2004 INSPECTION OF FLOOD CONTROL STRUCTURES IN THE CITY OF LONDON

UPPER THAMES RIVER
CONSERVATION AUTHORITY

Prepared for the Upper Thames River Conservation Authority




April 8, 2005

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2004 Inspection of Flood Control Structures in the City of London, Ontario

Prepared for:

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1.0 Background

1.1 BACKGROUND

The Upper Thames River Watershed has historically been susceptible to incidents of serious flooding. Due to these incidents, the Upper Thames River Conservation Authority (UTRCA) has, since formation in 1947, been involved in a number of flood control projects in an attempt to reduce the likelihood of risk to life and property damage. This includes the construction and maintenance of several dykes in partnership with the City of London over the past century. In conjunction with the flood control dams, these structures help protect more than a thousand homes from flood damage up to or surpassing the 100 year flood event.

Although ownership of the dykes remains with the municipality, the UTRCA has historically been involved with past maintenance of the structures and has undertook major studies and rehabilitation primarily from 1983 onwards. A maintenance agreement between the UTRCA and the City of London identifies the responsibilities of each.

Due to environmental conditions, the structures are susceptible to deterioration over time. As a result, the UTRCA has undertaken routine inspections of the structures every few years to ensure that the structures are able to function to their design capabilities.

1.2 PURPOSE

The UTRCA has identified seven dyke structures as requiring periodic inspections in an attempt to determine the general condition and to identify future maintenance requirements. Table 1 below lists the flood control structures.

Table 1 - UTRCA Flood Control Structures Requiring Periodic Inspection

Site	Name	General Location within the City
1	West London Dykes	West bank of the north branch of the Thames River between Oxford Street and extending west of Wharncliffe Road bridge
2	Jacqueline/Ada Street Dyke	South bank of the south branch of the Thames River east of the forks adjacent to the Adelaide Street bridge
3	Nelson/Clarence Dyke	North and west bank of the south branch of the Thames River between Wellington Road bridge and terminating in the vicinity of Clarence Street and South Street
4	Broughdale Dyke	West bank of the north branch of the Thames River located south of the Richmond Street bridge extending to Meadowdown Drive
5	Byron Dyke	South bank of the south branch of the Thames River located at the west end of Old Bridge Street in Byron

Table 1 - UTRCA Flood Control Structures Requiring Periodic Inspection		
Site	**Name**	**General Location within the City**
6	Coves Dyke and Floodgate	Located in Greenway Park in the Coves Branch off the south bank of the Thames River
7	Riverview/Evergreen Dyke	South branch of the Thames River, west of the forks located approximately between the west end of Evergreen Avenue and the north limit of O'Brien Street

This report details the results of the inspection program initiated for each dyke structure noted above. The purpose of the inspection program was to provide the UTRCA with the following:

- Preparation of an inspection protocol for each structure with the development of an Inspection Sheet based upon non-intrusive visual observation;
- Assessment of the current condition of each structure to allow the UTRCA to undertake periodic inspections in the future or to respond to incidents with baseline data on the 2004 condition of the structures;
- Cost estimates for repair and/or maintenance to each dyke structure and the recommended timing for this work; and
- Recommendations relating to the frequency for subsequent periodic inspections for each structure and/or specific component.

The intent of the program was to assist the UTRCA in managing these assets by updating data on their condition. This was accomplished through the development of standardized checklists, the development of standardized condition ratings and a protocol for immediate action if serious or unsafe conditions were observed. Appendix 1 contains the Terms of Reference for this report. A copy of the Stantec memo report dated September 22, 2004 is included in Appendix 2.

2.0 Scope of Work

2.1 INSPECTION PROTOCOL

In order to meet the objectives of the investigation, an inspection protocol was developed based upon data obtained from the UTRCA, the City of London and a review of the following guidance documents:

- *The Lakes and Improvements Act*;
- *Canadian Dam Safety Guidelines*, January 1999; and
- *Ontario Dam Safety Guidelines*, September 1999, in particular Section 11 *Inspection Guidelines*.

Based upon the protocol developed, an inspection form was prepared to catalogue the following unique features:

- The performance requirements for the structure;
- The environmental setting of the structure;
- The sensitivity of the area protected by the structure;
- The materials used to construct the structure;
- The major appurtenances or components of the structure; and
- Known concerns from past events or inspections.

Appendix 3 of this report contains inspection sheets for each structure reviewed. Depending upon the size and complexity of the structure, individual reports were prepared for sections of the dyke and are numbered sequentially. Included with each inspection review is a site drawing based on OBM mapping which is divided into stations corresponding to reference locations within the inspection report. The drawings also include general notes and photo references depicting the condition of the structure. Copies of the reference photographs are included in Appendix 4.

2.2 INSPECTION SHEET METHODOLOGY

The following subsections provide a brief description of the information included in the inspection form in order to assist the UTRCA in interpreting the methodology developed.

2.2.1 DYKE INSPECTION INFORMATION (HEADER)

Information regarding the name of the structure inspected, name of inspectors and report number are included at the top of the front page. In addition, the date of inspection and weather conditions encountered are also provided in order to better compare conditions observed during subsequent reviews (i.e. water level, vegetation growth, etc.) to the baseline data. Recommendations for immediate action or further investigative work is also provided at the top of the form, however specific deficiencies noted are highlighted in the subsequent sections.

2.2.2 GENERAL INFORMATION

The general information category includes information regarding the portion of the dyke inspected, specifically whether the form relates to the complete structure (typical for smaller structures inspected) or a specific section reviewed. Information regarding the adjacent property use and overall condition rating for the reviewed area is also included. A comments area is provided to allow for explanation of the rating assigned and to allow for any additional remarks including specific adjacent land use issues.

2.2.3 DYKE FACING

The dyke facing section is subdivided as follows:

2.2.3.1 Dyke Face Material

Describes what the dyke facing is constructed of and includes a condition rating for the material present. A comments section is provided for any additional information including variations in the facing material (if applicable), deficiencies and referencing to OBM station locations and reference photographs.

2.2.3.2 Structural Condition (Dyke Face)

Lists whether erosion, movement (unevenness, slipping, bulging, etc.), damage (impact, cracks, etc.) or other specified conditions exist. A condition rating for the general structural condition based on visual examination is also provided. Additional comments can also be provided and typically should reference sections on the OBM mapping or specific photographs. Where necessary, the comments section may be followed by recommendations related to the structural condition of the dyke face including the need for further monitoring, maintenance or repair.

2.2.3.3 Toe

Includes information regarding the toe protection material present and whether any erosion is occurring at the toe of the dyke. A condition rating for the toe is also provided. Additional comments may also be included and should note cases where inspection of the toe was not possible (i.e. due to vegetation cover, murky water, etc.).

2.2.3.4 Joints

States whether sealant is present in the joints along the dyke face or toe and the condition rating, if present. This subsection also includes information related to the presence of vegetation within the joints. A comments area is also provided and should include any additional information to justify the condition rating, references to the OBM mapping or site photographs, and specific information regarding the extent of vegetation growth that may be present (i.e. root diameters, etc.). This section is not applicable to an earthfill dyke.

2.2.3.5 Vegetation

Describes whether vegetation is present along the dyke face or toe and specifies the type, if applicable. A comments area is provided for referencing specific locations to the OBM mapping and site photographs. If present, the comments section also includes the extent of vegetation growth, with specific emphasis on root diameter, etc.

2.2.3.6 Water Infiltration

Specifies whether signs of water infiltration were observed during the review and where the infiltration occurred. Under the comments area, additional information such as the extent and likely cause is provided.

2.2.3.7 Additional Information

Includes information regarding accessibility along the dyke face and toe and the estimated depth of water over the section reviewed. A comments section is provided for any other information related to the dyke face and toe not already included in the subsections.

2.2.4 TOP OF DYKE

This section gives a description of what is located along the top of dyke but does not include the area behind the dyke or along the face. The section is subdivided as follows:

2.2.4.1 Dyke Top Material

Describes what the dyke top is constructed of and includes a condition rating for the material present. A comments section is provided for any additional information including variations in the material present (if applicable), deficiencies and referencing to OBM station locations and reference photographs.

2.2.4.2 Structural Condition (Top of Dyke)

Lists whether erosion, movement (unevenness, heaving or settlement), damage (vandalism, etc.) or other specified conditions exist and includes a condition rating based on the visual review. A comments section is included to allow for explanation of the rating provided and referencing to OBM and relevant site photographs.

2.2.4.3 Pedestrian Access

Specifies the type of pedestrian access and width, if present, and includes a condition rating for the item. A comments section is provided for additional information including the location of the pathway and deficiencies noted during the investigation.

2.2.4.4 Protective Barrier

States the type of protective barrier at the top of the dyke, generally located in a manner as to prevent people from falling down the face of the structure. A condition rating of the barrier, if

present, is also provided along with a comments section which may be used to reference specific areas, deficiencies and/or site photographs.

2.2.4.5 Joints

States whether sealant is present in the joints along the top of the dyke and the condition rating of the sealant, if present. This subsection also includes information related to the presence of vegetation within the joints. A comments area is also provided and should include any additional information to justify the condition rating, references to the OBM mapping or site photographs, and specific information regarding the extent of vegetation growth that may be present (i.e. root diameters, etc.). This section is not applicable to an earthfill dyke.

2.2.4.6 Drainage Conditions

Specifies whether low areas or ponding of water was observed along the top of dyke over the section reviewed. A description of the general drainage direction and/or problem areas observed is included in the comments section.

2.2.4.7 Illumination

Identifies whether illumination is present along the top of dyke. If present, a condition rating is given. Any additional information such as the type of illumination present and/or specific areas of deficiencies as well as references to OBM mapping and site photographs is provided in the comments area. Note that this section does not relate to illumination installed behind the top of dyke.

2.2.4.8 Vegetation

Describes whether vegetation is present along the top of dyke and specifies the type, if applicable. A general description of the condition of the vegetation and the location is included in the comments section.

2.2.4.9 Additional Information

A general comments category is provided at the end of the top of dyke section to allow for any additional information not already included in the subsections.

2.2.5 AREA BEHIND THE DYKE

This section of the form describes the features immediately adjacent to the dyke (which may consist of public and/or private property, land easements, etc.). The section is subdivided as follows:

2.2.5.1 Predominant Material

Describes the predominant material observed behind the structure (i.e. concrete, asphalt, earth, grass, etc.) and assigns a condition rating to the material. A comments section allows for

additional information such as a description of the adjacent land use, changes in material type, reference photo numbers, etc.

2.2.5.2 Drainage Conditions

Specifies whether ponding or low lying areas are present behind the section of the dyke structure reviewed. A comments section allows for any additional information to be provided. Also included in this section is information relating to the presence of catchbasins behind the structure. These catchbasins may be present to direct water to storm sewers or directly to the river. A condition rating for the catchbasins and a comments section is also provided.

2.2.5.3 Vegetation

Contains information regarding the presence of vegetation and the type observed. A comments section is also provided for any additional information related to the vegetation or for referencing to the OBM mapping or site photographs.

2.2.5.4 Accessibility

Describes the type of accessibility available behind the dyke structure, if any. A condition rating and comments section is also provided where access is determined to be present.

2.2.5.5 Protective Barrier

Identifies the type of protective barrier observed immediately behind the dyke, if any. A description of the type of barrier present, assumed ownership (i.e. private or city) and condition rating is also provided. Any additional information is included in the comments section.

2.2.5.6 Illumination

Identifies whether illumination is present immediately behind the dyke. If present, a condition rating is given. Any additional information such as the type of illumination present and/or specific areas of deficiencies as well as references to OBM mapping and site photographs is provided in the comments area.

2.2.6 STORM SEWERS/SANITARY SEWERS/OUTLET STRUCTURES

This section includes information on any outlet structures and the type, if present. A condition rating for the structure is also included. A comments area is provided for additional information including the material type (if known), sizing, reference to OBM mapping and photographs, etc.

The following additional subsections are also provided:

2.2.6.1 Outlet

Includes information related to the presence of gates or grates at the outlet discharge, a condition rating (if applicable) and any other additional comments and referencing information including the orientation of flap gates (up or down), lubrication of hinges, etc.

2.2.6.2 Outlet Flow

Describes the condition of the outlet channel downstream from the outlet and/or obstructions noted within the pipe. A comments section is provided for additional information such as the extent of erosion observed, obstructions and reference locations to OBM mapping and site photographs.

2.2.6.3 General Comments

Any additional comments regarding sewers and/or outlet structures observed (i.e. presence of wingwalls, safety railing, energy dissipators, etc.) are included in this section.

2.3 ONTARIO BASE MAPS (OBM)

Included with each dyke inspection report is an OBM map which is subdivided into stations corresponding to those of the individual inspection sheets. The OBM maps also show the locations of deficiencies, outlet structures and other major features of importance as well as reference photo numbers. Copies of the inspection reports and mapping are provided in Appendix 3.

2.4 INSPECTION RATING SYSTEM

In order to assess the condition of key components observed during the dyke inspection, a standardized condition rating system was created as part of the inspection protocol development. The following is a description of the rating system used:

Table 2 – Inspection Rating System

Rating	Classification	Description
1	Unsafe Condition	Structure (or element) in very poor or unsafe condition which poses an immediate public safety hazard.
2	Poor Condition	Structure (or element) in poor condition with significant deterioration noted. Deteriorations noted may impact on integrity and may require significant capital cost to bring to fair to poor condition rating. No safety hazard noted.
3	Fair/Poor Condition	Structure (or element) condition varies from fair to poor with some signs of significant deterioration in localized areas. Able to perform function, but at reduced capacity.
4	Fair Condition	Structure (or element) in fair condition with no visible signs of significant deterioration. Able to perform intended function with no apparent hindrance.
5	Good Condition	Structure (or element) in good condition with minor deterioration. Able to perform intended function with no apparent hindrance.

Condition ratings for select components of the dyke structure are included in various subsections of the inspection report.

3.0 Findings and Recommendations

3.1 GENERAL

In preparing the findings of the inspection program for the various structures reviewed, it is recognized that little, if any, information was available in order to assess changes in the condition of each structure over time. As such, and in addition to providing recommendations as to the need for immediate action, the intention of preparing the findings for each structure is to provide the UTRCA with baseline data on the 2004 condition of each dyke so as to allow for comparative assessment with future inspections.

Table 3 below contains general information on each dyke reviewed and includes an opinion of the cost for replacement for the entire structure.

Table 3

Structure	Description	Estimated Dimensions		Order of Magnitude Cost Estimate[2]
		Length (m)[1]	Elevation Range (mASL)[1]	
West London Dyke	Earth fill dyke with concrete facing and concrete toe protection. One short rip rap section and a section of gabion toe protection also included	2,374	232 – 237 over concrete dyke facing 230 - 236 over remaining section	$2,000,000 to $5,000,000[3]
Jacqueline/Ada Dyke	Earth dyke with rock erosion protection	525	235 – 239	$250,000 to $750,000[4]
Nelson/Clarence Dyke	Primarily earth dyke with concrete wall	600	234 – 238	$500,000 to $900,000
Broughdale Dyke	Earth fill dyke	767	237 – 241	$550,000 to $750,000[4]
Byron Dyke	Earth fill dyke	374	225 – 229	$200,000 to $400,000[4]
Coves Dyke and Flood Gate	Earth dyke with control structure	190	230 – 236	$550,000 to $1,100,000[5]
Riverview/Evergreen Dyke	Earth dyke	424	230 - 234	$200,000 to $400,000[4]

Notes:

1. Estimated length and elevation based on OBM mapping.
2. Range of cost estimate reflects variation in replacement options, phasing of work, site conditions, etc. In general, the cost estimate reflects the replacement of the surface area of the existing dyke, but not the underlying earth volume. Based upon the 2000 flood event, it appears as though the structures are currently capable of providing adequate flood protection. The estimates above reflect the assumption that regular maintenance of each structure will be conducted which should minimize the requirement for more extensive replacement work.
3. Reflects work related to replacement of the concrete panels and gabion baskets.
4. Reflects the cost associated with surficial fill placement, installation of geo-grid, site access restrictions and vegetation replanting.
5. Range reflects potential additional cost in replacement of flood gate structure in addition to surficial restoration.

3.2 SUMMARY

The following table summarizes the results of the inspection program completed on each structure and the estimated costs for repairs/maintenance and further investigation. Included with each deficiency is a priority rating which corresponds to the recommended timeliness for repairs/maintenance. For detailed information, refer to the individual inspection forms in Appendix 3.

Table 4– Recommendations and Estimated Costs

Deficiency Noted	Approximate Location (refer to attached drawings)	Recommendations/Cost	Priority Rating[1]
West London Dyke			
Delamination / Deterioration	St. 0+000 to 0+200, 0+275, 0+410, 0+485, 0+520, 0+560, 0+570, 0+850, 1+020, 1+120, 1+140, 1+190, 1+200, 1+225, 1+290, 1+300, 1+830, 1+850, 1+860	Conduct additional investigation (i.e. chain drag survey, hammer tap, etc.) to determine extent of defect. Remedial action dependent upon results of additional investigative work (i.e. partial to full panel replacement, grouting, etc.). Estimated cost for additional survey: $10,000.	2
Bulging (panels), cracks, slipping (panel)	St. 0+060, 0+080, 0+225, 0+235, 0+270, 0+450, 0+470, 0+820, 0+850, 1+010, 1+025, 1+040, 1+190, 1+830, 2+000	Complete a monitoring program to assess the level of movement/differential settlement. The program should include a review of the existing (baseline) conditions with the establishment of monitoring gauges, preliminary measurements, etc. Follow-up review to be completed within one year and results compared to baseline data obtained. Remedial action, including action related to repair and/or frequency of future monitoring dependent on results obtained from monitoring program. Estimated cost for program: $10, 000.	2
Storm Outlet (damaged gasket)	St. 1+110	Replace in conjunction with additional work scheduled (no immediate danger noted).	2
Exposed Rebar (above panel)	St. 1+290	**Repair sections of exposed/extended rebar (under Queens Av. Bridge) immediately**. Estimated cost of ~$2,000 (does not account for potential requirement for further repairs pending the results of the monitoring program/survey previously noted).	1
Overgrown vegetation	St. 0+600 to 0+875	Trim/remove excessive vegetation noted along dyke face over section noted. Vegetation currently prohibits proper assessment of dyke condition.	2 – 3
Damaged railing (steel)	Periodically located from St. 0+550 to 1+300	Corroded and broken rails/posts noted periodically over length of steel rail present. As a minimum, damaged areas should be repaired immediately to prevent failure. UTRCA should consult with City of London regarding potential plans/funding available. Estimated cost ~$100/m (dependent upon quantity replaced). Assuming damaged areas only (i.e. not a full replacement), estimated cost: $10,000 to $15,000.	1
Damaged Gabion Basket	St. 1+615	Replace/repair in conjunction with additional work scheduled (no immediate danger noted).	2
Steep Slopes	St. 1+775	Install protective barrier to prevent pedestrian	1

Table 4– Recommendations and Estimated Costs			
Deficiency Noted	**Approximate Location (refer to attached drawings)**	**Recommendations/Cost**	**Priority Rating[1]**
adjacent to pedestrian pathway		accidents down steep side slope of dyke. Estimated cost: $3,000. **The UTRCA should consider immediate action due to potential unsafe conditions**.	
Jacqueline/Ada Street Dyke			
Plugged storm outlet	St. 0+125	Remove accumulated debris within storm outlet. No immediate safety hazard noted, however work should be completed as soon as possible to prevent possible backup of storm sewers. Coordinate with additional work for structure (i.e. vegetation removal/maintenance).	1
Overgrown and overturned vegetation	St. 0+160 to 0+325	Trim/remove excessive and overturned vegetation observed along dyke face over section noted. Vegetation currently prohibits proper assessment of dyke condition.	2 – 3
Nelson/Clarence Dyke			
Overgrown and overturned vegetation/steep slopes	Periodically encountered	Trim/remove excessive and overturned vegetation observed along dyke face over section noted. Vegetation currently prohibits proper assessment of dyke condition. Monitor steep slopes for movement and loss of vegetation.	2 – 3
Broughdale Dyke			
No major deficiencies noted		Periodic inspection to assess changes to condition of structure.	3
Byron Dyke			
Overgrown and overturned vegetation	Periodically encountered	Trim/remove excessive and overturned vegetation noted along dyke face over section noted. Vegetation currently prohibits proper assessment of dyke condition.	2 – 3
Damaged Concrete Headwall	St. 0+050	Monitor condition as part of periodic inspection. No immediate hazard noted, however outlet structure observed to be approximately 80% plugged.	2
Erosion	Periodically encountered	Monitor condition as part of periodic inspection. Note: Soil erosion has resulted in exposed vegetation roots in several locations. If warranted through additional visual assessment, placement of rip-rap at critical areas. Estimated cost: $15,000.	2
Coves Dyke and Floodgate			
No major deficiencies noted		Periodic inspection to assess changes to condition of structure.	3
Riverview/Evergreen Dyke			
Overgrown and overturned vegetation/steep slopes	Periodically encountered	Trim/remove excessive and overturned vegetation noted along dyke face over section noted. Vegetation currently prohibits proper assessment of dyke condition. Monitor steep slopes for movement and loss of vegetation.	2 - 3

Note:

1. Priority ratings differ from the condition ratings specified in Section 2.4 of this report and as indicated on the inspection reports. Priority ratings are assessed as follows:
   - 1 – Item requiring immediate attention;
   - 2 – Item requiring regular monitoring; and
   - 3 – Item requiring future monitoring.

2. The priority ratings generally correlate to the condition ratings based on the following:
   Priority rating of 1 = Condition rating of 1. However, any condition rating of 2 or 3 that can, if left unattended, result in greater future capital cost to repair in the future is also assessed a priority rating of 1;
   Priority rating of 2 = Condition rating of 2 or 3; and
   Priority rating of 3 = Condition rating of 4 or 5.

3.3 FUTURE INSPECTIONS

In addition to the recommendations noted above, future inspections on each structure should be completed, where possible, during the same time of year so that changes in the condition of the dyke can be determined in a consistent manner (i.e. water level, vegetation growth, etc.).

During any subsequent inspection review, a copy of the previous inspection form should be referred to in assessing whether conditions have further deterioration or, conversely, whether repairs have been completed. In order to determine overall trends in the condition of each structure, it is recommended that a copy of all previous inspection reviews be maintained.

As the 2004 inspection is intended to provide baseline information for subsequent investigations/work, it is recommended that the structures be reviewed annually until the results of future investigations can be assessed and compared to previous data in order to determine a more appropriate frequency for future inspections.

3.4 REVISED INSPECTION REPORT FOR FUTURE INSPECTIONS

Included in Appendix 5 are blank copies of the inspection forms and OBM mapping for the structures. The inspection forms have been revised to include additional background information such as the approximate age of the dyke structure (if known), the date of any maintenance work completed and the date of the last inspection review.

4.0 Report Supplements

The inspection reports and OBM maps for each structure are provided in Appendix 3 of this report. Appendix 4 contains the reference photographs for each dyke. Copies of inspection sheets for subsequent inspections and OBM maps are included in Appendix 5. Digital copies of the inspection sheets (in Microsoft Office 2000 format) and OBM mapping (in AutoCad version 2000) are included with the CD, as per the Terms of Reference.

5.0 Conclusions

We trust that this submission is in order and if there are any questions of a technical nature, please submit them to the undersigned.

Respectfully Submitted,

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