or "No Trespassing" signage. The public can readily access the upstream face of the dam.

There are no lockable gates or barricades at the control structure that would restrict public access during stop log adjustment.

There is a continuous handrail along the dam segments and control structure. This is painted black. Another galvanized pipe handrail is present to delineate the sidewalk at the south side of the road as well as at the north side of the bridge. This former handrail does not extend along the entire length of structure. The steel frame for the winch operation is situated between the two handrails on the south side and has been painted black.

Log Boom

There is no log boom at the Sydenham Lake Dam.

<u>Operational Deficiencies and Issues</u>

A draft Operations Plan exists for the water control structure, but requires updating to conform to current standards and guidelines. The dam is operated with knowledge of stage-discharge-storage relationships; the structure does have a rule curve, and a plan existing for operation under flood conditions.

It is necessary that the dam stop log settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the operation plan is being carried out, records are being maintained and the operation plan is effective for seasonal periods as well as during flood events.

The dam does not have an emergency spillway or an overflow weir. Should an event exceed the capacity of the stop log bays or if insufficient logs are removed from the bays, excess runoff may overtop the dam and the street. There could be flooding of the adjoining businesses and residences.

There is a hook to operate the stop log winch cables during high flow conditions. The hook is equipped with a steel tube with slots cut into it. A pole with two protrusions can fit into the tube to direct the hook. However, this method of securing the hook to the stop log should be reviewed under high flow conditions.

The low flow valve is difficult to access as the handrail and the operating wheel being slightly above the top of the control structure hinder its operation. Raising the stem to the top of the handrail would facilitate this operation. CRCA staff indicated that the gate could be partially plugged with sediment. This may be overcome by creating a raised crest around the gate to the height of the sill. This would act as a morning glory inlet. The structure should not impede flow at the bay and be sturdy enough to withstand ice pressures.

The new staff gauge may be sufficiently close to the control structure that drawdown could impact the reading, especially at periods of high runoff.

The gain covers are metal and are susceptible to freezing. Where winter operations are needed, consideration should be given to having available tools such as steam genies or torches to unfreeze covers.

The stop logs may be jacked to reduce the seepage through the joints and to secure the top half log. Hydraulic jacks can exert several tons of pressure. Aside from the potential to overstress the concrete causing cracks as a result of this jacking, the transport and use of the equipment may expose the operators to potential injury.

<u>Maintenance Deficiencies and Issues</u>

There are no significant maintenance issues required at the dam. CRCA staff indicated that the stop logs are to be replaced this fall. They are also considering adding riprap at the downstream channel. The riprap should be of a size to resist the forces of the flow from less frequent events, be well graded and be placed in a manner to provide a sound yet rough surface.

The inspection of the downstream river noted a large tree across the channel. Due to the proximity of this obstruction to the structure, it should be removed.

Seepage is occurring at the downstream north embankment at the old mill structure. CRCA staff should review the earlier investigations and findings of the seepage study. Further, the discharge at the collector drain should be monitored for rate / volume and clarity at various seasons and water levels at the dam. Samples should be taken to check sediment levels. Changes to volume, colouration, and sediment may give indications of a broaching of the embankment along the bedrock contact. Settlement at the embankment between the road and the mill structure should be recorded by survey and elevation. These settlements may indicate a flow path of the seepage.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended. The docks encourage boaters to come to the dam. Consideration of installing buoy(s) with the warning signs at the area to which boaters should not travel beyond and/or a boom would better identify a safe boating area.

During adjustments to the stop logs, there are no barriers to keep the public away while the gain cover is open. A temporary fence could be placed at each end of the control structure, between the two handrails, while this work is being undertaken. Stacking of stop logs on the deck reduces the operator working area. It could also present a hazard to the public crossing the bridge. Should the stop logs be stacked against the upstream handrail, the effectiveness of the handrail as a barricade would be reduced.

The CRCA handrails and winch system are painted black and could be difficult to see at dusk and night. The winch boxes project into the pedestrian pathway. Warning signage or reflective tape / coupons could be mounted on these structures to provide better public awareness.

Since the dam serves as a pedestrian walkway, the existing horizontal pipe handrail system should be replaced with a vertical picket railing system 1.07 m high to meet Ontario Building Code (OBC) and Occupational Health and Safety Act (OHSA) requirements. The picket railing will prevent people climbing up on horizontal bars, which is possible with the existing pipe handrail.

There is no fall protection system on the control structure deck. The fall height from the deck of the dam to the base of the dam is greater than 2 metres. Personnel can attach themselves to the handrails but the handrails were not designed for this purpose. The frame of the winch system appears to be of sturdier material. Alternative systems need to be reviewed. Any system needs to be designed to meet OHSA.

3.2.4.2 Millhaven Dam & Reservoir

General

Millhaven Dam is also known as both the Odessa Dam and the Wilton Road Dam. The dam is located on Wilton Road immediately north of Highway 401 in Loyalist Township (former Ernestown Township) and forms Mud (Odessa) Lake. The dam is on Millhaven Creek and is immediately upstream of the bridge crossing of Wilton Road. Millhaven Creek flows southwesterly at this site. The dam has been constructed similar in shape to a horseshoe. The control structure consists of four gated bays and a low flow valve facing the lake. These gates and valve are undershot; flow is under the gate and the flow is adjusted by lowering and raising the gate. There are spillways on each end of the dam that extend between the control structure and the road embankment on the south and the bridge headwall on the north. The bridge is a separate concrete structure, has a clear span, and is maintained by the County. The outlet channel from the dam flows through the bridge to the natural channel. It would appear that all structures are founded on bedrock and that the riverbed is also bedrock. Concrete steps have been constructed on the north side of the dam parallel to the bridge headwall to gain access to and for reading of the staff gauge.

Mud (Odessa) Lake

The road embankment is well vegetated. At the toe-of-slope, a marsh / wetland is present. Further to the north and south at the shoreline, there are trees and shrubs. Looking upstream, there is a 30-m to 50-m wide channel of open water with wetlands extending to the shoreline. There is no evidence of erosion protection (riprap) at the road embankment. There are no signs of erosion or settlement at this embankment.

Millhaven Creek Channel

The river immediately downstream of the bridge has a low flow (incised) channel with a `U' shaped cross section. The upper banks are well grassed and generally have trees growing to the top-of-bank. Both drainage ditches on the west side of the road have standing water. There would appear to be an indication of seepage moving from the lake through the road embankment.

Material Deficiencies and Issues

Concrete

The control structure and abutment did not exhibit diagonal or transverse cracks or other types of cracks that were sufficiently long, wide and deep enough to suggest any structural concerns. There was no minor cracking at this structure. A construction joint was noted at the deck between Bays 1 and 2 (viewing upstream from left to right).

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence. Testing with the Schmitt hammer on the dam deck, outer piers and weirs indicated the concrete was of the same relative strength throughout. Testing with the steel hammer showed there were no delamination or hollow areas of the main components of the dam. Some concrete repairs have been undertaken on the winch pedestals, particularly the north pedestal of Gate 3. This patch has a hollow sound and appears to be delaminating from the original concrete.

The concrete at the water level shows some minor surface abrasion due to flow. With the extent of wetland, the water from the lake may be slightly acidic and this may result in a chemical attack on the concrete.

The expansion joint between the north weir and the bridge headwall dam at the upstream face has no sealant present. There are no other expansion joints observed at this structure.

The bridge is owned and maintained by the County and is a single structure. As a general observation, the concrete has no signs of stress. The road pavement shows the joint at the bridge abutments.

Gates, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There are four vertical steel gates set into a steel gain at each pier. These gates have been modified by raising the crest to maintain a higher water level in the lake. The gates were serviced approximately 10 years ago. They were removed, sandblasted and refinished. At this inspection, there was no apparent seepage at the gate edge.

The winches are in good condition, and have covers that are locked. CRCA staff indicated that the gates could be maneuvered with a lone operator. Typically, in winter, the gates are raised to near the top of the deck and are suspended on the winch cables.

The steel gains show little deterioration or rust at the waterline. The gains extend above the top of the deck.

The gain covers are grid steel plate with lockdown straps. These plates are painted. A single operator can raise the cover.

The low flow valve is an aluminum gate set at the south end of the structure in its own bay. The gate slide mechanism rises to the height of the handrail, as does the operating stem. The wheel is chained to the handrail. A small inspection / maintenance platform has been constructed at the north side of the gate between the handrail and the winch pedestal. The valve is difficult to operate as a result of debris accumulating against the gate. A trash rack has been installed in front of the gate. Trash build-up on the screen restricts flow entry to the gate. Removal of the trashrack for cleaning generally results in the grate not being able to be set to the lowest position.

Two staff gauges have been mounted on the north side of the structure. The first on the north pier facing the concrete steps and the second on the downstream side of the southerly pier of Bay 1. The former gauge has been damaged by ice and is ineffective for water level measurement. Only the upstream gauge is tied to a geodetic datum. The downstream gauge has been set to reflect the floor of the structure.

Signage, Gate, and Handrails

There is warning signage mounted to the handrail at the control structure identifying “Dam Ahead, Stay Back”. There is no other warning or no trespassing signage.

There are no lockable gates at the control structure that would restrict public access. The road guide rail will act as a barricade.

There is a continuous handrail on both sides and the south end of the dam deck. The handrail is painted black. Wire mesh fencing has been fastened to the handrail at the downstream side.

Log Boom

There is no log boom at the Millhaven Dam.

Operational Deficiencies and Issues

A draft Operations Plan exists for the water control structure, but requires updating to conform to current standards and guidelines. The dam is operated with knowledge of stage-discharge-storage relationships; the structure does have a rule curve, and a plan existing for operation under flood conditions.

Some flow measurements have been taken by the CRCA at a reach of channel downstream from this structure. However, it is necessary that the dam gate settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the Operations plan is being carried out, records are being maintained and the operation plan is effective for seasonal periods as well as during flood events.

The dam has two overflow weirs. These weirs provide the water level control. The flow rating of the weirs needs to be determined in association with the gate setting and backwater.

The present methodology of suspending the gates on the cables during the winter period needs to be reviewed. This provides stress on the cables. Devices to lock the gates in the open position above the deck would provide the cable with a longer life expectancy and reduce the likelihood of damage as a result of vandalism by persons cutting the cable. There also needs to be a method of determining the position of the gate and that the gate is sitting level. A reference mark could be placed on the piers at the fully closed position. Inspection of the gates needs to be done yearly in the winter months when they are in the open position. The gains should be checked at the same time. Maintenance should be scheduled on a set basis.

The low flow valve is difficult to operate as a result of debris accumulation at the face. This may be overcome by creating a raised crest around the gate to a height below the summer water level. A bar trashrack could be placed on top of the sill to the summer water level. The structure should not impede flow at the bays and be sturdy enough to pressures from floating mats of organics. An extension of the deck for maintenance should also be provided. The gate should be opened fully on a regular basis to flush debris in this area through the system.

The gain covers are metal and are susceptible to freezing. Where winter operations are needed, consideration should be given to having available tools such as steam genies or torches to unfreeze covers.

Maintenance Deficiencies and Issues

There are no significant maintenance issues required at the dam. CRCA staff indicated that the steel gates are due for servicing. The staff gauge needs to be repaired and mounted in a location that is not impacted by the drawdown at the weir and gate. The gauge should be referenced to geodetic and be metric.

Seepage is occurring at the downstream road embankment. The CRCA and Townshipshould conduct a stability and seepage investigation of the embankment and establish monitoring devices. Visual inspections of both the road surface and embankments should be undertaken on a regular basis including photographs and report. The grass on the embankment will need to be cut to allow a close inspection of the surface. Cracking, bulging and settlement of these surfaces may indicate a potential failure.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English only. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended.

Access to the dam is along the shoulder of the road. Staff tends to park their vehicle on the shoulder. A portable flashing light set on the roof of the vehicle should be turned on in this instance. Preferably, vehicles should be parked off the road at a farm or other entrance. Operators should wear safety-coloured vests. Warning signage should be set beyond the limits of the dam should maintenance staff be making several trips between the vehicle and the dam. Staff is required to step over the guide rail to access the dam. A support could be installed at the guide rail to reduce the likelihood of slippage during wet or icy conditions.

There is no fall protection system on the control structure deck. The fall height from the deck of the dam to the base of the dam is greater than 2 metres. Personnel can attach themselves to the handrails but the handrails were not designed for this purpose. Alternative systems need to be reviewed. Any system needs to be designed to meet the Occupational Health and Safety Act.

3.2.4.3 Babcock Mill Dam & Diversion

General

Babcock Mill Dam is accessed from Bridge Street immediately south of the community of Odessa in Loyalist Township (former Ernestown Township). The dam is on Millhaven Creek and as described in the name, creates a head pond for a mill structure established in the 1860’s. The dam is owned and operated by the Township. Millhaven Creek flows southward at this site. The control structure has four stop log bays with raised sills. There is a concrete dam segment extending eastward for a distance of approximately 7 metres to the diversion channel. An embankment extends approximately 80 metres west and then turns northward to a high area east of the road. The headwall for the diversion structure abuts to the east dam segment. A 4-metre length of 0.9-metre diameter CSP culvert creates an access to property on the other side of the diversion. The diversion channel, which is lined with concrete, turns southward after this crossing and extends greater than 20 metres to the inlet control structure for the power wheel for the mill. The outlet is another 0.9 metre diameter CSP culvert into a branch of Millhaven Creek.

Babcock Mill Headpond

The pond at the time of the site visit was lower by 0.5 metres than the typical summer operating level. There is a bifurcation of the inlet channel upstream with the main flow in the westerly channel. Bedrock is evident at the bed of the lake area. Some erosion protection in the form of small stone has been placed at the east bank upstream of the inlet channel to the diversion. A tree belt extends along the top of the east bank. The south embankment to the west of the control structure has a 3-metre top width, is moderately sloping upstream and has a flatter gradient downstream. There is aquatic vegetation along most of the upstream toe. There is no evidence of erosion at this face. The downstream toe is grassed and has several large trees near the top-of-slope. There are some signs of animal burrowing.

Millhaven Creek Channel

The creek immediately downstream of the dam is situated on bedrock. The low flow channel is confined by a small rock face at the toe of the slope with gently sloping banks above this ledge. Riprap has been placed on the east bank for a small distance downstream, likely in the area of fill.

Material Deficiencies and Issues

Concrete

The control structure, upstream abutments and downstream wingwalls exhibit diagonal and transverse cracking as well as other types of cracks that were sufficiently long, wide and deep to strongly indicate structural concerns. The west wingwall has a major crack with displacement. Seepage is noted at the base of this area. Beyond the west concrete wingwall (downstream) is a section of stone retaining wall that is a transition section to the earth embankment. There appears to be minor bulging of this stone wall with seepage at the toe. The concrete deck has been patched with asphalt supported by plywood and other materials.

The concrete shows pervasive pattern cracking and visible efflorescence. Testing with the Schmitt hammer on the control structure deck, piers, dam segments and wingwalls indicated the concrete was of varying strength. Testing with the steel hammer showed there is drummy concrete, signs of delamination and hollow areas especially at the east dam segment.

The concrete at the water level shows significant surface abrasion due to flow. Freeze thaw has also resulted in areas of concrete spalling.

It was not possible to check the concrete walls at the diversion channel, as the area was fenced. There was some cracking noted at the easterly wall.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There are four stop log bays, each with a raised sill. The sill at the outer two bays is higher than the inner two bays. The stop logs set into each bay are a mixture of new and old, and have varying sizes from 0.15 metres to 0.3 metres. There is significant seepage through the logs and at the sill and gain to the point that there is no flow over the logs.

There are no winches or winch pedestals on the piers. These are brought to the site should the stop logs require adjustment. Portions of the top surface of the concrete at many of the piers have failed.

The gains are concrete with cracks extending into and through the opening.

There are no gain covers. The deck does not extend over the gains.

There is no low flow valve at the main control structure. The operation of the control gate at the diversion at the power wheel was not identifiable. The area was fenced off. There was a structure, but no signs of stop logs or slide gate.

There is no staff gauge.

Signage, Gate, and Handrails

There is no warning signage.

There are no lockable gates at the control structure that would restrict public access.

There is a continuous handrail on both sides of the control structure and along the east dam segment. Chain link fencing has been fastened on the handrail. Some of the posts are corroded and there has been failure of the slope where the fence has been installed in the bank.

Log Boom

There is no log boom at the head pond.

Operational Deficiencies and Issues

It is not known whether a draft Operations Plan exists for the water control structure. It is necessary that the dam gate settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the operation plan is being carried out, records are being maintained and the operation plan is effective for seasonal periods as well as during flood events.

The dam does not have an emergency spillway or an overflow weir. Should an event exceed the capacity of the stop log bays or if insufficient logs are removed from the bays, excess runoff may overtop the dam and the adjoining embankment. This could result in flooding of downstream areas.

The present operational status of bringing winches to site and mounting them on the piers to remove stop logs is time consuming and has an element of risk. The railing can be removed to adjust the stop logs. The concrete piers are in a state of failure and the force from the winch could cause further failure of the pier nose. Access on the deck is questionable due to the concrete deterioration. Repairs undertaken were not structural.

Stop logs appear to have been installed randomly. There is no consistent size of log or elevation that the stop logs are set at.

The diversion structure should have a trash rack at the entry from the reservoir. The channel was dry during the inspection. It is not known whether there is water in this channel during normal summer operation. CRCA staff thought this channel may supply another user other than the mill.

Maintenance Deficiencies and Issues

There has been no structural maintenance undertaken at this dam. With the apparent state of disrepair, it would not seem practical to undertake this work.

Seepage is occurring at the each side of the downstream wingwall. The CRCA and Township should undertake visual inspections on a regular basis including photographs and report. Should this seepage increase to the point that there could be a breach of the structure, the dam should be decommissioned. Trees growing on the south side of the west embankment of the reservoir could cause failure of the embankment. However, until a decision is made as to the action to be taken with this dam, there would appear to be no reason to remove the trees.

Safety Deficiencies and Issues

The deck of the control structure would appear to be in a failure mode. Adjustment of stop logs with winches will add stress to the existing concrete and could result in further concrete failure.

There is no warning signage to advise upstream water users of the presence of the dam. The control structure deck should be fenced off and warning signage placed to advise of the risk of crossing the deck.

The discussion of a fall protection system for operator safety is not relevant since the dam is in a serious state of disrepair and operation of the dam should be discontinued.

3.2.4.4 Highgate Creek Channelization

General

The Highgate Creek Channelization extends from Carmil Boulevard at the north to Prince Charles Drive at the south. The channelization is within the developed area of the City of Kingston. There are two street and one residential driveway bridges along this reach of watercourse. These bridges are municipal structures. The channelization consists of two concrete retaining walls with footings resting on bedrock. Wall heights vary along the channel and are set to be above the abutting residential or road grades. There are inlet structures generally with flap gates set into the walls.

Highgate Channel (Upstream)

The Highgate Channel stream banks immediately upstream of the Carmil Boulevard Bridge are gabion-lined, with vegetation extending above the baskets to the top of bank and beyond.

Highgate Channel (Downstream)

The Highgate Channel crosses Prince Charles Drive, parallels this road for a short distance then turns in a southeast direction, moving away from this road. A concrete retaining wall extends 5 metres downstream of the driveway bridge to retain the road structure. Similarly, the other bank of the channel at this same reach is walled. The wall consists of a gabion basket base with the upper portion of stacked stone. The bed is bedrock. Beyond this walled section, the banks become sloping and are tree-lined.

Material Deficiencies and Issues

Concrete

This concrete structure does not exhibit any diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns. Minor cracking was noted at a few segments along this structure. Cracks are generally present at the large drain inlets extending from the crown of the pipe to the top of wall where the pipe inlet was close to the top of the structure. An individual crack on the west wall upstream of the Prince Charles Drive bridge shows signs of dampness. At this area, the drain ports are plugged with soil. At one location, there is a small pile of saturated soil sitting on the top of the footing. This is near an expansion joint.

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence. Testing with the Schmitt hammer on the channel walls indicated the concrete is of the same relative strength throughout. Testing with the steel hammer showed there are no delamination or hollow areas of the main components of the dam. There have been no concrete repairs undertaken. There is some concrete spalling at the top of the wall at the base of the guide rail post. This spalling could be the result of the guide rail steel anchors within the wall being to close to the surface and/or freeze thaw where water has entered the bolt hole or flowed under the base plate. A check was made of the outer top of wall. No spalling at the mounting plates was noted.

The concrete at the water level shows no signs of surface abrasion due to flow or attack by the acidic environment created by the wetland type vegetation.

The sealant at the expansion joints at the wall segments has been replaced in the last five years and is intact. It was noted that sealant was generally missing at the junction of the channel wall and bridge headwalls.

The bridges are owned and maintained by the City. As a general observation, the concrete at these structures shows no signs of stress.

Gates, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There are no gates, winches, gain covers, low flow valves at this structure. There is a staff gauge upstream of the Prince Charles Drive bridge on the east wall. This gauge has been set to a geodetic datum.

Signage, Gate, and Handrails

There is no warning or “No Trespassing” signage.

There is no ready access to the channel bed. Gates are not required. The bridge guide rails act as a barricade.

There is a continuous chain link fencing and / or barricade (guide rail) on both sides of the channel. The fence posts have been cast into the top of the concrete wall.

Log Boom

There is no log boom at the Highgate Creek Channel.

Operational Deficiencies and Issues

There is no operation required at this structure. There is a significant build up of organics and sediment in the channel resulting in a loss of capacity.

Maintenance Deficiencies and Issues

There are some maintenance issues required at this structure. CRCA staff indicated that the channel is due for a cleaning of the organics and sediment. The timing of cleaning is based on an estimate of when the loss of channel flow area is equivalent to the areas of the flow zone within the freeboard. Cleaning equipment is physically lowered into the channel. There are no reference markers on the channel walls or within the channel to indicate the level of sediment. Materials are pushed to a point where they can be loaded onto trucks and disposed off-site. Concrete repairs should be carried out at those areas of spalling at the posts of the guide rail. Where the drain ports are blocked with soil, the ports should be cleaned and measures installed at the outside face of the wall to prevent soil loss. Cracking should be monitored. Where the cracking exhibits signs of dampness, these cracks should be sealed. The gauge should be referenced to metric geodetic.

A hydro pole is set at the outer edge of the east wall downstream of Meadwood Drive. This pole could create forces on the wall. The wall at the pole should be monitored for cracking. There are some trees growing immediately behind the wall. Where possible, they should be removed. Again, monitoring of the wall is required in these areas.

Safety Deficiencies and Issues

There is no site warning signage related to the dangers of fast flowing water in times of runoff from less frequent events.

Access to the channel is typically at each end of the channel or at a bridge. The latter requires physically lowering oneself from the bridge deck. There are no means for an emergency exit or escape along the channel segments in the event of a sudden rise in the water levels. During channel inspections, temporary ladders should be installed in the channel to provide emergency egress for inspection staff.

3.2.4.5 Little Cataraqui Creek Dam

General

Little Cataraqui Creek Dam is located in the City of Kingston (former Kingston Township) west of Perth Road and north of Highway 401 and forms the Little Cataraqui Creek Reservoir. The dam is on the Main Branch of the Little Cataraqui Creek that flows in a southerly direction below the dam. The control structure consists of a low flow valve at the east side of the dam. The eastern portion of the dam is described as a spillway. To the west of the low flow valve, the spillway consists of an embankment with sheet piling near the downstream top-of-bank, armour stone on the upstream face, and large riprap on the downstream slope. To the east of the low flow valve, the sheet piling is evident at the downstream side. Flow spills onto a mat of riprap. To the west of the low flow valve, rockfill has been piled on top of the sheet piling. In some areas, this has resulted in a vertical drop to the downstream riprap. The westerly portion of the dam is an earthen embankment that is well grassed.

Little Cataraqui Creek Reservoir

The banks of the reservoir are gently sloping. The east shoreline at the dam is grassed. The upper bank is maintained for a picnic spot. The west bank is grassed and has trees and shrubs growing to the water edge. There are no signs of erosion at these embankments in the area of the dam.

Little Cataraqui Creek

Little Cataraqui Creek immediately below the spillway narrows to an incised channel and flows through a footbridge approximately 30 metres downstream from the dam. The area is grassed. The footpath extends westward along the toe of the dam embankment.

Material Deficiencies and Issues

Concrete

The only portion of the dam that is concrete is the chamber for the low flow valve. Of the portions visible, there are no diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns. No testing of this concrete was undertaken.

Gates, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

The low flow valve is contained within a concrete box structure. The drawings show pipe extending into and out of this chamber. The outlet pipe is located under armour stone and is not visible from above. The box is capped with a hinged steel (open grid) plate. CRCA staff does not operate this valve. Access to the valve is gained by a raised wood walkway extending across a portion of the spillway.

There is no staff gauge at the dam.

Signage, Gate, and Handrails

There is a typical warning signage of “Dam Ahead, Stay Back” on the west side of the spillway. There is warning signage “No Trespassing” at the entry to the walkway to the low flow valve, but no gate to restrict access.

There is a handrail on both sides and end of the walkway. The handrail is painted black.

Log Boom

There is no log boom at the Little Cataraqui Creek Dam.

Operational Deficiencies and Issues

The dam performs as a weir, and as such, there is no operation required. The drawings show the sheet-pile extending to the top of the weir / embankment. As there is no as-built or recent survey information, it appears the crest of the weir has been raised. This may result in a higher operating level under all runoff events.

The low flow valve is not operated, but the gate is functional. It is not known whether the inlet is blocked with sediment. Flow over the weir at the spillway provides a base flow downstream. The gate should be opened fully on a regular basis to flush debris in this area through the system.

Maintenance Deficiencies and Issues

There are no significant maintenance issues required at the dam. The armour stone at the upstream side of the dam is covered with sediment and organic matter and was not able to be inspected. Riprap placed at the downstream side had a variation of size and was generally well chinked. The depth of riprap was not measured. There are areas where the rockfill did not extend to the top of the sheetpile and is possibly an indication of settlement. These areas should have rockfill placed to grade and monitored for settlement. The low flow valve is not operated. This structure should be maintained as it could allow greater dewatering for inspection of the upstream dam face.

Seepage through the earthen portion of the dam is collected in an infiltration gallery and piped to a small drain ditch beyond the downstream toe of the embankment. Measurements of flow are taken and, along with colour, are recorded. The location of one observation well and outlet is not known. This well should be found. Sufficient size of sample should be taken to be able to measure the amount of sediment. Water levels should be recorded, and if possible, flows at the pipe outlets should be checked at varying upstream water levels. This will aid in evaluating the effectiveness of the internal drainage system.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is in English. The colouration of the signage would be difficult to see at dusk. Signage placed further upstream at the banks would provide greater warning of the dam. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended.

Access to the low flow valve is along a walkway. Although there is signage of “No Trespassing”, a physical barricade should be installed. As a minimum, a chain across the entry will enforce the signage.

3.2.4.6 Temperance Lake Dam

General

Temperance Lake Dam is in Athens Township (former Rear of Young and Escott Township) and is accessed from Temperance Lake Road and a narrow earth road / trail to the dam. The dam is on the Gananoque River with the local name being Leaders Creek. Leaders Creek flows northward at this site. Access to the control structure is from the west by a small footpath to and across the top of the dam segment. The dam has a single stop log bay, upstream dam segments and downstream wingwalls. The dam segments will perform as spillways. Major modifications were made to the dam in the 1970’s when the deck at the control structure was raised and the dam segments were capped. General concrete restoration was undertaken at the same time. It would appear that this structure is founded on bedrock and that the riverbed is also bedrock. Concrete steps have been placed on the west side of the control structure parallel to the steps to the deck to assist in access to the downstream side of the structure. Fill has been placed behind the dam segments. The extent or depth of sediment at the upstream face of the dam was not measured.

Temperance Lake

The reach upstream of the dam for approximately 200 metres has a narrow channel with bedrock exposed at the shoreline. This channel leads to the main body of the lake. The area beyond the bank is treed. At the dam, there is a small cove at the west side that extends towards the access road.

Leaders Creek

The river immediately downstream of the bridge has a 4-metre bed with moderately steep banks of 3-metre height. The bed is lined with stone likely resting on bedrock. There are large stones-to-boulders along the lower bank and in the bed. Trees and shrubs extend to the bed. There are no signs of erosion. There is beaver activity with small branches strewn along the bed, likely washed through the dam. Immediately below the dam is evidence of a trail used by small vehicles (ATV). This trail is part of a system extending from Marsh Bridge Dam downstream on the Gananoque River. This trail has damaged the vegetation and exposed soil.

<u>Material Deficiencies and Issues</u>

Concrete

The control structure and abutments do not exhibit diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns. A construction joint near the top of the dam segments is considered to be the area of earlier repairs. The lake was at the level of this joint. Vegetation at the downstream embankment does not indicate any signs of seepage. Concrete repairs have been undertaken by CRCA staff to the mid area of the east abutment, with some patching at the lower portion of the wall and near the gain. Less extensive repairs were taken of the west abutment near the top of the wall. A cold joint at mid wall height extends across the east abutment and wingwall. There is no sign of displacement or seepage at this crack. There is a significant crack near the top and limit of the west wingwall at an area of past repair. At the easterly limit of the wall, the crack is transverse. It would appear that the newer concrete did not bond to the old and that the pressure of the backfill may have resulted in some minor displacement.

The concrete shows pervasive pattern cracking and signs of visible efflorescence. Testing with the Schmitt hammer on the dam deck, abutments, dam segments and wingwalls indicated the concrete was of the same relative strength throughout. A few lower readings were noted at the top of the dam segments. Testing with the steel hammer showed there is delamination at the east abutment (interior repairs and exterior concrete) and at the repairs at the winch pedestals. The west wingwall shows some staining near the abutment, but this is attributable to runoff over the top of the wall.

The concrete within the control structure in the flow zone shows minor to moderate surface abrasion with the poorer areas closer to the gain. This abrasion is not deep enough to expose any reinforcement. It was not possible to view the condition of the concrete at the upstream side of the dam segments. The concrete above the water surface shows no deterioration or cracking.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There are eight 0.25-metre stop logs in the single stop log bay with steel gains at each abutment rising into the deck. The stop logs rest on the floor of the structure. Water was flowing over the upper stop log with a minor flow at the second and third log. There was little or no flow at the gain. There was no significant deterioration of the stop logs noted.

The winches are manufactured by Jeamar, are in good condition, and have covers that are locked. CRCA staff has not removed all the stop logs in recent times. Typically, in winter, one stop log is removed.

The steel gains show little deterioration at the waterline. The gains extend into the concrete of the deck.

The gain covers are made of the same diamond grid steel plate as the downstream deck. The covers have lockdown straps. These plates are galvanized. A single operator can raise the cover.

There is no low flow valve.

A staff gauge has been mounted flush to the west dam segment approximately a third of the way to the shoreline. The gauge has been set to a geodetic datum of 384.0 ft GSC.

Signage, Gate, and Handrails

There is warning signage mounted to the handrail at the control structure identifying `Dam Ahead, Stay Back’. There is no other warning or “No Trespassing” signage.

There are no lockable gates at the control structure that would restrict public access.

The downstream set of steps on the west side of the control structure does not have a handrail. There is no handrail on the east side of the control structure deck. The drop to ground may be nominal, but the grass cover makes judgement difficult. The dam segments have a handrail on the upstream side only. There is a small drop to the embankment. The handrails are painted black.

Log Boom

There is no log boom at Temperance Lake Dam.

<u>Operational Deficiencies and Issues</u>

A draft Operations Plan exists for the water control structure, but requires updating to conform to current standards and guidelines. The dam is operated with knowledge of stage-discharge-storage relationships; the structure does have a rule curve, and a plan existing for operation under flood conditions.

It is necessary that the dam stop log settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the operation plan is being carried out, records are being maintained and the Operations Plan is effective for seasonal periods as well as during flood events.

The dam has a defined emergency spillway at the dam segments on either side of the control structure. During the site inspection, it was observed that flow may be directed around the end of the east dam segment, as the bedrock appeared to be lower than the dam segment. This should be confirmed by survey. The flow rating of the spillways needs to be determined in association with the stop log setting and any tailwater.

The gain covers are metal and are susceptible to freezing. Where winter operations are needed, consideration should be given to having available tools such as steam genies or torches to unfreeze covers.

CRCA staff have not replaced the stop logs recently or had to pull logs at flooding conditions. The present methodology of securing the hook to the stop log needs to be reviewed. In the event of high flows at the stop log bay, there was no device to assist in securing the hook on the cable to the recessed bar at the stop log. Stacking of stop logs on the deck reduces the operator working area. Should the stop logs be stacked against the downstream handrail, the effectiveness of the handrail as a barricade would be reduced.

The staff gauge would not be able to be read under events where spillage at the dam segments occur as it would be submerged. Rotating the gauge to face the west shoreline and extending the height would allow readings to be taken at all events. The gauge should be set to geodetic and a metric reading provided. The staff gauge may sufficiently close to the control structure that drawdown could impact the reading, especially at periods of high runoff.

The stop logs may be jacked to reduce the seepage through the joints. Hydraulic jacks can exert several tons of pressure. Aside from the potential to overstress the concrete causing cracks as a result of this jacking, the transport and use of the equipment may expose the operators to potential injury.

Maintenance Deficiencies and Issues

There are maintenance issues that need to be addressed at the dam. Repairs to concrete need to continue and areas of patching that has not bonded to the existing concrete need to be replaced.

Visual inspections of the embankments behind the dam segments should be undertaken on a regular basis including photographs and report. The grass on the embankment will need to be cut to allow a close inspection of the surface. Cracking, bulging and settlement on these surfaces may indicate a potential failure. Vehicular traffic is disturbing the ground cover on the embankments downstream of the structure. This traffic should be discouraged and barricades set accordingly. These barricades could be made of large stone.

Significant beaver activity is observed at the reservoir. Branches were trapped at the top of the stop log. Installing a log boom may reduce some of this debris. It would, however, require a boat to collect the floating debris at the boom and haul it to the shore.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English only. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended. Should there be boating traffic on the lake, another sign(s) should be placed at the start of the channel leading to the dam.

There is no fall protection system on the control structure deck. The fall height from the deck of the dam to the base of the dam is greater than 3 metres. Personnel can attach themselves to the handrails but the handrails were not designed for this purpose. The winch system is a sturdier structure. Alternative systems need to be reviewed. Any system needs to be designed to meet OHSA.

3.2.4.7 Marsh Bridge Dam

General

Marsh Bridge Dam is located in Front of Yonge Township, west of Graham Lake Road and creates Centre Lake, also known as Stump Lake. The dam is on the Gananoque River with the local name being Leaders Creek. The river flows in a southerly direction below the dam. The dam consists of a concrete weir with a low flow valve at the east side and an earthen embankment on each side of the weir. The easterly bank is relatively short and is used as a boat landing area. The westerly bank extends to a peninsula and forms part of a trail system to Temperance Lake Dam. Erosion protection has been placed at the upstream side of the west berm. Both embankments are grassed and the east bank is maintained. There are areas of exposed ground at the boating area at the east bank and at the walking and riding trail on the top of the west berm. Access to the dam is generally gained through the Pleasure Park recreation trailer and campground. CRCA has a walking access that leads directly from Graham Lake Road. This access is used and maintained.

Centre Lake

The banks at the lake near the dam are gently sloping. The east bank is used as a landing and temporary storage area for boats. There is a small fringe of aquatic vegetation beyond which are trees. The west shoreline of the lake is vegetated with grasses and small shrubs and bushes with trees beyond. Near the dam, there is no evidence of erosion at the west shoreline, but the east shoreline in the boat launch area is somewhat degraded due to public traffic.

Gananoque River

The Gananoque River immediately below the dam is part of the Graham Lake system that has an expanse similar to the dam with water levels extending to and submerging the downstream toe of the westerly embankment. A recreation park and boat docks are situated at the east shoreline. The west shoreline at the peninsula has trees extending to the water edge.

Material Deficiencies and Issues

Concrete

The weir portion of the dam consists of a concrete cap placed over clear stone with a steeply sloping downstream face. At the concrete abutments, a wingwall extends into the embankment. The height of the weir is approximately 1 metre. The low flow valve extends through the weir with the gate operator extending to the top of the abutment. There are no diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns. There is a small crack at the downstream face of the weir at the low flow valve extending from near the top of the pipe to the top of the weir crest. There is some shrinkage cracking at the top of the west abutment at one location.

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence. Testing with the Schmitt hammer on the abutments and weir indicated the concrete is of the same relative strength throughout. A few low readings were noted at the east side of the top of the weir. Testing with the steel hammer showed there are no delamination or hollow areas.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There is no control structure. However, steel gains were installed at the west abutment and headwall at the low flow valve in association with holes in the weir crest to allow the use of flash-boards to raise the lake water level. The holes in the weir crest have been filled with concrete.

The low flow valve is located within the weir and is set against the east abutment. A concrete headwall extending from the weir crest to the top of the abutment supports the gate operator. The inlet grate has rock resting against the bars. The steel outlet pipe is rusted, has been partially crimped at the concrete face and is blocked with rock and stone. This pipe outlets onto bedrock. CRCA staff does not operate this valve. Access to the valve is gained by traversing the handrail and standing on the valve headwall.

The staff gauge at the dam is situated at the west abutment immediately upstream of the weir. The base of the gauge has been set to the crest of the weir and not to geodetic datum.

Signage, Gate, and Handrails

There is a typical warning signage of “Dam Ahead, Stay Back” on the west side of the spillway. There has been vandalism to the signs in the past. There is no other warning signage at the weir.

There is a handrail on both sides of the abutments at the weir. The handrail is painted black.

Log Boom

There is no log boom at the Marsh Bridge Dam.

Operational Deficiencies and Issues

The dam is a weir, and as such, there is no operation required.

The low flow valve is not operated but the gate is functional. The inlet and outlet are partially blocked with stone and sediment. Flow over the weir at the spillway provides a base flow downstream. The low flow valve system should be cleaned, the gate serviced and opened fully on a regular basis to flush debris through the system.

CRCA staff indicated that the original dam diverted flow for a mill on another pond to the east known as Lees Pond. This diversion would direct flow to another river system, Lynn Creek. Presently, operating water levels are not sufficiently high to effect this diversion. Any hydrotechnical study should take this diversion into consideration. Field surveys would need to be conducted to obtain data at this location.

Maintenance Deficiencies and Issues

There are no significant maintenance issues required at the dam. There has been some minor degradation of the upstream bank, including the erosion protection at the east side of the weir, which is acting as a boat landing / storage area and near the middle of the west berm due to the public moving from the one waterbody to the other. At the former, the public should be discouraged from using this area and erosion protection placed. At the west berm, the riprap needs to be restored and the bank regraded. A defined area for a crossing should be considered. A regular inspection program for checking for seepage at the embankments should be implemented. Signs of seepage include cracking, slumpage and bulging, and settlement of the bank. The grass may need to be cut periodically to provide better visibility. There were no signs of water loving vegetation growing on the downstream side of this berm. There are a few larger shrubs / trees growing on the berm that need to be removed. There does not appear to be any erosion protection at the downstream toe of the west embankment. The soil has settled at the wingwall at the east abutment. This area should be restored to grade and vegetated.

Stone has been placed at the downstream side of the weir to fill the void created by excavation of the bedrock for the weir. The size of this rock is minimal and would likely be washed out under high flow. An alternative is a concrete apron.

CRCA staff is not aware of any seepage investigations at this site. Water levels rise onto the downstream toe of the westerly portion of the dam. Instrumentation in this reach and monitoring would provide greater surety as to the berm stability.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English only. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended. Due to the shallow nature of the water below the weir and the flat bedrock, this area could be a playground for children. Warning signage and fencing should be considered in this area.

Operation of the low flow valve requires standing on the valve headwall that has a small concrete surface with no handrail. Should operation of the low flow valve recommence, a gate should be added at the abutment handrail and a wider working platform with handrails installed.

The public use the east berm as a boat landing / storage area. This needs to be discouraged as boats are in the flow zone of the weir. This landing site should be relocated well away from the weir, possibly further around the east shoreline. Materials could be placed at the shoreline to discourage this usage. A boom may also direct the boating public to other areas.

The channel extending from the weir to the downstream lake makes a 90-degree bend with the flow zone at the downstream toe of the west berm. The depth of channel on the south side is minimal. At the outlet to the lake, a dock has been constructed. A trailer has been placed within 10 metres of the channel. In the event of higher flows, these structures would impede the flow and could be damaged by flow over the weir or ice if they are permanent. A hydraulic study should be undertaken to analyse this reach of channel. With this information, measures could be considered to protect structures in this reach.

This dam is part of a trail system. CRCA staff commented on the use of ATVs at the dam and the resulting degradation of vegetation. To discourage this type of vehicle, a fence across the entire berm with a staggered entry at the pathway could be considered.

3.2.4.8 Fred Grant Dam

General

Fred Grant Dam is located in Elizabethtown-Kitley Township (former Elizabethtown Township). The dam is on Lyn Creek and creates Lees Pond. Access to the dam is gained from Leeds-Grenville County Road #46 at Pettem Road. The first leg of road into the site is gravel that stops at a gate. There is a Township road allowance along this road. Beyond the gate, the access is more of a trail. Lyn Creek flows southerly at this site. The bypass control structure has two stop log bays and a low flow valve at the south shoreline. Pipes lead into and away from the concrete valve chamber. The bedrock at this bypass channel has been excavated to provide an outlet for this drainpipe at the natural watercourse to the west. At the limit of excavation, flow spills over a rock face to the toe of the main dam. This dam embankment traverses, in an east-west direction, the main river channel. A gated diversion near the centre of this dam has been abandoned. There is also a dyke to confine the lake. This dyke was not inspected at this time and needs to be inspected in the near future.

Lees Pond

The east shoreline at the area of the control structure has exposed bedrock with patches of grass extending to the water edge. There are a few individual trees in the immediate vicinity. The east bank is gently sloping. The west bank is situated at a north-south facing knoll. The bank is grassed and there are pockets of trees near the berm. The control structure and berm / dam are situated on a small cove with the main body of water extending north and westward on the other side of the knoll.

Lyn Creek

The bypass channel downstream of the control structure is situated on bedrock. Flow at the low flow valve is contained in an excavated channel of 1 metre width. The bypass channel narrows as it swings to a westerly direction towards the main dam. The banks are bedrock with some grass. Where the bypass channel abuts the downstream toe of the dam embankment, the bed and lower portion of the bank are lined with rock and boulders. The main river channel below the main dam is treed to the water edge. The incised channel is relatively shallow with banks of soil. There are no signs of erosion.

Material Deficiencies and Issues

Concrete

Concrete at the bypass control structure consists of two abutments, one of which houses the low flow valve, and a centre pier. The concrete does not exhibit diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns.

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence. Due to the small amount of concrete, no testing with the Schmitt hammer was undertaken.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There were 2 logs (0.15-metre) in each stop log bay, set on the floor of the structure, at the time of the inspection. Another smaller log was resting on top of the deck that had been brought to site by other parties to raise the water level above the normal operating range. Logs, when removed, are set in a steel tray on the upstream side of the structure. There was no flow over and little seepage through the stop logs.

The stop log lifting system consists of a set of four winches similarly to those used on boat trailers.

The steel gains show little deterioration or rust at the waterline. The steel in the gains extends above the deck.

There are no gain covers. The deck is constructed from diamond grid steel plate with lockdown clips. The deck plating is galvanized.

The low flow valve at the control structure is set within a concrete box at the south side of the structure. A painted steel plate covers the opening. The valve is a slide valve. The operating shaft is below the deck. PVC pipe extends upstream and downstream in an excavated channel in the bedrock. Portions of the pipe have been backfilled / covered with fill concrete. There is a headwall and grate at the outlet. At the main dam, the low flow valve was mounted in a concrete box in the middle of the berm. The operating shaft rises above the top of berm. This structure has been abandoned, the gate closed and the structure backfilled. There is settlement at this location possibly due to seepage through and erosion of the backfill. Temporary snow fencing (orange plastic mesh) has been installed as a warning.

There is a staff gauge located in the middle pier of the new outlet structure. It is not known whether it is set to a geodetic datum.

Signage, Gate, and Handrails

There is warning signage mounted to the south of the control structure identifying “Dam Ahead, Stay Back”. There is no other warning or no trespassing signage.

There are no lockable gates or barricades at the control structure.

There is a continuous handrail on both sides of the control structure. This is painted black. The elevation difference between the deck and bed is approximately 1.2 metres. There is no fencing along the main dam at the walled section.

Log Boom

There is no log boom at the Fred Grant Dam.

Embankment

The top of the main dam embankment is grassed. Other than at the abandoned low flow valve, there are no obvious signs of settlement. Erosion protection was noted at the upstream bank, but the extent was not able to be determined due to siltation, aquatic vegetation and grass above the water edge. There are a few areas showing signs of loss of soil. This may be where trees have been removed or rotted in place. There are other remnants of tree stumps and roots at the water edge. The downstream side of the embankment shows several structural components. At the south limit, the embankment would appear to be an earth fill section. There is some erosion protection or natural stone at the downstream toe where the diversion channel is situated. The next segment is a stone wall. The stone is flat, of varying sizes, and has an appearance of being randomly stacked with a rough exterior and no chinking. At the control structure, the stone wall continues, but there appears to be a construction joint with the earlier reach. At this location, the wall is constructed with more uniform stone, and has been plumbed and chinked. It gives the appearance of stability. Beyond the diversion structure, the stone wall construction is similar to the other side. The extent of this westerly wall was not able to be determined due to the density of vegetation. Trees are actively growing out of the wall, some with a trunk size of 0.3-metre diameter. Silburn prepared a geotechnical report in 2003 on the condition of the embankment.

The control structure outlet is rectangular in shape and appears to have a concrete top and sides with the latter having a small footing. The flow was estimated at 100 litres per second. CRCA staff indicated that the flow has been increasing over time. Seepage is flowing through and around the outlet. A clay blanket had been placed at the upstream face of the embankment to mitigate seepage at the control structure with some success. At this inspection, there is a significant vortex in the water indicating the clay seal has been breached. Ice action, rodents, waves may have damaged this sealant.

<u>Operational Deficiencies and Issues</u>

A draft Operations Plan exists for the water control structure, but requires updating to conform to current standards and guidelines. The dam is operated with knowledge of stage-discharge-storage relationships; the structure does have a rule curve, and a plan existing for operation under flood conditions.

It is necessary that the control structure stop log settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the operation plan is being carried out, records are being maintained and the operation plan is effective for seasonal periods as well as during flood events.

The dam does not have an emergency spillway or an overflow weir. Should an event exceed the capacity of the stop log bays or if insufficient logs are removed from the bays, excess runoff may overtop the dam.

The present methodology of stop log removal by lowering the hook and feeling for the stop log lift bar needs to be reviewed. In the event of high flows at the stop log bay, there was no device to assist in securing the hook on the cable to the stop log. An extra log has been brought to site by others to raise the water level above the normal summer operating range. The log should be removed to prevent this reoccurring.

The low flow valve at the control structure is not operated. The valve should be opened to flush sediment from the pipe. The inlet area should be checked to ensure it has not been damaged by ice. Protective measures could be installed at the inlet in the form of a headwall as necessary. This could be a gabion basket. Rock has been placed in the low flow diversion channel 10 metres downstream from the structure. This should be removed.

There is a staff gauge located on the upstream side of the middle pier of the control structure.

The pulley system for stop log operation is inadequate. It is not as reliable and safe as a winch system and should be replaced.

There are landowner issues regarding the dam access that have yet to be resolved. Resolution of these measures should be expedited. Temporary access can be gained from the west, but this is across ploughed fields.

Maintenance Deficiencies and Issues

There are significant maintenance issues required at the main dam. Past repairs to control seepage at the control structure at the main dam have been breached. Seepage is evident at the downstream toe beyond the outlet of this control structure. The discharge at this outlet should be monitored for rate / volume and clarity at various seasons and water levels. Samples should be taken to check sediment levels. Changes to volume, colour, and sediment may give indications of possible failure. CRCA staff should review the earlier investigations and findings of the seepage study conducted in 2003 by Silburn.

Trees have been removed at the upstream face of the embankment at the main dam. There are still several stumps with large roots. Any seepage study should consider their removal. Monitoring of bank stability should be undertaken. The vegetation needs to be cut for good observation of cracking, settlement, bulging and creeping of soil. Trees need to be removed at the downstream earth embankment. Trees within the stone wall and at the toe need to be cut as not to disturb the wall. Monitoring of the wall should be done on a regular basis looking for signs of movement. Photographic records with reference plains (vertical rods) should be taken at known intervals. A stability analysis of the main dam including the stone wall would typically be taken as part of a detailed dam safety assessment. To do this, the structure of the wall and embankment has to be identified.

There is a reach of the bypass channel flowing against the downstream toe of the main dam. The erosion protection is minimal. A greater extent of properly sized and placed riprap should be installed and/or the channel diverted away from the embankment. Similarly, the extent of riprap at the upstream face needs to be determined. Areas where there has been settlement or loss of riprap should be corrected in conjunction with any seepage control measures.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English only. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended. Consideration of installing buoy(s) with warning signage at the area to which boaters should not travel beyond and/or a boom would better identify a safe boating area.

There is no fence along the downstream side of the main dam at the area of the wall. The settlement at the main dam control structure should be repaired, a proper fence installed as needed, and the gate operator removed.

3.2.4.9 Broome-Runciman Dam

General

Broome–Runciman Dam is located within the City of Brockville. The dam is on Buell Creek and is part of a bridge crossing of Centennial Road. Buells Creek flows southward at this site. There are two stop log bays with wingwalls extending into the reservoir. A low flow valve is situated in the centre pier. The control structure is integral with the bridge. The City maintains the bridge. Centennial Road is paved and has a rural cross section with narrow gravel shoulders. The bridge at the downstream side has concrete wingwalls. At the outlet of the structure, the riverbed is lined with stone.

Broome–Runciman Reservoir

The road embankment is well vegetated. At the toe-of-slope, a marsh / wetland is present. Further to the east and west at the shoreline are trees and shrubs. Looking upstream, there is a 10-metre wide channel of open water with wetlands extending to the shoreline. There is some erosion protection (riprap capped with concrete) immediately at the wingwalls. There are no signs of erosion or settlement at the road embankment, although with the extensive vegetation, it was difficult to assess.

Buells Creek

The river immediately downstream of the bridge has a low flow (incised) channel with a `U' shaped cross section. The banks are well grassed and have small trees and shrubs growing to the top of bank on the east side. There were no defined drainage ditches on the south side of the road. The area beyond the road toe-of-slope was grassed.

Material Deficiencies and Issues

Concrete

The control structure, abutment and wingwalls do not exhibit diagonal or transverse cracks or other types of cracks that are sufficiently long, wide and deep enough to suggest any structural concerns.

The concrete shows neither pervasive pattern cracking nor signs of visible efflorescence (leaching of calcium compounds). A small area of spalling at the underside of the deck at Bay 1 was noted. Rebar is in proximity to the concrete surface. Testing with the Schmitt hammer on the deck, pier, abutments and wingwalls indicated the concrete is of the same relative strength throughout. Testing with the steel hammer showed there are no delamination or hollow areas.

The concrete at the water level shows some minor surface abrasion due to flow both upstream and within the control structure. With the extent of wetland, the water from the lake may be slightly acidic and this may result in a chemical attack on the concrete.

The expansion joint between the control structure and the wingwalls at the upstream face has sealant present.

The bridge is owned and maintained by the City and consists of a single concrete cast-in-place box culvert. As a general observation, the concrete shows no signs of distress. A few shrinkage cracks were observed on the walls. There is minor abrasion due to flowing water or freeze-thaw.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There were 9 (8-inch) logs in each stop log bay. The logs are set on the concrete floor of the structure. There was no water flowing over the stop logs and the top log was dry. There was minimal seepage through the logs or at the gain. The logs are sound and in good condition.

The stop log lifting mechanism is a cable on a pulley system with a shaft and two drums, crank operator at one end, set on a tubular pipe frame. This system does not have a gear reducer to give torque for lifting of the stop logs. There is no locking clip on the pulley to hold the log in the up-position. The steel parts have been painted black. The present stop log lifting system is awkward and unsafe, and should be replaced.

The gains are concrete with steel angles at the exterior corners. These angles show little deterioration or rust at the waterline.

The gain covers are diamond-grid steel plate with lockdown straps. These plates are painted. A single operator can raise the cover.

The low flow valve is set in the middle pier and has a pipe extending into the reservoir. The operating shaft extends above the control structure deck. The operating wheel has been removed and stored off-site. The valve is generally not operated.

The staff gauge is situated on the west side of Bay 1 and is directly mounted to the wingwall. The gauge has been set to geodetic datum. The staff gauge is sufficiently close to the control structure that drawdown could impact the reading, especially at periods of high runoff. This structure has a Geological Survey of Canada (GSC) brass plug monument set at the retaining wall at the road.

Signage, Gate, and Handrails

There is warning signage mounted to the handrail at the control structure identifying `Dam Ahead, Stay Back'. There is no other warning or no trespassing signage.

There are no lockable gates at the control structure that would restrict public access. The road guide rail will act as a barricade.

There is a handrail at the sides and upstream face of the control structure. This is painted black. At the rear of the deck is a retaining wall for the road embankment. There is a single concrete step placed to gain access to the deck.

Log Boom

There is no log boom at the Broome–Runciman Reservoir.

<u>Operational Deficiencies and Issues</u>

A draft Operations Plan exists for the water control structure, but requires updating to conform to current standards and guidelines. The dam is operated with knowledge of stage-discharge-storage relationships; the structure does have a rule curve, and a plan existing for operation under flood conditions.

It is necessary that the dam stop log settings and associated lake water level elevations be recorded during the seasonal periods and flood events. The records need to be reviewed from time to time to ensure that the operation plan is being carried out, records are being maintained and the operation plan is effective for seasonal periods as well as during flood events.

The dam does not have an emergency spillway or an overflow weir. Should an event exceed the capacity of the stop log bays or if insufficient logs are removed from the bays, excess runoff may overtop the dam.

Difficulty in securing the hook to the stop log at times of greater flow depth may be experienced by operating staff. There is no device to assist in securing the hook on the cable to the stop log. The present methodology of securing the hook to the stop log needs to be reviewed.

The low flow valve is generally not operated as sediment builds at the inlet pipe. This may be overcome by creating a raised crest around the gate to a height below the summer operating level. This would act as a morning glory inlet. The structure should not impede flow at the bay and be sturdy enough to withstand ice pressures.

The gain covers are metal and are susceptible to freezing. Where winter operations are needed, consideration should be given to having available tools such as steam genies or torches to unfreeze covers.

The stop logs may be jacked to reduce the seepage through the joints. Hydraulic jacks can exert several tons of pressure. Aside from the potential to overstress the concrete causing cracks as a result of this jacking, the transport and use of the equipment may expose the operators to potential injury.

Maintenance Deficiencies and Issues

There are no significant maintenance issues at the dam. The small area of spalling of concrete at the underside of the deck at Bay 1 should be repaired.

There were no obvious signs of seepage at the downstream road embankment. Water loving vegetation was not present. However, the inspection for soil stress (cracking, depressions, slumping, bulging) was limited due to the extent of vegetation on the road embankments. The grass needs to be maintained periodically to be able to undertake a visual inspection of the surface of the embankment as well as checking for signs of seepage. Photographic records and surveys of potential areas should be taken. Should visual signs of seepage and embankment stress be noted, a geotechnical investigation should be conducted with soil sampling taken, instrumentation installed and results reported.

Safety Deficiencies and Issues

Site signage (Danger, Dam Ahead, Stay Back) is minimal related to the dangers of fast flowing water at the dam in times of runoff from less frequent events. The signage is also in English only. The colouration of the signage would be difficult to see at dusk. Alternative warning signage of red lettering on white background having visibility at a minimum of 50 m upstream would be recommended. Consideration of installing buoy(s) at the area to which boaters should not travel beyond and/or a boom would better identify a safe boating area.

Access to the dam is along the shoulder of the road. Staff at the time of the inspection parked their vehicle on an entry to the east and was well off the road. Operators should wear safety coloured vests. Warning signage should be set beyond the limits of the dam should maintenance staff be making several trips between the vehicle and the dam. Staff is required to step over the guide rail to access the dam. A support could be installed at the guide rail to reduce the likelihood of slippage during wet or icy conditions.

Stacking of stop logs on the deck reduces the operator working area. Should the stop logs be stacked against the upstream handrail, the effectiveness of the handrail as a barricade would be reduced.

There is no fall protection system on the control structure deck. The fall height from the deck of the dam to the base of the dam is greater than 2 metres. Personnel can attach themselves to the handrails but the handrails are not designed for this purpose. The frame of the winch system is of similar materials as the handrail. Alternative systems need to be reviewed. Any system needs to be designed to meet the Occupational Health and Safety Act.

3.2.4.10 Buells Creek Detention Basin

General

The Buells Creek Detention Basin is located within the City of Brockville. The detention basin is on Buell Creek. The constructed drain flows in a southerly direction into, through and below this facility. The structure consists of a dry reservoir with a gated diversion / bypass structure. The watercourse south of Laurier Boulevard is a realigned channel with recreational amenities on each side. There is one footbridge crossing in this reach. The outlet / bypass channel has been constructed parallel to the CPR rail-line and joins the watercourse 30 metres north of Parkdale Avenue. The watercourse flows eastward at this location to a crossing of the CPR tracks. The reservoir extends in a westerly and southerly direction towards Millwood Avenue. A storm sewer outlet into the reservoir was noted at Millwood Avenue north of Magedoma Boulevard. This outlet has a low flow pipe that directs flow into a watercourse that extends eastward to connect with the main bypass channel.

Detention Basin

The banks at the detention basin have a moderate slope but are readily maintainable. The banks and areas beyond the crest are grassed. Many areas of the bench lands are used for recreational playing fields. There is a small inlet channel to the control structure. This channel has steeper banks and is lined with gabion mat. The control structure consists of a slide gate on a concrete headwall set into a manhole. A 10-metre wide berm separates the inlet and outlet channels.

Inlet and Outlet Channels

The inlet channel typically has a 2-m to 3-m wide bed with steeply sloping banks. Areas of this channel are lined with gabion baskets and mats. There is one reach where a gabion drop structure has been constructed. The banks are grassed. There is no evidence of severe erosion. A foot crossing at the downstream end of the gabion drop structure has disturbed the existing vegetation.

The outlet channel has a 3-m bed width with steeply sloping banks. The reach immediately downstream of the control structure is lined with a gabion mat.

Buells Creek

The remaining segment of Buell Creek within this stormwater management basin is north of Parkdale Avenue and extends from Millwood Avenue on the west to and beyond the CPR tracks on the east. The watercourse has a `U’ shaped incised channel and is situated in a park setting. Grass is growing to the top of bank and scattered trees are along its length on both sides.

Material Deficiencies and Issues

Concrete

The only concrete at this structure is the headwall for the gate at the bypass control structure. A visual inspection of this headwall was not undertaken.

Stop Logs, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There is no stop log bay, winch, gain or gain cover.

A low flow pipe forms part of the bypass structure. This pipe is uncontrolled and extends across the trail access between the inlet and outlet channels. The control valve for the large pipe bypass structure is a slide gate mounted on a concrete headwall within a CSP manhole. The gate operator extends above the grade with a steel handwheel mounted to the top. CRCA staff indicated that the CSP bypass pipe has shown signs of settlement, both in the roundness of the pipe and joint separation. The latter is being monitored.

There are three staff gauges at the inlet to the control structure staggered on the bank. Access is gained to the gauges by a set of concrete steps near the main pipe diversion. The gauges could be read from the trail access. The gauges are metric.

Signage, Gate, and Handrails

There is a small warning signage of `No Trespassing’ midway on the bank to the inlet of the main pipe diversion. Danger signs are also located at the corners of the fencing.

The trail access is fenced as is the downstream channel and the inlet channel at the diversion structure. A service gate in the north fence at the trail access allows entry to the inlet of the diversion pipe.

There is a small segment of handrail at the stairs to the inlet of the diversion pipe.

Log Boom

There is a log boom extending from the top of bank approximately 10 m upstream of the diversion pipe inlet. The boom is constructed of wood logs joined with cable and connected to a large wood post at the top-of-bank.

Operational Deficiencies and Issues

There are minimal operational requirements at the diversion structure. The gate is closed for the summer (rain season) and open for the winter (snowmelt/frozen ground).

Maintenance Deficiencies and Issues

There are no significant maintenance issues required at the reservoir or channels. There has been some minor degradation of the east bank of the channel downstream from Laurier Boulevard where pedestrian traffic has crossed the creek. Stone in a few of the gabion baskets in this same reach has settled and a few baskets have had the wire cage damaged. Geotextile was noted behind the gabion wall. Settlements at the rear of the gabion basket were minor. A thorough review of all embankments and erosion protection should be undertaken.

Concrete has been placed on the stone erosion protection at the inlet pipes of the diversion structure. Some of this concrete has failed possibly as a result of settlement of the riprap. Monitoring and repairs at the settlement should be undertaken. The concrete should not be replaced. Some debris had accumulated on the grate of the low flow diversion. Inspections and cleaning should be undertaken on a regular basis at all pipe inlets especially after significant rainfall events.

The low flow pipe at the crossing of Magedoma Drive was partially blocked at the time of the inspection. As this outlet is a small pipe with a grate, it does not take much vegetation to create a blockage. This inlet was cleaned while at the site. A small pervious check dam upstream of the inlet would reduce debris accumulating at this pipe, yet maintain its function.

Safety Deficiencies and Issues

Site signage (Warning, No Trespassing) is minimal related to the inlet of the bypass structure. The signage is in English. Access to area of the pipe inlet can be gained from within the reservoir. More warning signage and of a bigger size should be considered in this area especially facing upstream with red lettering on a white background.

The access steps to the bypass pipe are obscured by vegetation. Maintenance of the vegetation is required.

The access to the bypass valve was not checked. Although there is a ladder in place in the operation well, entry into manholes is considered a confined / restricted space by the Ministry of Labour (MOL). Safety gear including harness, winch should be available along with a breathing apparatus as needed with any entry. In no case should entry be undertaken without personnel being topside manning the winch. Communications (telephone) would also facilitate any emergency requirements regarding access.

The public can gain access to the channel downstream of Laurier Boulevard through openings in the east fence at the playing fields. There is no fence at the west side of the channel. The gabion drop structure has a wall height in excess of 2 metres. The public should be warned and access restricted at this area especially.

3.2.4.11 Booth Falls Channelization

General

Buells Creek has been realigned downstream of Central Avenue. Where this channel turns eastward, the Booth Falls Channelization, which is an emergency spillway, continues southward. The channelization and the emergency spillway are within the developed area of the City of Brockville. The emergency spillway is set approximately 0.5 m above the main channel. A small masonry stone wall has been constructed along a portion of the channel to confine the flow. At the south limit of the spillway, there is a 3 m cascading drop in elevation of the bedrock to where it joins the main channel.

Buells Creek (Upstream)

Buells Creek immediately upstream of the spillway to Central Street is set on bedrock with side banks of bedrock with soil above. This channel has been constructed in a straight alignment.

Buells Creek Downstream)

The Buells Creek downstream at the spillway flows eastward and then swings to a southwesterly direction to join with the spillway south of the upstream channel. This channel is set on bedrock. Vegetation consisting of grasses, trees and shrubs extends to the stream banks.

Material Deficiencies and Issues

Concrete

There is no concrete at this structure.

Gates, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There are no gates, winches, gain covers, low flow valves or staff gauge at this structure.

Signage, Gate, and Handrails

There is no `Warning' signage, gates or handrail at the emergency spillway.

Log Boom

There is no log boom at the Booth Falls Channelization.

Operational Deficiencies and Issues

There is no operation required at this structure.

Maintenance Deficiencies and Issues

There are some minor maintenance issues required at the bypass channel. The masonry stone wall at the south limit is showing signs of shifting. There appears to be a lack of cement binding the segment of the wall. Should the wall fail, high flow could breach the east bank and spread across this sloping ground to outlet tangent to the main channel. This may result in some scouring of the upstream banks of the main channel. The wall should be repaired. Additionally, the erosion downstream needs to be stabilized.

Safety Deficiencies and Issues

There is no site warning signage related to the dangers of fast flowing water in times of runoff from less frequent events at the emergency spillway. Warning signage both at the top and bottom of the spillway should be installed.

4.0 HYDROTECHNICAL ASSESSMENTS

4.1 GENERAL

In accordance with the draft Ontario Dam Safety Guidelines (ODSG), hydrotechnical assessments need to be completed to establish peak inflows and outflows at the dam, change in lake volume and water level, and flood duration for the various return frequency events. In the Ministry of Natural Resources (MNR) Technical Guidelines, watersheds within the jurisdiction of the Cataraqui Region Conservation Authority are located in Zone 2, where the Regulatory Flood is the 100 year flood level.

This section describes the hydrologic and hydraulic analyses required to complete the hydrotechnical assessment for the eleven CRCA water control sites studied in this assessment.

4.2 HYDROLOGY

4.2.1 General

Hydrology is the science that deals with the properties, distribution and circulation of water and snow. The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes, as precipitation, interception, runoff, infiltration, percolation, storage, evaporation and transpiration is known as the hydrologic cycle.

In any hydrologic study, quantitative information in the rainfall runoff relationship of the study area is of prime importance. Natural precipitation varies greatly in time and space, and methods for quantifying it depend upon the technique employed for runoff estimation.

In applying any runoff estimation method, major difficulties lie in considering:

(a) Regional climatological, hydro-physiographical, and geological differences.

(b) Differences in basin characteristics such as drainage area size and shape, channel length and slopes, potential storage, etc.

(c) Changing basin characteristics such as unregulated to regulated and land usage.

(d) Availability of data, and

(e) Statistical significance.

In catchments where no streamflow records are available, flood hydrographs are computed using synthetic unit hydrographs. This procedure involves applying a design storm, determining rainfall-runoff relationship using the Soil Conservation Service (SCS) curve number methodology and routing and summing the individual reach hydrographs to various points of interest.

4.2.2 Hydrologic Model

Several hydrologic models are available for use to generate the flood hydrographs at various points of interest within the watershed. The commonly used hydrologic models are INTERHYMO (OTTHYMO-89), SWMHYMO, Visual OTTHYMO, QUALHYMO and PCSWMM, to name a few.

The majority of the models are single event models. QUALHYMO and PCSWMM allow the user to carry out continuous simulations based on many years of precipitation records.

There has been hydrologic modeling undertaken using OTTHYMO for Millhaven Creek, Highgate Creek, the Gananoque River, Lyn Creek and Buell Creek at all the dams other than the Little Cataraqui Creek Dam.

4.2.3 Watershed Parameters

Watershed parameters are required as input into the hydrologic model to generate the flood hydrographs. The typical watershed parameters that would have been determined for the existing OTTHYMO modeling are:

(a) Watershed or catchment drainage areas.

(b) Watershed or catchment equivalent slopes. The Equivalent Slope Method is published in the Ministry of Transportation Ontario Drainage Manual.

(c) Watershed or catchment times to peak.

(d) Soils and land use data to determine the hydrologic soil cover curve numbers (CN) of the rural watershed or catchment.

(e) Lake surface areas.

(f) Lake storage volumes.

(g) Percent imperviousness of urban catchments, and what percentage of the impervious areas is directly connected to the drainage system.

4.2.4 Flood Events

Utilizing the hydrologic model and the watershed parameters, the existing OTTHYMO modeling would generate flood hydrographs of the 2, 5, 10, 25, 50, 100, 500 and 1000 year return frequency events, based on rainfall and snowmelt conditions.

4.2.5 Streamflow Records

For watershed with streamflow records, the following can be undertaken:

(a) A flood frequency analysis for the streamflow station.

(b) Collection and review of precipitation and streamflow data.

(c) Calibration of the hydrologic model based on two runoff events.

(d) Validation of the hydrologic model based on a third event.

(e) Upon review with and acceptance by CRCA staff, the transposition of the watershed parameters to adjacent watersheds.

4.3 HYDRAULICS

4.3.1 Hydraulic Characteristics

The hydraulic characteristics of the dam need to be determined, pertaining to the stage-discharge relationship of the control structure and/or channel. Floodplain mapping has been undertaken for Millhaven Creek, Highgate Creek, the Gananoque River, Lyn Creek and Buell Creek using the hydraulic software HEC-2 and, in some instances, HEC-RAS.

For the control structures of the dam, flow equations can be used to calculate the discharge capabilities of the structures.

The stage-discharge relationships combined with the stage-storage relationships of the lakes (or reservoirs) will provide the stage-discharge-storage relationships to carry out flood (reservoir) routing through the control dams.

4.3.2 Flood Routing

Flood (reservoir) routing through the control structures can be undertaken for all the flood events of the 2, 5, 10, 25, 50, 100, 500 and 1000-year flood events, to determine:

(a) The peak flow of the inflow hydrograph.

(b) The routed peak flow of the outflow hydrograph.

(c) The change in lake volume.

(d) The maximum water level attained on the lake.

(e) The flood duration of the flood hydrograph.

5.0 GEOTECHNICAL INVESTIGATIONS

5.1 GEOLOGICAL SUMMARY

Geological information is generally not available to determine the type of rock formation underneath the water control structures. Boreholes were made during the design of the Millhaven Dam and the Little Cataraqui Creek Dam. A geotechnical investigation program consisting of geological mapping and core drilling needs to be performed for the remaining structures to obtain this information.

5.2 DAM SAFETY ASSESSMENT

A dam safety assessment has not been completed for the dams studied is this assessment. However, when carrying out the dam safety assessment on concrete dams, the analyses will be undertaken as outlined in the *Draft Ontario Dam Safety Guidelines*, *Section 7*, *Concrete Structures*. The loading combinations will be reviewed as outlined in *Subsection 7.4 Load Combinations*.

Analytical methodology will be as recommended in *Subsection 7.5 Design and Analysis*. The dam sections will be assessed by static analysis. Earthquake response will be determined by pseudostatic analysis.

The performance of the structure will be assessed and discussed on the basis of the criteria as outlined in *Subsection 7.6 Performance Indicators* and *Subsection 7.7 Acceptance Criteria*. Detailed calculations will be presented in the appendix.

For earth and rock filled structures, the analyses will be carried out as outlined in *Section 6 Geotechnical Considerations* and *Subsection 6.2 Embankment Dams and Soil Foundations*.

5.3 ACCEPTANCE CRITERIA

The *Draft Ontario Dam Safety Guidelines* provide *Commonly Accepted Values of Sliding Factors for Gravity and Buttress Dams Table 7-1* as follows:

Type of Analysis	Usual Loading	Unusual Loading	Earthquake Loading	Flood Loading
Peak Sliding Factor - no tests	3.0	2.0	1.3	2.0
Peak Sliding Factor - tests	2.0	1.5	1.1	1.5
Residual Sliding Factor	1.5	1.1	1.1	1.3

The analyses will be carried out to determine if the structure meets the above criteria.

6.0 HAZARD POTENTIAL CLASSIFICATION

The eleven dams or water control structures have been reviewed and given a preliminary Hazard Potential Classification by the Conservation Ontario committee responsible for the Water and Erosion Control Infrastructure data base. Table 6.1 provides a summary of the classification.

7.0 REHABILITATION

Section 3 describes the deficiencies at each dam site. These deficiencies can be considered in three categories as follows;

1. Operational
2. Maintenance and Materials
3. Safety

A summary of the observations of the dam inspections and remedial measures as identified for each of the three categories of deficiencies is provided in Table 7-1.

7.1 OPERATIONAL

A site-specific Operational Plan defines the operations of the dam at both seasonal times and during events having significant runoff. The inflow design flood (IDF) forms part of this Plan. An Emergency Preparedness Plan provides a protocol of notification of key personnel and operational requirements to mitigate and/or minimize loss of life and reduce property damage.

There are draft Operational Plans for nine of the eleven water control structures. However, they require updating. The remaining two structures require written Operational Plans.

The following observations are made:

- Monitoring of water levels is done manually and the frequency of site visits is periodic and random.

- Only three streams with water control structures have stream gauges.

- Many low flow valves are typically not operated; the need for these valves should be assessed at each dam.

- Measures can be implemented to provide for easier operation and reduced maintenance at these valves.

Removal of stop logs at seasonal periods can be difficult and, at times of high flow, this operation can be considered to be problematic. Issues noted include:

- There are generally no devices present to assist in the connection of the hook to the stop log. Only the Sydenham Lake Dam has a device to maneuver the winch cable into the stop log handles.

- Where pulleys are used to raise the logs, they should be replaced with a winch system.

- Deck space is minimal and storage of stop logs on the deck will reduce operator space. This practice should be avoided, unless storage space has been considered in deck design.

- Stacking of logs against a handrail can reduce the effectiveness of the handrail as a barrier as well as create a public walking hazard.

Where there is more than one bay and several logs per bay and logs are manipulated frequently, an alternative method of stop log adjustment should be considered. The Ministry of Natural Resources is using a gantry system in these instances.

Staff gauges are typically imperial, set to the structure sill and at a location where the water level would be influenced by the drawdown at the control structure. Rehabilitation measures include:

- Check all staff gauges for metric measurement and a geodetic datum. If necessary install new metric gauges set to geodetic datum.

- Install the staff gauge at a suitable location not influenced by the drawdown at the control structure. This location is set for each individual control structure.

- Gauges should be clearly visible and mounted in a manner to provide operator safety during reading (avoidance of leaning over handrails).

7.2 MAINTENANCE AND MATERIALS

Few sites with concrete structures demonstrated significant material issues. Where deficiencies were noted, remediation should be undertaken consisting of:

- Concrete structural repairs where the cracking is pervasive and where deterioration consisting of spalling and drummy concrete is evident.

- Assess the appropriate methodology for repair.

- Workmen who are qualified and experienced in these materials should undertake work.

- Monitoring of other areas of deterioration on a regular basis.

Significant seepage was noted at two sites, each where the road embankment acts as a dam. There may be other sites that seepage was not readily apparent. There were no visual signs of embankment stress. Vegetation did not permit ease of viewing. Where deficiencies were noted or suspected, an evaluation should be undertaken consisting of:

- A detailed site inspection when vegetation has been maintained or is at a state where the ground surface can be seen.

- Where seepage is evident or suspected, conduct a geotechnical investigation to identify the severity of the problem and remedial measures.

- Implement a rehabilitation program.

7.3 SAFETY

Safety can be improved at many of the sites. Safety measures that could be readily implemented are;

- Increased signage with better visibility especially at danger areas and areas used for boating and swimming. Signs should be in both English and any other language where there is a discernable speaking minority and be consistent at each site; signs should be red reflective letters on a white background.

- Provision of highly visible safety clothing for dam operators where the dam abuts road bridges.

- Operate structures with two operating staff present.

- Provide a fall protection system for operators when they are on the control structure deck where the fall is greater than 3 m. Consider personal floatation devices for operators at other structures.

- Install additional fencing and barricades at defined hazard areas and where public has access to the control structure during operations, including “No Trespassing” signage.

- Paint existing handrails with reflective paint for better visibility (red, white, and yellow).

- At areas of high public access and recreational usage, consider installing a picket fence type railing, buoys with warning signs and booms.

7.4 PRIORITIZATION

CRCA staff has asked that the deficiencies be prioritized and that a ranking for undertaking this work be provided. A two-part program is suggested.

Firstly, each site should be ranked according to its Hazard Classification. Where the Classification is rated High to Significant, the necessary studies and data collection should be undertaken to determine the stability of the dam per the ODSG along with any remedial measures, both short and long term. An Operations Plan would be prepared as part of this program. A Dam Break Analysis will also need to be undertaken.

Where the dam does not meet the safety factors for stability as identified in the ODSG, a further review of each structure should be undertaken. This review should take the form of an environmental assessment considering all relative issues. Alternatives to be considered include:

- Do Nothing.

- Rehabilitation.

- Reconstruction.

- Decommissioning.

Implementation strategies would be based on the outcome of these studies and ranked accordingly.

Secondly, deficiencies would be evaluated related to operations, maintenance and materials, and operator and public safety. Prioritization of these three deficiencies would be as follows;

- Safety.

- Operations that impact on the ability to pass floods at the dam and relate to the ability of the operator to access the site and to remove logs safely and expeditiously.

- Maintenance to facilitate operations.

Maintenance of the dam would be undertaken only where the structural integrity of the dam is deemed adequate. Areas showing signs of potential failure such as stability need to be properly evaluated before undertaking remedial measures. A physical assessment of existing dam materials may need to be undertaken.

The Babcock Mill Dam is considered to be in a serious state of disrepair. Operations should be discontinued to protect the Operator. Barricades and warning signage should be installed to protect the public and restrict access to the site.

All the other CRCA structures are able to be operated, serve their original design function and will continue to perform under typical seasonal runoff events. Maintenance has been undertaken both on a regular basis and as needed. Public usage is increasing at most sites.

Prioritizing each area of deficiency is as follows;

Safety (Public):

Marsh Bridge Dam – unrestricted boat access to the upstream side of the dam; open access to and flood potential immediately below the dam.

Sydenham Lake Dam – unrestricted boat access to the upstream side of the dam; unrestricted public access at the control structure during operations.

Fred Grant Dam – unfenced high wall at the downstream face of the main dam.

Safety (Operator):

Broome–Runciman Dam – poor accessibility along the road; small deck.

Millhaven Dam – poor accessibility along the road; lack of suitable parking area; height of structure; lack of gate restraint.

Temperance Lake Dam – poor accessibility to the dam; height of structure.

Operations:

Broome–Runciman Dam – inadequate pulley operating system for stop log adjustment; no emergency spillway.

Fred Grant Dam – lack of access; inadequate pulley operating system for stop log adjustment.

Little Cataraqui Creek Dam – materials placed above the weir crest for erosion protection have the potential to raise water levels during flood events.

Maintenance and Materials:

Temperance Lake Dam – significant cracks and efflorescence; lack of enclosure at control structure.

Fred Grant Dam – stone wall with active tree growth; seepage repairs breached; potential erosion.

Millhaven Dam – Some areas of past repairs to the concrete at pedestals have delaminated; seepage at road embankment.

8.0 RECOMMENDATIONS

8.1 GENERAL

Section 7 describes the remedial measures at each dam site. These measures have been considered in three categories as follows:

1. Operations
2. Maintenance and Materials
3. Safety

Recommendations to be considered by the Cataraqui Region Conservation Authority at the eleven dam sites have been derived from discussions with CRCA staff, site inspections, the data base provided at each dam and the consulting team's experience. The primary recommendations are presented herein.

As discussed and outlined in section 7.4 – Prioritization, the three categories of deficiencies have been prioritized and ranked as follows: safety, operations, and maintenance. Areas where the CRCA should focus their capital (repair) spending have been suggested. However, structure rehabilitation should only be undertaken where the dam meets the ODSG, and at sites where a lack of repair work would jeopardize the public and operator safety, or where the structure would not be able to be operated for key usage of flood control and wetland preservation.

8.2 SAFETY

A number of safety issues were identified for the eleven water control structures that should be addressed through capital spending.

8.2.1 Operator and Public Safety

Operator and public safety are paramount and should be reviewed at all sites.. Locations with public access should have a higher level of safety. Two such sites have been identified.

RECOMMENDATION: 1. Prepare a Safety Plan that specifically addresses public safety through signage, barriers, booms and other measures.

2. Undertake a capital program at each site based on the Safety Plan to improve both public and operator safety.

8.2.2 Draft Ontario Dam Safety Guidelines

The draft Ontario Dam Safety Guidelines (ODSG) considers the structural integrity of the dam as it applies to the safety of the public. Dams are assigned a Hazard Potential Classification. This needs to be carried out at all dams.

8.2.2.1 Hazard Potential Classification of Dams

Most dam sites have been assigned a Hazard Potential Classification according to the draft ODSG, but without the benefit of a stability analysis. Detailed information needs to be assembled on the site including site topography, physical works, geology, geotechnical and hydrotechnical to be able to undertake a stability analysis.

RECOMMENDATION: 1. Complete the Dam Safety Assessment including a stability analysis according to the ODSG.

2. Undertake a program of field and office studies to expand the database necessary to conduct a stability analysis.

3. Confirm the Hazard Classification at each dam.

Where the Hazard Classification of the dam is rated as High under the ODSG, the final risk management analysis includes the consequences of a failure described as a Dam Break Analysis, an Incremental Consequence Category (ICC) assessment and identification of flood risk areas delineated on Inundation Mapping.

The outcome of the Dam Break Analysis and ICC assessment needs to be documented and appropriate plans prepared. This documentation is called an Emergency Preparedness Plan. The Plan should be circulated to and adopted by parties having responsibility in times of an emergency.

RECOMMENDATION: 4. Conduct a Dam Break Analysis and Incremental Consequence Category assessment at dams with a rating of High.

5. Prepare an Emergency Preparedness Plan. Register the Plan with other agencies.

8.2.2.2 Environmental Assessment

The stability analysis may determine that the structure is unstable or does not meet the factor of safety as provided in the ODSG. An evaluation has to be made as to the course of action to be taken. This action may include do nothing, rehabilitate, reconstruct, and decommission. Again, to understand the implications of these alternatives, additional studies should be conducted to assess environmental, sociological and economic impacts. These studies typically take the form of an environmental assessment and include public input.

RECOMMENDATION: 1. Undertake an environmental assessment as needed to determine the preferred alternative regarding the course of action for each dam that does not meet ODSG stability criteria.

8.3 OPERATIONS

The dam records and record keeping practices of CRCA need to be addressed using current digital drawing and document management systems. The dam records lack key information pertaining to as constructed drawings, formalized Operation, Surveillance and Maintenance Manuals, Emergency Preparedness Plans and dam inspection reports and lake inventories.

Eight of the eleven water control structures have a draft Operations Plan that requires updating and two structures do not have one.

RECOMMENDATION: 1. A review should be undertaken of the forms used to record dam settings, staff gauge readings and/or lake elevations.

2. For those sites without adequate site plans (five have been identified), a survey should be undertaken of the dam and associates works, including a topographic survey of upstream and downstream areas.

3. A permanent elevation marker, referencing the Geodetic Survey of Canada (GSC) elevation should be established on the deck of each dam or water control structure.

4. All staff gauge locations be identified and re-established as necessary to GSC metric datum. The staff gauge, dam elevations and lake water levels should be correlated to each other.

5. Update each Operations Plan to create an Operations, Maintenance, and Surveillance Manual that can be used by CRCA staff.

8.4 MAINTENANCE AND MATERIALS

Maintenance and materials issues requiring capital expenditure were identified at each site. They ranged from the minor (e.g. overgrown vegetation) to the major (e.g. concrete deterioration and embankment settlement).

RECOMMENDATION: 1. Undertake a capital program at the dam sites to repair identified deficiencies and maintain the structures in a sound condition.

Table 2.1 Summary of Dam Operations

Dam	Winter Operation	Spring Operation	Summer Operation	Fall Operation	Low Flow Valve Operation	Emergency Operations
Sydenham Lake Dam Dam is integral component of Road No. 5A. Dam and control platform located on upstream side of road Structure (35 m wide) includes two 3.63 m wide stop log bays set in a twin concrete box culvert. Each bay handles 5 stop logs. 450 mm diameter low flow pipe in one bay.	Target water level = 130.61 m Log configuration of three 9" logs in each bay.	Target for May & June = 131.0 m After peak of spring freshet, a fourth 9" log and upper 4.5" log added to each bay (5 logs in total in each bay). Logs added and removed as necessary to maintain level below 131.1 m.	Target water level = 130.91 m Summer log configuration is four lower 9" logs and upper 4.5" log in each bay (4.5 logs across dam).	Target water level = 130.61 m Logs should be removed (one 9" and one 4.5" log from each bay) in late August or early September to lower water level to target.	Valve closed in early September and closed all winter. Low flow valve currently inoperable (filled with sediment).	Max. acceptable level = 131.06 m Flood conditions occurring when creek water level within 15 cm from foot bridge. Summer Operation: - At 131.31 m, remove one 4.5" log and replace with 9" log. - At 131.40 m, remove remaining 4.5" log and replace with 9" log. Winter Operation: - At 130.94 m, add 9" log to one bay. - At 131.03 m, add 9" log to other bay. - At 131.18 m, add 4.5" log to one bay. - At 131.25 m, add 4.5" log to other bay. - At 131.31 m, remove one 4.5" log and replace with 9" log. - At 131.40 m, remove remaining 4.5" log and replace with 9" log.
Millhaven Lake Dam (Wilton Road/Odessa) Concrete structure (24.13 m long) attached to Wilton Road bridge. Dam contains four bays, each 4.57 m wide, with metal gates operated by winches accessible from control platform. A low flow chamber (.2 m wide) exists at south end of dam. Overflow weirs (crest elev. = 124.36 m) located at either end of dam connect dam to bridge abutments.	Target water level = naturally regulated by rock outcrop downstream of dam Dam is not operated. Gates remain above water surface.	Early Spring Target water level = 124.54 to 124.66 m Spring Target water level = 124.39 to 124.66 m Following peak of spring freshet and passage of all ice, lower gates to maintain level between 124.51 and 124.66 m. Main gates and low flow gate operated to ensure reservoir below maximum level 124.66 m. Level should be as high as possible in target range until end of June. Low flow gate lowered to completely closed position. Water level must be above 124.39 m before performed. Should reservoir not reach 124.39 during spring freshet, all gates lowered as soon as possible and low flow valve set to pass 120 L/s.	Target water level = less than 124.39 m, with gradual drawdown through summer months.	All four main gates and low flow gate lifted well above water level by end of November.	Low flow gate set to discharge 170 L/s once summer water level recedes to 124.39 m.	Max. acceptable water level = 124.8 m Max. desirable water level = 124.6 m If extreme event possible during spring/summer, raising main gates and/or low flow gate considered to create additional storage. Stop logs in Potters and Babcock Dams must be removed prior to onset of extreme events.

Dam	Winter Operation	Spring Operation	Summer Operation	Fall Operation	Low Flow Valve Operation	Emergency Operations
Little Cataraqui Creek Dam Earth-fill dam (67 m long) with steel sheet pile overflow weir (33.5 m long). Low flow valve in 610 mm diameter culvert operated manually.	No operations required as designed as an overflow weir. Normal water level is static at 81.23 m.	Overflow weir Monitor relief wells in April.	Overflow weir	Overflow weir Monitor relief wells in October.	Low flow valve used to drain reservoir for maintenance. Valve closed under normal conditions throughout the year.	Water levels to be monitored daily during flood event. No emergency operation.
Temperance Lake Dam Small concrete dam (36.5 m long) with single stop log bay of 8 stop logs, each 254 mm square and 2.44 m long.	Target water level = 114.11 m If water equivalent in snow pack greater than 75 mm, seventh log removed.	If water levels above 114.45 m, consideration given to removing a log. By March 10, seventh log replaced. By March 25, eighth log replaced.	Target water level = 114.36 - 144.45 m Dam acts as an overflow weir structure.	Eighth log removed on September 1.	No low flow valve	High water level (H.W.L.) = 114.45 m One log pulled when levels exceed H.W.L. When level drops below H.W.L., replace log.
Marsh Bridge Dam Earth-fill dyke (275 m long) with concrete overflow weir (17.4 m long) and 460 mm diameter low flow valve operated manually.	No operations required as acts as an overflow weir.	Overflow weir	Overflow weir	Overflow weir	Low flow valve used to drain reservoir for maintenance. Valve should remain closed under normal conditions throughout the year.	High water level = 108.7 m No emergency operation.
Fred Grant Dam Embankment dam comprising clay core with stone and concrete facing (118 m long). Concrete control structure with 2 stop log bays, each 3.14 m wide and holding 8 stop logs. 305 mm diameter low flow valve.	Target water level = 107.6 m All stop logs removed.	Target water level = 107.9 m After spring freshet, stop logs gradually replaced to reach target level.	Water level gradually reduced.	On September 1, all stop logs removed over 2-3 week period to bring level to 107.6 m by September 30.	Low flow valve opened in late June to maintain minimum base flow of 50 L/s downstream.	Removal of all stop logs results in maximum discharge of 6 m^3/s and a water level of 108.3 m (passage of 100 year storm event).
Broome-Runciman Dam Earth-fill road embankment with concrete box culvert (2.6 m square). Two stop log bays in 2.7 m sq. operating platform, separated by 400 mm I.D. steel low flow valve unit. Stop logs are 1.66 m long by 203 cm square.	Target water level (min. water level) = 101.80 m (6.5 logs placed in each of the two bays). Monitor temperature, water content of snow and soil conditions to determine if additional draw down is necessary by February 1.	Max. water level = 102.56 m Beginning March 1, water level allowed to rise. Seventh stop log in place by March 23; eighth log in place by April 25 and ninth between May 10 and May 20 in both bays.	Target water level (June 1) = 102.41 m (9 logs in each of the two bays). Reservoir should be kept at this level, but will decline slowly after June 1. Avg. evaporation loss = 177.8 mm.	Target water level = 102.11 m (by August 31). Need to create storage by October.	Operated from June 1 to August 31 at rate of 50 L/s. During severe dry summer, open gate in front of low flow valve for flow of 280 L/s for a three to four hour period once a week to flush creek. Presently valve is inoperable,	Maximum water level = 102.57 m CPR line closed if levels exceed maximum. Remove 1 log from each bay when level reaches 102.54 m. Additional logs may be removed after Buells Creek Detention Basin has crested. Logs replaced when level below 102.32 m.

Dam	Winter Operation	Spring Operation	Summer Operation	Fall Operation	Low Flow Valve Operation	Emergency Operations
Buells Creek Detention Basin Detention basin inflows handled by main control structure comprising earth dyke with uncontrolled outlet pipes (750 and 450 mm diameter) and gate controlled outlet pipe, 1350 mm diameter.	1350 mm diameter outlet pipe open.	1350 mm diameter outlet pipe left open until May 15 or end of spring melt.	Gate on the 1350 mm diameter outlet pipe should be closed and all flow handled by uncontrolled low flow pipes.	On or about November 15, or when temperatures begin to drop for winter, the gate on the 1350 mm diameter outlet pipe in the east control structure opened. It is imperative that no more than one stop log at a time be removed from Broome-Runciman dam and then only after the 1350 mm diameter outlet gate opened.	Uncontrolled low flow pipes (750 and 450 mm diameter).	Max. water level before spill over sides = 99.0 m Operation of Broome-Runciman dam must be coordinated with operation of Buell Creek Detention Basin.

Table 6.1 Hazard Potential Classification

Name of Structure	CRCA Structure ID	Description	Height (m)	Storage (x 1000 m3)	Loss of Life Potential	Property Damages	Environmental Damages	Other Damages	MNR ODSG Hazard Classification
Sydenham Lake Dam	4	Concrete dam with 2 stop log bays and 1 low flow valve. Dam is located on the upstream side of a bridge structure and is an integral part of the bridge.	3	2190	Yes	<$10,000,000. Appreciable damage to agricultural operations, other dams, or to residential, commercial, industrial or future (20 yrs) development.	Fisheries, sediment release, habitat loss.	Loss of recreational benefits, social impact, tourism impact. Village of Sydenham located immediately downstream, Church Street bridge 500 m d/s, County Road 600 m d/s, flood damage center d/s.	HIGH
Millhaven Dam (Wilton Road)	8	Concrete dam with 4 sluice gates, 2 weirs and 1 low flow valve. Located upstream of a bridge structure.	4.5	2510	No	<$10,000,000. Appreciable damage to agricultural operations, other dams, or to residential, commercial, industrial or future (20 yrs) development.	Fisheries, habitat loss.	Loss of municipal water supply, loss of water for sewage treatment plant effluent dilution, loss of water for riparian users. Hwy 401 and County Road immediately d/s, abandoned Potters Dam 400 m d/s, Babcock Mill Dam 1 km d/s.	HIGH
Babcock Mill Dam & Diversion	Municipal	Concrete dam with 4 stop log bays.	1.5		No	<$100,000. Damage to dam only	Aesthetic issues, fisheries, erosion.	Limited property damage. Benefit of mill operation only.	LOW
Highgate Creek Channelization	425	Concrete retaining wall and bedrock channel.				<$10,000,000. Appreciable damage to agricultural operations, other dams, or to residential, commercial, industrial or future (20 yrs) development.	Erosion, sediment release.		N/A
Little Cataraqui Creek Dam	6	Earth embankment dam with sheet pile weir and low flow valve.	2	400	No	<$100,000. Damage to dam only	Sediment release, fisheries, habitat loss, erosion.	Reduced recreation and tourism benefits as reservoir is focus of major conservation area. Two conservation area bridges located immediately d/s, Hwy 401 200 m d/s.	LOW
Temperance Lake Dam	7	Concrete dam with 1 stop log bay and an overflow weir on each side of the control structure.	3	362	No	<$1,000,000. Minimal damage to agriculture, other dams, or structures not to human habitation, no damage to residential, commercial, industrial or future (20 yrs) development.	Fisheries, sediment release.	Loss of recreational benefits.	LOW
Marsh Bridge Dam	9	Earth embankment dam with 1 concrete weir and a low flow valve.	2	460	No	<$10,000,000. Appreciable damage to agricultural operations, other dams, or to residential, commercial, industrial or future (20 yrs) development.	Fisheries, sediment release, habitat loss.	Reduced property values/recreation. Trailer park located immediately d/s.	LOW
Fred Grant Dam	10	Earth embankment with an abandoned low flow valve. Bypass concrete control structure has 2 stop log bays. New low flow valve.	3.7	175	No	<$10,000,000. Appreciable damage to agricultural operations, other dams, or structures not to human habitation, no damage to residential, commercial, industrial or future (20 yrs) development.	Fisheries, sediment release, habitat loss.	Reduced property values/recreation, County Road located 500 m d/s.	SIGNIFICANT
Broome-Runciman Dam	5	Concrete dam with 2 stop log bays. Dam is located on the upstream side of a bridge structure and is an integral part of the bridge.	3	1740	No	<$10,000,000. Appreciable damage to agricultural operations, other dams, or to residential, commercial, industrial or future (20 yrs) development.	Fisheries, sediment release, habitat loss.	Loss of recreational and tourism benefits.	LOW
Buells Creek Detention Basin	11	Dry detention pond with control manhole at outlet (bypass). 1-1300mm CSP and 1-800mm CSP culverts.	3	155	No	>$10,000,000. Extensive damage to large residential, commercial, agriculture, industrial or infrastructure.	Erosion.	CN Rail 500 m d/s, Parkdale Ave bridge 600 m d/s, Hwy 401 700 m d/s.	HIGH
Booth Falls Channelization	429	Channelization works consisting of emergency spillway.							N/A

Table 7.1 Deficiencies & Rehabilitation

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Sydenham Lake Dam	Design dwgs for plan & profile, elevation, cross-sections and structural. No As-built dwgs for plan, elevations, cross-sections and structural.	No design or as-built reports. Seepage investigation carried out. Hydrotechnical / floodplain report available.	NTS/OBM; plan & profile; no survey / site plan.	Operation manual to be finalized. Review method of securing the hook to the stop log at periods of high flow. Low flow valve is difficult to access; raise the stem to the top of the handrail to facilitate operation. Gain covers susceptible to freezing; have tools available to unfreeze. No emergency spillway.	Minor deterioration of upstream gabion basket wall; repair. Tree has fallen across channel downstream of dam; remove. Areas of erosion block may fail under high flow conditions; monitor. Settlement of ground surface of downstream northwest embankment continues to occur; monitor and survey. Indication of seepage approximately 2 m downstream of outlet channel structure; review earlier investigations; monitor discharge at collector drain. Valve is difficult to operate – plugged with sediment; flush; create a raised crest around the gate. Original staff gauge is set at geodetic datum; second staff gauge set to geodetic datum and mounted in location not affected by drawdown. Replace stop logs. Add riprap to the downstream channel.	Warning signage is minimal, in English and colouration makes it difficult to read; install more visible warning signage and buoy(s) and/or a boom to identify a safe boating area. No barriers to keep public away when adjusting stop logs; install temporary fence during operations. Handrails and winch difficult to see at night and winch projects into pedestrian pathway; install warning signage; paint railing with light reflective colour at control structure. As control structure and headwall are part of a public walkway, railing should be of picket fence type per Ontario Building Code. No fall protection system; review alternative systems.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Millhaven Lake Dam (Wilton Road/Odessa)	Design dwgs. For plan, elevation, cross-sections and structural.	No structural/seepage, design or as-built reports. Hydrotechnical / floodplain report available.	NTS/OBM; site plan (Imperial)	Operation manual to be finalized. Review suspension of gates on cables in winter; install devices to lock gates in open position above deck. Gate operator does not identify position; install an indicator to identify position of gate. Schedule maintenance of gates on a fixed basis. Open low flow valve fully on regular basis to flush. Gain covers susceptible to freezing; have tools available to unfreeze.	Drainage ditches on west side road have standing water, indicating possible seepage; conduct stability and seepage investigation. Patching at winch pedestals appears to be delaminating from original concrete; repair. Expansion joint between north weir and bridge headwall has no sealant; install sealant. Valve is difficult to operate due to being plugged with sediment; create a raised crest around the gate. Removal of trashrack results in grate not set at lowest position; install a porous check dam. Staff gauge has been damaged by ice; replace and mount geodetically in location not affected by drawdown.	Warning signage is minimal, in English and colouration makes it difficult to read; install larger more visible warning signage and buoy(s) and/or a boom to identify a safe boating area. Staff vehicles should park off the road instead of the shoulder. Operators should wear safety coloured vests if on road and domed and vehicle flashing lights should be turned on; use safety signage. Install a support at guide rail to assist staff when accessing dam. No fall arrest system; review alternative systems.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Babcock Mill Dam & Diversion	No design or as-built dwgs	No structural / seepage, design or as-built reports. Hydrotechnical / floodplain report available.	None	No specific Operations Plan, only a general operational guide with respect to the Millhaven Dam, Potter's Dam and Babcock Mill Dam. Bringing in winches and mounting them to piers has element of risk as piers in state of failure. Access on deck questionable due to concrete deterioration. No emergency spillway.	West embankment has signs of animal burrowing & trees are present; monitor. Structural concerns at control structure, upstream abutments and downstream wingwalls - diagonal and transverse cracking, displacement, seepage. Pattern cracking, visible florescence, drummy concrete, spalling and non-structural repairs noted. Minor bulging of the downstream stone retaining wall and seepage. Stop logs at each bay have varying sizes and are not set at a consistent elevation. Significant seepage between logs and at the sill and gain noted. No staff gauge; install metric gauge at a geodetic datum. Some posts of handrail corroded; failure of slope where fence installed in bank. Install trash rack at diversion structure entry. Walls of diversion channel are cracking No structural maintenance has been undertaken; condition would indicate repair would not be practical.	No warning signage at dam for upstream water users; install appropriate warning signage. With structural concerns at the control structure, place fencing at the limits and install warning signage of NO ACCESS. Discontinue operation of dam. Properly install a fence at the diversion channel.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Highgate Creek Channelization	Design dwgs for plan & profile and wall, culvert and fence details & structural. No as-built dwgs.	Hydrotechnical and design reports available. No as-built report.	NTS/OBM; plan and profiles.	Significant build up of organics and sediment resulting in loss of capacity; clean. Add reference markers to indicate level of sediment. Monitor wall at hydro pole along Meadowood Drive for cracking.	Minor cracking (large drain inlets; west wall u/s of Prince Charles Drive has dampness; monitor & repair as necessary Drain ports u/s of Prince Charles Drive plugged with soil; clean and install measures to prevent soil loss. Concrete spalling at top of wall at base of the guide rail post; undertake structural repairs. Sealant missing at junction of channel wall and bridge headwalls; monitor and repair.	Access can be gained at above upstream and below downstream bridges and at intermediate bridges; install warning and no trespassing signage. No means for an emergency exit along channel; provide mechanical escape measures at bridges while staff in the channel.
Little Cataraqui Creek Dam	Design dwgs for plan & elevation with details. No as-built dwgs	No hydrotechnical, design or as-built reports. Seepage report relating to construction of relief wells available.	NTS/OBM; no survey.	Operation manual to be finalized. Riprap set above sheet-piling has raised crest of the weir; confirm backfill level to operating level. Low flow valve is not operator; open fully on a regular basis to flush.	No staff gauge; install and set to geodetic metric datum. Armour stone at upstream side of dam covered with sediment and organic matter; undertake inspection of erosion protection. Downstream riprap does not extend to the top of the sheetpile; add riprap. Low flow valve is not operated; maintain. Location of one observation well and outlet is not known; locate and clean.	Warning signage at access to low flow valve is minimal; install a physical barricade at access entry. No warning signage at dam; install signage upstream of dam to warn boating public.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Temperance Lake Dam	Design dwgs for plan, elevation, sections & structural; dam repair details. No as-built dwgs.	No structural /seepage, design or as-built reports. Hydrotechnical / floodplain report available.	NTS/OBM; no survey.	Operation manual to be finalized. Gain covers susceptible to freezing; make tools available to unfreeze. 'Review method of securing the hook to the stop log at periods of high flow. Runoff may flow around east dam segment; confirm by survey.	Significant crack on the east abutment and wingwall; repair. Concrete shows pattern cracking and signs of visible efflorescence; monitor. Testing shows delamination at east abutment and at repairs at winch pedestals; repair. Control structure shows minor to moderate surface abrasion; monitor. Staff gauge is set to site conditions, can be submerged under high flow and is imperial; set to geodetic metric datum, rotate, extend and mount in a location not affected by drawdown. No handrail on the east side of the control structure or the downstream set of steps on the west side; install handrail. Undertake visual inspections of embankments at dam segments regularly. Vehicular traffic is disturbing ground cover on d/s embankments; install barricades. Significant beaver activity with debris on top of logs; install log boom.	Warning signage is minimal, in English and colouration makes sign difficult to read; install more visible warning signage at dam and additional signage at lake / channel leading to the dam for boat traffic. No fall protection system; review alternative systems.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Marsh Bridge Dam	Design dwgs for plan, profile, elevations, cross-sections and structural. No as-built dwgs.	No structural / seepage, or design reports. Hydrotechnical / floodplain report available.	NTS/OBM; plan and profile. No survey.	Operation manual to be finalized, however no operations are generally undertaken. Low flow valve is not operated, inlet and outlet partially blocked; clean, service gate and open regularly to flush debris.	Small crack at the downstream face of the weir at the low flow valve; monitor and repair as necessary. Shrinkage cracking at the top of the west abutment; monitor. Staff gauge imperial; re-establish to geodetic metric datum. Degradation of the east upstream bank due to boating; discourage public from using and add erosion protection. Define an area for crossing at main earth dam. Restore riprap at portions of west embankment. Undertake regular inspection for seepage at the embankments. Remove large shrubs and trees on embankment. Soil has settled at the east wingwall; repair and vegetate. Undertake stability study of the west embankment including seepage. Monitor banks regularly and report. Vehicular traffic is disturbing ground cover on d/s embankments at weir; install barricade / fence to discourage traffic.	Access to low flow valve gained by traversing handrail and standing on valve headwall; install a wider working platform with handrails and gate at handrail. Warning signage is minimal, in English and colouration makes it difficult to read. Warning signage and fencing should be considered for area above and below weir. Structure is situated in a public place. Consider replacement of bar railing with a picket fence type railing to meet Ontario Building Code. High flow at weir could flood downstream abutting property; undertake a hydraulic study with recommendations to flood proof property.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Fred Grant Dam	Design dwgs incomplete. As-built dwgs available.	No design or as-built reports. Seepage and geotechnical reports available. Hydrotechnical / floodplain report available.	NTS/OBM As-built survey conducted in 2002.	Operation manual to be finalized. Review method of securing the hook to the stop log at periods of high flow. Valve is not operated; open to flush sediment. Add measures to protect inlet from ice damage. Remove stop logs not necessary for Operations. Access to site is in dispute; provide a permanent legal access.	Settlement in location of low flow valve at the main dam; repair and fence. Replace staff gauge and set to geodetic metric datum. Past repairs for seepage at main dam have been breached; review earlier investigations and findings of seepage study; undertake assessment to determine cause of failure of repairs (geotechnical seepage investigation of entire structure); determine alternatives. Monitor bank stability especially at areas of stone wall. Erosion protection minimal at d/s toe of main dam near bypass channel; install riprap. Determine extent of riprap at u/s face; repair as necessary.	Vertical drop at stone wall at main dam; install safety fencing. Signage is minimal, in English and colouration makes sign difficult to read; install clearly visible warning signage at dam and control structure and buoy(s) and/or a boom to identify safe boating area. Settlement at existing valve at main dam; repair and provide safety fence.
Broome-Runciman Dam	Design dwgs for site plan, cross-sections, structural & details. No as-built dwgs.	No structural / seepage, design or as-built reports. Hydrotechnical / floodplain report available.	NTS/OBM; no survey.	Operation manual to be finalized. Valve inlet becomes plugged with sediment; open to flush and create a raised crest around the gate. Review method of securing the hook to the stop log at periods of high flow. Gain covers susceptible to freezing; make tools available to unfreeze. No emergency spillway.	No locking clip on the pulley to hold stop log in up-position; replace pulley system with winch system. Staff gauge may be in a location affected by drawdown.	Warning signage is minimal, in English and colouration makes it difficult to read; install clearly visible warning signage and buoy(s) and/or a boom to identify safe boating area. Operators should wear safety coloured vests. No fall arrest system; review alternative systems.

Name of Structure	Drawings	Reports	Survey	Deficiencies / Rehabilitation		
				Operation	Maintenance & Materials	Safety
Buells Creek Detention Basin	As-built dwgs for site plan & plan, sections and details for east & west channels.	No structural / seepage, hydrotechnical or as-built reports. Design report available. Hydrotechnical / floodplain report available.	Site plan (as-built). Floodplain mapping.	Operation manual to be finalized.	Foot crossing at d/s end of gabion drop structure has disturbed existing vegetation. Gabion baskets have settled and wire cage damaged; undertake a thorough review of all embankments and erosion protection. Failure of concrete capping placed on stone erosion protection at inlet pipe; repair settlements and monitor. Low flow pipe at Magedoma Boulevard becomes easily blocked with vegetation; install a small pervious check dam u/s of inlet.	Warning signage is minimal and in English; place more signage and of a bigger size at inlet of bypass. Access steps to inlet bypass pipe obscured by vegetation; maintain. Ministry of Labour guidelines for confined / restricted space entry must be followed for inspection and maintenance of bypass valve. Wall height at gabion drop structure excessive; restrict bank access and install warning signage.
Booth Falls Channelization	As-built dwgs for plans & profile.	No hydrotechnical, design or as-built reports.	Site plan (design).		Masonry wall at south limit of the emergency spillway is showing signs of shifting; undertaken repairs.	No warning signage at the emergency spillway; install signage at both ends of spillway.

APPENDIX B

CRCA WATER AND EROSION CONTROL INFRASTRUCTURE DATABASE

Water and Erosion Control Infrastructure Database

Cataraqui CA
Sydenham Lake Dam Structure ID: 4

Structure Location

Municipality	Township of South Frontenac
Name of Waterbody	Millhaven Creek
Owned By	Cataraqui CA
Operated By	Cataraqui CA
Maintained By	Cataraqui CA
Location Description	Lot 4, Conc. 5 Loughborough Twp. - County Road 19 Road Culvert

Type of Structure	dam (dam/dyke/chan/eros/other)
Lake/River Controlled	Sydenham Lake
Watershed	Millhaven Creek
Drainage Area	61.6 sq kms
UTM Zone	18 NAD
UTM East	373000
UTM North	4918800
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- [x] Flood Control
- [x] Low Flow Augmentation
- [x] Municipal Water supply
- [ ] Navigation
- [ ] Power Generation
- [x] Habitat Creation
- [ ] Erosion Control
- [ ] Slope Stabilization
- [x] Recreation
- [x] Other Use (specify): fish and wildlife habitat

Primary Uses:

Benefits of Structure

Value of property protected	$1,300,000.00
Number of Residences protected	11
Avg annual flood damage reduction	$270,000.00
Avg annual erosion damage reduction	$150,000.00

Infrastructure Protected: 2 road crossings

Costs

Cost when built: $206,000 | [ ] Cost Includes land | Land Cost: $75,000 | Year(s) Constructed: 1977

Present Value Estimate	$431,318	comments: rebuilt in 1977, historical grist mill dam
Replacement Cost Estimate	$625,000	comments:
Decommissioning Cost Estimate		comments:

Annual Costs Operating: | Minor Maint.: | Preventative Main: | [ ] MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	87.00%	50.00%
Loughborough Township	13.00%	

C

50.00%

General Structure Description

☑ Concrete ☑ Earth ☑ Rock ☐ Timber ☐ Steel ☐ Other

Description of Construction:

Height 3 m

Length 36 m

Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m

Width: m

Level of Protection for Water Control Structure:

Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams

This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	219	0	
Area (ha)	730	730	
Elevation (m)	130.9	130.6	

Height of Dam (as per ICOLD): 3 m

Normal Head: 2 m

Discarge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ___ cms

Maximum Controlled Discharge: ___ cms

- ☑ Stop Log
- ☐ Gates — # of gates: 2 — Width*: 7.2 m — Height*: ___ m
- ☐ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 7.2 m
- ☐ Valves — Valve Size*: ___ m
- ☐ Pipe
- ☑ Other Control — Specify: low flow valve
- ☐ Fishway

Dam Safety

This section is completed for Dams only

Inspection Frequency

Field: seasonally

Engineering: ___ — Last Date: Jan 1995

External: ___ — Last Date: ___

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

Complete — Review dat: ___ — ☐ Dam Break/Mapping completed — ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☑ Loss of Life — Property damage: 2

Property Damage Categories (as per Draft OMNR DSG)

1 >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure

2 <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas

3 <$1,000,000 minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) developments

4 <$100,000 damage to dam only

☑ Environmnetal Damage — describe: Fisheries, Sediment release, habitat loss

☑ Other Damages — describe: loss of recreational benefits; social impact; tourism impact; Village of Sydenham located immediately downstream (0-600m); Church Street crossing 500 m d/s; County Road 600 m downstream; flood damage centre (residences) 500 m downstream

MNR DSG hazard Class: high — high, significant, low, very low, not applicable

Notes to data entry (append additional sheet if required)

Water and Erosion Control Infrastructure Database

Cataraqui CA
Wilton Road Dam

Structure ID 8

Structure Location

Municipality	Township of Loyalist	Type of Structure	dam (dam/dyke/chan/eros/other)
Name of Waterbody	Millhaven Creek	Lake/River Controlled	Mud (Odessa) Lake
Owned By	Cataraqui CA	Watershed	Millhaven Creek
Operated By	Cataraqui CA	Drainage Area	123.1 sq kms
Maintained By	Cataraqui CA	UTM Zone	18
Location Description	Lot 34, Conc. 4, Ernestown Twp.	NAD	
		UTM East	363000
		UTM North	4904800
		Longitude	
		Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- [x] Flood Control
- [x] Low Flow Augmentation
- [x] Municipal Water supply
- [ ] Navigation
- [ ] Power Generation
- [x] Habitat Creation
- [ ] Erosion Control
- [ ] Slope Stabilization
- [x] Recreation
- [x] Other Use (specify): maintains Class 1 wetland (with f&w habitat), sewage

Primary Uses

Benefits of Structure

Value of property protected	$2,000,000.00
Number of Residences protected	10
Avg annual flood damage reduction	$200,000.00
Avg annual erosion damage reduction	$30,000.00

Infrastructure Protected:

2 d/s dams
2 road crossings

Costs

Cost when built	$115,275	☐ Cost Includes land
Land Cost	$163,000	
Year(s) Constructed	1974	
Present Value Estimate	$263,741	comments
Replacement Cost Estimate	$456,000	comments
Decommissioning Cost Estimate		comments

Annual Costs Operating | Minor Maint. | Preventative Main | ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	60.00%	50.00%
Cataraqui C. A.	40.00%	50.00%

General Structure Description

- [ ] Concrete
- [x] Earth
- [x] Rock
- [ ] Timber
- [ ] Steel
- [ ] Other

…cription of …struction:

Height 4.5 m | Length 37.5 m | Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m | Width: m

Level of Protection for Water Control Structure: | Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

[illegible] ns — This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	251	0	
Area (ha)	440	220	
Elevation (m)	124.36	123.6	

Height of Dam (as per ICOLD): 4.5 m

Normal Head: 1 m

Discarge Facilities

*note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ____ cms

Maximum Controlled Discharge: ____ cms

- ☐ Stop Log
- ☑ Gates — # of gates: 5 — Width*: 19.5 m — Height*: ____ m
- ☑ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 13.3 m
- ☐ Valves — Valve Size*: ____ m
- ☐ Pipe
- ☑ Other Control — Specify: low flow gate (2m high x 1.3 m. wide
- ☐ Fishway

Dam Safety — This section is completed for Dams only

Inspection Frequency

Field: seasonally

Engineering: ____ Last Date: Jan 1995

External: ____ Last Date: ____

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

[illegible]omplete — Review dat: ____ — ☐ Dam Break/Mapping completed — ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 2

Property Damage Categories (as per draft OMNR DSG)
1: >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2: <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3: <$1,000,000 minimal damage to agricultural, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4: <$100,000 damage to dam only

☑ Environmnetal Damage — describe: Fisheries

☑ Other Damages — describe: loss of municipal water supply; loss of water for sewage treatment plant effluent dilution; loss of water for riparian users; Hwy #401 & Cty Rd immediately downstream; worn Potters Dam 400 m downstream; Babcock Mill Dam 1 km downstream

MNR DSG hazard Class: high (high/significant/low/very low/not applicable)

Notes to data entry (append additional sheet if required)

Water and Erosion Control Infrastructure Database

Cataraqui CA

Highgate Creek Channelization

Structure ID: 425

S cture Location

Municipality	City of Kingston
Name of Waterbody	Highgate Creek
Owned By	CRCA
Operated By	CRCA
Maintained By	CRCA
Location Description	between Carmil Blvd. & Prince Charles Blvd.

Type of Structure	Chan (dam/dyke/chan/eros/other)
Lake/River Controlled	Highgate Creek
Watershed	Highgate Creek
Drainage Area	sq kms
UTM Zone	NAD
UTM East	371500
UTM North	4900500
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☐ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☑ Erosion Control
- ☐ Slope Stabilization
- ☐ Recreation
- ☐ Other Use (specify)

Primary Uses

Benefits of Structure

Value of property protected	$2,400,000.00
Number of Residences protected	16
Avg annual flood damage reduction	$500,000.00
Avg annual erosion damage reduction	$100,000.00

Infrastructure Protected:

2 road crossings

Costs

C vhen built $285,000 ☐ Cost Includes land Land Cost Year(s) Constructed 1980

Present Value Estimate	$546,089	comments
Replacement Cost Estimate	$665,000	comments
Decommissioning Cost Estimate		comments

Annual Costs Operating Minor Maint. Preventative Main ☐ MNR Funded

Funding Partners	**Original Funding %**	**Maintenance Funding %**
Ministry of Natural Resources	61.00%	50.00%
Cataraqui Region C. A.	39.00%	50.00%

G neral Structure Description

☐ oncrete ☐ Earth ☐ Rock ☐ Timber ☐ Steel ☐ Other

Water and Erosion Control Infrastructure Database

Cataraqui CA

Highgate Creek Channelization

Structure ID: 425

Description of Construction:

Height: 3 m

Length: 300 m

Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m

Width: m

Level of Protection for Water Control Structure:

Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams

This section is completed for Dams only

Dam Safety

This section is completed for Dams only

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 2

Property Damage Categories (as per draft OMNR DSG)
1 >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2 <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3 <$1,000,000 minimal damage to agriculture, other dams, or structures not to human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4 <$100,000 damage to dam only

☑ Environmnetal Damage — describe : sediment release, erosion

☐ Other Damages — describe :

MNR DSG hazard Class: significant — [illegible] significant, low, very low, not applicable

Notes to data entry (append additional sheet if required)

S... cture Location

Municipality	City of Kingston
Name of Waterbody	Main Branch Little Cataraqui Creek
Owned By	Cataraqui CA
Operated By	Cataraqui CA
Maintained By	Cataraqui CA
Location Description	Lot 22, Conc. 4, Kingston Twp.

Type of Structure	dam (dam/dyke/chan/eros/other)
Lake/River Controlled	Little Cataraqui Creek Reservoir
Watershed	Little Cataraqui Creek
Drainage Area	20. sq kms
UTM Zone	18
NAD	
UTM East	378400
UTM North	4903600
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☑ Navigation
- ☐ Power Generation
- ☑ Habitat Creation
- ☐ Erosion Control
- ☐ Slope Stabilization
- ☑ Recreation
- ☑ Other Use (specify): maintains Class 2 wetland (with f&w habitat)

Primary Uses

Benefits of Structure

Value of property protected

Number of Residences protected

Avg annual flood damage reduction

Avg annual erosion damage reduction

Infrastructure Protected:

Costs

C... when built: $106,000 ☐ Cost Includes land Land Cost: $40,000 Year(s) Constructed: 1971

Present Value Estimate	$265,009	comments	
Replacement Cost Estimate	$507,000	comments	
Decommissioning Cost Estimate		comments	

Annual Costs Operating: Minor Maint.: Preventative Main: ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	75.00%	50.00%
Cataraqui Region C. A.	25.00%	50.00%

G...neral Structure Description

☐ Concrete ☑ Earth ☑ Rock ☐ Timber ☐ Steel ☑ Other: Steel

:cription of
truction:

Height 3.1 m | Length 100.5 m | Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m | Width: m

Level of Protection for Water Control Structure: | Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams — This section is completed for Dams only

Reservoir Description

Height of Dam (as per ICOLD): 3.1 m
Normal Head: 2 m

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	0	0	
Area (ha)	28.7	28.7	
Elevation (m)	81.23	81.23	

Discarge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: 0 cms
Maximum Controlled Discharge: cms

- ☐ Stop Log
- ☐ Gates — # of gates: 0 — Width*: m — Height*: m
- ☐ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 33.5 m
- ☐ Valves — Valve Size*: 0.6m diameter m
- ☐ Pipe
- ☑ Other Control — Specify: a) sheet-pile weir; b)concrete encased low flow valve/pipe
- ☐ Fishway

Dam Safety — This section is completed for Dams only

Inspection Frequency

Field: seasonally
Engineering: — Last Date: Jan 1995
External: — Last Date:

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

☐ Complete — Review dat: — ☐ Dam Break/Mapping completed — ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 4

Property Damage Categories (as per draft OMNR DSG)
1: $10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2: $10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3: $1,000,000 minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4: $100,000 damage to dam only

☑ Environmneteal Damage — describe: Sediment Release

☑ Other Damages — describe: reduced recreation and tourism benefits as reservoir is focus of major conservation area; two conservation area bridges located immediately d/s; highway #401 about 200 m downstream (consequences unknown) - erosion

MNR DSG hazard Class: low — high, significant, low, very low, n/a, not applicable

Notes to data entry (append additional sheet if required)

Water and Erosion Control Infrastructure Database

Cataraqui CA

Temperance Lake Dam

Structure ID

Structure Location

Municipality	Athens Township	Type of Structure	dam (dam/dyke/chan/eros/other)
Name of Waterbody	Gananoque River (Leaders Creek)	Lake/River Controlled	Temperance Lake
Owned By	Cataraqui CA	Watershed	Gananoque River
Operated By	Cataraqui CA	Drainage Area	6.9 sq kms
Maintained By	Cataraqui CA	UTM Zone	18
Location Description	Lot 3, Conc. 7, Yonge Twp.	NAD	
		UTM East	438850
		UTM North	4938850
		Longitude	
		Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☐ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☐ Erosion Control
- ☐ Slope Stabilization
- ☑ Recreation
- ☑ Other Use (specify): fish and wildlife habitat

Primary Uses:

Benefits of Structure

Value of property protected	
Number of Residences protected	
Avg annual flood damage reduction	
Avg annual erosion damage reduction	$10,000.00

Infrastructure Protected:

Costs

when built: $30,000 ☐ Cost Includes land Land Cost: $258 Year(s) Constructed: 1952

Present Value Estimate	$131,517	comments	
Replacement Cost Estimate	$204,000	comments	
Decommissioning Cost Estimate		comments	

Annual Costs Operating: Minor Maint.: Preventative Main: ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	75.00%	50.00%
Cataraqui Region C. A.	25.00%	50.00%

General Structure Description

☐ Concrete ☑ Earth ☑ Rock ☐ Timber ☐ Steel ☐ Other

Water and Erosion Control Infrastructure Database

Cataraqui CA

Temperance Lake Dam — Structure ID 7

scription of
struction:

Height 3 m — Length 37 m — Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m — Width: m

Level of Protection for Water Control Structure: — Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Water and Erosion Control Infrastructure Database

Cataraqui CA

Temperance Lake Dam — Structure_ID: 7

L ns — This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	36.25	0	
Area (ha)	145	145	
Elevation (m)	114.36	114.11	

Height of Dam (as per ICOLD): 3 m

Normal Head: 2 m

Discarge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ______ cms

Maximum Controlled Discharge: ______ cms

- [x] Stop Log
- [ ] Gates — # of gates: 1 — Width*: 2.4 m — Height*: ______ m
- [x] Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 37 m
- [ ] Valves — Valve Size*: ______ m
- [ ] Pipe
- [ ] Other Control — Specify: ______
- [ ] Fishway

Dam Safety — This section is completed for Dams only

Inspection Frequency

Field: seasonally

Engineering: every 5 yrs — Last Date: Aug 2001

External: ______ — Last Date: ______

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

- [ ] omplete — Review dat: ______
- [ ] Dam Break/Mapping completed
- [ ] Emergency Preparedness Plan completed

Ui. taken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

- [ ] Loss of Life

Property damage: 3

Property Damage Categories (as per draft OMNR DSG)

1 >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure

2 <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas

3 <$1,000,000 minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development

4 <$100,000 damage to dam only

- [x] Environmnetal Damage — describe: Fisheries, Sediment release
- [x] Other Damages — describe: loss of recreational benefits

MNR DSG hazard Class: low

high, significant, low, very low, not applicable

Notes to data entry (append additional sheet if required)

Structure Location

Municipality	Township of Front of Yonge
Name of Waterbody	Gananoque River (Leaders Creek)
Owned By	Cataraqui CA
Operated By	Cataraqui CA
Maintained By	Cataraqui CA
Location Description	Lot 3, conc. 5, Front of Yonge

Type of Structure	dam (dam/dyke/chan/eros/other)
Lake/River Controlled	Centre (Stump) Lake
Watershed	
Drainage Area	20 sq kms
UTM Zone	18
NAD	
UTM East	431400
UTM North	4937700
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☑ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☐ Erosion Control
- ☐ Slope Stabilization
- ☑ Recreation
- ☑ Other Use (specify): maintains Class 3 wetland (with f&w habitat)

Primary Uses:

Benefits of Structure

Value of property protected	
Number of Residences protected	0
Avg annual flood damage reduction	
Avg annual erosion damage reduction	

Infrastructure Protected:

Costs

Cost when built: $78,700 ☐ Cost Includes land Land Cost: $251 Year(s) Constructed: 1974

Present Value Estimate	$180,060	comments: again, historical structure with rebuild in 1974
Replacement Cost Estimate	$311,000	comments:
Decommissioning Cost Estimate		comments:

Annual Costs Operating: Minor Maint.: Preventative Main: ☐ MNR Funded

Funding Partners	**Original Funding %**	**Maintenance Funding %**
Ministry of Natural Resources	75.00%	50.00%
Cataraqui C. A.	25.00%	50.00%

General Structure Description

☐ Concrete ☑ Earth ☐ Rock ☐ Timber ☐ Steel ☐ Other

Description of structure:

Height	2 m	Length	293 m	Type of erosion protected from (riverine, coastal, both, other):	
Height of slope:	m	Width:	m		

Level of Protection for Water Control Structure:

Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams

This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	0	0	
Area (ha)	220	220	
Elevation (m)	107.72	107.72	

Height of Dam (as per ICOLD): 2 m

Normal Head: 1 m

Discharge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ____ cms

Maximum Controlled Discharge: ____ cms

- ☐ Stop Log
- ☐ Gates — # of gates: 0 — Width*: 0 m — Height*: ____ m
- ☑ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 17.4 m
- ☐ Valves — Valve Size*: ____ m
- ☐ Pipe
- ☑ Other Control — Specify: low flow gate (18")
- ☐ Fishway

Dam Safety

This section is completed for Dams only

Inspection Frequency

Field: ____ Engineering: ____ External: ____

Last Date (Engineering): Jan 1995 — Last Date (External): ____

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

☐ Complete — Review dat: ____ — ☐ Dam Break/Mapping completed — ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 3

Property Damage Categories (as per draft OMNR DSG)
1:>$10,000,000: extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2:<$10,000,000: appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3:<$1,000,000: minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4:<$100,000: damage to dam only

- ☑ Environmnetal Damage — describe: Fisheries, Sediment release, habitat loss
- ☑ Other Damages — describe: affect on property values/recreation

MNR DSG hazard Class: ____ (high/significant/low/very low/not applicable)

Notes to data entry (append additional sheet if required)

Structure Location

Municipality	Township of Elizabethtown - Kitley
Name of Waterbody	Lyn Creek
Owned By	Cataraqui CA
Operated By	Cataraqui CA
Maintained By	Cataraqui CA
Location Description	Lot 33, conc. 4, Elizabethtown.

Type of Structure	dam (dam/dyke/chan/eros/other)
Lake/River Controlled	Lees Pond
Watershed	
Drainage Area	14.7 sq kms
UTM Zone	18
NAD	
UTM East	434700
UTM North	4937800
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☑ Low Flow Augmentation
- ☐ Municipal Water supply
- ☐ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☐ Erosion Control
- ☐ Slope Stabilization
- ☑ Recreation
- ☑ Other Use (specify): maintains Class 1 wetland (with f&w habitat)

Primary Uses:

Benefits of Structure

Value of property protected	$1,500,000.00
Number of Residences protected	10
Avg annual flood damage reduction	$200,000.00
Avg annual erosion damage reduction	$30,000.00

Infrastructure Protected:

3 road crossings

Costs

Cost when built: $40,000 ☐ Cost Includes land Land Cost: $35,000 Year(s) Constructed: 1993

Present Value Estimate	$52,191	comments	originally built in 1700's, outlet rebuilt in 1993
Replacement Cost Estimate	$20,000	comments	Full rebuild with existing material estimated at $250,000+
Decommissioning Cost Estimate		comments	

Annual Costs Operating: Minor Maint.: Preventative Main: ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	60.00%	50.00%
Cataraqui Region C. A.	40.00%	50.00%

General Structure Description

☐ Concrete ☑ Earth ☑ Rock ☐ Timber ☐ Steel ☐ Other: The dam includes a stoplog section, a stone da

Water and Erosion Control Infrastructure Database

Cataraqui CA

Fred Grant Dam

Structure ID: 10

scription of
struction:

Height 3.7 m | Length 418 m | Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m | Width: m

Level of Protection for Water Control Structure: | Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams

This section is completed for Dams only

Reservoir Description

Height of Dam (as per ICOLD): 3.7 m
Normal Head: 3 m

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	17.5	0	
Area (ha)	70	70	
Elevation (m)	107.87	107.62	

Discarge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ____ cms
Maximum Controlled Discharge: ____ cms

- ☑ Stop Log
- ☐ Gates — # of gates: 2 — Width*: 6 m — Height*: 0.25 m
- ☐ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 6 m
- ☐ Valves — Valve Size*: ____ m
- ☐ Pipe
- ☑ Other Control — Specify: low flow pipe (12")
- ☐ Fishway

Dam Safety

This section is completed for Dams only

Inspection Frequency

Field: seasonally
Engineering: ____ Last Date: Jan 1995
External: ____ Last Date: ____

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

☐ Complete — Review dat: ____ ☐ Dam Break/Mapping completed ☐ Emergency Preparedness Plan completed

Undertaken By: ____

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 2

Property Damage Categories (as per draft OMNR DSG)
1 - $10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2 - $10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20 yrs) development areas
3 - $1,000,000 minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4 - $100,000 damage to dam only

☑ Environmnetal Damage — describe: Fisheries, Sediment release

☑ Other Damages — describe: affect on property values/recreation; county road located 500 metres downstream of dam

MNR DSG hazard Class: significant (high significant low very low not applicable)

Notes to data entry (append additional sheet if required)

Water and Erosion Control Infrastructure Database

Cataraqui CA

Broome-Runciman Dam

Structure ID: 5

Structure Location

Municipality: City of Brockville

Name of Waterbody: Buell Creek

Owned By: Cataraqui CA

Operated By: Cataraqui CA

Maintained By: Cataraqui CA

Location Description: Centennial Drive

Type of Structure: dam (dam/dyke/chan/eros/other)

Lake/River Controlled: Buells Creek Reservoir

Watershed: Buells Creek

Drainage Area: 8.3 sq kms

UTM Zone: 18 NAD

UTM East: 444010

UTM North: 4941400

Longitude:

Latitude:

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☑ Low Flow Augmentation
- ☐ Municipal Water supply
- ☑ Navigation
- ☐ Power Generation
- ☑ Habitat Creation
- ☑ Erosion Control
- ☐ Slope Stabilization
- ☑ Recreation
- ☐ Other Use (specify): maintains Class 1 wetland (with f&w habitat)

Primary Uses:

Benefits of Structure

Value of property protected: $1,500,000.00

Number of Residences protected: 12

Avg annual flood damage reduction: $288,000.00

Avg annual erosion damage reduction: $20,000.00

Infrastructure Protected: 1 road crossing

Costs

when built: $175,825 ☐ Cost Includes land Land Cost: Year(s) Constructed: 1966

Present Value Estimate: $509,590 comments:

Replacement Cost Estimate: $1,000,000 comments:

Decommissioning Cost Estimate: comments:

Annual Costs Operating: Minor Maint.: Preventative Main: ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	75.00%	50.00%
Cataraqui Region C. A.	25.00%	50.00%

General Structure Description

☐ Concrete ☑ Earth ☑ Rock ☐ Timber ☐ Steel ☐ Other scription of struction:

Height 3 m Length 6 m Type of erosion protected from (riverine, coastal, both, other):

Height of slope: m Width: m

Level of Protection for Water Control Structure: Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Dams — This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	174	0	
Area (ha)	290	290	
Elevation (m)	102.4	101.8	

Height of Dam (as per ICOLD): 3 m

Normal Head: 1.5 m

Discharge Facilities

note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)

Normal Summer Discharge: ____ cms

Maximum Controlled Discharge: ____ cms

- ☑ Stop Log
- ☐ Gates — # of gates: 2 — Width*: 3.32 m — Height*: 2 m
- ☐ Uncontrolled/Emergency Spill Way — Total Spillway Length (including all logs and gated parts of spillway): 3.32 m
- ☐ Valves — Valve Size*: ____ m
- ☐ Pipe
- ☐ Other Control — Specify: ____
- ☐ Fishway

Dam Safety — This section is completed for Dams only

Inspection Frequency

Field: seasonally — Engineering: ____ — Last Date: Jan 1995 — External: ____ — Last Date: ____

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

☐ Complete — Review dat ____ — ☐ Dam Break/Mapping completed — ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life — Property damage: 2

Property Damage Categories (as per draft OMNR DSG):
1 >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2 <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3 <$1,000,000 minimal damage to agriculture, other dams, or structures not to human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4 <$100,000 damage to dam only

☑ Environmnetal Damage — describe: Fisheries, Sediment release, habitat loss

☑ Other Damages — describe: loss of recreational and tourism benefits

MNR DSG hazard Class: low — (high/significant/low/very low/not applicable)

Notes to data entry (append additional sheet if required)

Structure Location

Type of Structure: Other (dam/dyke/chan/eros/other)

Municipality	City of Brockville
Name of Waterbody	Buells Creek
Owned By	Cataraqui CA
Operated By	Cataraqui CA
Maintained By	Cataraqui CA
Location Description	between Parkedale Ave. and Laurier Blvd. - Brockville Memorial Centre

Lake/River Controlled	Buells Creek Detention Basin
Watershed	Buells Creek
Drainage Area	sq kms
UTM Zone	18
NAD	
UTM East	444400
UTM North	4939500
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☐ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☑ Erosion Control
- ☐ Slope Stabilization
- ☐ Recreation
- ☐ Other Use (specify)

Primary Uses

Benefits of Structure

Value of property protected	$10,000,000.00
Number of Residences protected	60
Avg annual flood damage reduction	$1,500,000.00
Avg annual erosion damage reduction	$50,000.00

Infrastructure Protected:

16 road crossings
1 rail crossing
1 schoolyard,
4 commercial properties

Costs

when built $620,000 ☐ Cost Includes land Land Cost Year(s) Constructed 1980

Present Value Estimate	$1,187,984	comments
Replacement Cost Estimate	$1,447,000	comments
Decommissioning Cost Estimate		comments

Annual Costs Operating Minor Maint. Preventative Main ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	65.00%	50.00%
Cataraqui Region C. A.	35.00%	50.00%

General Structure Description

☐ Concrete ☑ Earth ☐ Rock ☐ Timber ☐ Steel ☐ Other

Water and Erosion Control Infrastructure Database

Cataraqui CA

Buells Creek Detention Basin — Structure ID 11

Description of Construction:

Height	3 m	Length	m	Type of erosion protected from (riverine, coastal, both, other):	
Height of slope:	m	Width:	m		

Level of Protection for Water Control Structure: ______ Design Flow of Water Control Structure: ______ cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

Water and Erosion Control Infrastructure Database

Cataraqui CA

Buells Creek Detention Basin

Structure ID: 11

Dams This section is completed for Dams only

Reservoir Description

	Maximum	Minimum	Augmentation Storage
Storage (ha m)	15.5	0	
Area (ha)	4.8	0	
Elevation (m)	98.7	95.5	

Height of Dam (as per ICOLD) 3 m

Normal Head 0 m

Discharge Facilities

***note: When specifying sizes use a "-" to seperate quanity from size (ie 2-5, 3-4.5 means 2 at 5m and 3 at 4.5m)**

Normal Summer Discharge ______ cms

Maximum Controlled Discharge ______ cms

- ☐ Stop Log
- ☑ Gates # of gates 1 Width* 1.4 m Height* 1.4 m
- ☑ Uncontrolled/Emergency Spill Way Total Spillway Length (including all logs and gated parts of spillway) 7 m
- ☐ Valves Valve Size* ______ m
- ☑ Pipe
- ☑ Other Control Specify : alternate outlet (12" pipe) for riparian uses (2 places)
- ☐ Fishway

Dam Safety This section is completed for Dams only

Inspection Frequency

Field: seasonally Engineering: ______ External: ______

Last Date: Jan 1995 Last Date: ______

Note: Frequency select either Daily, Weekly, Seasonally, Annually, every 2, 5, 10 years or as required.

Dam Safety Review

☐ Complete Review dat ______ ☐ Dam Break/Mapping completed ☐ Emergency Preparedness Plan completed

Undertaken By: CRCA Summer Student

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☐ Loss of Life Property damage: 1

Property Damage Categories (as per draft OMNR DSG)
1 >$10,000,000 extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2 <$10,000,000 appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3 <$1,000,000 minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4 <$100,000 damage to dam only

☐ Environmnetal Damage describe : ______

☐ Other Damages describe : ; CN Rail Line (mainline) 500 metres downstream; Parkdale Avenue located 600 m d/s, Hwy #401 located 700 m d/s; (no impact likely)

MNR DSG hazard Class: high (high, significant, low, very low, not applicable)

Notes to data entry (append additional sheet if required)

Water and Erosion Control Infrastructure Database

Cataraqui CA

Booth Falls Channelization — Structure ID: 429

Structure Location

Municipality	City of Brockville
Name of Waterbody	Buells Creek
Owned By	CRCA
Operated By	CRCA
Maintained By	CRCA
Location Description	between Central Avenue and Stewart Street

Type of Structure	Chan (dam/dyke/chan/eros/other)
Lake/River Controlled	Buells Creek
Watershed	Buells Creek
Drainage Area	sq kms
UTM Zone	NAD
UTM East	445000
UTM North	4938300
Longitude	
Latitude	

Note: Enter either UTM or Long/Lat

Purpose

- ☑ Flood Control
- ☐ Low Flow Augmentation
- ☐ Municipal Water supply
- ☐ Navigation
- ☐ Power Generation
- ☐ Habitat Creation
- ☑ Erosion Control
- ☑ Slope Stabilization
- ☐ Recreation
- ☐ Other Use (specify)

Primary Uses

Benefits of Structure

Value of property protected	
Number of Residences protected	0
Avg annual flood damage reduction	$50,000.00
Avg annual erosion damage reduction	$50,000.00

Infrastructure Protected:

1 schoolyard

Costs

when built $115,000 ☐ Cost Includes land Land Cost Year(s) Constructed 1980

Present Value Estimate	$220,352	comments
Replacement Cost Estimate	$268,000	comments
Decommissioning Cost Estimate		comments

Annual Costs Operating Minor Maint. Preventative Main ☐ MNR Funded

Funding Partners	Original Funding %	Maintenance Funding %
Ministry of Natural Resources	75.00%	50.00%
Cataraqui Region C. A.	25.00%	50.00%

General Structure Description

☐ Concrete ☐ Earth ☑ Rock ☐ Timber ☐ Steel ☐ Other

Water and Erosion Control Infrastructure Database

Cataraqui CA

Booth Falls Channelization

Structure ID: 429

Description of Construction:

Height	2 m	Length	100 m	Type of erosion protected from (riverine, coastal, both, other):	
Height of slope:	m	Width:	m		

Level of Protection for Water Control Structure: Design Flow of Water Control Structure: cms

Notes: Height is height of dyke or depth of channel. Width of erosion revetment generally measured away from waterbody, width of channel or footprint of dam or dyke. Length of structure is generally taken parallel to watercourse (except for dams).

[illegible]ns

This section is completed for Dams only

Dam Safety

This section is completed for Dams only

Consequences of Failure

Consequences of failure should be identified for all structures, hazard class is only relevant to dams.

☑ Loss of Life Property damage: 3

Property Damage Categories (as per draft [illegible])
1. [illegible] extensive damage to large residential, commercial, agriculture, industrial or infrastructure
2. [illegible] appreciable damage to agricultural operations, other dams, residential, commercial, industrial or future (20yrs) development areas
3. [illegible] minimal damage to agriculture, other dams, or structures not for human habitation, no damage to residential, commercial, industrial or future (20yrs) development
4. [illegible] damage to dam only

☑ Environmnetal Damage describe : erosion on deep ravine walls

☐ Other Damages describe :

MNR DSG hazard Class: significant (high, significant, low, very low, not applicable)

Notes to data entry (append additional sheet if required)

APPENDIX C

REFERENCES

1. Soil Associates of Southern Ontario, Report No. 30 of the Ontario Soil Survey, Canada Department of Agriculture, Ontario Department of Agriculture, April, 1964.

2. Soil Survey of Lennox & Addington County, Report No. 36 of the Ontario Soil Survey, Canada Department of Agriculture, Ontario Department of Agriculture, 1963.

3. Soil Survey of Frontenac County, Report No. 39 of the Ontario Soil Survey, Canada Department of Agriculture, Ontario Department of Agriculture, 1966.

4. Soil Survey of Leeds County, Report No. 41 of the Ontario Soil Survey, Canada Department of Agriculture, Ontario Department of Agriculture and Food, 1968.

5. Paleozoic Geology of Wolfe Island, Bath, Sydenham and Gananoque Map Areas, Ontario, paper 70-35, Geological Survey of Canada, Department of Energy, Mines & Resources, 1971.

6. Map No 31c, County of Leeds, Ontario Department of Mines Report, 1922.

7. Geology of Brockville-Mallorytown Area, Map 7-1963, Geological Survey of Canada, Department of Energy, Mines & Resources, 1963.

8. Map No 1946-9, Part of Southeastern Ontario Showing Distribution of Potsdam Sandstone, Province of Ontario, Department of Mines.

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