GREELY SAND AND GRAVEL
Ottawa Playground Sand
Surface Impact Testing

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1. Abstract

This report summarizes the results of a controlled laboratory impact surface test that was conducted on sand by Grace-Kells Consultant Inc. for Greely Sand and Gravel. All testing was performed to procedures specified by the Ottawa-Carleton District School Board and outlined in a report titled New Playstructure Sand Testing (March 2001). The test used a Triax 2000 Impact Surface Testing device to measure the impact attenuating properties of the sand sample. The purpose of the impact test was to establish the highest drop height attainable that yielded both a HIC of less than 1000 and a peak G-max of less than 200 in both a dry and a wetted state. Results are recorded in tabular form. In addition tests were performed according to OCDSB procedures to ascertain water saturation and flow rates for the sample.

2. Distribution List

Brent Pyper, Greely Sand and Gravel

3. Contents

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4. Summary

4.1. Surface Impact Tests

Surface Impact Tests were performed on two separate sand samples (ie. washed sand and unwashed sand) under two conditions - wet and dry. The sand was first placed in a testing crib in a dry condition and tested. Once dry testing was complete, the sand in the crib was wetted with 30.8 litres of water and another series of impact tests were performed on wet sand.

The highest drop heights with a HIC less than 1000 and G-max less than 200 were as follows:

Ottawa Playground Sand Dry	390 cm
Ottawa Playground Sand Wet	270 cm

4.2. Saturation Tests

A volume of 14.1 litres of dry sand was placed in the testing apparatus. A measured quantity of water was added until the sand became saturated and water started dripping out the bottom of the apparatus.
The volume of water to saturate the sand sample was 3.9 litres.

4.3. Drainage Tests

A volume of 14.1 litres of dry sand was placed in the testing apparatus. A continuous stream of water was poured over the sand and the time measured from start until water started dripping out the bottom of the apparatus.
The flow time for the sample was 1 minute 50 seconds.

5. Introduction

Greely Sand and Gravel contracted Grace-Kells Consultant Inc. to perform surface impact tests on a sand sample according to the procedures established by the Ottawa-Carleton District School board in a CALL FOR QUOTOTATION 2000-10-26 and subsequently described in a report titled *Ottawa-Carleton District School Board New Playstructure Sand Testing* (March 2001).

1. Method

1.1. Location

The tests were performed in a heated garage space at 5362 Bank Street, Ottawa. The tests were conducted over a concrete floor.

1.2. Sample

Approximately 1 cubic metre Greely Ottawa Playground Sand was supplied by Greely Sand and Gravel.
The sample was collected and stored on the concrete floor of the testing garage for 1 week prior to testing (see sieve analysis Appendix B)

1.3. Apparatus (see Appendix A for details)

1.3.1. Equipment used for laboratory impact surface testing

- 19 mm thick plywood crib 76 cm x 76 cm x 60 cm deep c/w drain holes and lined with geotextile filter cloth
- Triax 2000 Impact Surface Testing device
- digital probe thermometer
- Steel hand tamping device

- gas powered 81 Kg. Vibra plate
- digital stopwatch

1.3.2. Equipment used for the saturation and drainage tests

- Plastic garden watering cans (2)
- 14.1 L burlap bag suspended from a steel pail with bottom removed
- digital stopwatch

1.3.3. Test Procedure

1.3.3.1. Dry Impact Surface Tests

Sand was placed in the plywood crib then loosened and levelled to a depth of approximately 46 cm. A plywood sheet was then placed over the sand and the gas powered vibra plate was placed on top and run for 1.5 minutes to compact the dry sand. The vibra plate and plywood sheet were then removed and the sand surface scraped if necessary to bring the finished compacted sand depth to 41 cm. The Triax 2000 was installed over the centre of this test crib and an initial series of 3 drops was performed from a given height with the results recorded. The average of the last 2 drops was calculated and recorded as the HIC/G-max value for that height.

The entire loosening and compaction procedure was then repeated and another series of 3 drops held at a height 30 cm up or down as required with the results again recorded and averaged. The procedure was repeated until a maximum passing height (where both the HIC was at or below 1000 and the peak G-max was at or below 200) as well as a minimum failing height (where either the HIC was over 1000 or the G-max was over 200) were both recorded.

1.3.3.2. Wet Impact Surface Tests

Based upon values determined in the original OCDSB tests of 2001 the sample in the crib was wetted with 30.8 L of water. The OCDSB had decided that this would simulate the field conditions of a well drained playground site after a rain storm. The water was added to the the sand sample in the crib from the plastic watering cans. The sand was then loosened with a garden spade, levelled and hand tamped with a steel hand tamping device. The sand surface was scraped if necessary to bring the compacted sand depth to 41 cm. The Triax 2000 was installed over the centre of this test crib and an initial series of 3 drops was performed from a given drop height with the results recorded. The average of the last 2 drops was calculated and recorded as the HIC/G-max value for that height.

The entire loosening and compaction procedure was then repeated and another series of 3 drops held at a height 30 cm up or down as required with the results again recorded and averaged.
The procedure was repeated until a maximum passing height (where both the HIC was at or below 1000 and the peak G-max was at or below 200) as well as a minimum failing height (where either the HIC was over 1000 or the G-max was over 200) were both recorded.

1.3.3.3. Saturation Tests

A 14.1 L sample of dry sand was placed in the burlap testing device. Prior to placement the burlap was wetted with water. Water was added in small measured amounts from a measuring cup until water was observed to drip from the underside of the test device. This was determined to be the saturation point and the total amount of water added to reach that point was recorded.

1.3.3.4. Flow Tests

A 14.1 L sample of dry sand was placed in burlap testing device. Prior to placement the burlap was wetted with water. Water was then poured continuously from the plastic watering pails on top of the sand at a rate that ensured a continuous film of water was maintained on top of the sample. Once water began to flow out the bottom the test was stopped and the time from start to finish recorded.

2. Results

2.1. Surface Impact Tests

2.1.1. Ottawa Playground Sand - Dry Condition

Date of Test: 2009-06-17

Max Drop Height with Peak G-max ≦ 200 and HIC ≦ 1000 : 390 cm

Drop Height (cm)	Drop 1 HIC/Peak	Drop 2 HIC/Peak	Drop 3 HIC/Peak	Avg 2&3 HIC/Peak
360	534/134	517/119	558/123	537/121
390	594/143	850/158	667/136	758/147

Note: due to limitations of the testing equipment and facility the maximum height that drops could be made from was 390 cm;

2.1.2. Ottawa Playground Sand - Wet Condition

Date of Test: 2009-06-17

Max Drop Height with Peak G-max ≦ 200 and HIC ≦ 1000 : 270 cm

Drop Height (cm)	Drop 1 HIC/Peak	Drop 2 HIC/Peak	Drop 3 HIC/Peak	Avg 2&3 HIC/Peak
270	283/89	568/135	609/137	588/136
300	350/98	542/127	1547/242	1044/184

2.2. Saturation and Flow Test

2.2.1. Ottawa Playground Sand

Date of Test: 2009-06-17

The volume of water to saturate the 14.1 L sand sample was 3.9 litres.

The flow time for the 14.1 L sand sample was 1 minute 50 seconds.

Tests Performed by: _____ Date:

Peter Kells

Grace-Kells Consultant Inc.

Appendix A
Apparatus

Sand Storage, Crib and Triax

Tamping Dry Sample with Vibra Plate

Crib With Dry Sand After Drop

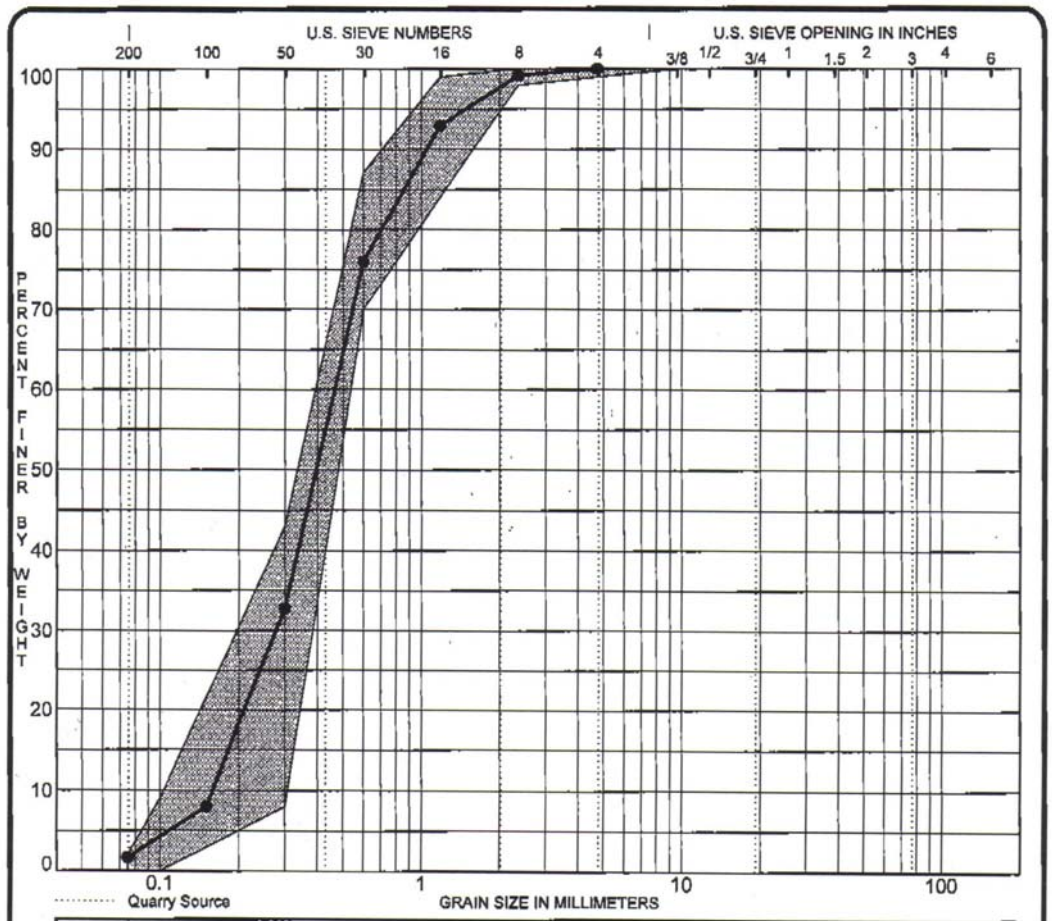
High Drop Height

Hand Tamping the Wet Sample

Saturation/Flow Test Device

Appendix B
The Samples

Ottawa Playground Sand



SILT	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	27876M	Playground Sand					1.05	2.9
■								
▲								
★								

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	27876M	4.75	0.46	0.277	0.1586	0.0	98.3	1.7	
■									
▲									
★									

CLIENT Greely Sand and Gravel FILE NO. PM0754

PROJECT Laboratory Testing - Spratt Road Pit DATE 19 Jun 09

ASTM-C136 SAMPLE CONFORMS TO OPSS ENVELOPE

patersongroup Consulting Engineers
28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

GRAIN SIZE DISTRIBUTION

Ottawa Playground Sand

patersongroup
Consulting Engineers
1-28 Concourse Gate, Nepean, Ontario K2E 7T7
Phone: (613) 226-7381 Fax.: (613) 226-6344

SIEVE ANALYSIS

CLIENT:	Greely Sand & Gravel	DESCRIPTION:	Sand	FILE NO.:	PM0754
CONTRACT NO.:	-	SPECIFICATION:	Playground Sand	LAB NO.:	27876M
PROJECT:	Lab Testing	INTENDED USE:	-	LOT/SUB:	-
		PIT OR QUARRY:	Pit	SEAL # :	-
SAMPLED BY:	Client	LOCATION:	Spratt Road	DATE REC'D:	16-Jun-09
DATE SAMPLED:	N/A	SAMPLE LOCATION:	Stockpile	DATE REQ'D :	-
WEIGHT BEFORE WASH			A+B 351.4	DATE TESTED:	18-Jun-09
WEIGHT AFTER WASH	A	B	A+B 347.6	TESTED BY:	J.W

SIEVE SIZE	TOTAL WEIGHT RETAINED	CUM. WT RETAINED (A)	CUM. WT RETAINED (B)	% RETAINED	% PASSING	SPEC.	REMARK
150 mm							
106 mm							
75 mm							
63 mm							
53 mm							
37.5 mm							
26.5 mm							
19 mm							
16 mm							
13.2 mm							
9.5 mm							
6.7 mm							
4.75 mm	0.0	0.0		0.0	100.0		
2.36 mm	2.8	2.8		0.8	99.2		
1.18 mm	24.9	24.9		7.1	92.9		
0.600 mm	84.2	84.2		24.0	76.0		
0.300 mm	236.0	236.0		67.2	32.8		
0.150 mm	323.3	323.3		92.0	8.0		
0.075 mm	345.3	345.3		98.3	1.7		
PAN	347.6	347.6					
SIEVE CHECK		0.000	0.3% max.				

OTHER TESTS	RESULT	REFERENCE MATERIAL LAB NO.	REFERENCE MATERIAL RESULT

REVIEWED BY: Stephen J. Walker, P.Eng. DATE REPORTED: 19-Jun-09

Appendix C
Surface Impact Data

Ottawa Playground Sand - Dry Tests

Sand Temperature: 21 degrees C.

Dry Test Drop Height: 330 cm

Drop	G-Max	HIC	Velocity
1	126	460	810
2	149	742	815
3	133	630	815
Avg 2 &3	141	686	815

Dry Test Drop Height: 360 cm

Drop	G-Max	HIC	Velocity
1	134	534	848
2	119	517	848
3	123	558	853
Avg 2 &3	121	537	850

Dry Test Drop Height: 390 cm

Drop	G-Max	HIC	Velocity
1	143	594	880
2	158	850	885
3	136	667	885
Avg 2 &3	147	758	885

Ottawa Playground Sand - Wet Tests

Sand Temperature: 22 degrees C.

Wet Test Drop Height: 240 cm

Drop	G-Max	HIC	Velocity
1	82	242	693
2	129	505	696
3	76	242	693
Avg 2 &3	102	373	694

Wet Test Drop Height: 270 cm

Drop	G-Max	HIC	Velocity
1	89	283	734
2	135	568	737
3	137	609	739
Avg 2 &3	136	588	738

Wet Test Drop Height: 300 cm

Drop	G-Max	HIC	Velocity
1	98	350	772
2	127	542	777
3	242	1,547	782
Avg 2 &3	184	1,044	780

Appendix D
Certificates

CERTIFICATE OF ACHIEVEMENT

AWARDED TO

Mr. Peter Kells

In recognition of his attending and passing the training program for the utilization of the TRIAX 2000 SIT (Surface Impact Tester) in compliance with the ASTM F1292-99 Standard Specification for Impact Attenuation of Surface Systems under and Around Playground Equipment.

Course designed and provided by:
Playground Clearing House

Paul Hogan — President

May 5th, 2000 — Date

alpha automation

alpha automation, inc.
125-127 Walters Avenue
Trenton, New Jersey 08638
609-882-0366 FAX 609-882-0382

CERTIFICATE OF COMPLIANCE

TRIAX 2000

The Triax 2000 system for surface resiliency testing meets the equipment specifications as stated in ASTM F1292-99

Paul Bamburak, P.E.

• Engineers and Manufacturers •
Electronic Instruments and Controls • Precision Mechanisms

Dytran Instruments, Inc.
21592 Marilla St. Chatsworth, CA 91311 Ph: 818-700-7818 Fax 818-700-7880
www.dytran.com email: info@dytran.com

CALIBRATION CERTIFICATE
TRIAXIAL LIVM ACCELEROMETER

CUSTOMER:	*ALPHA AUTOMATION*			**TEST REPORT #:** *1356*	*1/16/2009*
PURCHASE ORDER #:	*18263*	**SALES ORDER #:** *RMA#19360*		**PROCEDURE:**	*TP3002*
MODEL:	*3014M2*	**SERIAL #:** *1356*	**RANGE, F.S. (g's):** *+/- 500*		
NEW UNIT		**RE-CALIBRATION [1]** X	**AS RECEIVED CODE** 1	**AS RETURNED CODE** 1	
TEMPERATURE (°C): *24*				**HUMIDITY (%):** *24*	

FREQUENCY RESPONSE [2]

FREQUENCY (Hz)	AXIS 1 (mV/g)	AXIS 2 (mV/g)	AXIS 3 (mV/g)
20	*10.10*	*10.20*	*10.30*
30	*10.10*	*10.20*	*10.30*
50	*10.10*	*10.30*	*10.30*
100	*10.10*	*10.40*	*10.30*
300	*10.10*	*10.40*	*10.40*
500	*10.10*	*10.50*	*10.40*
1000	*10.30*	*10.60*	*10.60*
2000	*10.50*	*10.60*	*10.60*
BIAS VOLTAGE (VDC)	*10.7*	*10.7*	*10.7*
DISCHARGE T.C. (sec)	*0.50*	*0.50*	*0.40*

REMARKS: *NONE*

TEST EQUIPMENT LIST - CALIBRATION STATION # 8

DII #	MANUFACTURER	MODEL	SERIAL #	DESCRIPTION	CAL DATE	DUE DATE
527	*INSTEK*	*GFG-8217A*	*B 720272*	*FUNCTION GENERATOR*	*02/07/08*	*02/07/09*
599	*KENWOOD*	*CS-4135A*	*09070200*	*OSCILLOSCOPE*	*02/06/08*	*02/06/09*
525	*FLUKE*	*45*	*6188017*	*MULTIMETER*	*05/20/08*	*05/20/09*
392	*TRIG-TEK*	*346B*	*277*	*SYNTHESIZED CALIBRATOR*	*07/03/08*	*07/03/09*
686	*DYTRAN INST.*	*3010M14*	*1684*	*ACCELEROMETER*	*08/26/08*	*08/26/09*
014	*NICOLET*	*3091*	*84D00744*	*DIGITAL OSCILLOSCOPE*	*04/22/08*	*04/22/09*

[1] AS RECEIVED / AS RETURNED CODES:
1 = IN TOLERANCE, NO ADJUSTMENTS
2 = IN TOLERANCE, BUT ADJUSTED
3 = OUT OF TOLERANCE < 5%
4 = OUT OF TOLERANCE > 5%
5 = REPAIR REQUIRED
6 = REPAIRED AND CALIBRATED
7 = UNIT NON-REPAIRABLE, RECOMMEND REPLACEMENT
8 = UNIT SERVICEABLE WITH CURRENT CALIBRATION DATA

[2] THE REFERENCE SENSITIVITY IS MEASURED AT 100 Hz, 1G RMS.
[3] THIS CALIBRATION WAS PERFORMED IN ACCORDANCE WITH ANSI/NCSL Z540-1-1994, ISO 10012-1, ISO/IEC17025 USING THE BACK-TO-BACK COMPARISON METHOD PER ISA RP37.2 AND IS TRACEABLE TO THE NIST THROUGH TEST REPORT # 10892-120LHS DUE 08-26-09
ESTIMATED UNCERTAINTY OF CALIBRATION: 2% FROM 20-50 Hz, 1.5% FROM 100-2500 Hz, 2.8% FROM 2.5-10 kHz. APPLIES TO FREQUENCY RESPONSE ONLY.

CALIBRATION TECHNICIAN: *EDWIN BAUTISTA*	**TEST DATE:** *01/16/09*
	RECALL DATE: *01/16/10*

CPRA ACPL

CANADIAN PLAYGROUND SAFETY INSTITUTE

The Canadian Parks and Recreation Association

certifies that

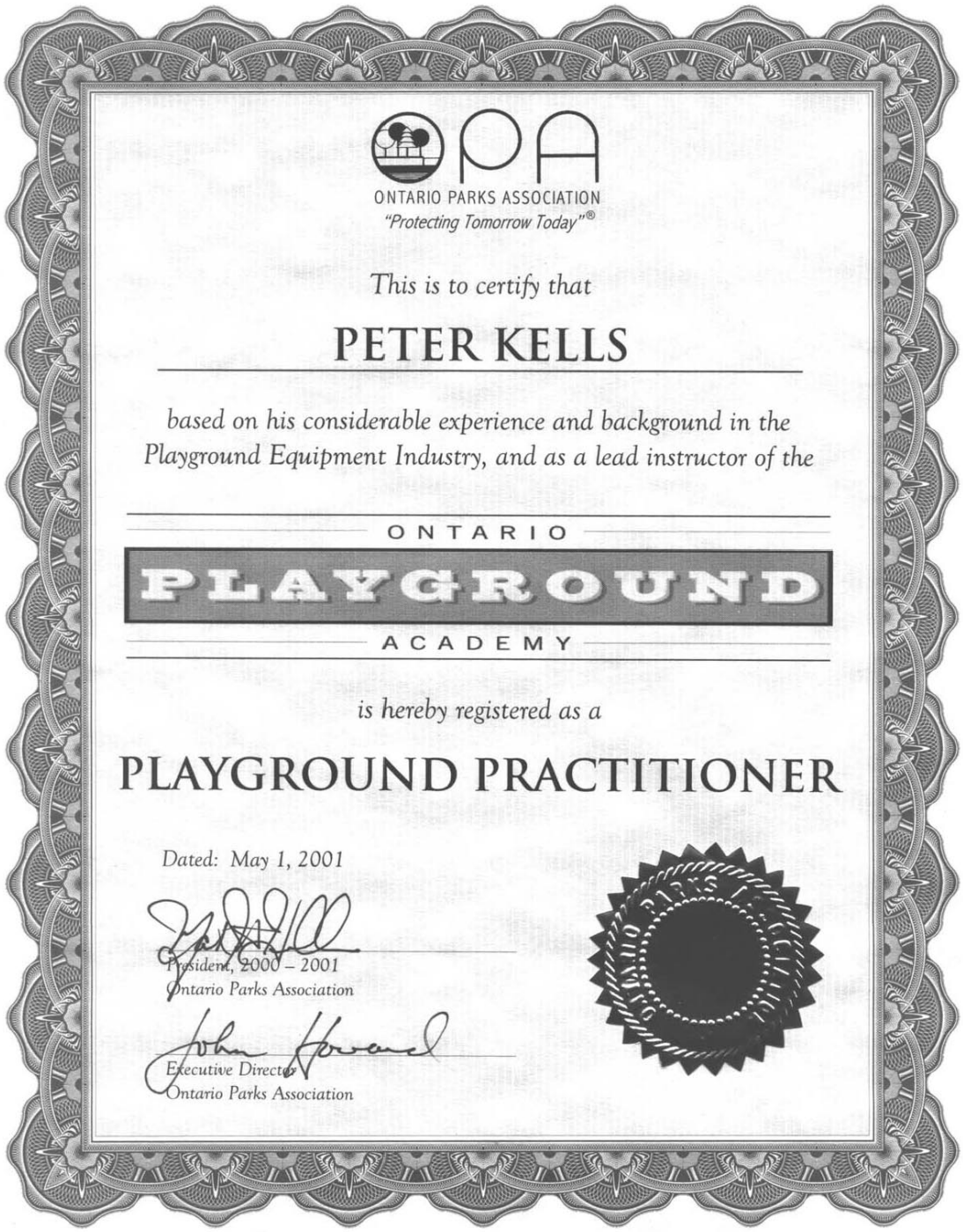
Peter Kells

has successfully completed the requirements to be a

Canadian Certified Playground Inspector

[Expiry Date: March 15, 2012]

March 15, 2009	
Date	CPRA Chair



ONTARIO PARKS ASSOCIATION
"Protecting Tomorrow Today"®

This is to certify that

PETER KELLS

based on his considerable experience and background in the Playground Equipment Industry, and as a lead instructor of the

ONTARIO
PLAYGROUND
ACADEMY

is hereby registered as a

PLAYGROUND PRACTITIONER

Dated: May 1, 2001

President, 2000 – 2001
Ontario Parks Association

Executive Director
Ontario Parks Association