



C.C. Tatham & Associates Ltd.
Consulting Engineers

SHOREWALL INSPECTION PROGRAM

Lagoon City, Township of Ramara

Inspection Report – Phase 1
2016

prepared by:

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prepared for

Lagoon City Parks and Waterways Commission

November 23, 2016

CCTA File 316803-1

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1 Introduction

1.1 Project Description

C.C. Tatham & Associates Ltd. (CCTA) was retained by the Lagoon City Parks and Waterways Commission to complete Phase 1 of a multi-year inspection program of the shorewalls located within Lagoon City. As part of Phase 1, CCTA has conducted inspections at the lots with odd numbers 1 to 23 on Old Indian Trail, even numbers 2 to 30 on Old Indian Trail, odd numbers 1 to 51 on Poplar Crescent, and the North Footbridge (refer to Appendix A for inspection program map). Visual inspections of the exposed elements and surrounding area were completed from both land and water, with deficiencies being noted and photographed (refer to Appendix C of this report).

The inspections were limited to portions of the shorewalls and surrounding grade accessible from either land and/or water and unobstructed by finishes or built structures (e.g. decks, patios, sheds). No testing (destructive or non-destructive) or structural analysis has been completed as part of this investigation. Site specific design drawings, other than the standard designs provided as part of the By-laws, were not available for our review.

1.2 By-Laws #97.54 & #99.68

By-laws #97.54 & #99.68 of the Township of Ramara provide details for the construction and maintenance of shorewalls within Lagoon City. Outlined within these regulations are three (3) allowable configurations of shorewalls and two (2) permissible construction types/specifications. The three allowable shorewall configurations consist of **“straight wall”**, **“angled recess”**, and **“lay by”** types as depicted in Figure 1 overleaf.

Schedules **“B”** and **“C”** of By-law #97.54 outline design specifications for concrete and steel walls. Concrete walls are to be constructed of precast reinforced concrete panels extending below the base of the canal and supported by driven steel piles **spaced at approximately 8'-0”** on centre. The tops of the piles are to be restrained with steel bar tiebacks and deadhead anchors buried approximately twenty feet back from the wall. As per the specifications of the By-law, the concrete walls are permissible for the straight wall type only. Steel walls are permitted to be used in any of the three configurations specified and are to be constructed of steel sheeting with similar support conditions to the concrete walls. In both wall configurations, a concrete fascia panel and top cap is to be installed on the outside of the piles for additional protection and aesthetics. For additional information, please refer to the drawings provided in Appendix B of this report.

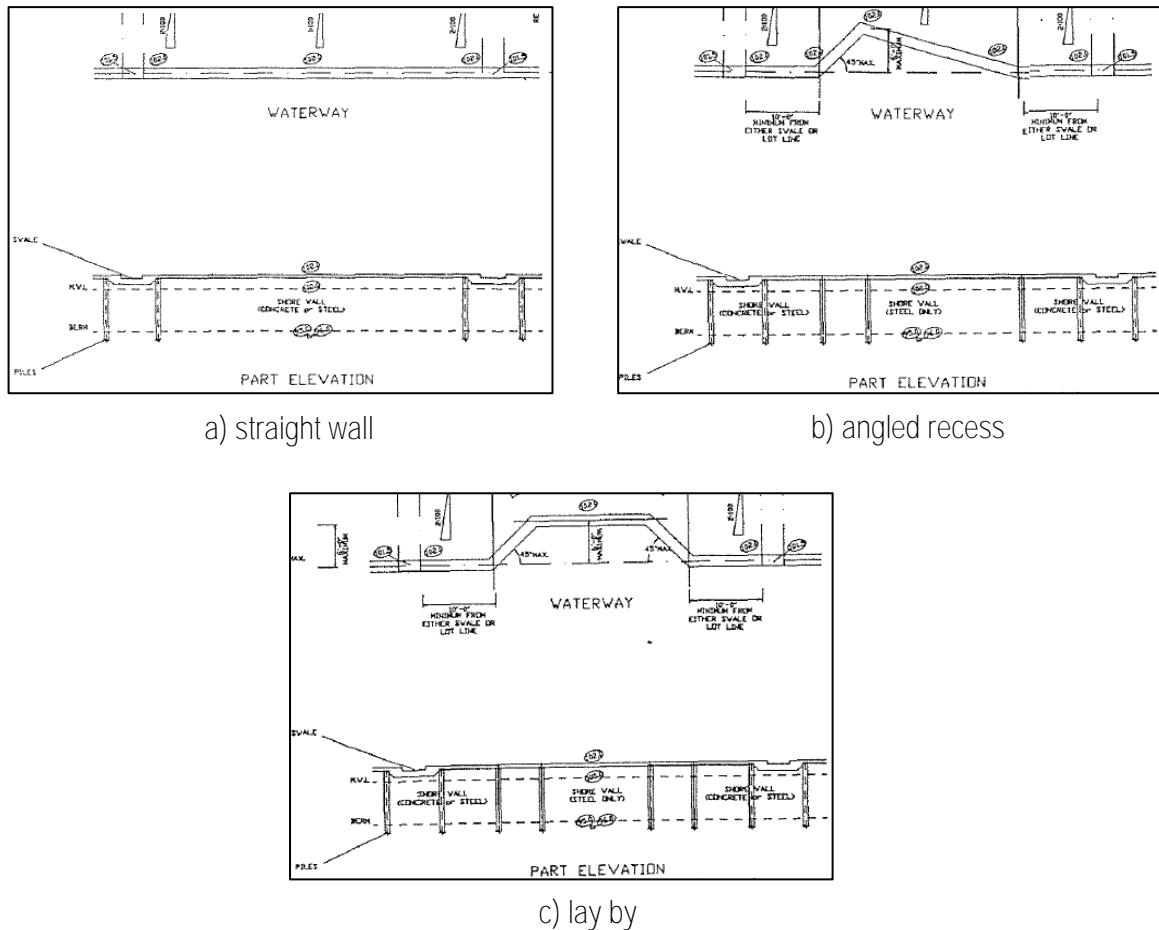


Figure 1: Allowable Shorewall Configurations (By-laws #97.54 & #99.68)

The By-law further states owners shall construct, at their own expense, a shorewall adhering to these specifications and both existing and newly constructed shorewalls must be kept in a state of repair satisfactory to the Lagoon City Parks and Waterways Commission. To protect the integrity of the tiebacks and deadhead anchors, the By-law stipulates no structure, permanent or temporary shall be placed within 25'-0" of the shorewall, otherwise known as the "restricted area".

2 Site Investigation

2.1 Existing Wall Construction

During our inspections, we found most of the shorewalls are constructed of either 3" thick vertical wood planks or a single concrete fascia panel with thin vertical wood planks behind as depicted in Figure 2 and Photograph Nos. 1 and 2 of Appendix C. In several instances, a mix of each wall type was installed on an individual property, typically transitioning from concrete along the main canal to wood-only within the boat slips. These wall specifications contravene those specified in the By-laws, however we believe construction of most of the shorewalls inspected during Phase 1 of the program pre-date implementation of the By-laws. Wall repairs have been completed at several properties involving the use of steel sheeting either as the main structural system or as a back-up behind the concrete fascia panel. A breakdown of the wall types constructed on each property have been provided in both Appendices D and E.

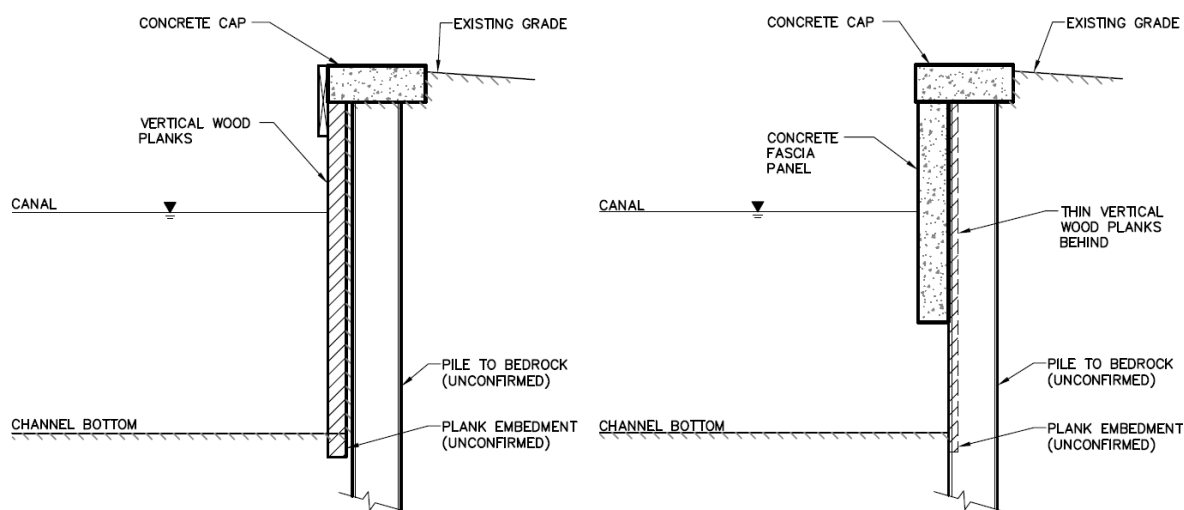


Figure 2: Typical Shorewall Construction: a) Wood Plank; b) Concrete Fascia

2.2 Observations

The shorewalls were inspected from land on September 6th, 7th, 12th, and 13th, 2016 and by boat on September 13th, 2016. During the investigation, common deficiencies were frequently observed. These include the following:

- at concrete fascia shorewalls, it was apparent the wood planks behind have deteriorated and become dislodged, effectively minimizing their soil retention capabilities (refer to Photograph No. 2 of Appendix C);

- at wood shorewalls, bowing and warping was evident as well as outward deflection of the lower end of the wood planks, likely due to inadequate resistance to lateral earth pressures and poor embedment of the plank bases into the channel bottom (refer to Photograph No. 3);
- damaged and/or missing wood planks leading to exposure of the granular fill behind (refer to Photograph No. 4). This was further evident from the granular fill deposits noted at the base of the walls within the canal;
- soil erosion of the existing grade behind the wall, ranging from minor (isolated locations) to severe (full height and length of wall), likely due to poor soil retention and porous nature of the shorewalls (i.e. loss of backfill through wood planks, or under wood planks after displacement). This deficiency is exacerbated by the following:
 - properties are typically graded to drain surface water over the wall, or direct it towards swales at each property line that drain to an outlet built into the top of the wall. In many instances, however, the top of wall grade or the wall outlet grade is elevated above the surrounding grade preventing positive drainage. Furthermore, several of the outlets have been obstructed.
 - the above drainage issue results in ponding behind the wall which, when coupled with the wood plank deterioration, results in erosion of the backfill soils. This resulting erosion is typically accompanied by significant settlement of grade, standing water, and exposure of structural wall components (piles, tiebacks, etc.) as depicted in Photographs 5 to 11.
- due to the loss of backfill and settlement of grade behind the wall, many property owners frequently replace the backfill soils by refilling with granular backfill, or have constructed deck structures over eroded areas.

In addition, as noted in the site reports and subsequent property summary (Appendices D and E), a variety of other localized deficiencies were observed throughout the inspection program. These include such items as: concrete damage, exposed rebar, piles and tiebacks with varying degrees of corrosion, leaning, lateral movement of wall sections and/or individual panels, and structures built within the restricted area. Typical photos of these deficiencies have been presented in Appendix C with further descriptions provided in Table 1 below.

Table 1: Photograph Reference of Typical Deficiencies (Refer to Appendix C)

Photograph	Description
No. 3	Bowing, splitting, and isolated damages to sections of wood plank shorewall.
No. 4	Missing planks and exposed granular fill in sections of wood plank shorewall.
No. 5	Erosion on backside of wall. Surrounding grade is sloping towards the wall. The concrete cap has begun to tip backwards away from the canal.
No. 6	Minor erosion along the length of the wall. Improper drainage outlet has caused water to form natural spillways.
No. 7	Severe erosion at swale outlet. Swale has been blocked by a constructed boardwalk.

Photograph	Description
No. 8	Severe erosion behind wall has resulted in the settlement of patio stones.
Nos. 9 to 11	Severe erosion behind wall has exposed the steel piles and tiebacks. Wood planks behind concrete fascia have deteriorated resulting in poor soil retention and standing water behind wall.
No. 12 to 14	Damages to concrete cap have resulted in settlement as well as exposed rebar and piles with varying degrees of corrosion.
No. 15	Significant lateral movement between adjacent wall sections. A past bolted repair detail has been completed, however, the wall was not returned to its original position.
No. 16	Slight lean in wall towards canal. Additionally, a gap was observed between the top of the wall and adjacent grade possibly caused by movement of and/or damage to tiebacks.
No. 17	Differential lateral movement between concrete fascia panels.
No. 18	Isolated spall of concrete cap has resulted in exposed rebar.
Nos. 19 & 20	Severe corrosion on exposed tieback and pile.
No. 21	Exposed tiebacks at grade with minor (surface) corrosion.
Nos. 22 to 24	Typical structures built within the restricted area (25' setback) . In most cases, the wooden decks appeared to be used to span over severe erosion on backside of wall.

2.3 Condition Summary

To understand the severity of the deficiencies observed during the investigation, the properties have been categorized based on the condition of both the shorewall as well as the surrounding grade, as presented in Table 2. Elements have been divided into one of three condition ratings consisting of either poor, fair, or good and categorized based on a qualitative comparison with a hypothetical, newly constructed retaining wall of the same materials and configuration (i.e. original wall construction).

The attached site reports and subsequent property summary (Appendices D and E) provide a breakdown of shorewall and grade conditions for each property as well as recommendations for remedial action moving forward. The degree of repairs (i.e. minor vs. major) have been formed based on our engineering judgement of the current condition and should not form the basis of a relative cost comparison.

Table 2: Number of Properties by Condition (Refer to Appendix D)

	Condition			N/A	Total
	<i>Poor</i>	<i>Fair</i>	<i>Good</i>		
Shorewall	18	26	7	7	58
Grade	24	16	12	6	58

As indicated in the summary provided in Appendix D and Table 3 below, there are several properties where the concrete shorewalls have been assessed as fair and further investigation has been recommended (by an Engineer retained through the resident) due to suspected underlying issues.

Table 3: Properties Requiring Further Investigation – Suspected Issues

Address	Recommended Further Investigation
35 Poplar Crescent	Erosion of Grade
31 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
15 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
13 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
11 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
9 Poplar Crescent	Concrete Shorewall Leaning/Damaged Section (suspect failed tie-backs)
5 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
3 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
1 Poplar Crescent	Concrete Shorewall Leaning (suspect failed tie-backs)
28 Old Indian Trail	Concrete Cap Leaning/Possible Settlement (suspect failed tie-backs)
26 Old Indian Trail	Concrete Cap Leaning/Exposed Piles (suspect failed tie-backs)
16 Old Indian Trail	Concrete Shorewall Leaning (suspect failed tie-backs)
10 Old Indian Trail	Concrete Cap Leaning/Possible Settlement (suspect failed tie-backs)
23 Old Indian Trail	Concrete Cap Leaning/Exposed Piles (suspect failed tie-backs)

Several properties could not be reviewed during the investigation due to the presence of obstructions and have been categorized as Not Available (N/A) within this report. As per our letter dated July 22, 2016, residents were informed “if a structure interferes with our inspection and we expect there is an unseen deficiency, the structure will have to be removed for us to complete a return inspection, at additional cost”. These properties have been outlined in Table 4 overleaf:

Table 4: Properties Requiring Further Investigation – Obstructed During Review

Address	Recommended Further Investigation
52 Poplar Crescent	Entirety due to Obstructions
27 Poplar Crescent	Entirety due to Obstructions
25 Poplar Crescent	Entirety due to Obstructions
7 Poplar Crescent	Entirety due to Obstructions
22 Old Indian Trail	Entirety due to Obstructions
20 Old Indian Trail	Entirety due to Obstructions
18 Old Indian Trail	Entirety due to Obstructions
6 Old Indian Trail	Entirety due to Obstructions
4 Old Indian Trail	Entirety due to Obstructions
13 Old Indian Trail	Entirety due to Obstructions
15 Old Indian Trail	Entirety due to Obstructions
17 Old Indian Trail	Entirety due to Obstructions

2.4 Owner Provided Information

During the investigation, multiple property owners provided anecdotal information to CCTA regarding shorewall issues prevalent in the area. We cannot confirm whether the information provided is accurate, however, it may be useful to consider moving forward.

1. A property owner expressed to CCTA that extensive repairs had been completed to sections of the shorewall on their property by installing steel sheeting behind the concrete fascia panels and embedded into the canal bottom. This has appeared to mitigate the erosion of granular fill from behind the wall. During the repairs, it was also discovered that the leaning of the shorewall was a result of damage to the tiebacks (failure of the lap splices) and this damage was also repaired.
2. A property owner expressed to CCTA that they place gravel along the shorewall on a regular basis (estimated biannually) to combat the extensive erosion that occurs. This has caused bowing at the bases of the wood walls and granular deposits within the canal.
3. The properties have significantly settled since the original construction of Lagoon City. In several cases this has caused poor site grading and the inability of water to outlet through the retaining wall resulting in ponding and the deficiencies observed.
4. The increase in water level due to melting snow has resulted in past instances of the canal backing up onto properties. The surrounding soil becomes saturated for a significant period of time.

3 Commentary

3.1 Shorewall Inspection Results

The shorewalls inspected during the Phase 1 inspection program are generally constructed of either 3" thick vertical wood planks or a single concrete fascia panel with thin vertical wood planks behind. Although these details contravene the specifications provided in By-laws #97.54 & #99.68, we believe that their construction pre-dates the By-laws implementation. Of the fifty-eight (58) properties, seven (7) had shorewalls **considered to be in "good" condition, while the remaining** properties had shorewalls deemed to require replacement, repair, and/or further investigation. Nineteen (19) walls were classified as being in "poor" condition. During the inspections, many of the same shorewall deficiencies were observed throughout and include:

- deteriorated and dislodged wood planks behind the concrete fascia shorewalls;
- leaning and differential movement of the concrete fascia panels;
- bowing, warping, splitting of the vertical planks as well as isolated damages within the wooden shorewalls;
- cracking and spalling of the concrete cap resulting in exposed reinforcement and piles; and
- exposed tiebacks and piles which have experienced significant corrosion.

Furthermore, of the fifty-eight (58) properties, the surrounding grade was only considered to be in **"good condition"** at twelve (12) properties with the remaining being recommended for repair or further investigation. Of these, twenty-four (24) **were considered to be in a "poor" state**. The erosion of the existing grade behind the wall is attributed to the poor soil retention of the deficient shorewalls and has been exacerbated by:

- swale outlets obstructed or elevated above the surrounding grade and preventing positive drainage; and
- settlement/poor grading of the properties which has resulted in the ponding of water behind the walls.

3.2 By-laws #97.54 & #99.68 (Standard Shorewall Design)

The shorewalls inspected for Phase 1 of the program do not conform to the specifications outlined in By-laws #97.54 & #99.68. This is believed to be due in part to the fact they were likely constructed prior to implementation of the By-laws. This has resulted in the inability of CCTA to investigate the in-situ performance of the standard wall design within this program phase. We understand that shorewalls constructed in conformance with the By-laws will be investigated as part of the Phase 2 inspection program, at which time comment on their performance can be provided.

We have reviewed the wording of the By-laws and the shorewall specifications described in the By-laws, and have the following comments:

- section 4.4 of By-law #97.54 states that the **designs described in Schedules “B” and “C” are only to be used if site specific test piling operations demonstrate that the steel piles can be driven 3’-0” into the bedrock**, whereas the design drawings specify the piles are to be **driven to 3’-0” below the bottom of the peat layer**. Generally, it would be impractical to drive steel piles **3’-0” into bedrock and considering the wording discrepancy described, it is likely the designer’s intention was to have the piles driven a minimum of 3’-0” into the stiffer soil layer below the peat layer, or to refusal**. We recommend this wording be revised to state the piles are to be driven to refusal at bedrock;
- due to the corrosive nature of the existing soil, we recommend that a provision be included as part of the standard design for the protection of all exposed steel elements via a rust inhibitive coating or galvanization. During the Phase 1 inspection program, significant corrosion (flaking) was consistently observed on exposed steel elements close to the waterline;
- currently, the By-laws restrict the shorewalls to certain types and configurations. In order to allow property owners to better manage their wall construction and to provide an opportunity for property owners to consider construction cost and the life cycle cost-benefit of different material types, we recommend the Commission define in more detail the allowable wall types (including possible alternative materials) while maintaining the desired general aesthetics as per section 4.3 of By-law #97.54; and
- the By-laws do not clearly define the requirements surrounding regular inspection of the walls by a qualified structural engineer. We recommend these requirements be explicitly described in the By-laws.

It has been expressed by others that the leaning observed as part of this inspection program may be attributed to the relatively heavy concrete fascia panels. Upon review of the standard designs, we believe the weight and eccentricity of the concrete fascia panels would only advance the leaning upon a failure of the tie-backs and/or anchorage. The standard structural details provided generally appear to be acceptable shorewall designs.

4 Conclusions

Generally, there are a significant number of shorewalls that require work or further investigation. In summary, this investigation found the following:

- 19 walls were found to be in poor condition and all require replacement and/or repair;
- 25 walls were found to be in fair condition and should also be repaired;
- 26 walls require further investigation. Of these, 12 are due to the presence of obstructions during the initial inspection, and 14 are required to investigate suspected failure of the tie-backs below grade due to the wall leaning;
- 7 walls were found to be in good condition; and
- 40 properties were found to have poor or fair drainage conditions and all of these require some level or repair.

We recommend By-laws #97.54 & #99.68 be revised to address the following:

- wording of Section 4.4 revised to say piles shall be driven to refusal at bedrock;
- wording of Section 4.4 revised to describe property owners' responsibilities in the event they determine the standard designs cannot be implemented at their property;
- add provisions to protect steel elements from corrosion (thereby increasing the longevity of the wall structure);
- if desired allow more options for shorewall construction types, affording more flexibility to property owners while maintaining a desired general aesthetic;
- clearly define the aesthetics desired by the Commission; and
- clearly define regular inspection requirements.



Authorized by: Nick Smith
Engineering Intern



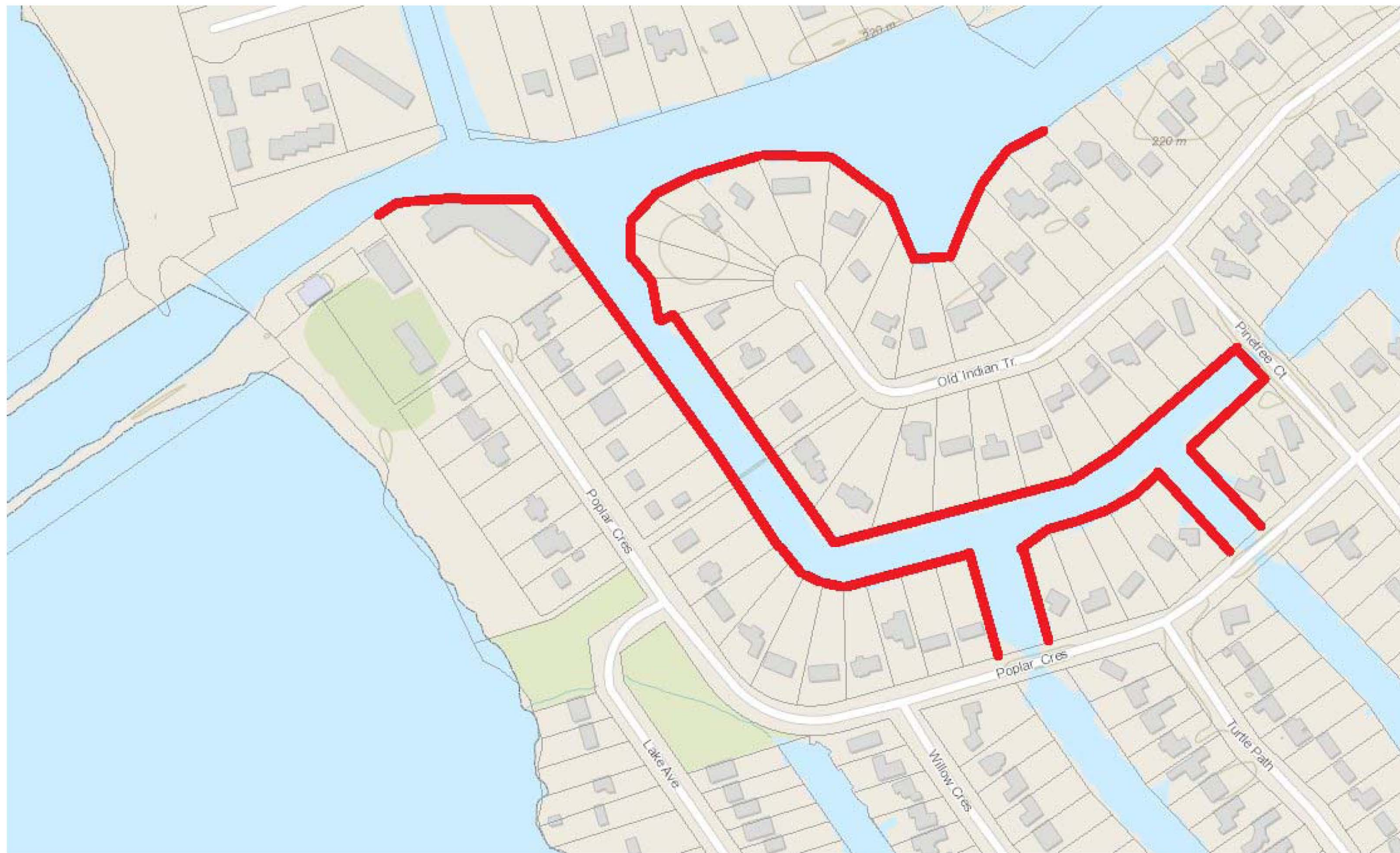
Reviewed by: Michael Sanfilippo, P. Eng.
Senior Engineer, Project Manager

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APPENDIX A: INSPECTION MAP



APPENDIX B:
BY-LAWS #97.54 & #99.68

BY-LAW NUMBER 97.54

THE CORPORATION OF THE TOWNSHIP OF RAMARA

BEING A BY-LAW REGARDING THE CONSTRUCTION AND MAINTENANCE OF SHOREWALLS WITHIN THE DEVELOPMENT KNOWN AS LAGOON CITY.

WHEREAS the provisions of the Township of Mara Act, 1986, (hereinafter referred to as the "Act") authorizes the enactment of a by-law requiring the construction and maintenance of shorewalls by all owners of land abutting a waterway conveyed to the Corporation of the Township of Mara in accordance with the provisions of the Act;

NOW THEREFORE the Council of the Corporation of the Township of Ramara ENACTS AS FOLLOWS;

1. DEFINITIONS:

- A. "shorewall" means a building improvement on a lot or block on a registered plan of subdivision or registered reference plan abutting a waterway and constructed to replace the natural shore at the rear or side of the lot or block.
- B. "waterway" means a lagoon, water channel, canal or passageway for boats including the shore and bed thereof and including any bank of land lying between the shore and the abutting boundary of any lot or block shown on a registered plan of subdivision or registered reference plan".

2. SCOPE:

2.1 That all owners of land abutting land conveyed to the Corporation of the Township of Ramara and used, or to be used, for a waterway shall construct at their sole expense a shorewall to the specifications hereinafter set forth, the said shorewalls to be fully constructed, installed and completed within a period of two years from the date upon which title is conveyed to the said owner, whether such conveyance has taken place prior or subsequent to the enactment of this by-law.

2.2 That all owners of land abutting land conveyed to the Corporation of the Township of Ramara and used, or to be used, for a waterway shall maintain at all times the shorewall which is either presently existing or which is constructed in accordance with the provisions of the preceding clause, in a state of repair satisfactory to the Lagoon City Parks and Waterways Commission, but the requirements of the said Commission shall at no time exceed the specifications set out herein.

2.3 That all construction or repair work shall conform to the designs and specifications set out herein.

3. SITE AND GRADING:

3.1 Shorewall configurations shall be:

- 3.1.1 "straight wall" or
- 3.1.2 "angled recess", or
- 3.1.3 "lay by"

as shown in Schedule "A", attached hereto.

3.2 The site shall be graded and sodded in the restricted areas shown in Schedule "A".

3.3 The side swales shown in Schedule "A" shall be maintained so as to be clear and functional.

3.4 No permanent or temporary building or structure shall be allowed in the restricted areas shown in Schedule "A".

4. CONSTRUCTION DESIGNS AND SPECIFICATIONS:

4.1 No construction or maintenance of the shorewalls, or site changes to the restricted areas or to the swales, shown in Schedule "A", shall be carried out without first obtaining a building permit issued by the Corporation.

4.2 All construction or maintenance of the shorewalls shall be carried out the designs and specifications of a professional engineer, except as provided for in 4.4.

4.3 All designs and specifications shall be prepared to maintain the general exterior appearances shown in Schedule "B" and Schedule "C", attached hereto.

4.4 If test piles driven at the particular site determine that an 8" I section steel pile 24'0" or less in length is driven at least 3'0" into the bed rock, then the designs shown in Schedule "B" or "C" may be used.

5. CONCRETE SHOREWALL - SCHEDULE "B":

5.1 Concrete shorewalls shall only be used for the "3.1.1 straight wall" site configuration.

5.2 Subject to 4.3 above, concrete shorewalls shall be constructed according to the design and specifications shown in Schedule "B".

6. STEEL SHOREWALL - SCHEDULE "C":

6.1 Steel shorewalls shall be used for type "3.1.2 angled recess" and "3.1.3 lay by" site configurations, and may be used for the "3.1.1 straight wall" type.

6.2 Subject to 4.3 above, steel shorewalls shall be constructed according to the design and specifications shown in Schedule "C".

7. ENFORCEMENT:

7.1 In the event that any owner fails to construct or maintain the portion of shorewall for which that owner is responsible in a state of repair satisfactory to the Lagoon City Parks and Waterways Commission, the said Commission may exercise its powers and privileges set out in the Act to compel the said owner to construct or repair the shorewall for which he or she is responsible, and, if necessary, in accordance with the provisions of the Act, to perform the said construction or repair and to collect the cost of so doing in accordance with the provisions of the Act.

7.2 The provisions of this by-law shall not apply to any owner excluded therefrom by the provisions of Section 7(2) of the Act.

8. GENERAL:

8.1 If an "angled recess" or "lay by" design shorewall is used in place of a "straight wall" design, the owner must dedicate to the Corporation an easement a minimum of ten (10') feet in width along the full limit of the lot immediately adjacent to the shorewall.

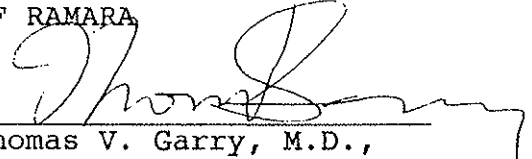
8.2 The specifications heretofore referred to are set out in Schedules "A", "B" and "C" hereto.

8.3 By-law 1595 is hereby rescinded.

8.4 That this by-law will take effect from the date of passing by the Council of the Corporation of the Township of Ramara.

BY-LAW READ A FIRST, SECOND AND THIRD TIME this 14th day
of July, 1997.

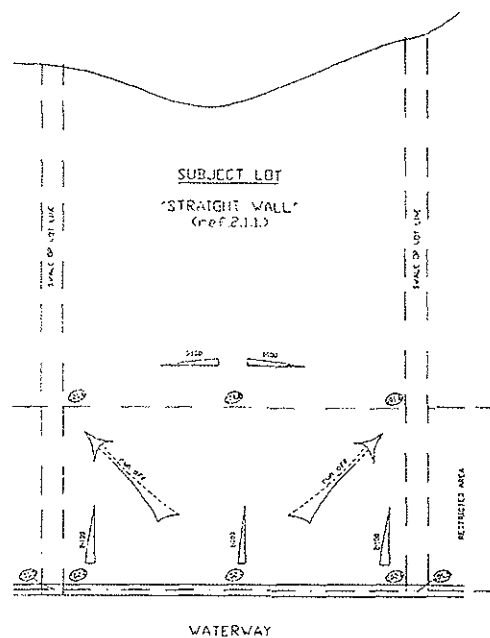
THE CORPORATION OF THE TOWNSHIP
OF RAMARA

A handwritten signature in dark ink, appearing to read 'Thomas V. Garry', written over a horizontal line.

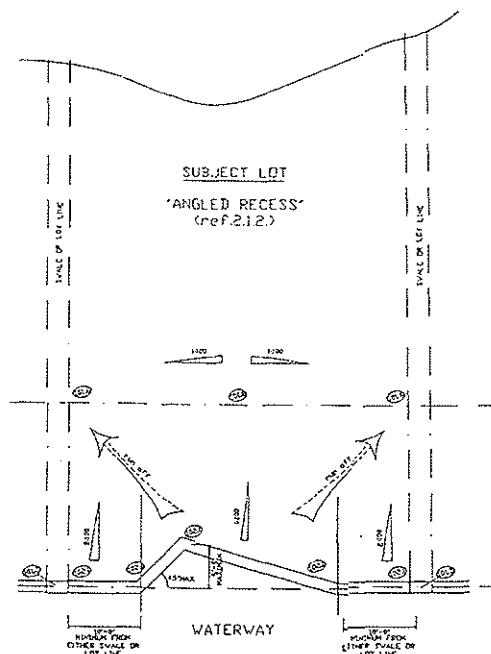
Thomas V. Garry, M.D.,
(Mayor)

A handwritten signature in dark ink, appearing to read 'Richard P. Bates', written over a horizontal line.

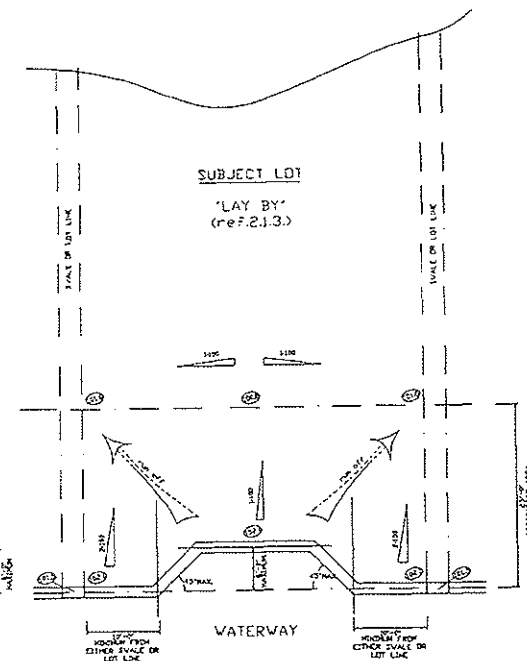
Richard P. Bates, BAS, CET,
(Clerk)



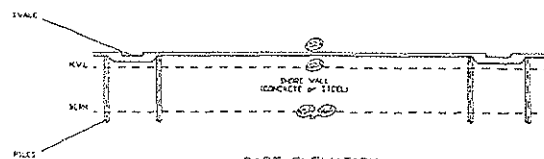
WATERWAY



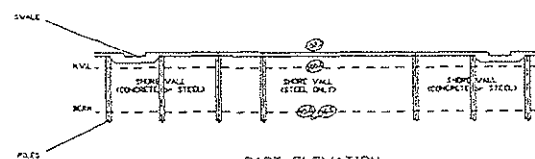
WATERWAY



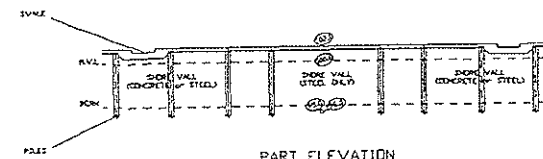
WATERWAY



PART ELEVATION
(see Schedule 'B' or 'C' for details)



PART ELEVATION
(see Schedule 'B' or 'C' for details)



PART ELEVATION
(see Schedule 'B' or 'C' for details)

NOTE: IF SETTLEMENT OCCURS WITHIN THE "RESTRICTED AREAS" SHOWN THEN
USE ONLY TOP SOIL TO FILL AND RE-ESTABLISH GRADING AS SHOWN.

Ref: C. 2000 mean Water Level Original design is 27.7A per Division 212-C-100

DATE	REASON	NAME OF	APPROVED	REMARKS
REVISIONS				
DATE	REASON	NAME	APPROVED	
12/2/81	Rev	S.L.	RELA	CAS REF. 1701



SCHEDULE "A" BYLAW NO.		
LAGOON CITY - Shoreline Walls		
Water Street	Township of Aurora	
SITE PLANS & GRADING		
REL SealP Eng. Vernon, Ont. 720-229-6337	Scale 1" = 8'0"	Sheet 1 of 1

SCHEDULE 'B' Sht.2 of 2. BYLAW NO.

SCHEDULE 'C' Sht.2 of 2. BYLAW NO.

CORPORATION OF TOWNSHIP OF RAMARA

BILL OF MATERIALS FOR TYPICAL 8'0" WALL SECTION

S1	Steel Pile	1	MAX. 24'0" - W8x36 1" SECTION
S2	Steel Cleat	1	3/8" C.R.S. FABRICATION
S3	Coping Rebar	3	8'0" - No.5 (5/8") REBAR
S3*	Coping Rebar	3	8'0" - No.5 (5/8") REBAR (SWALE SECTION)
S3**	Coping Rebar	3	8'0" - No.5 (5/8") REBAR (SWALE SECTION)
S4	Angle Iron	2	8'0" - 3x3x1/4" ANGLE SECTION
S4*	Angle Iron	2	8'0" - FORMED 3x3x1/4" SECTION (R/L & L/H)
S4**	Angle Iron	2	8'0" - FORMED 3x3x1/4" SECTION (R/L & L/H)
S5	Steel sheeting	5	12'0" - L41 / 19 1/2" STEEL SHEET
S6	Steel Deadhead		SITE FABRICATED
S7	Steel Washer	1	8'0" - 4x6x3/8" ANGLE SECTION
S8	Steel Mesh	2	24 SQ.FT. 4'x4' MESH/PANEL
H1	Mounting Bolt	1	3" - 3/4" BOLT & WASHER
H2	Insert	1	3" - RAWPLUG (OR EQUAL)
H3	Drainage Insert	1	3" DIA. PVC PIPING
H4	Tie Rod Assembly	1	20'0" - BYVIDAG (OR EQUAL)
H5	Fiber Cloth		24 SQ.FT. 17PAR (OR EQUAL)
H6	Crushed Stone		1 1/2 CU.YDS - 1 1/2" - 2" STONE
C1	Concrete Deadhead	1	4'0"x2'0"x2'0" C.I.P. (0.6 cu.yds)
C2	Concrete Coping	1	8'0"x6"x18" C.I.P. (0.2 cu.yds)
C3	Concrete Face Panel	1	8'0"x5'x2'6" C.I.P. (0.3 cu.yds)
C4	Concrete Wall Panel	3	VARIES WITH SITE (APPROX. 0.3 cu.yds each)

NOTES:

1. CONCRETE IN PRECAST PANELS SHALL COMPLY A MIN. EARLY STRENGTH DESIGN TO OBTAIN A MINIMUM STRENGTH OF 20MPa AT 3 DAYS AND ULTIMATE STRENGTH OF 35 MPa AT 28 DAYS.
2. ALL OTHER CONCRETE SHALL HAVE A MINIMUM ULTIMATE STRENGTH OF 35 MPa AT 28 DAYS.
3. ALL CONCRETE SHALL HAVE A VAPOR BARRIER AND AN EXPANSION JOINT TO PREVENT SEVERE AIR PERMEABILITY OR APPROVED EQUAL IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. SLUMP SHALL NOT EXCEED 8".
4. TOP OF CONCRETE COPING SHALL HAVE VEE THROUGH FURISH. ALL OTHER EXPOSED CONCRETE FACES SHALL HAVE STEEL TIE ROD FINISH.
5. ALL EXPOSED CONCRETE CORNERS SHALL HAVE 3/4" CHAMFER.
6. ALL PRECAST CONCRETE PANELS SHALL BE MOVED BY THE FIELD IN A SAND BED FACE UP, USING STANDARD LAMINAR FORMING WITH LIGHTS/DRAWING. DISCREPANCY TO MATCH ACTUAL SITE CONDITIONS.
7. REINFORCING STEEL SHALL BE CLEAN AND MUST MEET CLEAR COVERING OF REINFORCING STEEL SHALL BE 1" EXCEPT WHERE OTHERWISE NOTED.
8. MINIMUM ELEVATION USER REPRESENTS AVERAGE LOWEST WATER LEVEL. DRAIN LEVEL SHOWN DOTTED AS ALLEGED TO BE AT 10'0" UNLESS NOTED. MINIMUM DRAIN EL. 223.00.
9. ALL 1" REINFORCING STEEL SHALL PENETRATE TO A MINIMUM DEPTH OF 12" AND SHALL HAVE A MINIMUM DEPTH OF 3" INTO SAND BED BUT SHALL NOT EXCEED 24" IN LENGTH.

SCHEDULE 'B' & 'C' BYLAW NO.

LAGOON CITY - Shoreline Walls

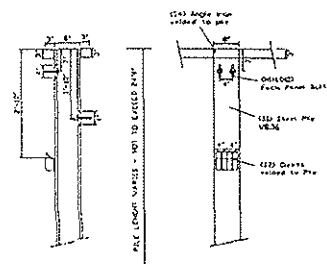
WALL PARTS DETAILS & B. OF M.

REVISIONS

DATE: 1997/12/21 BY: [Signature] CHECKED: 1/7019

1" = 16' Sht: 2 of 2

(S2) STEEL PILE

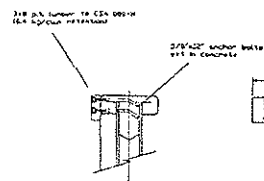


Dimensions shown are nominal - actuals to match site.

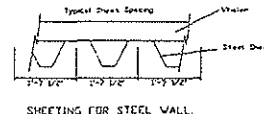


Formwork from 2/8" and 1/2" steel plate & 1/2"

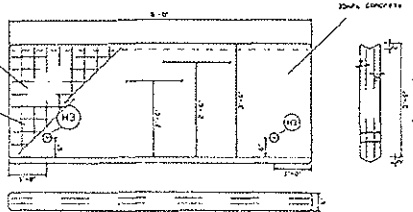
(S2) STEEL CLEAT (S1S)



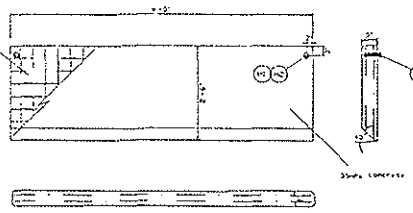
TYPICAL BOAT SLIP BUMPER DETAIL (not included in B of M)



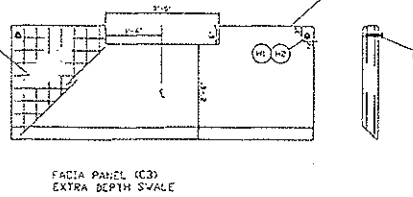
SHEETING FOR STEEL WALL



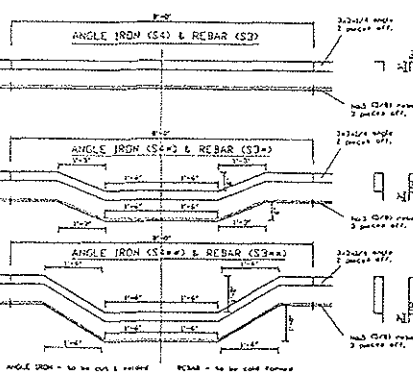
WALL PANEL (C4)



FACIA PANEL (C3)

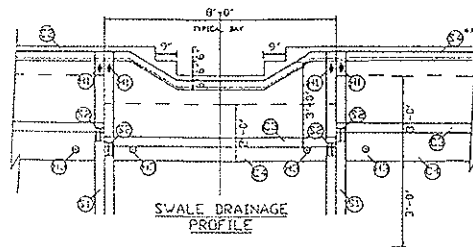
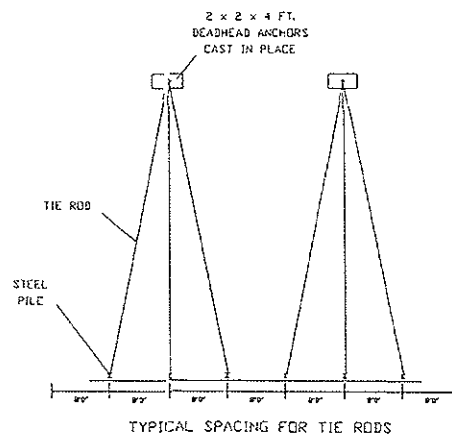
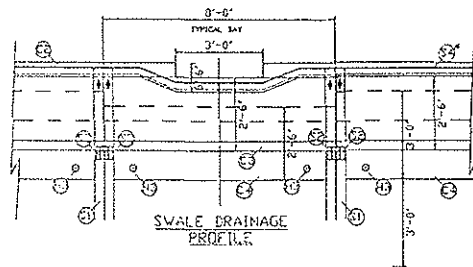
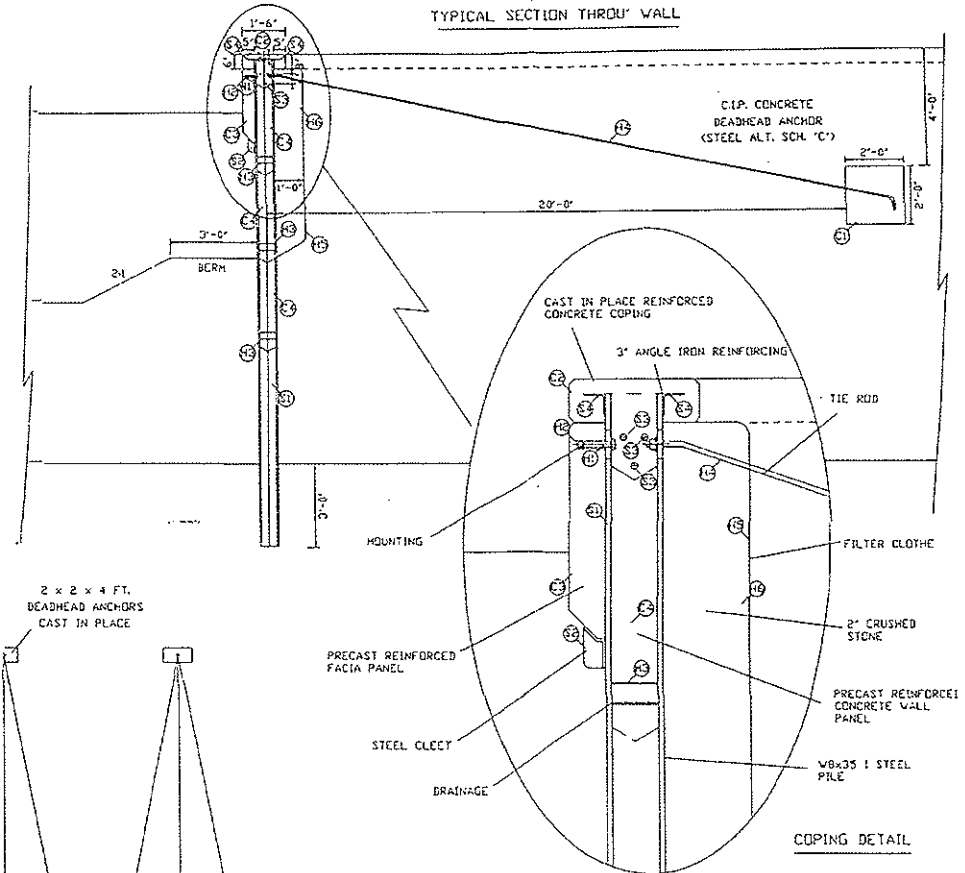
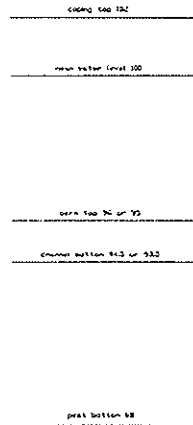
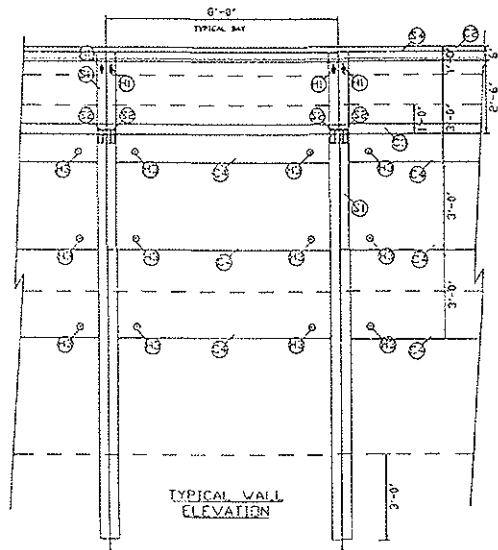


FACIA PANEL (C3) EXTRA DEPTH SWALE



ANGLE IRON - to be cut & welded

ANGLE IRON - to be cut & welded



DATE	NAME	MADE BY	APPROVED	DESCRIPTION
1993/07/01	Tom	SA	ELLA	C.B. REP. 17019

	SCHEDULE 'B' BYLAW NO.	
	LAGOON CITY - Shoreline Walls	
	Concrete Wall - General Arrangement	
	Scale: 1" = 2'-0"	Sht. 1 of 1

THE CORPORATION OF THE TOWNSHIP OF RAMARA

BYLAW NUMBER 99.68

**A BYLAW TO AMEND BYLAW NUMBER 97.54 BEING A BYLAW TO
REGARDING THE CONSTRUCTION AND MAINTENANCE OF SHOREWALLS
WITHIN THE DEVELOPMENT KNOWN AS LAGOON CITY.**

WHEREAS Township of Ramara Bylaw 97.54 being a bylaw regarding the construction and maintenance of shorewalls within the development known as Lagoon City, was passed under the provisions of the Township of Mara Act, 1986;

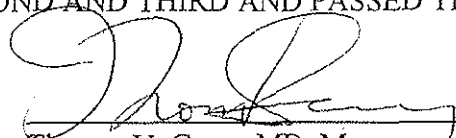
AND WHEREAS the Council of The Corporation of the Township of Ramara deems it expedient to amend Bylaw 97.54 to include criteria for the repair and design specifications;

NOW THEREFORE, the Council of the Corporation of the Township of Ramara enacts that bylaw 97.54 be amended by including the following:

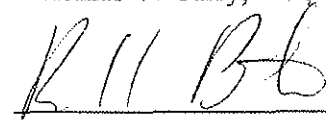
1. That Section 4.2 of Bylaw 97.54 be amended to add at the end "and 4.5";
2. That Bylaw 97.54 is hereby amended by the addition of paragraph 4.5 to read as follows:

"4.5 If the maintenance or repair does not require the replacement of any pile, the tie roads and deadhead anchors being replaced shall be constructed to the design as shown in Schedule "B" or "C"."
3. That this Bylaw shall come into force and take effect on the date of passing.

BYLAW CONSIDERED READ A FIRST, SECOND AND THIRD AND PASSED TIME THIS
28th DAY OF JUNE, 1999.



Thomas V. Garry, MD, Mayor



Richard P. Bates, BAS, CET, CAO/Clerk

APPENDIX C:
SITE PHOTOGRAPHS



Photograph No. 1
Typical wood plank shorewall.



Photograph No. 2
Typical concrete fascia wall with wood planks behind.



Photograph No. 3
Leaning/bowing/splitting of wood planks.



Photograph No. 4
Missing planks and exposed granular fill.



Photograph No. 5
Erosion and sloping of grade towards wall. Top cap tipping away from canal.



Photograph No. 6
Minor erosion (isolated spillways) behind wall.



Photograph No. 7
Severe erosion at swale outlet. Swale blocked by constructed boardwalk.



Photograph No. 8
Severe erosion behind wall – settlement of patio stones.



Photograph No. 9

Severe erosion behind wall – deteriorated wood planks, exposed piles and tiebacks.



Photograph No. 10

Severe erosion behind wall – deteriorated wood planks, exposed piles and tiebacks.



Photograph No. 11
Severe erosion behind wall – exposed piles and tiebacks.



Photograph No. 12
Damaged top cap and erosion behind wall.



Photograph No. 13
Damaged top cap, exposed rebar and pile – settlement of wall.



Photograph No. 14
Damaged top cap, exposed rebar and pile.



Photograph No. 15
Lateral movement in wall and repair detail.



Photograph No. 16
Slight lean in top of wall towards canal.



Photograph No. 17
Differential lateral movement of concrete fascia panels.



Photograph No. 18
Spalling of concrete cap with exposed rebar.



Photograph No. 19
Severe corrosion (flaking) of pile flange.



Photograph No. 20
Severe corrosion (flaking) of pile flange and tieback.



Photograph No. 21
Exposed tieback at grade with minor (surface) corrosion.



Photograph No. 22
Deck structure built within restricted area (**25' setback**).



Photograph No. 23
Deck structure built within restricted area (25' setback).



Photograph No. 24
Gazebo structure built within restricted area (25' setback).

APPENDIX D:
SHOREWALL INSPECTION SUMMARY

<p align="center">316803 - Lagoon City Shorewall Inspection Post-Review Property Summary September 26, 2016</p>									
<i>Municipal Address</i>	<i>Wall Type</i>	<i>Total length (m)</i>	<i>Wall Deficiencies</i>	<i>Grade Deficiencies</i>	<i>Condition of Wall</i>	<i>Condition of Grade</i>	<i>Structures within 25' Setback</i>	<i>Wall Recommendations</i>	<i>Grade Recommendations</i>
52 Poplar Cres.	Wood	20.5	Warping, Splitting	N/A	Poor	N/A	Deck	Replace	N/A
49 Poplar Cres.	Conc./Wood Mix	28.5	Leaning, warping, splitting, Corrosion on exposed piles and tiebacks	Significant Erosion	Poor	Poor	None	Replace	Major Repair
47 Poplar Cres.	Conc./Wood Mix	114	Leaning, warping, splitting, cap damage in wood wall, tiebacks exposed	None	Poor	Good	Deck, Residence	Replace Wood, Repair Rest	None
45 Poplar Cres.	Concrete	132.5	Minor leaning/cracking of concrete cap, differential movement in concrete panels	Isolated natural spillways	Fair	Fair	Fire pit, Residence	Repair	Minor Repair
43 Poplar Cres.	Concrete	44	Leaning/cracking of concrete cap, differential movement in concrete panels, exposed tiebacks	Severe erosion near property line, blocked swale	Fair	Fair	Lighthouse	Repair	Repair
41 Poplar Cres.	Wood	16.5	Leaning, splitting, bowing, damage to cap	Granular deposits in canal, significant erosion behind cap, swale outlet above grade	Poor	Poor	Deck Box	Replace	Major Repair
39 Poplar Cres.	Conc./Wood Mix	26	Leaning/splitting/bowing in wood, section of concrete wall and cap failed, cracking in slab behind cap	Significant erosion and undermining where wall has failed, swale outlet above grade	Poor	Poor	None	Replace	Repair
37 Poplar Cres.	Concrete	103	Narrow cracking in cap, cracked/missing panel piece	Isolated natural spillways, swale elevated/erosion	Fair	Fair	Deck, Residence	Repair	Repair
35 Poplar Cres.	Concrete	106.5	Wall leaning towards water, wood behind concrete panel are falling into canal, warping on concrete panels, isolated spalling of cap	Erosion between slab and cap towards #33	Fair	Fair	Fence, Fabric Storage Bldg., Deck at slip	Repair	Investigate/Repair
33 Poplar Cres.	Concrete	29	Minor leaning, slab appears to have significant movement/cracking, exposed tiebacks	Significant settlement/erosion, blocked swale	Fair	Poor	Small Fence, Deck box	Repair	Major Repair
31 Poplar Cres.	Conc./Wood Mix	29	Leaning/splitting/bowing in wood, leaning of concrete wall, exposed tiebacks	Undermining beneath slab	Poor	Fair (Poor in isolated locations)	Deck, Boat Covering	Replace Wood, Investigate/Repair Leaning of Concrete	Repair
29 Poplar Cres.	Conc./Wood Mix	21.5	Leaning/splitting/bowing in wood wall, corrosion (flaking) of piles, wood behind concrete panels damaged	Significant erosion behind wall (full height)	Poor	Poor	Deck	Replace	Major Repair
27 Poplar Cres.	Concrete	18.5	Difficult to review due to deck structure, exposed piles and tiebacks where accessible	Granular deposits in canal, significant erosion/standing water where accessible	Poor	Poor	Deck, Pagoda	Investigate/Repair, Possible replacement	Investigate/Repair
25 Poplar Cres.	Concrete	14.5	Difficult to review due to deck structure, exposed piles and tiebacks where accessible, corrosion (flaking) on piles, wood behind concrete panels damaged	Significant erosion at swale - expected to continue beneath deck	Poor	Poor	Deck	Investigate/Repair, Possible replacement	Investigate/Repair
23 Poplar Cres.	Conc./Wood Mix	20.5	Leaning/splitting/bowing in wood wall, cracking/spalling of concrete cap	Granular deposits in canal, swale elevated above adjacent grade	Poor	Fair	Boardwalk	Replace	Repair
21 Poplar Cres.	Conc./Wood Mix	23.5	Concrete sections of wall appear to be in good condition, bowing/leaning of wood wall	Minor fill areas	Good	Good	Picnic Table	Replace Wood Section	None
19 Poplar Cres.	Conc./Wood Mix	26.5	Leaning/splitting/bowing in wood wall, cracking/spalling/exposed rebar on concrete cap, section of walls missing, exposed piles and tiebacks - significant corrosion (flaking) on piles	Significant erosion behind wall (full height), settlement of patio stones	Poor	Poor	None	Replace	Major Repair
17 Poplar Cres.	Conc./Wood Mix	37.5	Leaning/splitting/bowing in wood wall, corrosion (flaking) of piles and tiebacks, significant lean of pile near footbridge, apparent sheet pile repair damaged/ineffective	Granular deposits in canal, significant erosion behind wall	Poor	Poor	Boardwalk	Replace	Major Repair
Footbridge - Poplar Abut.	Concrete	7	None	Minor erosion toward #15	Good	Fair	Bridge	None	Minor Repair
15 Poplar Cres.	Concrete	29.5	Sections of wall leaning towards canal, significant cracking in cap at swale - surface corrosion of exposed rebar	Significant erosion beneath patio stones and at swale, swale elevated	Fair	Poor	None	Investigate/Repair, Possible replacement	Repair
13 Poplar Cres.	Concrete	29.5	Wall leaning towards canal, minor cracking in cap	Minor erosion, swale elevated, gap between grade and cap	Fair	Good	Boardwalk, Fence to Water	Investigate leaning/Repair	Minor Repair
11 Poplar Cres.	Concrete	37.5	Wall leaning towards canal, minor cracking in cap	Erosion near swale, gap between grade and cap	Fair	Good	Deck, Manhole	Investigate leaning/Repair	Minor Repair
9 Poplar Cres.	Concrete	47.5	Wall leaning towards wall near flower bed, significant damage to pile cap at slip corner - exposed rebar and pile (surface corrosion)	Erosion/soft ground behind wall towards #11, significant erosion and standing water beneath deck	Fair	Poor	Deck	Investigate/Repair, Possible replacement of damaged section	Repair
7 Poplar Cres.	Conc./Wood Mix	25.5	Leaning/splitting/bowing in wood wall, inaccessible due to deck, large crack in cap - exposed rebar	Void/soft ground behind wall - possible undermining	Poor	N/A	Deck	Replace	Investigate/Repair
5 Poplar Cres.	Concrete	27.5	Slight leaning in cap	Soft ground behind length of wall, significant erosion and standing water at slip corner	Fair	Fair (Poor in isolated locations)	Concrete/Stone Patio	Investigate leaning/Repair	Repair
3 Poplar Cres.	Concrete	42.5	Wall leaning towards canal, isolated spalling, large crack in concrete panel, wide cracking in cap, damage in cap next to swale	Significant erosion towards swale, settlement of patio stones, soft soils behind wall	Fair	Poor	Shed, Dock in water, Boat lift	Investigate/Repair, Possible replacement	Major Repair
1 Poplar Cres.	Concrete	180	Minor cracking on cap, isolated spalls - exposed rebar, small lean in isolated location, damage to cap near swale	Isolated erosion near swale	Fair	Fair	Patios	Investigate leaning, Minor Repair	Minor Repair
30 Old Indian Tr.	Wood	22	Leaning/splitting/bowing in wood wall, leaning/spalling - exposed rebar on cap, exposed pile at corner towards bridge	Erosion behind wall towards bridge (isolated)	Poor	Fair	Pumphouse	Replace	Repair
28 Old Indian Trail	Conc./Wood Mix	25	Leaning of cap towards residence, cracking in cap near middle of property, bowing of wood in isolated locations, possible settlement of wall towards #26	Erosion behind cap towards middle of property, settlement of patio stones along length	Poor	Poor	None	Replace Wood, Investigate/Repair Concrete	Investigate/Repair
26 Old Indian Trail	Conc./Wood Mix	25	Leaning/bowing in wood wall at several locations, leaning of cap towards residence, cracking of cap in isolated locations, exposed pile	Erosion in several locations - significant at patio stones, natural spillways	Poor	Poor	Deck boxes, Pumphouse	Replace Wood, Investigate/Repair Concrete	Repair
24 Old Indian Trail	Conc./Wood Mix	38.5	Leaning/splitting/bowing in wood wall, cracking in concrete cap	Significant erosion beneath deck	Poor	Poor	Deck - Removed	Replace Wood, Repair Concrete Cracking	Repair
22 Old Indian Trail	Concrete	36	Wall inaccessible due to large deck, no outlet for swale	Erosion observed at swale, expected to continue	N/A	N/A	Deck	Investigate/Repair	Investigate/Repair

316803 - Lagoon City Shorewall Inspection Post-Review Property Summary September 26, 2016									
<i>Municipal Address</i>	<i>Wall Type</i>	<i>Total length (m)</i>	<i>Wall Deficiencies</i>	<i>Grade Deficiencies</i>	<i>Condition of Wall</i>	<i>Condition of Grade</i>	<i>Structures within 25' Setback</i>	<i>Wall Recommendations</i>	<i>Grade Recommendations</i>
20 Old Indian Trail	Concrete	38	Wall inaccessible due to boardwalk	Granular deposits in canal, erosion evident through gaps in decking, significant erosion behind cap towards #18	N/A	Poor	Boardwalk, Fire pit	Investigate/Repair	Major Repair
18 Old Indian Trail	Concrete	33	Wall inaccessible due to deck	Granular deposits in canal, signs of erosion on backside of deck	N/A	Poor	Deck/Boardwalk	Investigate/Repair	Investigate/Repair
16 Old Indian Trail	Concrete	46.5	Leaning towards canal in several locations, lateral movement (worst at slip corners) - attempted repair complete to prevent further movement	Granular deposits in canal, significant erosion towards #14, swale elevated	Fair	Fair	Deck, Planters, Deck Boxes	Investigate leaning/movement and Repair	Repair
14 Old Indian Trail	Concrete	48.5	Piles and tiebacks exposed (surface corrosion/flaking near top), cracking in cap, wood behind concrete panels damaged, significant lateral movement adjacent to swale -attempted repair to prevent further movement	Granular deposits in canal, significant erosion behind wall, swale elevated	Fair	Poor	Deck	Repair	Major Repair
12 Old Indian Trail	Concrete/SP Repair	56.5	Localized spalling/leaning towards canal near #14, 17.5m section previously repaired, damaged pile at interface between original and repaired	Swale elevated above grade	Fair	Good	None	Minor Repairs	None
10 Old Indian Trail	Concrete	51	Much of cap has slight lean towards canal, wide cracking/spalling in cap corners, possible settlement of wall sections	Granular deposits in canal	Fair	Good	Fire pit	Investigate leaning/settlement, Repair	None
Footbridge - OIT Abut.	Concrete	7	Scouring on face of abutment, minor honeycombing on top	None	Fair	Good	Bridge	Investigate/Repair	None
8 Old Indian Trail	Concrete	26.5	Corrosion of exposed tiebacks	Significant erosion towards bridge and where exposed at property lines, settlement of patio stones,	Fair	Poor	Boat Lift	Repair	Repair
6 Old Indian Trail	Conc./Wood Mix	31.5	Wall inaccessible due to deck, corroded tiebacks in concrete sections towards #4, isolated instances of wood damage - overall appears relatively plumb	Significant erosion towards #4	N/A	N/A	Deck	Investigate/Repair	Investigate/Repair
4 Old Indian Trail	Concrete	25.5	Inaccessible due to deck, exposed tieback and pile, cap/wall appears to have settled towards #2	Significant erosion in exposed areas	N/A	N/A	Deck, Lift	Investigate/Repair	Investigate/Repair
2 Old Indian Trail	Concrete	56	Cap leaning towards canal, cracking/spalling/exposed rebar in corner of cap	Significant erosion beneath deck, settlement on backside of wall, erosion at swale - plugged	Fair	Poor	Deck, Lift	Repair	Repair
1 Old Indian Trail	Concrete	24.5	Exposed tiebacks and piles - surface corrosion, slight lean towards canal	Significant erosion behind entire wall, significant settlement of patio stones	Good	Poor	None	Investigate leaning	Major Repair
1B Old Indian Trail	Concrete	40	Exposed tiebacks and piles - surface corrosion, slight lean towards canal, narrow cracking in cap at corner	Significant erosion behind entire wall, significant settlement of patio stones	Fair	Poor	None	Minor Repair	Major Repair
1C Old Indian Trail	Concrete	31	Exposed tiebacks and piles - surface corrosion, slight lean towards canal, narrow cracking in cap at corner	Significant erosion behind entire wall, significant settlement of patio stones	Fair	Poor	None	Minor Repair	Major Repair
1D Old Indian Trail	Concrete	30	Exposed tiebacks and piles - surface corrosion, slight lean towards canal, narrow cracking in cap at corner	Significant erosion behind entire wall, significant settlement of patio stones	Fair	Poor	None	Minor Repair	Major Repair
3 Old Indian Trail	Conc./Wood Mix	63.5	Leaning/splitting/bowing in wood wall, cracking in cap	Granular deposits in canal, erosion where transitions from wood to concrete	Poor	Fair	None	Replace Wood, Repair Concrete Cracking	Repair
5 Old Indian Trail	Concrete	52	Wall recently repaired with sheet piling behind (as per Owner)	Soft ground behind cap towards #7 property line	Good	Good	Lift	None	Minor Repair
7 Old Indian Trail	Concrete	49	Slight lean in wall towards canal, significant damage to corner of slip-exposed rebar and pile, cap has settled	Significant erosion towards #5, natural spillways developed behind cap	Fair	Fair	Planter	Repair/Possible Replacement	Repair
9 Old Indian Trail	Sheet Piles	25	Hairline cracking in top of cap	Minor erosion beneath deck structure	Good	Good	Small Deck	None	Minor Repair
11 Old Indian Trail	Conc./Wood Mix	24	Minor bowing at base of wood walls - missing boards, cracking in stone walkway where cap expected below, delamination of topping towards #13, slight lean towards canal near #13 , minor cracking/spalling at corners	None	Fair	Good	Light Gazebo, Small Shed, Concrete Pad	Repair/Possible Replacement	None
13 Old Indian Trail	Wood	20	Wall in slip inaccessible due to deck, settlement of cap towards #11, cap leaning towards and away from canal in isolated locations, bowing at base of wood wall towards #11 - missing boards	Past erosion and fill evident beneath deck	Fair	Fair	Deck	Investigate leaning, Repair/Possible Replacement	Minor Repair
15 Old Indian Trail	Concrete	11	Wall inaccessible due to deck, deterioration of wood behind concrete panel, exposed tiebacks	Significant erosion beneath deck - saturated soil	N/A	Poor	Deck	Investigate/Repair	Major Repair
17 Old Indian Trail	Conc./Wood Mix	32.5	Wall inaccessible due to boardwalk, exposed pile - surface corrosion, leaning/splitting/bowing of wood towards #15 - isolated instances of wood damage	Erosion evident towards property lines	N/A	N/A	Deck/Boardwalk	Investigate, Repair/Possible Replacement	Investigate/Repair
19 Old Indian Trail	Concrete	29.5	Longitudinal crack in swale	None	Good	Good	Concrete Walkway, Awning/Seating Area	None	None
21 Old Indian Trail	Concrete	39	Hairline cracking in concrete walkway where cap expected, differential lateral movement in panels	None	Good	Good	Concrete Walkway, Lighthouse, Gazebo, Fire Pit	None	None
23 Old Indian Trail	Concrete	32.5	Cap appears to have slight lean towards canal in slip, cracking in top cap at slips corners, spalling/exposed pile at corner of slip towards #21, differential movement in concrete panels towards #25, crack along length of swale	Isolated instances of minor erosion	Fair	Fair	Small Bench	Investigate leaning, Repair	Minor Repairs