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ny Corps of Engineers Waterways Experiment Station

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Evaluation of Concrete Seawalls at Perry's Victory and International Peace Memorial

by Roy L. Campbell, Sr., G. Sam Wong



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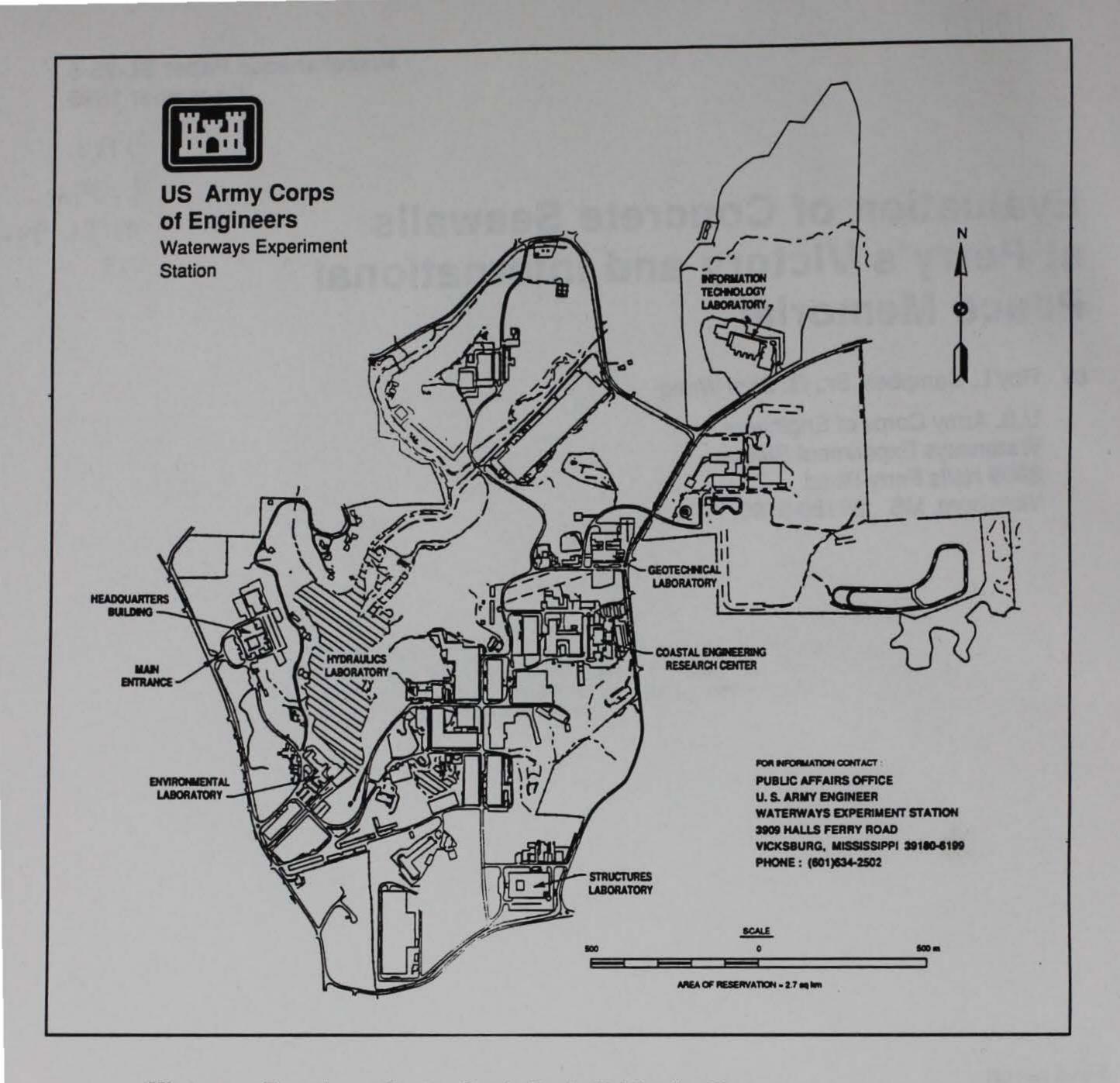
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by Roy L. Campbell, Sr., G. Sam Wong
U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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Preface

The work described in this report was conducted for the U.S. Army Engineer District, Buffalo, and was part of an evaluation being performed for the U.S. Department of the Interior, National Park Service. This work was authorized by Military Interdepartmental Purchase Request (MIPR) NCB-MR-95-27EF. Messrs. Frank Lewandowski and Jon Kolber were the project points of contact for the Buffalo District. Mr. Ted Hillmer was the project point of contact for the National Park Service. Mr. Richard A. Lusardi, Superintendent at Perry's Victory and International Peace Memorial, was the field point of contact for National Park Service.

Mr. James E. McDonald was the principal investigator for the Structures Laboratory (SL), U.S. Army Engineer Waterways Experiment Station (WES). The report was prepared by Messrs. Roy L. Campbell, Sr., and G. Sam Wong, Concrete Technology Division, CTD. Mr. Campbell performed the visual inspection of the seawalls and selected coring locations. Mr. A. Michael Alexander, CTD, helped plan the nondestructive investigation, and Mr. Dan E. Wilson, CTD, made the ultrasonic pulse velocity measurements. Coring of concrete and testing of cores in compression were performed by Mr. Jimmy W. Hall III, CTD. The petrographic analysis was performed by Mr. Wong. The work was conducted under the general supervision of Mr. William F. McCleese, Acting Chief, CTD, and Mr. Bryant Mather, Director, SL.

Dr. Robert W. Whalin was Director of WES during the performance of this work. COL Bruce K. Howard, EN, was Commander.

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1 Introduction

Background

Perry's Victory and International Peace Memorial is located at Put-In-Bay, Ohio on South Bass Island in Lake Erie and is maintained and operated by the National Park Service. To protect the memorial from wave erosion damage, a seawall was constructed along the north shoreline. In 1977-78, the north seawall was modified to increase its elevation and length and a second seawall constructed along the south shoreline.

On 11 October 1994, Mr. Frank Lewandowski of the Army Engineer District, Buffalo conducted a visual inspection of the seawalls and found areas of distress and deterioration in the concrete. Based on this inspection, it was concluded that remedial action would probably be necessary sometime in the future and that a more extensive evaluation was required to determine the cause(s) of distress and deterioration and to detail remedial actions required.

The U.S. Army Corps of Engineer Waterways Experiment Station was requested in spring of 1995 to evaluate the concrete in the seawalls and to report the cause(s) and extent of concrete deterioration and proposed remedial procedures.

Seawalls

The north seawall contains 60 monoliths and has an approximate length of 580 m (1900 ft). Monoliths 1-17 and 42-60 are extensions to the old seawall and vary in length between 4.6 and 7.6 m (15 and 25 ft). Monoliths 18-41 are a part of the old seawall and are 15.2 m (50 ft) long.

The south seawall contains 73 monoliths and has an approximate length of 460 m (1500 ft). Most monoliths are 6.1 m (20 ft) long, except for a few that are 6.7 m (22 ft) long.

Lengths for monoliths were estimated from distances given in Appendix A, Tables A-1 and A-2 (Pulse Velocity Measurements).

Monolith Numbering

The monoliths for the north seawall were designated from east to west starting with monolith N1 and ending with N60. The monoliths for the south seawall were designated from west to east starting with monolith S1 and ending with monolith S73.

2 Field Evaluation

During the period 16-22 May 1995, a team from WES performed a visual and photographic examination of accessible concrete surfaces, made ultrasonic pulse velocity measurements across the top portion of walls, and took cores from the tops of seawalls in both distressed and nondistressed areas.

Visual Inspection

North Seawall

A visual inspection of the north seawall found that most of the distress and deterioration in the concrete was observed at the vertical joints. At a few of the joints, the distress was observed at both corners of the top surface and in the landside face (Figures 1 and 2). Localized distress was observed in the form of hairline cracks with a reddish-brown stain coming from some of the cracks at the ladder recess of monolith N22 (Figure 3). Moisture was retained in some of the aggregate visible in the surface of new borings (Figure 4).

There were a number of minor areas of distress observed along the north seawall. The distress appeared in the form of hairline cracks, staining, and popouts. Small areas of reddish-brown stains were observed coming from some of the random and traverse cracks.

All joint seals showed varying degrees of damage, deterioration, and adhesive and cohesive failures. At a few joints, the seal and filler materials were completely missing. Adjacent monolith ends at joints 3/4 through 6/7, 8/9 through 11/12, 13 /14 through 16/17, 42/43 through 44/45, 46/47 through 50/51, 52/53 through 55/56, and 57/58 through 59/60 were cast against each other. These joints had an approximate 2-in.-deep slot for joint sealant material.

South Seawall

A visual inspection of the south seawall found that most of the distress and deterioration in the concrete was observed along the top-lakeside edges at the vertical joints (Figures 5 - 8). Extensive cracking was observed in the tops of four monoliths, S7, S16, S17, and S20 (Figures 9 -14). Areas of reddish-brown stains were observed coming from cracking along a longitudinal plane in landside (Figures 10 and 11) and lakeside faces of these monoliths.

Moisture was retained in some of the aggregate visible in the surface of new borings (Figures 15 - 17).

There were numerous areas of minor distress in the form of hairline cracks, staining, and popouts. Small areas of reddish-brown stains were observed coming from random and traverse cracks.

All joint seals showed varying degrees of damage, deterioration, and adhesive and cohesive failures. At a few joints, the seal and filler materials were completely missing. Adjacent monolith ends at joints 1/2 through 4/5, 6/7 through 8/9, 10/11 through 13/14, 15/16 through 18/19, 20/21 through 22/23, 24/25 through 28/29, 30/31 through 38/39, 40/41 through 43/44, 45/46 through 48/49, 50/51 through 53/54, 55/56 through 58/59, 60/61 through 63/64, 65/66 through 68/69, and 70/71 through 72/73 were cast against each other (Figure 17). These joints had an approximate 2-in.-deep slot for joint sealant material.

Concrete Coring

Cores were obtained from a total of 24 locations (9 north seawall, 2 old seawall, and 13 south seawall). At three locations in the south seawall, the concrete broke up into such small pieces that a test core could not be retrieved. The core rig was moved landward at these locations and a second attempt made to obtain a test core. Three cores (N57, S8, and S68) were taken from areas that showed no distress. The results of coring are summarized in Tables 1 and 2.

Pulse Velocity Measurements

Ultrasonic pulse velocity measurements were performed in accordance with ASTM C 597 and taken at locations approximately 150 mm (6 in.) below the top of seawalls at 1.5 m (5 ft) intervals along the length of each monolith.

The resulting measurements are given in Appendix A.

A suggested scale for estimating the quality of the concrete using pulse velocity measurements (Leslie and Cheesman 1949) is given as follows:

Ultrasonic Pulse Velocity, m/s (ft/s)	Quality of Concrete
> 4,570 (15,000)	Excellent
3,660 - 4,570 (12,000 - 15,000)	Good
3,050 - 3,660 (10,000 - 12,000)	Questionable
2,130 - 3,050 (7,000 - 10,000)	Poor
< 2,130 (7,000)	Very Poor

A total of 66 locations (29 north seawall and 37 south seawall) where low pulse velocity readings were recorded are listed in Tables 3 and 4. All low readings were within 1.5 m (5 ft) of a joint, except for those taken in monoliths N24, S16, and S20. The low reading in N24 was suspected to be the result of a localized deficiency in the concrete.

Table 1
Field Notes on Coring of North Seawall

	Core Location			
Monolith	Reference Point	Description of Core		
N10	North seawall joint 9/10	Rubble		
N11	North seawall joint 11/12	Core length = 356 mm (14 in.)		
N21	North seawall, near midlength of monolith	Core length = 483 mm (19 in.)		
N22	North seawall joint at ladder recess	Core length = 432 mm (17 in.)		
N30	North seawall joint 29/30	Core length = 381 mm (15 in.)		
N38	North seawall joint 37/38	Core length = 190 mm (7-1/2 in.)		
N45	North seawall joint 44/45	Core length = 384 mm (15-1/8)		
N56	North seawall joint 56/57	Core length = 432 mm (17 in.)		
N57	North seawall joint 57/58	Core length = 426 mm (16-3/4 in.)		
N34°	North seawall joint 34/35	Rubble		
N40°	North seawall joint 40/41	Core length = 102 mm (4 in.)		

^{*}Specimens taken from exposed landside top of old seawall at monolith location in new seawall.

Table 2
Field Notes on Coring of South Seawall

	Core Location			
Monolith Reference Point		Description of Core		
S7	South seawall joint 7/8	Core length = 76 mm (3 in.)		
S8	South seawall, near joint 7/8	Core length = 483 mm (19 in.)		
S16	South seawall joint 15/16	Core length = 102 mm (4 in.)		
S16/17	South seawall at joint 16/17	Core length = 190 mm (7-1/2 in.)		
S17A	South seawall joint 17/18	Rubble		
S17B	South seawall joint 17/18 (approximately 152 mm (6 in.) landward from S17A)	Core length = 375 mm (14-3/4 in.)		
S20	South seawall joint 19/20	Core length = 76 mm (3 in.)		
S27	South seawall joint 27/28	Core length = 102 and 330 mm (4 and 13 in. lengths)		
S37	South seawall joint 37/38	Core length = 381 mm (15 in.)		
S49	South seawall joint 48/49	Core length = 165 mm (6-1/2 in.)		
S52A	South seawall joint 1/52	Rubble		
S52B	South seawall joint 51/52 (approximately 152 mm (6 in.) landward from S52A)	Core length = 292 mm (11-1/2 in.)		
S60A	South seawall joint 59/60	Core length = 152 mm (6 in.)		
S60B	South seawall joint 59/60 (approximately 152 mm (6 in.) landward from S60A)	Core length = 413 mm (16-1/4 in.)		
S68	South seawall joint, near midlength of monolith	Core length = 356 mm (14 in.)		
S72	South seawall joint 72/73	Core length = 419 mm (16-1/2 in.)		

Table 3
North Seawall Locations Where Low Pulse Velocity Measurements were Recorded

Location		Location			
Monolith	Distance From East End of Monolith m (ft)	Pulse Velocity m/s (ft/s)	Monolith	Distance From East End of Monolith m (ft)	Pulse Velocity m/s (ft/s)
N6	0.08 (0.25)	2918 (9573)	N21	0.08 (0.25)	2272 (7453)
N7	0.08 (0.25)	2052 (6731)	N22	0.08 (0.25)	ERR
N8	6.10 (20.00)	2667 (8750)	N22	1.52 (5.00)	2223 (7292)
N9	0.08 (0.25)	2223 (7292)	N23	14.55 (47.75)	3419 (11218)
N9	6.10 (20.00)	2886 (9470)	N24	7.62 (25.00)	2646 (8681)
N10	0.08 (0.25)	ERR	N27	0.08 (0.25)	3334 (10938)
N10	6.10 (20.00)	ERR	N29	0.08 (0.25)	2223 (7292)
N11	0.08 (0.25)	ERR	N31	0.08 (0.25)	3252 (10671)
N11	5.94 (19.50)	ERR	N31	14.63 (48.00)	1905 (6250)
N12	0.08 (0.25)	2667 (8750)	N33	6.10 (20.00)	2287 (7504)
N14	0.08 (0.25)	2825 (9269)	N38	0.08 (0.25)	2540 (8333)
N14	6.10 (20.00)	2381 (7813)	N59	6.10 (20.00)	2020 (6629)
N18	0.08 (0.25))	1990 (6530)	N60	0.08 (0.25)	ERR
N19	14.63 (48.00)	3293 (10802)	N60	1.52 (5.00)	ERR
N20	0.08 (0.25)	2963 (9722)			

Table 4
South Seawall Locations Where Low Pulse Velocity Measurements were Recorded

	Location		Location		
Monolith	Distance From West End of Monolith m (ft)	Pulse Velocity m/s (ft/s)	Monolith	Distance From East End of Monolith m (ft)	Pulse Velocity m/s (ft/s)
S1	6.02 (19.75)	1909 (6263)	S30	0.08 (0.25)	2623 (8607)
S7	0.08 (0.25)	3310 (10860)	S31	6.10 (20.00)	1702 (5585)
S7	1.52 (5.00)	3293 (10803)	S33	0.08 (0.25)	2229 (7312)
S16	0.08 (0.25)	ERR	S40	6.10 (20.00)	ERR
S16	1.52 (5.00)	2899 (9511)	S42	0.08 (0.25)	2036 (6679)
S16	3.05 (10.00)	2241 (7353)	S49	0.08 (0.25)	ERR
S16	4.57 (15.00)	2020 (6629)	S52	0.08 (0.25)	ERR
S16	6.10 (20.00)	2015 (6612)	S52	6.10 (20.00)	2052 (6731)
S17	4.57 (15.00)	ERR	S53	0.08 (0.25)	2241 (7353)
S17	5.64 (18.50)	ERR	S58	0.08 (0.25)	3239 (10628)
S18	1.52 (5.00)	3200 (10500)	S59	0.08 (0.25)	1861 (6105)
S18	6.10 (20.00)	1455 (4773)	S60	0.08 (0.25)	2931 (9615)
S20	0.08 (0.25)	ERR	S63	0.08 (0.25)	3362 (11029)
S20	1.52 (5.00)	ERR	S63	6.10 (20.00)	2500 (8203)
S20	3.05 (10.00)	ERR	S67	0.08 (0.25)	1591 (5219)
S20	4.57 (15.00)	ERR	S67	6.02 (19.75)	3266 (10714)
S20	6.10 (20.00)	ERR	S72	0.08 (0.25)	ERR
S27	1.52 (5.00)	ERR	S72	6.10 (20.00)	ERR
S29	3.05 (10.00)	3334 (10938)			



Figure 1. Cracking at joint 9/10, north seawall monolith N10



Figure 2. Cracking at joint 11/12, north seawall monolith N11



Figure 3. Hairline cracks with reddish-brown stains at ladder recess, north seawall monolith N22

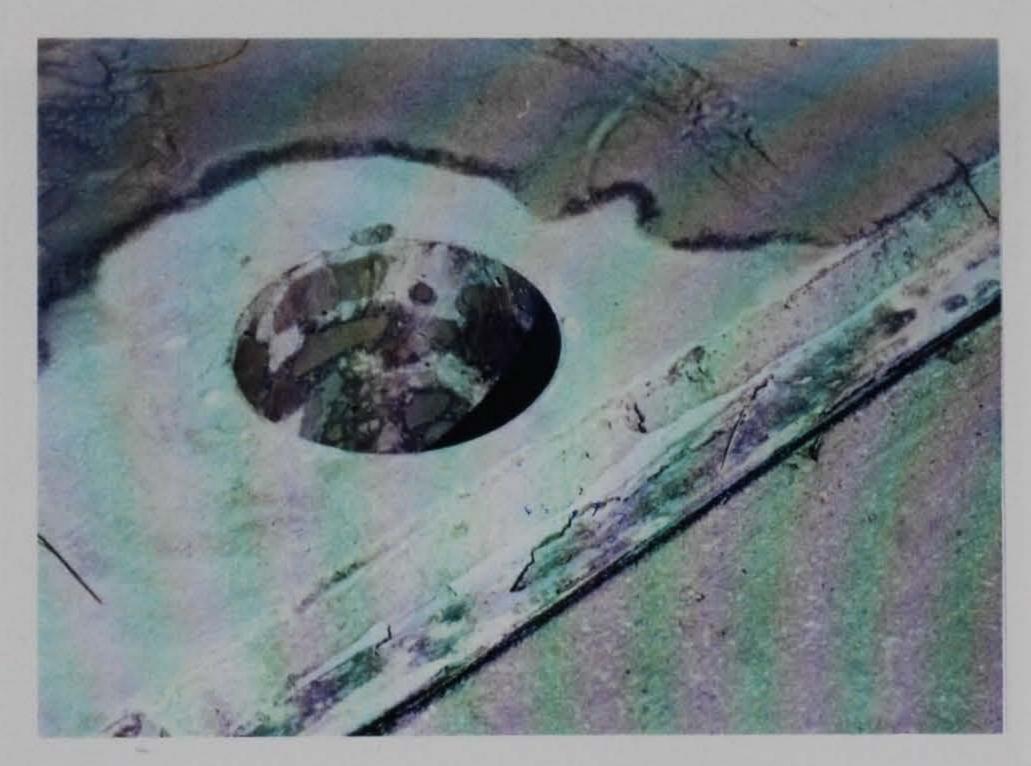


Figure 4. Moisture retained in and around some of the aggregate particles visible in the surface of boring at joint 37/38, north seawall monolith N38



Figure 5. Cracking along lakeside edge at joint 48/49, south seawall monolith S49



Figure 6. Cracking along lakeside edge at joint 51/52, south seawall monolith S52



Figure 7. Cracking along lakeside edge at joint 52/53 south seawall monolith S52



Figure 8. Cracking along lakeside edge at joint 71/72, south seawall monolith S72

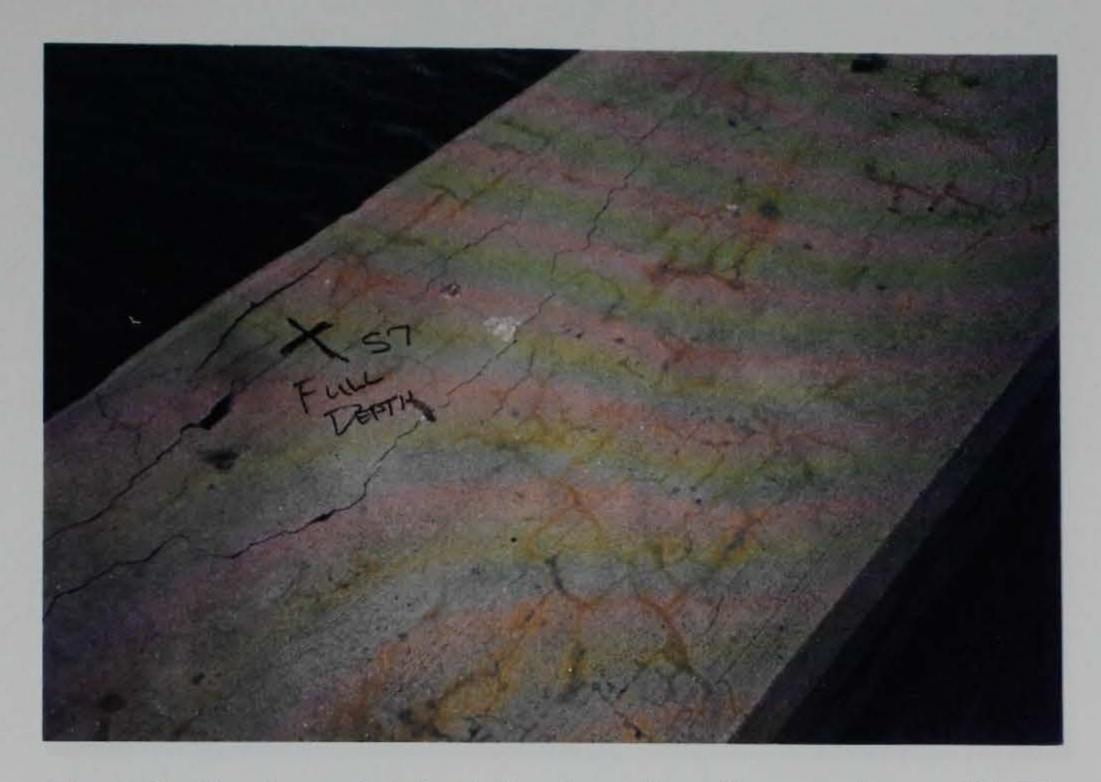


Figure 9. Cracks and stains in top face of south seawall monolith S7



Figure 10. Cracks and stains in landside face of south seawall monolith S7

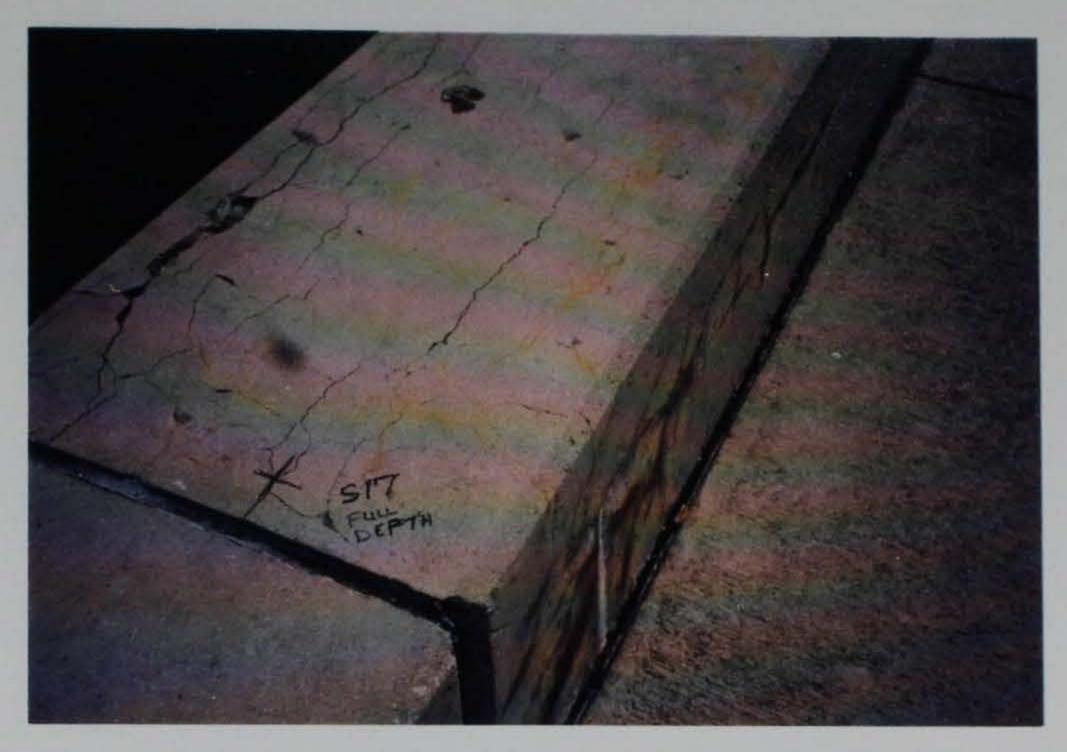


Figure 11. Cracks and stains in faces of south seawall monolith S17 at joint 17/18

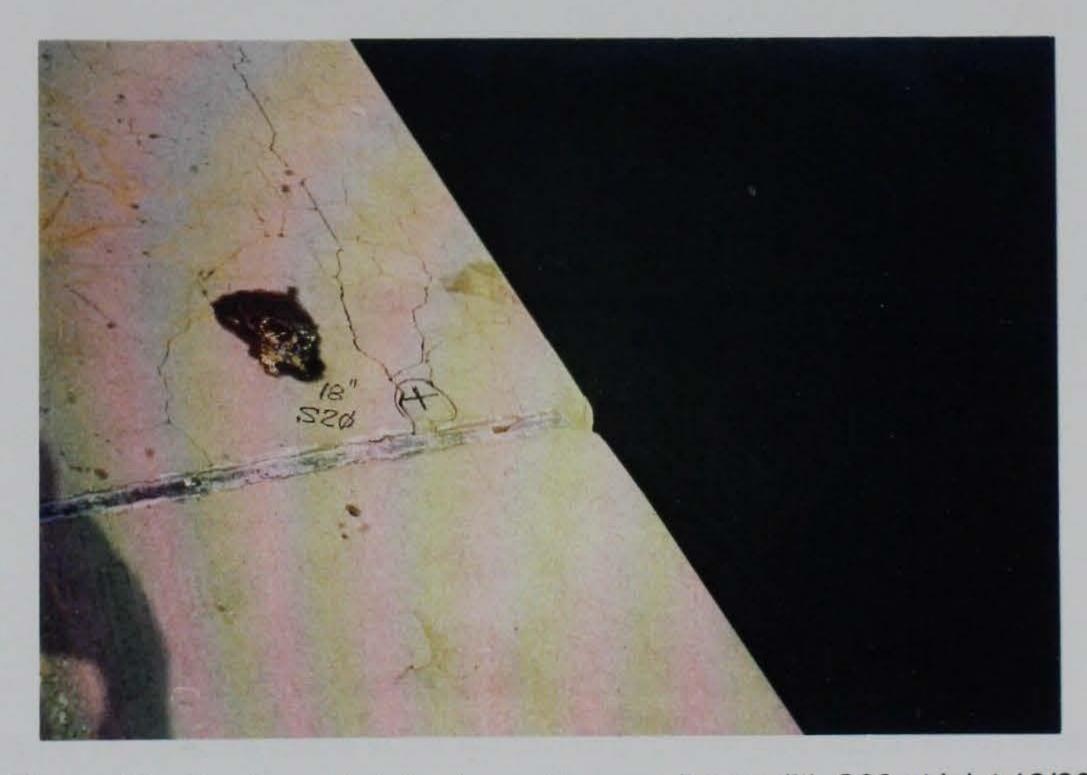


Figure 12. Cracks and stains in south seawall monolith S20 at joint 19/20

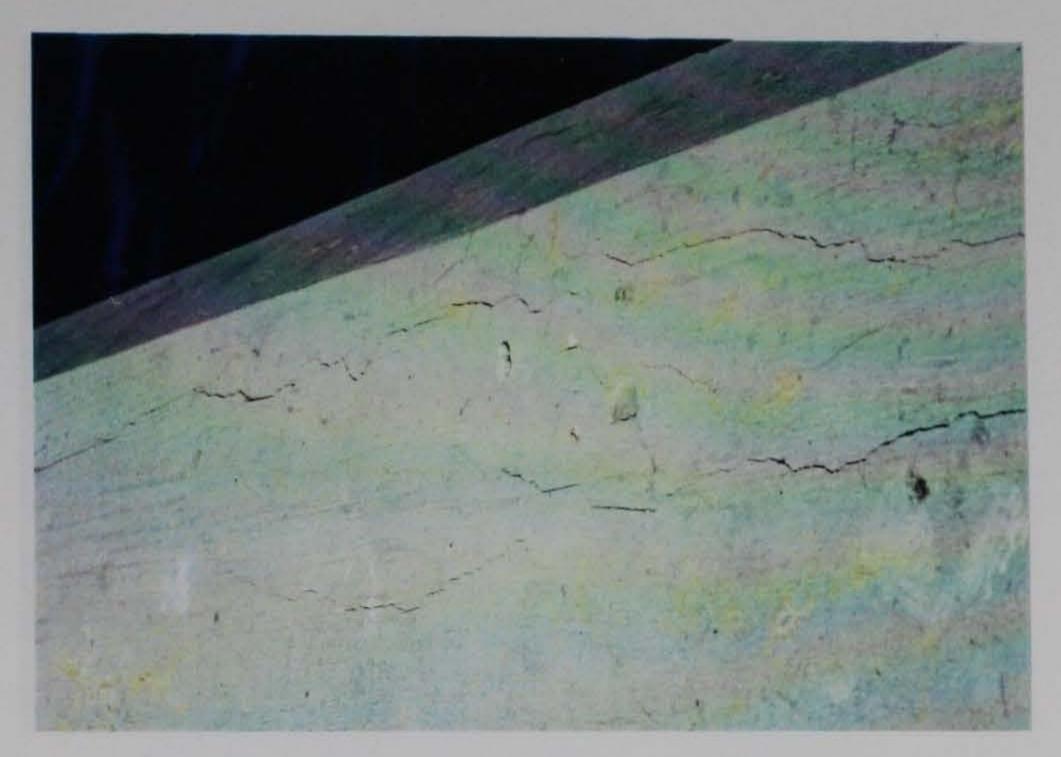


Figure 13. Longitudinal cracks along lakeside edge of south seawall monolith S20

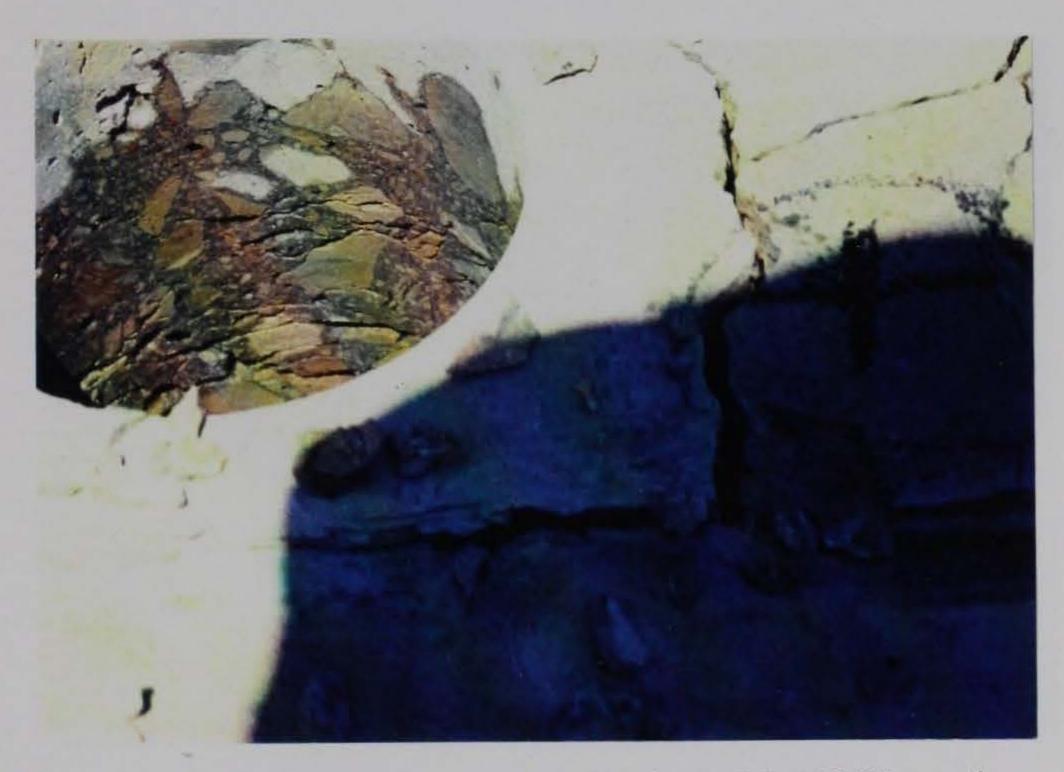


Figure 14. Cracks visible in the surface of boring at joint 19/20, south seawall monolith S20

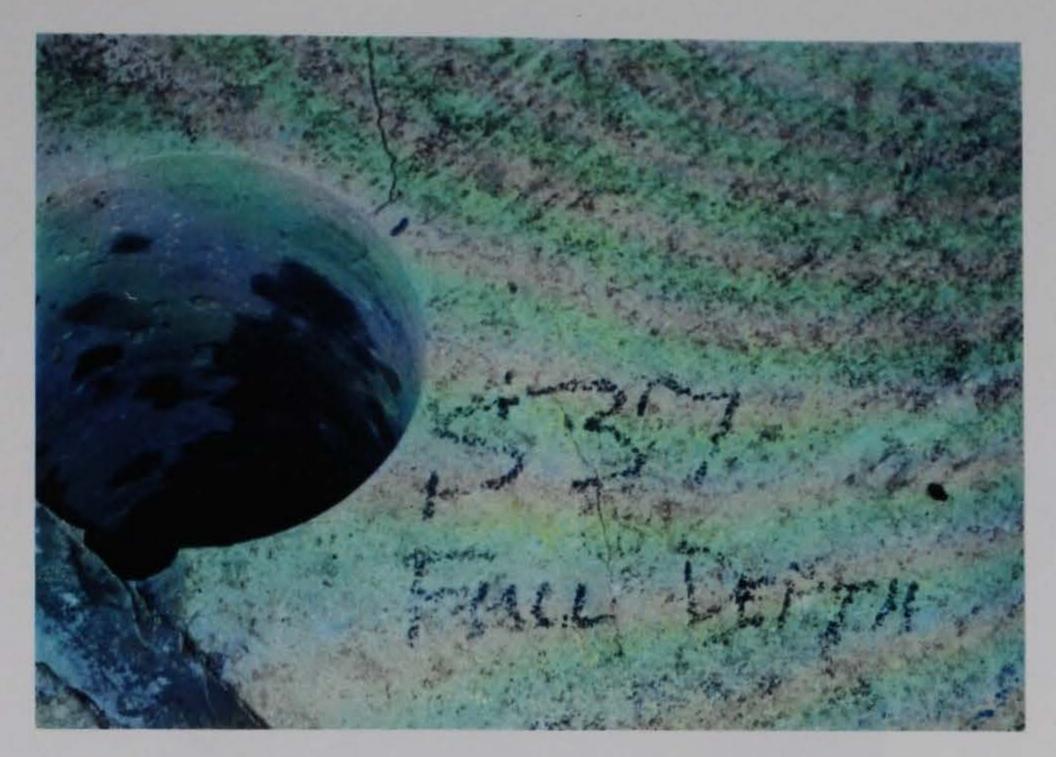


Figure 15. Moisture retained in and around some of the aggregate particles visible in the surface of boring at joint 37/38, south seawall monolith S37



Figure 16. Moisture retained in some of the aggregate particles visible in the surface of boring, south seawall joint 16/17

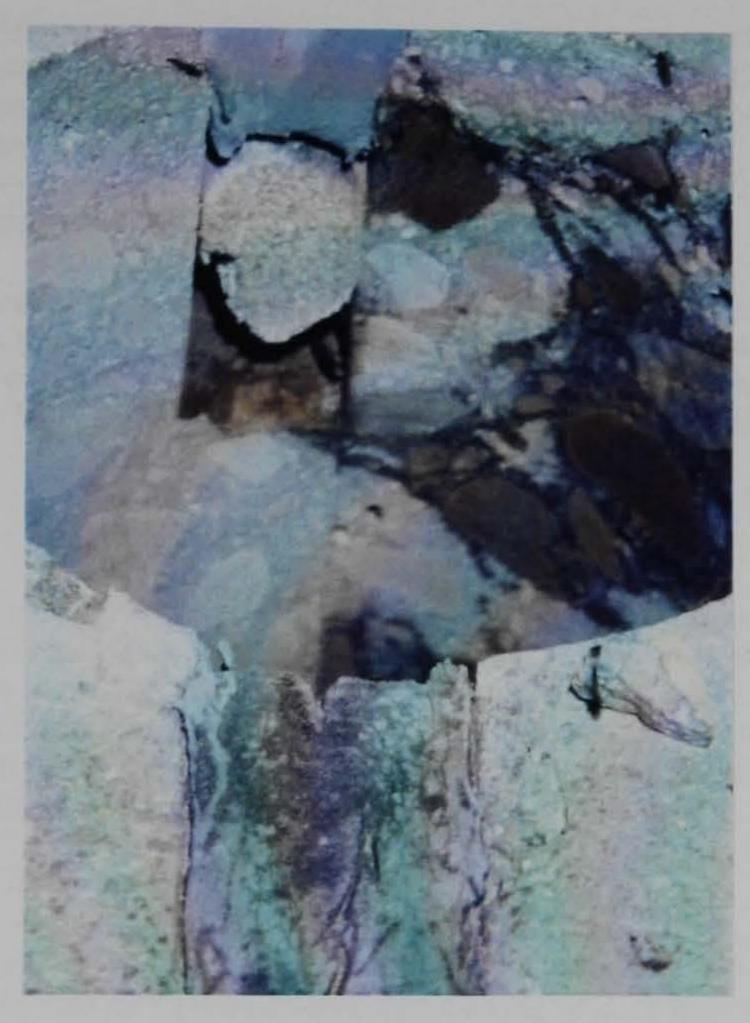


Figure 17. Monoliths 16 and 17 cast against each other, also moisture retained in and around some aggregate particles of monolith 16

3 Laboratory Tests

Core Tests

A total of 14 specimens (7 from each seawall) were selected from cores and tested in compression in accordance with ASTM C 39 and ASTM C 42. Ultrasonic pulse velocities and densities were also determined for each sample. The results of core tests are presented in Table 5.

Compressive Strength

The compressive strengths of the cores from the north seawall ranged from 31.7 to 58.7 MPa (4,600 to 8,510 psi) with an average strength of 46.0 MPa (6,680 psi). The compressive strengths of the cores from the south seawall ranged from 38.9 to 66.1 MPa (5,650 to 9,590 psi) with an average strength of 52.6 MPa (7,630 psi).

Pulse Velocity

The pulse velocity measurements on cores from the north seawall ranged from 4,182 to 4,803 m/s (13,720 to 15,758 ft/s) with an average velocity of 4,524 m/s (14,841 ft/s). The pulse velocity measurements on the cores from the south seawall ranged from 4,543 to 4,726 m/s (14,906 to 15,506 ft/s) with an average velocity of 4,623 m/s (15,166 ft/s). A correlation between compressive strength and pulse velocity is presented in Figure 18.

Density

The density of the cores from the north seawall ranged from 2.23 to 2.40 Mg/m³ (139 to 150 lb/ft³) with an average density of 2.27 Mg/m³ (142 lb/ft³). The density of the cores from the south seawall ranged from 2.23 to 2.37 Mg/m³ (139 to 148 lb/ft³) with an average density of the south seawall of 2.31 Mg/m³ (144 lb/ft³).

Table 5
Test Results for Core Specimens taken from Seawalls

Core	Specimen	Mass Density	Pulse Velocity Before Capping After Ca				Capping After Cappi	ping	Unconfined Compressive	
Location	Number	Mg/m³ (lb/ft³)	m/s (ft/s)	Length mm (in.)	Diameter mm (in.)	L/D Ratio	Length mm (in.)	L/D Ratio	Strength (ASTM C 42) MPa (psi)	
N11	1	2.40 (150)	4,182 (13,720)	206 (8.10)	102 (4.00)	2.03	210 (8.28)	2.07	36.6 (5,310)	
8121	1	2.26 (141)	4,803 (15,758)	203 (8.00)	102 (4.00)	2.00	206 (8.12)	2.03	50.3 (7,300)	
N21	2	2.29 (143)	4,486 (14,717)	203 (8.00)	102 (4.00)	2.00	208 (8.20)	2.05	52.0 (7,540)	
N30	1	2.23 (139)	4,705 (15,436)	206 (8.12)	102 (4.00)	2.03	209 (8.22)	2.06	58.7 (8,510)	
N45	1	2.32 (145)	4,673 (15,331)	206 (8.10)	102 (4.00)	2.03	209 (8.21)	2.05	49.0 (7,110)	
N56	1	2.24 (140)	4,341 (14,243)	205 (8.08)	102 (4.00)	2.02	208 (8.19)	2.05	31.7 (4,600)	
N57	1	2.23 (139)	4,476 (14,684)	204 (8.02)	102 (4.00)	2.01	207 (8.16)	2.04	44.0 (6,380)	
Averages for North Seawall		2.27 (142)	4,524 (14,841)						46.0 (6,680)	
60	1	2.23 (139)	4,580 (15,026)	207 (8.13)	102 (4.00)	2.03	209 (8.23)	2.06	53.4 (7,740)	
S8	2	2.24 (140)	4,613 (15,134)	201 (7.93)	102 (4.00)	1.98	207 (8.14)	2.04	49.3 (7,160)	
S17B	1	2.26 (141)	4,658 (15,281)	205 (8.08)	102 (4.00)	2.02	208 (8.18)	2.05	54.0 (7,830)	
S27	1	2.35 (147)	4,544 (14,907)	203 (8.00)	102 (4.00)	2.00	206 (8.11)	2.03	38.9 (5,650)	
S52B	1	2.37 (148)	4,726 (15,506)	206 (8.10)	102 (4.00)	2.03	209 (8.24)	2.06	52.9 (7,680)	
S68	1	2.31 (144)	4,694 (15,400)	206 (8.10)	102 (4.00)	2.03	209 (8.22)	2.06	66.1 (9,590)	
S72	1	2.34 (146)	4,543 (14,906)	163 (6.40)	102 (4.00)	1.60	168 (6.61)	1.65	53.9 (7,810)	
Averages for South Seawall		2.31 (144)	4,623 (15,166)						52.6 (7,630)	

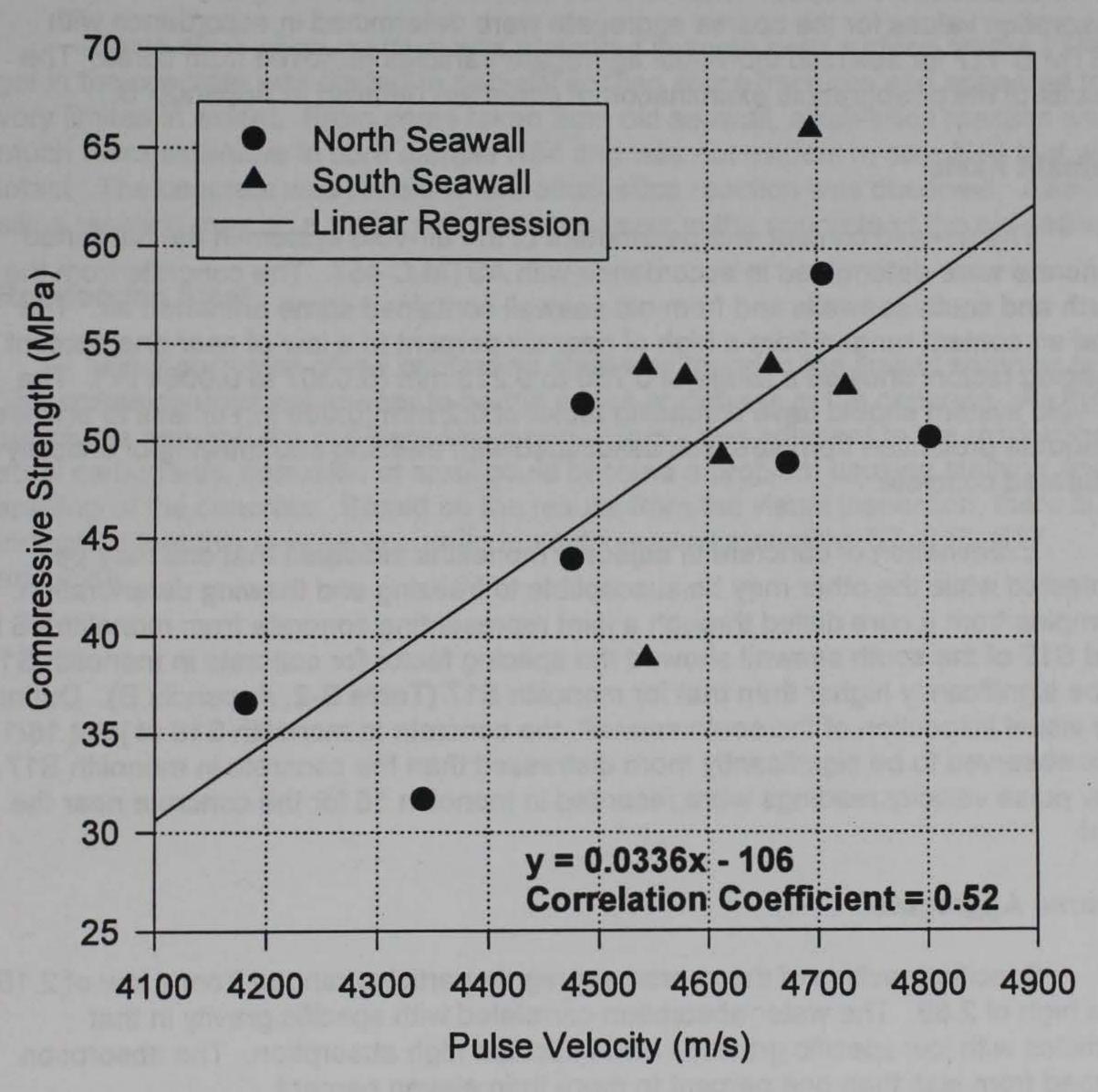


Figure 18. Compressive strength vs pulse velocity for core samples

Petrographic Examination

A total of 27 samples (9 north seawall, 2 old seawall, and 16 south seawall) were evaluated in accordance with ASTM C 856. The air content and the air-void spacing factor of the cement paste were determined in accordance with ASTM C 457 for selected concrete specimens removed from cores. Specific gravities and water absorption values for the coarse aggregate were determined in accordance with ASTM C 127 for selected individual aggregate particles removed from cores. The results of the petrographic examination of cores are detailed in Appendix B.

Cement Paste

The air-void content and parameters of the air-void system in the hardened concrete were determined in accordance with ASTM C 457. The concrete from the north and south seawalls and from old seawall contained some entrained air. The total air content ranged from a high of near six percent to a low of near one percent. Spacing factors showed a range of 0.780 to 0.213 mm (0.0307 to 0.0084 in.). The air-void system should have a spacing factor of 0.2 mm (0.008 in.) or less to provide adequate protection from stresses associated with freezing and thawing of critically saturated concrete.

Examination of concrete in adjacent monoliths indicated that one may be protected while the other may be susceptible to freezing and thawing deterioration. Samples from a core drilled through a joint representing concrete from monoliths S16 and S17 of the south seawall showed the spacing factor for concrete in monolith S16 to be significantly higher than that for monolith S17 (Table B-2, Appendix B). During the visual inspection of the south seawall, the concrete in monolith S16 at joint 16/17 was observed to be significantly more distressed than the concrete in monolith S17. Low pulse velocity readings were recorded in monolith 16 for the concrete near the joint.

Coarse Aggregate

Specific gravities of the coarse aggregate particles ranged from a low of 2.16 to a high of 2.89. The water absorption correlated with specific gravity in that particles with low specific gravities also indicated high absorption. The absorption ranged from less than one percent to more than eleven percent.

Aggregate particles with low specific gravities and high absorption usually are not resistant to freezing and thawing. In many places specific gravities of less than 2.4 are indications of potential problem aggregates. Problems associated with nondurable aggregate in this case would likely appear at edges and corners where the concrete has the highest potential for saturation.

The high absorption exhibited by some of the coarse aggregate particles may account for the popouts observed on concrete surfaces.

The dolomitic limestone showed some reaction rims around aggregate particles indicating some alkali-carbonate rock reaction. This reaction does not appear to be a problem as there was no evidence of joint closure in the structure or possible displacement.

Some alkali-silica reaction was observed in some near surface cracks. The gel in the concrete was limited to partially coating some fractures and appeared to be very limited in extent. From cores taken from old seawall, alkali-silica reaction was much more extensive in core sample N34 and was not evident in core N40 that was intact. The concrete was rubble where alkali-silica reaction was observed. Alkali-silica reaction may be a major deteriorating cause in the concrete of the old seawall.

Reinforcing Steel

Minor corrosion of the reinforcing steel was found in the limited samples taken. The corrosion does not appear to be the cause of distress in the concrete. As the structures age and the concrete along open cracks and adjacent to the reinforcing steel carbonates, corrosion of steel could become a problem causing staining and spalling of the concrete. Based on the results from the visual inspection, there is indication that this may be occurring in south seawall monoliths S7, S16, S17, and S20.

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4 Conclusions

The results of the petrographic examination of the concrete identified several mechanisms that may contribute to the deterioration of the concrete. Of those, the lack of resistance to freezing and thawing was concluded to be the major contributor to the observed distress and deterioration in the concrete.

The air-void system in the concrete of some monoliths is inadequate for protecting the concrete from damage due to freezing while critically saturated. An examination of selected specimens indicated the concrete from some monoliths has an air-void spacing factor near the critical limit where the concrete would be considered protected while the concrete from other monoliths has an air-void spacing factor that is well outside the protected range.

Both the concrete from the north and south seawalls were similar in composition. The performance is expected to be similar under similar environmental conditions. Both walls contain some aggregate particles that are susceptible to damage due to freezing and thawing while critically saturated. This may manifest itself in D cracking of the concrete at the joints and edges.

Alkali-aggregate reaction and corrosion were recognized as active chemical reactions in the concrete but are believed to be minor contributors to the deterioration process at this time. Of the two cores obtained from the old seawall, one was intact and free of apparent internal distress where the other was totally deteriorated. Only limited consideration was given to the old concrete and alkali-silica reaction may be a factor in deterioration of that concrete. Overall, the deterioration resulting from alkali-silica reaction is not expected to require remedial action in the future.

During the visual inspection of the seawalls, it was observed that a much higher frequency of the distress exists in the south seawall concrete than in north seawall concrete. An increase in damage has been observed in the south face of other structures that lie in a east-west plane. It is believed that the south face of these structures receives more sunlight in the winter than the north face due to the angle of the sun and, thereby, undergoes more cycles of freezing and thawing. This may account for the increased frequency of damage observed in the south seawall.

Most of the distress and deterioration in the concrete was observed along the top-lakeside edges of seawalls at the joints. The exceptions to this were at four south seawall monoliths (S7, S16, S17, and S20) where the damage was distributed

along the length of the monoliths and at a ladder recess in the north seawall monolith N22 where more extensive cracking was observed in top and landside faces of the concrete.

Corrosion of the reinforcing steel was indicated in the four south seawall monoliths by areas of reddish-brown stains coming from cracking along a longitudinal plane in landside and lakeside faces. Reddish-brown stains were also observed coming from cracks in the concrete at the ladder recess of north seawall monolith N22.

There were numerous areas of localized distress in the form of hairline cracks, staining, and popouts. Small areas of reddish-brown stains were observed coming from random and traverse cracks indicating localized corrosion of the reinforcing steel. Again, most of the distress was observed in the south seawall. It is possible that some areas of localized distress will required remedial action in the future for appearance purposes.

All joint seals showed varying degrees of damage, deterioration, and adhesive and cohesive failures. At a few joints, the seal and filler materials were completely missing. No correlation could be made between the missing joint materials and the occurrence of damage to the concrete as there were several joints where there was no joint material and no evidence of distress or deterioration.

5 Recommendations

North Seawall

There are eight locations in the north seawall where removal and replacement of distressed and deteriorated concrete should be considered (Table 6). All but one location is at a joint. In general, it is recommended that for repairs at a joint the concrete be removed and replaced from the joint back approximately 610 mm (24 in.) and from the top down approximately 380 mm (15 in.). For the repair at the ladder recess in monolith N22, it is recommended that approximately 380 mm (15 in.) of the concrete be removed and replaced from the vertical face between the top and ground level and 300 mm (12 in.) to either side of ladder blockout.

South Seawall

There are forty locations in the south seawall where distressed and deteriorated concrete should be consider for removal and replacement (Table 7). Four locations (monoliths S7, S16, S17, and S20) include removal and replacement of the top 460 mm (18 in.) of the monolith and the other thirty-six locations are for repairs at a joint. In general, it is recommended that for repairs at a joint the concrete be removed and replace from the joint back approximately 610 mm (24 in.) and from the top down approximately 380 mm (15 in.).

Table 6
Recommended Repairs to North Seawall

Monolith	Reference Point	Description of Repair
N10"	Joint 9/10	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N10°	Joint 10/11	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N11'	Joint 10/11	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N11"	Joint 11/12	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N14'	Joint 13/14	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N22'	Joint 21/22	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
N22	Ladder Recess	Remove and replace approximately 380 mm (15 in.) of concrete from vertical face between the top and ground level and 300 mm (12 in.) to either side of ladder blockout
N60°	Joint 59/60	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)

Table 7
Recommended Repairs to South Seawall (Continued)

Monolith	Reference Point	Description of Repair
S1'	Joint 1/2	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.) and make joint vertical at top
s7°	Entire Monolith	Remove and replace top 460 mm (18 in.) of monolith
S16°	Entire Monolith	Remove and replace top 460 mm (18 in.) of monolith
S17°	Entire Monolith	Remove and replace top 460 mm (18 in.) of monolith
S18*	Joint 18/19	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S20°	Entire Monolith	Remove and replace top 460 mm (18 in.) of monolith
S27	Joint 27/28	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S29	Joint 28/29	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
s30°	Joint 29/30	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S31*	Joint 31/32	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
532	Joint 32/33	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
s33°	Joint 32/33	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S33	Joint 33/34	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
534	Joint 33/34	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)

Table 7
Recommended Repairs to South Seawall (Continued)

Monolith	Reference Point	Description of Repair
S37	Joint 37/38	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S38	Joint 37/38	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S39	Joint 38/39	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S39	Joint 39/40	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S40	Joint 39/40	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S40'	Joint 40/41	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S41	Joint 41/42	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S42'	Joint 41/42	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S42	Joint 42/43	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S43	Joint 42/43	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S46	Joint 45/46	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S49 [']	Joint 48/49	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S52°	Joint 51/52	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S52°	Joint 52/53	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S53°	Joint 52/53	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)

Table 7
Recommended Repairs to South Seawall (Concluded)

Monolith	Reference Point	Description of Repair
S53	Joint 53/54	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S58°	Joint 57/58	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S59°	Joint 58/59	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S60°	Joint 59/60	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S63'	Joint 62/63	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S63°	Joint 63/64	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S64	Joint 63/64	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S67'	Joint 66/67	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S67'	Joint 67/68	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S72'	Joint 71/72	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)
S72°	Joint 72/73	Remove and replace from joint back approximately 610 mm (24 in.) and from top down 380 mm (15 in.)

Low Pulse Velocity Measurement

Overall

Additional removal and replacement will be required if sound concrete is not reached within specified repair limits. A minimum 25 mm (1-in.) saw cut should be made along removal boundaries to reduce the occurrence of feather edges during removal. If damage to a reinforcing bar has reduced the effective cross-sectional area by 25 percent or more, additional reinforcement should be added. Exposed concrete surfaces and reinforcing should be sandblasted prior to placement of concrete.

A conventional concrete should be used to make repairs. The concrete should have adequate air content to protect repair against freeze-thaw damage. The coarse aggregate should be tested for resistance to freezing and thawing (ASTM C 666, Procedure A).

Cracking has been a problem in some overlays and large repairs. It is believed that the cracking was the result of thermal and drying volume changes acting upon the highly restrained repair. To reduce the potential for such cracking, positive steps should be specified and followed to minimize temperature differentials and shrinkage. Reduced cracking in lock wall resurfacing has been attributed to lowering cement content, increasing the maximum size coarse aggregate, utilizing lower placing and curing temperatures, and paying close attention to curing (Wickersham 1987).

It is recommended that a surface sealer be applied to monolith tops and to lakeside and landside faces from top of monolith to minimum of 460 mm (18 in.) below. The sealer selected should allow significant water vapor transfer to avoid a critically water saturated condition that would result in damage due to freezing and thawing. Criteria for selection of sealers along with the test results of some 90 commercial surface treatment products can be found in Technical Report REMR-CS-17, Report 2 (Husbands and Causey 1990). Of the products tested only five products met the criteria (one hydrocarbon, two siloxanes, and two silanes). The manufacturer will have to be contacted regarding conditions under which a particular sealer can be applied as the application varies greatly between types of sealers.

It is also recommended that existing seals be removed and new seals installed at all joints.

Additional evaluation of the seawalls may be required as the lakeside faces of seawalls were not accessible due to high lake levels when field evaluation was performed. It is expected that the concrete in the lakeside surfaces has less than or minimal resistance to freezing and thawing damage when critically saturated. Therefore, it may be prudent to apply sealer to the full height of lakeside surfaces. The concrete in the sidewalk portion of the south seawall was not tested. The sidewalk did have minor cracking at the corner of one joint. The repair of this corner would only be necessary for appearance.

Maintenance

Because of the inadequate air-void system within the concrete, there is potential for the deterioration due to freezing and thawing to continue in what is now sound concrete, assuming critical saturation of the concrete. To minimize this potential, it is recommended that the sealer be reapplied periodically. The time interval between applications depends on the product used. For many sealers, the recommended interval is 5 years.

References

American Society of Testing Materials. 1994. 1994 Annual Book of ASTM Standards. Philadelphia, PA.

- Designation C 39. "Standard test method for compressive strength of cylindrical concrete specimens."
- Designation C 42. "Standard test method for obtaining and testing drilled cores and sawed beams of concrete."
- Designation C 127. "Standard test method for specific gravity and absorption of coarse aggregate."
- d. Designation C 457. "Standard practice for microscopical determination of air-void content and parameters of the air-void system in hardened concrete."
- e. Designation C 597. "Standard test method for pulse velocity through concrete."
- f. Designation C 666. "Standard test method for resistance of concrete to rapid freezing and thawing."
- g. Designation C 856. "Standard practice for petrographic examination of hardened concrete."
- Husbands, T. B. and Causey, F. E. (1990). "Surface treatments to minimize concrete deterioration, laboratory evaluation of surface treatment materials," Technical Report REMR-CS-17, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
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Appendix A1 Pulse Velocity Measurements

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of	Path Length	Pulse Velocity
Monolith	End of Monolith m (ft)	Arrival microseconds	m (ft)	m/s (ft/s)
N2	0.08 (0.25)	297	1.334 (4.375)	4490 (14731)
	1.52 (5.00)	292	1.334 (4.375)	4567 (14983)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	292	1.334 (4.375)	4567 (14983)
	5.94 (19.50)	315	1.334 (4.375)	4233 (13889)
N3	0.08 (0.25)	289	1.334 (4.375)	4614 (15138)
***************************************	1.52 (5.00)	294	1.334 (4.375)	4536 (14881)
***************************************	3.05 (10.00)	293	1.334 (4.375)	4551 (14932)
***************************************	4.57 (15.00)	289	1.334 (4.375)	4614 (15138)
***************************************	6.10 (20.00)	290	1.334 (4.375)	4598 (15086)
N4	0.08 (0.25)	301	1.334 (4.375)	4430 (14535)
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
	3.05 (10.00)	300	1.334 (4.375)	4445 (14583)
	4.57 (15.00)	287	1.334 (4.375)	4646 (15244)
	5.94 (19.50)	294	1.334 (4.375)	4536 (14881)
N5	0.08 (0.25)	347	1.334 (4.375)	3843 (12608)
	1.52 (5.00)	307	1.334 (4.375)	4344 (14251)
	3.05 (10.00)	302	1.334 (4.375)	4416 (14487)
	4.57 (15.00)	303	1.334 (4.375)	4401 (14439)
	6.02 (19.75)	304	1.334 (4.375)	4387 (14391)
N6	0.08 (0.25)	457	1.334 (4.375)	2918 (9573)*
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
***************************************	3.05 (10.00)	296	1.334 (4.375)	4505 (14780)
	4.57 (15.00)	319	1.334 (4.375)	4180 (13715)
***************************************	5.94 (19.50)	299	1.334 (4.375)	4460 (14632)
N7	0.08 (0.25)	650	1.334 (4.375)	2052 (6731)*
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
•••••••••••••••••••••••••••••••••••••••	3.05 (10.00)	293	1.334 (4.375)	4551 (14932)
	4.57 (15.00)	294	1.334 (4.375)	4536 (14881)
	6.02 (19.75)	296	1.334 (4.375)	4505 (14780)

Table	A-1				
Pulse	Velocity	Measurements	from	North	Seawall

	Location	Time of	AND THE RESERVE	
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N8	0.08 (0.25)	313	1.334 (4.375)	4260 (13978)
	1.52 (5.00)	314	1.334 (4.375)	4247 (13933)
	3.05 (10.00)	292	1.334 (4.375)	4567 (14983)
	4.57 (15.00)	291	1.334 (4.375)	4582 (15034)
	6.10 (20.00)	500	1.334 (4.375)	2667 (8750)*
N9	0.08 (0.25)	600	1.334 (4.375)	2223 (7292)*
	1.52 (5.00)	296	1.334 (4.375)	4505 (14780)
	3.05 (10.00)	302	1.334 (4.375)	4416 (14487)
	4.57 (15.00)	302	1.334 (4.375)	4416 (14487)
	6.10 (20.00)	462	1.334 (4.375)	2886 (9470)*
N10	0.08 (0.25)	delam.	1.334 (4.375)	ERR*
	1.52 (5.00)	300	1.334 (4.375)	4445 (14583)
**************	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	296	1.334 (4.375)	4505 (14780)
	6.10 (20.00)	delam.	1.334 (4.375)	ERR*
N11	0.08 (0.25)	delam.	1.334 (4.375)	ERR*
	1.52 (5.00)	290	1.334 (4.375)	4598 (15086)
	3.05 (10.00)	289	1.334 (4.375)	4614 (15138)
	4.57 (15.00)	287	1.334 (4.375)	4646 (15244)
	5.94 (19.50)	delam.	1.334 (4.375)	ERR*
N12	0.08 (0.25)	500	1.334 (4.375)	2667 (8750)*
***************************************	1.52 (5.00)	293	1.334 (4.375)	4551 (14932)
***************************************	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
***************************************	4.57 (15.00)	292	1.334 (4.375)	4567 (14983)
***************************************	6.10 (20.00)	293	1.334 (4.375)	4551 (14932)
N13	0.08 (0.25)	322	1.334 (4.375)	4141 (13587)
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
••••••••	3.05 (10.00)	299	1.334 (4.375)	4460 (14632)
•••••••	4.57 (15.00)	298	1.334 (4.375)	4475 (14681)
	5.94 (19.50)	297	1.334 (4.375)	4490 (14731)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N14	0.08 (0.25)	472	1.334 (4.375)	2825 (9269)*
	1.52 (5.00)	290	1.334 (4.375)	4598 (15086)
	3.05 (10.00)	290	1.334 (4.375)	4598 (15086)
	4.57 (15.00)	311	1.334 (4.375)	4288 (14068)
***************************************	6.10 (20.00)	560	1.334 (4.375)	2381 (7813)*
N15	0.08 (0.25)	331	1.334 (4.375)	4029 (13218)
***************************************	1.52 (5.00)	305	1.334 (4.375)	4372 (14344)
	3.05 (10.00)	301	1.334 (4.375)	4430 (14535)
	4.57 (15.00)	307	1.334 (4.375)	4344 (14251)
	6.02 (19.75)	302	1.334 (4.375)	4416 (14487)
N16	0.08 (0.25)	309	1.334 (4.375)	4316 (14159)
	1.52 (5.00)	313	1.334 (4.375)	4260 (13978)
	3.05 (10.00)	309	1.334 (4.375)	4316 (14159)
	4.57 (15.00)	334	1.334 (4.375)	3993 (13099)
	6.02 (19.75)	310	1.334 (4.375)	4302 (14113)
N17	0.08 (0.25)	300	1.334 (4.375)	4445 (14583)
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	297	1.334 (4.375)	4490 (14731)
	6.10 (20.00)	290	1.334 (4.375)	4598 (15086)
N18	0.08 (0.25)	670	1.334 (4.375)	1990 (6530)*
	1.52 (5.00)	275	1.334 (4.375)	4849 (15909)
	3.05 (10.00)	290	1.334 (4.375)	4598 (15086)
	4.57 (15.00)	288	1.334 (4.375)	4630 (15191)
	6.10 (20.00)	287	1.334 (4.375)	4646 (15244)
	7.62 (25.00)	285	1.334 (4.375)	4679 (15351)
	9.45 (31.00)	292	1.334 (4.375)	4567 (14983)
	10.67 (35.00)	300	1.334 (4.375)	4445 (14583)
	12.19 (40.00)	300	1.334 (4.375)	4445 (14583)
	14.63 (48.00)	296	1.334 (4.375)	4505 (14780)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N19	0.08 (0.25)	293	1.334 (4.375)	4551 (14932)
	1.52 (5.00)	292	1.334 (4.375)	4567 (14983)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	293	1.334 (4.375)	4551 (14932)
	6.10 (20.00)	296	1.334 (4.375)	4505 (14780)
	7.62 (25.00)	301	1.334 (4.375)	4430 (14535)
	9.14 (30.00)	296	1.334 (4.375)	4505 (14780)
	10.67 (35.00)	301	1.334 (4.375)	4430 (14535)
	12.19 (40.00)	315	1.334 (4.375)	4233 (13889)
	13.72 (45.00)	292	1.334 (4.375)	4567 (14983)
	14.63 (48.00)	405	1.334 (4.375)	3293 (10802)*
N20	0.08 (0.25)	450	1.334 (4.375)	2963 (9722)*
	1.52 (5.00)	287	1.334 (4.375)	4646 (15244)
	3.05 (10.00)	293	1.334 (4.375)	4551 (14932)
	4.57 (15.00)	296	1.334 (4.375)	4505 (14780)
	6.10 (20.00)	294	1.334 (4.375)	4536 (14881)
	7.62 (25.00)	304	1.334 (4.375)	4387 (14391)
	9.14 (30.00)	293	1.334 (4.375)	4551 (14932)
	10.67 (35.00)	297	1.334 (4.375)	4490 (14731)
	12.19 (40.00)	295	1.334 (4.375)	4520 (14831)
	13.72 (45.00)	298	1.334 (4.375)	4475 (14681)
	14.63 (48.00)	301	1.334 (4.375)	4430 (14535)
N21	0.08 (0.25)	587	1.334 (4.375)	2272 (7453)*
	1.52 (5.00)	297	1.334 (4.375)	4490 (14731)
	3.05 (10.00)	300	1.334 (4.375)	4445 (14583)
	4.57 (15.00)	307	1.334 (4.375)	4344 (14251)
	6.10 (20.00)	304	1.334 (4.375)	4387 (14391)
	7.62 (25.00)	292	1.334 (4.375)	4567 (14983)
	9.14 (30.00)	292	1.334 (4.375)	4567 (14983)
	10.67 (35.00)	301	1.334 (4.375)	4430 (14535)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of	42.23 35 35 35	
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N21	12.19 (40.00)	291	1.334 (4.375)	4582 (15034)
	13.72 (45.00)	295	1.334 (4.375)	4520 (14831)
***************************************	14.55 (47.75)	288	1.334 (4.375)	4630 (15191)
N22	0.08 (0.25)	delam.	1.334 (4.375)	ERR*
••••••	1.52 (5.00)	600	1.334 (4.375)	2223 (7292)*
	3.05 (10.00)	290	1.334 (4.375)	4598 (15086)
	4.57 (15.00)	287	1.334 (4.375)	4646 (15244)
	6.10 (20.00)	290	1.334 (4.375)	4598 (15086)
	7.62 (25.00)	291	1.334 (4.375)	4582 (15034)
	9.14 (30.00)	291	1.334 (4.375)	4582 (15034)
*******************************	10.67 (35.00)	315	1.334 (4.375)	4233 (13889)
	12.19 (40.00)	325	1.334 (4.375)	4103 (13462)
	13.72 (45.00)	291	1.334 (4.375)	4582 (15034)
	14.63 (48.00)	286	1.334 (4.375)	4663 (15297)
N23	0.08 (0.25)	293	1.334 (4.375)	4551 (14932)
	1.52 (5.00)	300	1.334 (4.375)	4445 (14583)
***************************************	3.05 (10.00)	302	1.334 (4.375)	4416 (14487)
	4.57 (15.00)	294	1.334 (4.375)	4536 (14881)
	6.10 (20.00)	297	1.334 (4.375)	4490 (14731)
	7.62 (25.00)	298	1.334 (4.375)	4475 (14681)
	9.14 (30.00)	295	1.334 (4.375)	4520 (14831)
	10.67 (35.00)	287	1.334 (4.375)	4646 (15244)
	12.19 (40.00)	290	1.334 (4.375)	4598 (15086)
***************************************	13.72 (45.00)	295	1.334 (4.375)	4520 (14831)
	14.55 (47.75)	390	1.334 (4.375)	3419 (11218)*
N24	0.08 (0.25)	293	1.334 (4.375)	4551 (14932)
	1.52 (5.00)	299	1.334 (4.375)	4460 (14632)
***************************************	3.05 (10.00)	302	1.334 (4.375)	4416 (14487)
***************************************	4.57 (15.00)	349	1.334 (4.375)	3821 (12536)
***************************************	6.10 (20.00)	306	1.334 (4.375)	4358 (14297)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location Distance from East	Time of	Path Length	Pulse Velocity
Monolith	End of Monolith m (ft)	Arrival microseconds	m (ft)	m/s (ft/s)
N24	7.62 (25.00)	504	1.334 (4.375)	2646 (8681)*
	9.14 (30.00)	304	1.334 (4.375)	4387 (14391)
	10.67 (35.00)	315	1.334 (4.375)	4233 (13889)
	12.19 (40.00)	300	1.334 (4.375)	4445 (14583)
	13.72 (45.00)	298	1.334 (4.375)	4475 (14681)
	14.63 (48.00)	287	1.334 (4.375)	4646 (15244)
N25	0.08 (0.25)	279	1.334 (4.375)	4780 (15681)
	1.52 (5.00)	287	1.334 (4.375)	4646 (15244)
***************************************	3.05 (10.00)	305	1.334 (4.375)	4372 (14344)
	4.57 (15.00)	297	1.334 (4.375)	4490 (14731)
	6.10 (20.00)	298	1.334 (4.375)	4475 (14681)
	7.62 (25.00)	296	1.334 (4.375) 1.334 (4.375)	4505 (14780) 4372 (14344)
	9.14 (30.00)	305		
***************************************	10.67 (35.00)	291	1.334 (4.375)	4582 (15034)
	12.19 (40.00)	295	1.334 (4.375)	4520 (14831)
	13.72 (45.00)	306	1.334 (4.375)	4358 (14297)
	14.94 (49.00)	296	1.334 (4.375)	4505 (14780)
N26	0.08 (0.25)	310	1.334 (4.375)	4302 (14113)
	1.52 (5.00)	301	1.334 (4.375)	4430 (14535)
	3.05 (10.00)	301	1.334 (4.375)	4430 (14535)
	4.57 (15.00)	303	1.334 (4.375)	4401 (14439)
	6.10 (20.00)	304	1.334 (4.375)	4387 (14391)
	7.62 (25.00)	303	1.334 (4.375)	4401 (14439)
	9.14 (30.00)	305	1.334 (4.375)	4372 (14344)
	10.67 (35.00)	309	1.334 (4.375)	4316 (14159)
*************************	12.19 (40.00)	307	1.334 (4.375)	4344 (14251)
	13.72 (45.00)	305	1.334 (4.375)	4372 (14344)
	14.63 (48.00)	305	1.334 (4.375)	4372 (14344)
N27	0.08 (0.25)	400	1.334 (4.375)	3334 (10938)*
	1.52 (5.00)	302	1.334 (4.375)	4416 (14487)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N27	3.05 (10.00)	300	1.334 (4.375)	4445 (14583)
	4.57 (15.00)	320	1.334 (4.375)	4167 (13672)
	6.10 (20.00)	306	1.334 (4.375)	4358 (14297)
	7.62 (25.00)	305	1.334 (4.375)	4372 (14344)
	9.14 (30.00)	307	1.334 (4.375)	4344 (14251)
***************************************	10.67 (35.00)	304	1.334 (4.375)	4387 (14391)
	12.19 (40.00)	298	1.334 (4.375)	4475 (14681)
	13.72 (45.00)	296	1.334 (4.375)	4505 (14780)
	14.63 (48.00)	294	1.334 (4.375)	4536 (14881)
N28	0.08 (0.25)	302	1.334 (4.375)	4416 (14487)
***************************************	1.52 (5.00)	308	1.334 (4.375)	4330 (14205)
	3.05 (10.00)	310	1.334 (4.375)	4302 (14113)
	4.57 (15.00)	307	1.334 (4.375)	4344 (14251)
	6.10 (20.00)	308	1.334 (4.375)	4330 (14205)
***************************************	7.62 (25.00)	293	1.334 (4.375)	4551 (14932)
	9.14 (30.00)	301	1.334 (4.375)	4430 (14535)
	10.67 (35.00)	301	1.334 (4.375)	4430 (14535)
	12.19 (40.00)	303	1.334 (4.375)	4401 (14439)
	13.72 (45.00)	301	1.334 (4.375)	4430 (14535)
	14.63 (48.00)	297	1.334 (4.375)	4490 (14731)
N29	0.08 (0.25)	600	1.334 (4.375)	2223 (7292)*
	1.52 (5.00)	293	1.334 (4.375)	4551 (14932)
	3.05 (10.00)	296	1.334 (4.375)	4505 (14780)
	4.57 (15.00)	301	1.334 (4.375)	4430 (14535)
	6.10 (20.00)	306	1.334 (4.375)	4358 (14297)
	7.62 (25.00)	305	1.334 (4.375)	4372 (14344)
	9.14 (30.00)	303	1.334 (4.375)	4401 (14439)
	10.67 (35.00)	334	1.334 (4.375)	3993 (13099)
	12.19 (40.00)	339	1.334 (4.375)	3934 (12906)
	13.72 (45.00)	334	1.334 (4.375)	3993 (13099)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of	with the latest and	
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N29	14.63 (48.00)	291	1.334 (4.375)	4582 (15034)
N30	0.08 (0.25)	292	1.334 (4.375)	4567 (14983)
	1.52 (5.00)	303	1.334 (4.375)	4401 (14439)
	3.05 (10.00)	303	1.334 (4.375)	4401 (14439)
	4.57 (15.00)	303	1.334 (4.375)	4401 (14439)
	6.10 (20.00)	289	1.334 (4.375)	4614 (15138)
	7.62 (25.00)	292	1.334 (4.375)	4567 (14983)
	9.14 (30.00)	304	1.334 (4.375)	4387 (14391)
	10.67 (35.00)	298	1.334 (4.375)	4475 (14681)
	12.19 (40.00)	302	1.334 (4.375)	4416 (14487)
	13.72 (45.00)	299	1.334 (4.375)	4460 (14632)
	14.63 (48.00)	295	1.334 (4.375)	4520 (14831)
N31	0.08 (0.25)	410	1.334 (4.375)	3252 (10671)*
	1.52 (5.00)	291	1.334 (4.375)	4582 (15034)
	3.05 (10.00)	299	1.334 (4.375)	4460 (14632)
	4.57 (15.00)	297	1.334 (4.375)	4490 (14731)
	6.10 (20.00)	289	1.334 (4.375)	4614 (15138)
	7.62 (25.00)	292	1.334 (4.375)	4567 (14983)
	9.14 (30.00)	350	1.334 (4.375)	3810 (12500)
	10.67 (35.00)	293	1.334 (4.375)	4551 (14932)
	12.19 (40.00)	297	1.334 (4.375)	4490 (14731)
	13.72 (45.00)	295	1.334 (4.375)	4520 (14831)
	14.63 (48.00)	700	1.334 (4.375)	1905 (6250)*
N32	0.08 (0.25)	295	1.334 (4.375)	4520 (14831)
	1.52 (5.00)	299	1.334 (4.375)	4460 (14632)
****************	3.05 (10.00)	296	1.334 (4.375)	4505 (14780)
	4.57 (15.00)	299	1.334 (4.375)	4460 (14632)
***************************************	6.10 (20.00)	300	1.334 (4.375)	4445 (14583)
	7.62 (25.00)	303	1.334 (4.375)	4401 (14439)
	9.14 (30.00)	305	1.334 (4.375)	4372 (14344)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N32	10.67 (35.00)	330	1.334 (4.375)	4041 (13258)
	12.19 (40.00)	307	1.334 (4.375)	4344 (14251)
	13.72 (45.00)	302	1.334 (4.375)	4416 (14487)
***************************************	14.63 (48.00)	306	1.334 (4.375)	4358 (14297)
N33	0.08 (0.25)	287	1.334 (4.375)	4646 (15244)
	1.52 (5.00)	290	1.334 (4.375)	4598 (15086)
	3.05 (10.00)	290	1.334 (4.375)	4598 (15086)
	4.57 (15.00)	333	1.334 (4.375)	4005 (13138)
***************************************	6.10 (20.00)	583	1.334 (4.375)	2287 (7504)*
	7.62 (25.00)	293	1.334 (4.375)	4551 (14932)
	9.14 (30.00)	303	1.334 (4.375)	4401 (14439)
	10.67 (35.00)	297	1.334 (4.375)	4490 (14731)
	12.19 (40.00)	290	1.334 (4.375)	4598 (15086)
	13.72 (45.00)	293	1.334 (4.375)	4551 (14932)
	14.63 (48.00)	310	1.334 (4.375)	4302 (14113)
N34	0.08 (0.25)	296	1.334 (4.375)	4505 (14780)
***************************************	1.52 (5.00)	298	1.334 (4.375)	4475 (14681)
***************************************	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	291	1.334 (4.375)	4582 (15034)
	6.10 (20.00)	288	1.334 (4.375)	4630 (15191)
	7.62 (25.00)	299	1.334 (4.375)	4460 (14632)
***************************************	9.14 (30.00)	293	1.334 (4.375)	4551 (14932)
	10.67 (35.00)	297	1.334 (4.375)	4490 (14731)
	12.19 (40.00)	298	1.334 (4.375)	4475 (14681)
	13.72 (45.00)	293	1.334 (4.375)	4551 (14932)
***************************************	14.86 (48.75)	292	1.334 (4.375)	4567 (14983)
N35	0.08 (0.25)	292	1.334 (4.375)	4567 (14983)
	1.52 (5.00)	288	1.334 (4.375)	4630 (15191)
	3.05 (10.00)	285	1.334 (4.375)	4679 (15351)
***************************************	4.57 (15.00)	288	1.334 (4.375)	4630 (15191)

Table	A-1				MA RITE
Pulse	Velocity	Measurements	from	North	Seawall

	Location	Time of		
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N35	6.10 (20.00)	295	1.334 (4.375)	4520 (14831)
	7.62 (25.00)	297	1.334 (4.375)	4490 (14731)
	9.14 (30.00)	300	1.334 (4.375)	4445 (14583)
	10.67 (35.00)	295	1.334 (4.375)	4520 (14831)
	12.19 (40.00)	289	1.334 (4.375)	4614 (15138)
	13.72 (45.00)	290	1.334 (4.375)	4598 (15086)
	14.63 (48.00)	296	1.334 (4.375)	4505 (14780)
N36	0.08 (0.25)	293	1.334 (4.375)	4551 (14932)
	1.52 (5.00)	291	1.334 (4.375)	4582 (15034)
	3.05 (10.00)	291	1.334 (4.375)	4582 (15034)
	4.57 (15.00)	286	1.334 (4.375)	4663 (15297)
	6.10 (20.00)	285	1.334 (4.375)	4679 (15351)
	7.62 (25.00)	282	1.334 (4.375)	4729 (15514)
	9.14 (30.00)	287	1.334 (4.375)	4646 (15244)
	10.67 (35.00)	292	1.334 (4.375)	4567 (14983)
	12.19 (40.00)	293	1.334 (4.375)	4551 (14932)
	13.72 (45.00)	297	1.334 (4.375)	4490 (14731)
	14.78 (48.50)	289	1.334 (4.375)	4614 (15138)
N37	0.08 (0.25)	305	1.334 (4.375)	4372 (14344)
	1.52 (5.00)	302	1.334 (4.375)	4416 (14487)
	3.05 (10.00)	308	1.334 (4.375)	4330 (14205)
	4.57 (15.00)	302	1.334 (4.375)	4416 (14487)
	6.10 (20.00)	302	1.334 (4.375)	4416 (14487)
	7.62 (25.00)	301	1.334 (4.375)	4430 (14535)
	9.14 (30.00)	310	1.334 (4.375)	4302 (14113)
	10.67 (35.00)	310	1.334 (4.375)	4302 (14113)
	12.19 (40.00)	303	1.334 (4.375)	4401 (14439)
	13.72 (45.00)	304	1.334 (4.375)	4387 (14391)
************************	14.63 (48.00)	296	1.334 (4.375)	4505 (14780)
N38	0.08 (0.25)	525	1.334 (4.375)	2540 (8333)*

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		Bulan Valaniau
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N38	1.52 (5.00)	291	1.334 (4.375)	4582 (15034)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	298	1.334 (4.375)	4475 (14681)
	6.10 (20.00)	293	1.334 (4.375)	4551 (14932)
	7.62 (25.00)	296	1.334 (4.375)	4505 (14780)
***************************************	9.14 (30.00)	295	1.334 (4.375)	4520 (14831)
	10.67 (35.00)	301	1.334 (4.375)	4430 (14535)
	12.19 (40.00)	301	1.334 (4.375)	4430 (14535)
	13.72 (45.00)	296	1.334 (4.375)	4505 (14780)
	14.63 (48.00)	302	1.334 (4.375)	4416 (14487)
N39	0.08 (0.25)	307	1.334 (4.375)	4344 (14251)
	1.52 (5.00)	301	1.334 (4.375)	4430 (14535)
	3.05 (10.00)	307	1.334 (4.375)	4344 (14251)
	4.57 (15.00)	301	1.334 (4.375)	4430 (14535)
	6.10 (20.00)	292	1.334 (4.375)	4567 (14983)
	7.62 (25.00)	294	1.334 (4.375)	4536 (14881)
	9.14 (30.00)	297	1.334 (4.375)	4490 (14731)
	10.67 (35.00)	288	1.334 (4.375)	4630 (15191)
	12.19 (40.00)	289	1.334 (4.375)	4614 (15138)
	13.72 (45.00)	289	1.334 (4.375)	4614 (15138)
	14.63 (48.00)	297	1.334 (4.375)	4490 (14731)
N40	0.08 (0.25)	290	1.334 (4.375)	4598 (15086)
	1.52 (5.00)	300	1.334 (4.375)	4445 (14583)
	3.05 (10.00)	298	1.334 (4.375)	4475 (14681)
	4.57 (15.00)	300	1.334 (4.375)	4445 (14583)
	6.10 (20.00)	300	1.334 (4.375)	4445 (14583)
	7.62 (25.00)	297	1.334 (4.375)	4490 (14731)
	9.14 (30.00)	294	1.334 (4.375)	4536 (14881)
	10.67 (35.00)	300	1.334 (4.375)	4445 (14583)
	12.19 (40.00)	308	1.334 (4.375)	4330 (14205)

Table A-1
Pulse Velocity Measurements from North Seawall

Monolith	Distance from East End of Monolith	Time of Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
	m (ft)			
N40	13.72 (45.00)	307	1.334 (4.375)	4344 (14251)
	14.78 (48.50)	297	1.334 (4.375)	4490 (14731)
N41	0.08 (0.25)	287	1.334 (4.375)	4646 (15244)
	1.52 (5.00)	292	1.334 (4.375)	4567 (14983)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	292	1.334 (4.375)	4567 (14983)
	6.10 (20.00)	297	1.334 (4.375)	4490 (14731)
	7.62 (25.00)	300	1.334 (4.375)	4445 (14583)
	9.14 (30.00)	364	1.334 (4.375)	3663 (12019)
	10.67 (35.00)	299	1.334 (4.375)	4460 (14632)
	12.19 (40.00)	297	1.334 (4.375)	4490 (14731)
***************************************	13.72 (45.00)	297	1.334 (4.375)	4490 (14731)
***************	15.09 (49.50)	292	1.334 (4.375)	4567 (14983)
N42	0.08 (0.25)	284	1.334 (4.375)	4695 (15405)
	1.52 (5.00)	287	1.334 (4.375)	4646 (15244)
	3.05 (10.00)	292	1.334 (4.375)	4567 (14983)
	4.57 (15.00)	299	1.334 (4.375)	4460 (14632)
N43	0.08 (0.25)	297	1.334 (4.375)	4490 (14731)
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
	3.05 (10.00)	291	1.334 (4.375)	4582 (15034)
***************************************	4.57 (15.00)	296	1.334 (4.375)	4505 (14780)
N44	0.08 (0.25)	306	1.334 (4.375)	4358 (14297)
	1.52 (5.00)	294	1.334 (4.375)	4536 (14881)
*************************	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	320	1.334 (4.375)	4167 (13672)
	6.10 (20.00)	300	1.334 (4.375)	4445 (14583)
	7.16 (23.50)	303	1.334 (4.375)	4401 (14439)
N45	0.08 (0.25)	293	1.334 (4.375)	4551 (14932)
	1.52 (5.00)	293	1.334 (4.375)	4551 (14932)
	3.05 (10.00)	296	1.334 (4.375)	4505 (14780)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of		5.1. 1/.1
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N45	5.18 (17.00)	293	1.334 (4.375)	4551 (14932)
	5.79 (19.00)	297	1.334 (4.375)	4490 (14731)
N46	0.08 (0.25)	299	1.334 (4.375)	4460 (14632)
	1.52 (5.00)	295	1.334 (4.375)	4520 (14831)
4-14	3.05 (10.00)	294	1.334 (4.375)	4536 (14881)
	4.57 (15.00)	295	1.334 (4.375)	4520 (14831)
	5.79 (19.00)	310	1.334 (4.375)	4302 (14113)
N47	0.08 (0.25)	296	1.334 (4.375)	4505 (14780)
	1.52 (5.00)	296	1.334 (4.375)	4505 (14780)
	3.05 (10.00)	297	1.334 (4.375)	4490 (14731)
	4.57 (15.00)	304	1.334 (4.375)	4387 (14391)
	5.79 (19.00)	304	1.334 (4.375)	4387 (14391)
N48	0.08 (0.25)	317	1.334 (4.375)	4207 (13801)
	1.52 (5.00)	309	1.334 (4.375)	4316 (14159)
	3.05 (10.00)	309	1.334 (4.375)	4316 (14159)
	4.57 (15.00)	315	1.334 (4.375)	4233 (13889)
	6.10 (20.00)	313	1.334 (4.375)	4260 (13978)
N49	0.08 (0.25)	292	1.334 (4.375)	4567 (14983)
	1.52 (5.00)	294	1.334 (4.375)	4536 (14881)
	3.05 (10.00)	295	1.334 (4.375)	4520 (14831)
	4.57 (15.00)	291	1.334 (4.375)	4582 (15034)
	5.64 (18.50)	294	1.334 (4.375)	4536 (14881)
N50	0.08 (0.25)	302	1.334 (4.375)	4416 (14487)
	1.52 (5.00)	300	1.334 (4.375)	4445 (14583)
	3.05 (10.00)	301	1.334 (4.375)	4430 (14535)
	4.57 (15.00)	295	1.334 (4.375)	4520 (14831)
	5.64 (18.50)	302	1.334 (4.375)	4416 (14487)
N51	0.08 (0.25)	296	1.334 (4.375)	4505 (14780)
	1.52 (5.00)	299	1.334 (4.375)	4460 (14632)
•••••••••••••••••••••••••••••••••••••••	3.05 (10.00)	296	1.334 (4.375)	4505 (14780)

Table A-1
Pulse Velocity Measurements from North Seawall

Monolith	Distance from East End of Monolith m (ft)	Time of Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N51	4.57 (15.00)	295	1.334 (4.375)	4520 (14831)
***************************************	5.72 (18.75)	295	1.334 (4.375)	4520 (14831)
N52	0.08 (0.25)	307	1.334 (4.375)	4344 (14251)
	1.52 (5.00)	303	1.334 (4.375)	4401 (14439)
	3.05 (10.00)	301	1.334 (4.375)	4430 (14535)
	4.57 (15.00)	300	1.334 (4.375)	4445 (14583)
	5.79 (19.00)	297	1.334 (4.375)	4490 (14731)
N53	0.08 (0.25)	297	1.334 (4.375)	4490 (14731)
	1.52 (5.00)	293	1.334 (4.375)	4551 (14932)
	3.05 (10.00)	310	1.334 (4.375)	4302 (14113)
	4.57 (15.00)	295	1.334 (4.375)	4520 (14831)
	5.79 (19.00)	293	1.334 (4.375)	4551 (14932)
N54	0.08 (0.25)	306	1.334 (4.375)	4358 (14297)
	1.52 (5.00)	307	1.334 (4.375)	4344 (14251)
	3.05 (10.00)	308	1.334 (4.375)	4330 (14205)
	4.57 (15.00)	305	1.334 (4.375)	4372 (14344)
	5.64 (18.50)	296	1.334 (4.375)	4505 (14780)
N55	0.08 (0.25)	296	1.334 (4.375)	4505 (14780)
	1.52 (5.00)	296	1.334 (4.375)	4505 (14780)
	3.05 (10.00)	301	1.334 (4.375)	4430 (14535)
	4.57 (15.00)	294	1.334 (4.375)	4536 (14881)
******************	5.18 (17.00)	294	1.334 (4.375)	4536 (14881)
N56	0.08 (0.25)	307	1.334 (4.375)	4344 (14251)
•••••••••••••••••••••••••••••••••••••••	1.52 (5.00)	300	1.334 (4.375)	4445 (14583)
	3.05 (10.00)	306	1.334 (4.375)	4358 (14297)
	4.57 (15.00)	307	1.334 (4.375)	4344 (14251)
•••••••••••••••••••••••••••••••••••••••	4.88 (16.00)	304	1.334 (4.375)	4387 (14391)
N57	0.08 (0.25)	315	1.334 (4.375)	4233 (13889)
	1.52 (5.00)	294	1.334 (4.375)	4536 (14881)
	3.05 (10.00)	294	1.334 (4.375)	4536 (14881)

Table A-1
Pulse Velocity Measurements from North Seawall

	Location	Time of	565	5.1.11.1.
Monolith	Distance from East End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
N57	4.57 (15.00)	302	1.334 (4.375)	4416 (14487)
	6.10 (20.00)	300	1.334 (4.375)	4445 (14583)
	6.40 (21.00)	299	1.334 (4.375)	4460 (14632)
N58	0.08 (0.25)	305	1.334 (4.375)	4372 (14344)
	1.52 (5.00)	290	1.334 (4.375)	4598 (15086)
	3.05 (10.00)	352	1.334 (4.375)	3788 (12429)
***************************************	4.57 (15.00)	295	1.334 (4.375)	4520 (14831)
	6.10 (20.00)	292	1.334 (4.375)	4567 (14983)
	6.55 (21.50)	299	1.334 (4.375)	4460 (14632)
N59	0.08 (0.25)	315	1.334 (4.375)	4233 (13889)
	1.52 (5.00)	288	1.334 (4.375)	4630 (15191)
	3.05 (10.00)	288	1.334 (4.375)	4630 (15191)
	4.57 (15.00)	298	1.334 (4.375)	4475 (14681)
	6.10 (20.00)	660	1.334 (4.375)	2020 (6629)*
N60	0.08 (0.25)	spalled	1.334 (4.375)	ERR*
***************************************	1.52 (5.00)	spalled	1.334 (4.375)	ERR*
	3.05 (10.00)	299	1.334 (4.375)	4460 (14632)
	4.57 (15.00)	302	1.334 (4.375)	4416 (14487)
	6.10 (20.00)	292	1.334 (4.375)	4567 (14983)
	7.62 (25.00)	291	1.334 (4.375)	4582 (15034)

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S1	0.08 (0.25)	142	0.622 (2.040)	4382 (14378)
	1.52 (5.00)	143	0.622 (2.040)	4352 (14278)
	3.05 (10.00)	144	0.622 (2.040)	4322 (14178)
	4.57 (15.00)	142	0.622 (2.040)	4382 (14378)
	6.02 (19.75)	326	0.622 (2.040)	1909 (6263)*1
S2	0.08 (0.25)	167	0.622 (2.040)	3726 (12226)
	1.52 (5.00)	168	0.622 (2.040)	3704 (12153)
	3.05 (10.00)	162	0.622 (2.040)	3841 (12603)
	4.57 (15.00)	158	0.622 (2.040)	3939 (12922)
	6.10 (20.00)	163	0.622 (2.040)	3818 (12526)
S3	0.08 (0.25)	156	0.622 (2.040)	3989 (13088)
	1.52 (5.00)	145	0.622 (2.040)	4292 (14081)
	3.05 (10.00)	140	0.622 (2.040)	4445 (14584)
••••••••	4.57 (15.00)	150	0.622 (2.040)	4149 (13611)
	6.10 (20.00)	162	0.622 (2.040)	3841 (12603)
S4	0.08 (0.25)	150	0.622 (2.040)	4149 (13611)
	1.52 (5.00)	149	0.622 (2.040)	4177 (13703)
	3.05 (10.00)	150	0.622 (2.040)	4149 (13611)
	4.57 (15.00)	147	0.622 (2.040)	4233 (13889)
	6.32 (20.75)	150	0.622 (2.040)	4149 (13611)
S5	0.08 (0.25)	152	0.622 (2.040)	4094 (13432)
	1.52 (5.00)	147	0.622 (2.040)	4233 (13889)
	3.05 (10.00)	148	0.622 (2.040)	4205 (13795)
	4.57 (15.00)	149	0.622 (2.040)	4177 (13703)
	5.79 (19.00)	140	0.622 (2.040)	4445 (14584)
S6	0.08 (0.25)	140	0.622 (2.040)	4445 (14584)
	1.52 (5.00)	146	0.622 (2.040)	4262 (13984)
	3.05 (10.00)	146	0.622 (2.040)	4262 (13984)
	4.57 (15.00)	147	0.622 (2.040)	4233 (13889)
	6.10 (20.00)	148	0.622 (2.040)	4205 (13795)

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		n
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S6	6.32 (20.75)	144	0.622 (2.040)	4322 (14178)
S7	0.08 (0.25)	188	0.622 (2.040)	3310 (10860)*1
	1.52 (5.00)	189	0.622 (2.040)	3293 (10803)*1
	3.05 (10.00)	151	0.622 (2.040)	4121 (13521) ³
	4.57 (15.00)	143	0.622 (2.040)	4352 (14278) ³
	6.10 (20.00)	163	0.622 (2.040)	3818 (12526) ³
S8	0.08 (0.25)	150	0.622 (2.040)	4149 (13611)
	1.52 (5.00)	145	0.622 (2.040)	4292 (14081)
	3.05 (10.00)	144	0.622 (2.040)	4322 (14178)
	4.57 (15.00)	149	0.622 (2.040)	4177 (13703)
	6.10 (20.00)	148	0.622 (2.040)	4205 (13795)
	6.63 (21.75)	148	0.622 (2.040)	4205 (13795)
S9	0.08 (0.25)	145	0.622 (2.040)	4292 (14081)
***************************************	1.52 (5.00)	144	0.622 (2.040)	4322 (14178)
	3.05 (10.00)	142	0.622 (2.040)	4382 (14378)
	4.57 (15.00)	141	0.622 (2.040)	4414 (14480)
	6.10 (20.00)	141	0.622 (2.040)	4414 (14480)
	6.40 (21.00)	138	0.622 (2.040)	4509 (14795)
S10	0.08 (0.25)	139	0.622 (2.040)	4477 (14688)
	1.52 (5.00)	141	0.622 (2.040)	4414 (14480)
***************************************	3.05 (10.00)	152	0.622 (2.040)	4094 (13432)
***************************************	3.96 (13.00)	144	0.622 (2.040)	4322 (14178)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	180	0.800 (2.625)	4445 (14583)
S11	0.08 (0.25)	178	0.800 (2.625)	4495 (14747)
	1.52 (5.00)	168	0.800 (2.625)	4763 (15625)
	3.05 (10.00)	174	0.800 (2.625)	4598 (15086)
	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
	6.40 (21.00)	206	0.800 (2.625)	3884 (12743)
ow Measure	ment 1c	palled	² Edge Delamination	n ³Cr

Table A-2			-	
Pulse Velocity	Measurements	from	South	Seawall

	Location	Time of	Poth Langth	Dules Valester
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S12	0.08 (0.25)	185	0.800 (2.625)	4325 (14189)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	173	0.800 (2.625)	4625 (15173)
	4.57 (15.00)	169	0.800 (2.625)	4734 (15533)
	5.79 (19.00)	244	0.800 (2.625)	3279 (10758)
S13	0.08 (0.25)	178	0.800 (2.625)	4495 (14747)
	1.52 (5.00)	179	0.800 (2.625)	4470 (14665)
	3.05 (10.00)	187	0.800 (2.625)	4279 (14037)
	4.57 (15.00)	181	0.800 (2.625)	4420 (14503)
***************************************	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S14	0.08 (0.25)	176	0.800 (2.625)	4546 (14915)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
****************	3.05 (10.00)	174	0.800 (2.625)	4598 (15086)
******************	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
***************************************	5.72 (18.75)	172	0.800 (2.625)	4652 (15262)
S15	0.08 (0.25)	173	0.800 (2.625)	4625 (15173)
	1.52 (5.00)	166	0.800 (2.625)	4820 (15813)
••••••	3.05 (10.00)	165	0.800 (2.625)	4849 (15909)
••••••••••	4.57 (15.00)	168	0.800 (2.625)	4763 (15625)
••••••	5.72 (18.75)	167	0.800 (2.625)	4791 (15719)
S16	0.08 (0.25)	spall	0.800 (2.625)	ERR *2
	1.52 (5.00)	276	0.800 (2.625)	2899 (9511)* ¹
•••••••••••••••••••••••••••••••••••••••	3.05 (10.00)	357	0.800 (2.625)	2241 (7353)* ¹
	4.57 (15.00)	396	0.800 (2.625)	2020 (6629)*1
**********	6.10 (20.00)	397	0.800 (2.625)	2015 (6612)*1
	6.55 (21.50)	200	0.800 (2.625)	4001 (13125)
S17	0.08 (0.25)	180	0.800 (2.625)	4445 (14583)
	1.52 (5.00)	179	0.800 (2.625)	4470 (14665)
***************	3.05 (10.00)	182	0.800 (2.625)	4396 (14423) ¹
***********	4.57 (15.00)	spall	0.800 (2.625)	ERR *12

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S17	5.64 (18.50)	spall	0.800 (2.625)	ERR*2
S18	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	250	0.800 (2.625)	3200 (10500)* ³
	3.05 (10.00)	167	0.800 (2.625)	4791 (15719)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	550	0.800 (2.625)	1455 (4773)*1
	6.40 (21.00)	192	0.800 (2.625)	4167 (13672)1
S19	0.08 (0.25)	171	0.800 (2.625)	4679 (15351)
	1.52 (5.00)	171	0.800 (2.625)	4679 (15351)
	3.05 (10.00)	172	0.800 (2.625)	4652 (15262)
	4.57 (15.00)	175	0.800 (2.625)	4572 (15000)
	5.79 (19.00)	171	0.800 (2.625)	4679 (15351)
S20	0.08 (0.25)	spalled	0.800 (2.625)	ERR*
	1.52 (5.00)	spalled	0.800 (2.625)	ERR*
	3.05 (10.00)	spalled	0.800 (2.625)	ERR*
	4.57 (15.00)	spalled	0.800 (2.625)	ERR*
	6.10 (20.00)	spalled	0.800 (2.625)	ERR*
S21	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	178	0.800 (2.625)	4495 (14747)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
	4.57 (15.00)	179	0.800 (2.625)	4470 (14665)
	6.10 (20.00)	180	0.800 (2.625)	4445 (14583)
S22	0.08 (0.25)	181	0.800 (2.625)	4420 (14503)
***************************************	1.52 (5.00)	183	0.800 (2.625)	4372 (14344)
*************************	3.05 (10.00)	182	0.800 (2.625)	4396 (14423)
	4.57 (15.00)	184	0.800 (2.625)	4348 (14266)
	6.10 (20.00)	200	0.800 (2.625)	4001 (13125)
S23	0.08 (0.25)	190	0.800 (2.625)	4211 (13816)
	1.52 (5.00)	176	0.800 (2.625)	4546 (14915)
	3.05 (10.00)	179	0.800 (2.625)	4470 (14665)
ow Measure	ment 1c	palled	² Edge Delamination	on ³ Cr

Table A-2
Pulse Velocity Measurements from South Seawall

Car Co	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S23	4.57 (15.00)	180	0.800 (2.625)	4445 (14583)
	6.10 (20.00)	179	0.800 (2.625)	4470 (14665)
S24	0.08 (0.25)	181	0.800 (2.625)	4420 (14503)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
	4.57 (15.00)	177	0.800 (2.625)	4520 (14831)
1343	6.10 (20.00)	173	0.800 (2.625)	4625 (15173)
S25	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)
	1.52 (5.00)	175	0.800 (2.625)	4572 (15000)
	3.05 (10.00)	178	0.800 (2.625)	4495 (14747)
	4.88 (16.00)	181	0.800 (2.625)	4420 (14503)
	6.10 (20.00)	179	0.800 (2.625)	4470 (14665)
S26	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	176	0.800 (2.625)	4546 (14915)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
	0.08 (0.25)	178	0.800 (2.625)	4495 (14747)
	1.52 (5.00)	179	0.800 (2.625)	4470 (14665)
S27	3.05 (10.00)	174	0.800 (2.625)	4598 (15086)
	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)
	5.79 (19.00)	172	0.800 (2.625)	4652 (15262)
	0.08 (0.25)	170	0.800 (2.625)	4706 (15441)
	1.52 (5.00)	NR	0.800 (2.625)	ERR*1
S28	3.05 (10.00)	181	0.800 (2.625)	4420 (14503)
	4.57 (15.00)	182	0.800 (2.625)	4396 (14423)
	6.10 (20.00)	184	0.800 (2.625)	4348 (14266)
	0.08 (0.25)	182	0.800 (2.625)	4396 (14423)
	1.52 (5.00)	184	0.800 (2.625)	4348 (14266)
S29	0.08 (0.25)	185	0.800 (2.625)	4325 (14189)
	1.52 (5.00)	175	0.800 (2.625)	4572 (15000)
	3.05 (10.00)	240	0.800 (2.625)	3334 (10938)*

Table A-2
Pulse Velocity Measurements from South Seawall

Location		Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S29	4.57 (15.00)	179	0.800 (2.625)	4470 (14665)
	6.10 (20.00)	175	0.800 (2.625)	4572 (15000)
S30	0.08 (0.25)	305	0.800 (2.625)	2623 (8607)*3
***************************************	1.52 (5.00)	178	0.800 (2.625)	4495 (14747)
***************************************	3.05 (10.00)	172	0.800 (2.625)	4652 (15262)
	4.57 (15.00)	175	0.800 (2.625)	4572 (15000)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S31	0.08 (0.25)	173	0.800 (2.625)	4625 (15173)
	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)
	3.05 (10.00)	173	0.800 (2.625)	4625 (15173)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	470	0.800 (2.625)	1702 (5585)*1
S32	0.08 (0.25)	176	0.800 (2.625)	4546 (14915)
	1.52 (5.00)	170	0.800 (2.625)	4706 (15441)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
	6.10 (20.00)	184	0.800 (2.625)	4348 (14266)
S33	0.08 (0.25)	359	0.800 (2.625)	2229 (7312)*3
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	193	0.800 (2.625)	4146 (13601)
S34	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	169	0.800 (2.625)	4734 (15533)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
	4.57 (15.00)	174	0.800 (2.625)	4598 (15086)
	6.10 (20.00)	171	0.800 (2.625)	4679 (15351)
S35	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	166	0.800 (2.625)	4820 (15813)
	3.05 (10.00)	163	0.800 (2.625)	4909 (16104)

Table A-2
Pulse Velocity Measurements from South Seawall

F PERMIT	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S35	4.88 (16.00)	169	0.800 (2.625)	4734 (15533)
	6.10 (20.00)	179	0.800 (2.625)	4470 (14665)
S36	0.08 (0.25)	179	0.800 (2.625)	4470 (14665)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
	4.57 (15.00)	174	0.800 (2.625)	4598 (15086)
	6.10 (20.00)	175	0.800 (2.625)	4572 (15000)
S37	0.08 (0.25)	176	0.800 (2.625)	4546 (14915)
	1.52 (5.00)	169	0.800 (2.625)	4734 (15533)
	3.05 (10.00)	167	0.800 (2.625)	4791 (15719)
**************	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
	6.10 (20.00)	185	0.800 (2.625)	4325 (14189)
S38	0.08 (0.25)	179	0.800 (2.625)	4470 (14665)
	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)
	3.05 (10.00)	173	0.800 (2.625)	4625 (15173)
	4.57 (15.00)	176	0.800 (2.625)	4546 (14915)
	6.10 (20.00)	179	0.800 (2.625)	4470 (14665)
S39	0.08 (0.25)	181	0.800 (2.625)	4420 (14503)
	1.52 (5.00)	165	0.800 (2.625)	4849 (15909)
	3.05 (10.00)	163	0.800 (2.625)	4909 (16104)
**************	4.57 (15.00)	168	0.800 (2.625)	4763 (15625)
	5.94 (19.50)	186	0.800 (2.625)	4302 (14113)
S40	0.08 (0.25)	172	0.800 (2.625)	4652 (15262)
	1.52 (5.00)	174	0.800 (2.625)	4598 (15086)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
	4.57 (15.00)	178	0.800 (2.625)	4495 (14747)
	6.10 (20.00)	NR	0.800 (2.625)	ERR*1
S41	0.08 (0.25)	186	0.800 (2.625)	4302 (14113)1
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	166	0.800 (2.625)	4820 (15813)

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S41	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)
	6.10 (20.00)	183	0.800 (2.625)	4372 (14344)
S42	0.08 (0.25)	393	0.800 (2.625)	2036 (6679)*1
	1.52 (5.00)	165	0.800 (2.625)	4849 (15909)
	3.05 (10.00)	167	0.800 (2.625)	4791 (15719)
	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S43	0.08 (0.25)	186	0.800 (2.625)	4302 (14113)
	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
***************************************	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	177	0.800 (2.625)	4520 (14831)
S44	0.08 (0.25)	179	0.800 (2.625)	4470 (14665)
	1.52 (5.00)	177	0.800 (2.625)	4520 (14831)
***************************************	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
***************************************	4.57 (15.00)	178	0.800 (2.625)	4495 (14747)
	6.10 (20.00)	175	0.800 (2.625)	4572 (15000)
S45	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	176	0.800 (2.625)	4546 (14915)
***************************************	3.05 (10.00)	173	0.800 (2.625)	4625 (15173)
***************************************	4.88 (16.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S46	0.08 (0.25)	187	0.800 (2.625)	4279 (14037)
•••••••••••••••••••••••••••••••••••••••	1.52 (5.00)	171	0.800 (2.625)	4679 (15351)
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)
***************************************	4.57 (15.00)	175	0.800 (2.625)	4572 (15000)
**********************	6.10 (20.00)	186	0.800 (2.625)	4302 (14113)
S47	0.08 (0.25)	179	0.800 (2.625)	4470 (14665)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	175	0.800 (2.625)	4572 (15000)
Low Measure	ment 1c	palled	² Edge Delamination	³ Crac

Table A-2			Harrist Committee
Pulse Velocity	Measurements fr	om South	Seawall

Location		Time of		BY ASSESSED BY USE	
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)	
S47	4.57 (15.00)	174	0.800 (2.625)	4598 (15086)	
	5.79 (19.00)	177	0.800 (2.625)	4520 (14831)	
S48	0.08 (0.25)	182	0.800 (2.625)	4396 (14423)	
	1.52 (5.00)	175	0.800 (2.625)	4572 (15000)	
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)	
	4.57 (15.00)	179	0.800 (2.625)	4470 (14665)	
	5.79 (19.00)	181	0.800 (2.625)	4420 (14503)	
S49	0.08 (0.25)	spalled	0.800 (2.625)	ERR*	
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)	
	3.05 (10.00)	166	0.800 (2.625)	4820 (15813)	
	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)	
	6.10 (20.00)	172	0.800 (2.625)	4652 (15262)	
S50	0.08 (0.25)	176	0.800 (2.625)	4546 (14915)	
•••••••••••••••••••••••	1.52 (5.00)	176	0.800 (2.625)	4546 (14915)	
	3.05 (10.00)	174	0.800 (2.625)	4598 (15086)	
	4.57 (15.00)	175	0.800 (2.625)	4572 (15000)	
	6.10 (20.00)	177	0.800 (2.625)	4520 (14831)	
S51	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)	
	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)	
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)	
	4.57 (15.00)	177	0.800 (2.625)	4520 (14831)	
•••••••••••••••••••••••••••••••••••••••	6.10 (20.00)	187	0.800 (2.625)	4279 (14037)	
S52	0.08 (0.25)	spalled	0.800 (2.625)	ERR*	
	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)	
***************************************	3.05 (10.00)	178	0.800 (2.625)	4495 (14747)	
***************************************	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)	
*****************	6.10 (20.00)	390	0.800 (2.625)	2052 (6731)* ³	
S53	0.08 (0.25)	357	0.800 (2.625)	2241 (7353)*3	
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)	
	3.05 (10.00)	168	0.800 (2.625)	4763 (15625)	

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S53	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
	6.10 (20.00)	184	0.800 (2.625)	4348 (14266)
S54	0.08 (0.25)	170	0.800 (2.625)	4706 (15441)
***************************************	1.52 (5.00)	172	0.800 (2.625)	4652 (15262)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.02 (19.75)	172	0.800 (2.625)	4652 (15262)
S 55	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	175	0.800 (2.625)	4572(15000)
	5.18 (17.00)	175	0.800 (2.625)	4572 (15000)
	6.10 (20.00)	181	0.800 (2.625)	4420 (14503)
S56	0.08 (0.25)	182	0.800 (2.625)	4396 (14423)
	1.52 (5.00)	174	0.800 (2.625)	4598 (15086)
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.02 (19.75)	176	0.800 (2.625)	4546 (14915)
S57	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
	1.52 (5.00)	171_	0.800 (2.625)	4679 (15351)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
	4.57 (15.00)	172	0.800 (2.625)	4652 (15262)
	6.02 (19.75)	204	0.800 (2.625)	3922 (12868)
S58	0.08 (0.25)	247	0.800 (2.625)	3239 (10628)*
	1.52 (5.00)	171	0.800 (2.625)	4679 (15351)
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)
	4.57 (15.00)	170	0.800 (2.625)	4706 (15441)
	6.02 (19.75)	182	0.800 (2.625)	4396 (14423)
S59	0.08 (0.25)	430	0.800 (2.625)	1861 (6105)* ³
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)
	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)

Table A-2				
Pulse Velocity	Measurements	from	South	Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith m (ft)	Arrival microseconds	Path Length m (ft)	Pulse Velocity m/s (ft/s)
S59	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)
	5.94 (19.50)	168	0.800 (2.625)	4763 (15625)
S60	0.08 (0.25)	273	0.800 (2.625)	2931 (9615)*
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)
	3.05 (10.00)	167	0.800 (2.625)	4791 (15719)
	4.57 (15.00)	166	0.800 (2.625)	4820 (15813)
	6.02 (19.75)	173	0.800 (2.625)	4625 (15173)
S61	0.08 (0.25)	173	0.800 (2.625)	4625 (15173)
	1.52 (5.00)	170	0.800 (2.625)	4706 (15441)
	3.05 (10.00)	169	0.800 (2.625)	4734 (15533)
	4.57 (15.00)	167	0.800 (2.625)	4791 (15719)
	5.94 (19.50)	172	0.800 (2.625)	4652 (15262)
S62	0.08 (0.25)	179	0.800 (2.625)	4470 (14665)
	1.52 (5.00)	166	0.800 (2.625)	4820 (15813)
	3.05 (10.00)	168	0.800 (2.625)	4763 (15625)
	4.57 (15.00)	169	0.800 (2.625)	4734 (15533)
	5.94 (19.50)	176	0.800 (2.625)	4546 (14915)
S63	0.08 (0.25)	238	0.800 (2.625)	3362 (11029)*3
	1.52 (5.00)	169	0.800 (2.625)	4734 (15533)
••••••	3.05 (10.00)	168	0.800 (2.625)	4763 (15625)
	4.57 (15.00)	168	0.800 (2.625)	4763 (15625)
***************************************	6.10 (20.00)	320	0.800 (2.625)	2500 (8203)* ³
S64	0.08 (0.25)	178	0.800 (2.625)	4495 (14747)
*************	1.52 (5.00)	170	0.800 (2.625)	4706 (15441)
•••••••••••••••••••••••••••••••••••••••	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	175	0.800 (2.625)	4572 (15000)
S65	0.08 (0.25)	178	0.800 (2.625)	4495 (14747)
	1.52 (5.00)	173	0.800 (2.625)	4625 (15173)
	3.05 (10.00)	171	0.800 (2.625)	4679 (15351)

Table A-2
Pulse Velocity Measurements from South Seawall

	Location	Time of		
Monolith	Distance from West End of Monolith M (ft)	Arrival microseconds	Path Length M (ft)	Pulse Velocity M/s (ft/s)
S65	4.88 (16.00)	180	0.800 (2.625)	4445 (14583)
***************************************	5.94 (19.50)	176	0.800 (2.625)	4546 (14915)
S66	0.08 (0.25)	177	0.800 (2.625)	4520 (14831)
***************************************	1,52 (5.00)	171	0.800 (2.625)	4679 (15351)
	3.05 (10.00)	175	0.800 (2.625)	4572 (15000)
*************	4.57 (15.00)	175	0.800 (2.625)	4572 (15000)
*****************	6.02 (19.75)	180	0.800 (2.625)	4445 (14583)
S67.	0.08 (0.25)	503	0.800 (2.625)	1591 (5219)*1
***************************************	1.52 (5.00)	169	0.800 (2.625)	4734 (15533)
***************************************	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
***************************************	4.57 (15.00)	170	0.800 (2.625)	4706 (15441)
***************************************	6.02 (19.75)	245	0.800 (2.625)	3266 (10714)*1
S68	0.08 (0.25)	172	0.800 (2.625)	4652 (15262)
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)
*****************	3.05 (10.00)	168	0.800 (2.625)	4763 (15625)
	4.57 (15.00)	171	0.800 (2.625)	4679 (15351)
	6.02 (19.75)	171	0.800 (2.625)	4679 (15351)
S69	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)
	1.52 (5.00)	167	0.800 (2.625)	4791 (15719)
***************************************	3.05 (10.00)	170	0.800 (2.625)	4706 (15441)
***************************************	4.57 (15.00)	169	0.800 (2.625)	4734 (15533)
**********************	6.02 (19.75)	172	0.800 (2.625)	4652 (15262)
S70	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)
	1.52 (5.00)	174	0.800 (2.625)	4598 (15086)
	3.05 (10.00)	177	0.800 (2.625)	4520 (14831)
	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S71	0.08 (0.25)	175	0.800 (2.625)	4572 (15000)
	1.52 (5.00)	174	0.800 (2.625)	4598 (15086)
	3.05 (10.00)	177	0.800 (2.625)	4520 (14831)

Table	A-2			1000	15675 00
Pulse	Velocity	Measurements	from	South	Seawall

	Location	Timestal		
Monolith	Distance from West End of Monolith M (ft)	Time of Arrival microseconds	Path Length M (ft)	Pulse Velocity M/s (ft/s)
S71	4.57 (15.00)	173	0.800 (2.625)	4625 (15173)
	6.10 (20.00)	178	0.800 (2.625)	4495 (14747)
S72	0.08 (0.25)	spalled	0.800 (2.625)	ERR*
	1.52 (5.00)	174	0.800 (2.625)	4598 (15086)
	3.05 (10.00)	176	0.800 (2.625)	4546 (14915)
	4.57 (15.00)	170	0.800 (2.625)	4706 (15441)
	6.10 (20.00)	spalled	0.800 (2.625)	ERR*
S73	0.08 (0.25)	176	0.800 (2.625)	4546 (14915)
•••••••••••	0.91 (3.00)	168	0.800 (2.625)	4763 (15625)
***************************************	1.83 (6.00)	170	0.800 (2.625)	4706 (15441)
•••••••••••••••••••••••••••••••••••••••	2.13 (7.00)	131	0.800 (2.040)	4750 (15585)
	3.35 (11.00)	137	0.800 (2.040)	4542 (14903)
*******************	4.88 (16.00)	135	0.800 (2.040)	4610 (15124)
***************************************	6.40 (21.00)	133	0.800 (2.040)	4679 (15351)
ow Measure	ement 1c-	alled	² Edge Delamination	n ³ Cra

Appendix B Petrographic Examination

Corps of Engineers, USAE Waterways Experiment Station	Concrete Report	Structures Laboratory 3909 Halls Ferry Road Vicksburg, MS 39180
Project: Perry's Victory Mon	Date: August 2, 1995	

Samples

I. Twenty seven, 102-mm (4-in.) diameter cores taken from top of seawalls were received for examination and testing to determine the cause of cracking in the concrete. The cores were assigned CTD serial numbers as described in Table B-1. These serial numbers will be used to describe the samples examined and tested.

Table B-1 Core Samples			
CTD Sample No.	Field Id.	CTD Sample No.	Field Id.
950372	S7	950386	S68
950373	S8	950387	S72
950374	S16	950388	N10
950375	S16/17	950389	N11
950376	S17	950390	N21
950377	S17B	950391	N22
950378	S27	950392	N30
950379	S20	950393	N38
950380	S37	950394	N45
950381	S49	950395	N56
950382	S52A	950396	N57
950383	S52B	950397	N34, old seawall
950384	S60A	950398	N40, old seawall
950385	S60B		

Procedure

- II. A log was made of each core describing the general composition and condition of the concrete. Generally intact pieces of core having a length to diameter ratio of 2:1 were designated for compressive-strength test specimens. They were indicated on the core logs as C/S. Selected samples were examined in more detail using guidance from "Standard Practice for Petrographic Examination of Hardened Concrete," CRD-C 57 (ASTM C 856).
- III. Slabs cut from cores were prepared according to "Standard Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete," CRD-C 42 (ASTM C 457) and tested to determine the air-void parameters of the concrete.
- IV. Specific gravities and absorption values were determined for selected individual aggregate particles removed from cores. Determinations were made according to "Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate," CRD-C 107 (ASTM C 127).

Results

- V. The cores consisted of concrete from the north, south, and old seawalls (logs of core are presented in Figures B-1 through B-27). Concrete from both north and south seawalls were similar in composition. Both consisted of air-entrained concrete, made using crushed and natural limestone coarse aggregates, and natural limestone fine aggregate. All showed no segregation and generally good consolidation. The individual descriptions are shown in the logs. Many of the cores contained open fractures running along the length of the core as well as normal to its length. In some cores the fractures were random, diagonal and in some, the cores had separated into rubble during the coring operation (Figures B-28 through B-31).
- VI. Many of the fractures were parallel to subparallel cracks. Some tended to be subparallel to the surface of the structure. Examination of photographs show the cracks and fractures are at edges, corners, and near exposed surfaces. Some of the cores show incipient fractures with only a slight indication of crack propagation while other were open and others consisted of multiple cracks causing the concrete to be rubble.
- VII. Some of the deterioration in the form of cracking went to full depth of the core having 0.46 m (1.5 ft) depths. More commonly the depth of deterioration was limited to about 0.15 m (0.5 ft).
- VIII. The old seawall concrete (950397 and 950398) contained a natural siliceous coarse aggregate and a natural siliceous fine aggregate. It contained

some entrained air voids. Examination of aggregate particles indicated some to be low refractive index chert.

- IX. Reaction rims were observed in coarse aggregate of the concrete from the north and south seawalls. When acid was used to etch the particles, some showed negative rimming in which the rims more easily dissolved but most rims showed no relief when etched.
- X. White reaction products were common in cracks. Some of the reaction completely filled air voids. Reaction product filling voids was identified as ettringite. Alkali-silica reaction (ASR) gel was present in limited amounts in some cracks. ASR gel was abundant in the concrete from the old seawall in which the fractured surfaces were coated with material.
- XI. Coarse aggregate particles were mostly dolomitic limestone with some containing trace amounts of clay and some quartz (X-ray diffraction patterns are shown in Figures B-32 through B-44). Some contained only dolomite as a mineral constituent.
- XII. Reinforcing steel for the most part was free of corrosion products. Only slight corrosion was observed on the steel in the cores.
- XIII. The concrete contained some entrained air in both the old and recent concrete (Table B-2). It however shows a wide range of total air ranging from a high of near six percent to a low of near one percent. Spacing factors show a range of 0.780 to 0.213 mm (0.0307 to 0.0084 in.). Sample 950375A and 950375B were from a core drilled through a joint representing concrete from monoliths S16 and S17 of the south seawall. Adjacent monolith in this case showed spacing factors to be significantly different.

Table B-2 Characteristics	of	Concrete	

Parameters			Sam	ple		
	950375A (S17)	950375B (S16)	950385 (S60B)	950398 (N40, Old Seawall)	950395 (N56)	950396 (N57)
Coarse Aggregate, %	45.6	26.3	41.0	36.7	32.3	38.6
Fine Aggregate, %	25.3	31.2	27.8	34.2	31.3	25.6
Paste, %	23.4	40.7	28.1	28.0	30.3	29.1
Entrained Voids, %	3.4	0.5	1.4	0.5	2.7	2.4
Entrapped Voids, %	2.3	1.3	1.7	0.6	3.4	4.3
Total Air,	5.7	1.8	3.1	1.1	6.1	6.7
Spacing Factor, mm (in.)	0.213 (0.0084)	0.789 (0.0307)	0.470 (0.0185)	0.282 (0.0111)	0.236 (0.0093)	0.335 (0.0132)

XIV. Specific gravities for the coarse aggregate ranged from a low of 2.16 to a high of 2.89 (Table B-3). Absorption correlated with specific gravity in that particles with low specific gravities also indicated high absorption. Absorption ranged from less than 1 percent to more than 11 percent. Bulk specific gravities for the particles as well as absorptions are presented below:

Sample Id.	Bulk Specific Gravity	Absorption, %
A	2.36	4.82
В	2.42	4.43
С	2.16	11.29
A	2.39	5.08
Α	2.12	6.98
В	2.63	1.85
С	2.57	1.74
D	2.89	0.52
E	2.53	3.36
Α	2.55	0.65
В	2.26	1.46
C*	2.60	1.44
A	2.34	5.94
В	2.20	9.09
AVERAGE	2.45	4.45

Conclusion and Discussions

XV. Concrete deterioration is most likely related to lack of resistance to freezing and thawing while critically saturated. Entrained air should provide a spacing factor of 0.203 mm (0.008 in.) or less to provide adequate protection from stresses associated with freezing and thawing of critically saturated concrete. Examination of concrete in adjacent monoliths show that one may be protected while the other may be susceptible to freezing and thawing deterioration.

XVI. Aggregate particles with low specific gravities and high absorption usually are not resistant to freezing and thawing. In many places specific gravities of less than

2.40 are indications of potential problem aggregates. Some of the aggregates had high absorption and could be traced to some durability problems as popouts were observed on concrete surfaces. Problems associated with nondurable aggregate in this case would be associated with edges and corners where the concrete has the highest potential for saturation.

XVII. The dolomitic limestone shows some reaction rims around aggregate particles indicating some alkali-carbonate rock reaction. This reaction does not appear to be a problem as there was no evidence joint closure in the structure or possible displacement.

XVIII. Some alkali-silica reaction was observed in some near surface cracks. The gel in the recent concrete was limited to partially coating some fractures and appears to be very limited in extent. Alkali-silica reaction was much more extensive in one core representing the concrete from old seawall and was not evident in the core that was intact. The concrete was rubble where ASR was observed in the old concrete. ASR may be a major deteriorating cause in the old concrete.

XIX. Corrosion of steel was minor and does not appear to be sufficient in the limited samples taken to be a cause of concrete cracking. As the structure ages and the concrete along open cracks and adjacent to the steel carbonates thus reducing the pH in the concrete around the steel and the open channel allows water and air penetration, corrosion of steel could become a problem causing spalling and staining of the concrete.

DRILL	ING LOC	; 0	IVISION	NAD	INSTALLATI	ON		1.12.15.1	SHEET 1 OF 1 SHEETS		
1. PROJECT	P	erry	s Vict		10. SIZE AND TYPE OF BIT 4-in 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
2. LOCATION				TOTAL TRANSPORT				NATION OF DRILL			
3. DRILLING	AGENCY	100	N. CHI	THE RESIDENCE OF THE PARTY OF T		NO. OF O		DISTURBED	UNDISTURBED		
4. HOLE NO.		n on dro	wing title	N34	The second secon	N SAMPLES		and the same of th	SKOTOKOLO		
5. NAME OF			100		14. TOTAL 15. ELEVA	NUMBER C					
6. DIRECTION			1000		16. DATE		-	TARTED	COMPLETED		
7. THICKNESS		BURDEN		DEG. FROM VERT	17. ELEVA		F HOLE	E	5-24-95		
8. DEPTH DR	Contract the Contract of the C					CORE RECO		FOR BORING	The same of the same		
9. TOTAL DEF	TH OF HO	LE O f			and the second	OILE OF III					
ELEVATION	DEPTH	LEGEND		(Description)	ALS	% CORE RECOV- ERY	BOX SAMP NO.		REMARKS me, water loss, depth of ng, etc. if significant)		
			ASR Control of the co	e ed at joint 3 doated Surface eous FA natural ecture particular establishment of the entrained air filled with and ettringing	al les voids						

Figure B-10. Log for North seawall core N34 (Old Seawall)

DRILLI	NG LOG	DIVISION	NAD	INSTALLATIO	N			SHEET 1	SHEETS	
1. PROJECT	Per	ry's Vict	orv	10. SIZE AND TYPE OF BIT 4-in 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
2. LOCATION	(Coordinates			- III. DATOM	FOR ELEV	ATION SHO	WH (IBM OR MS	-)	and the same	
3. DRILLING	AGENCY			12. MANUF	ACTURER'S	DESIGNATI	ON OF DRILL			
4. HOLE NO.	(As shown or	drawing title		13. TOTAL BURDEN	NO. OF OV		DISTURBED	UNDISTURBED		
and file n	umber)		N57			A PARLACENCE				
5. NAME OF	DRILLER		The Party State of the Party Sta	14. TOTAL						
6. DIRECTION	OF HOLE	-		15. ELEVAT	ION GROUN	STAR	ED	COMPLETED		
VERTICAL		0 0	DEG. FROM VERT	16. DATE I				5-24-9	5	
7. THICKNESS	OF OVERBUR	DEN		17. ELEVAT			. 222012			
8. DEPTH DRI	LLED INTO RO	CK		18. TOTAL 19. SIGNAT			BORING			
9. TOTAL DEF	TH OF HOLE	1.4 feet		13. SIGNAL	OKE OF IN	SILCION			1000000	
ELEVATION	DEPTH LEG	END	CLASSIFICATION OF MATERIA (Description)	is	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS le, water loss, de g, etc. if signific	epth of	
-1.4	0.00	EOB Loca 1 1/	1.4-ft ted at joint 5 2-in max size	7/58		N57				
		Natu Nume Air No s	tural / crushed ral Ls FA rous entrapped entrained egregation #950396							

Figure B-9. Log for north seawall core N57

DRILL	ING LOG	DIVISION	NAD	INSTALLATI	ON	1.03	The same is	SHEE	2 70	HEETS
1. PROJECT		-	VICTOR STATE OF THE STATE OF TH	10. SIZE A						
2 100471011	Perr (Coordinates o	y's Vict	ory	11. DATUM	FOR ELEV	ATION SHO	WN (TBM OR M	SL)		100 E
		J. L.	A STATE OF THE STA	12. MANUF	ACTURER'S	DESIGNAT	ON OF DRILL			
3. DRILLING	AGENCY	The State of		13. TOTAL	NO OF O	VED-	DISTURBED	LUNDI	STURBED	
	(As shown on	drawing title	N56		N SAMPLES		Distributes		J. OKDED	73/10
5. NAME OF	3. N. P. S.		.,	14. TOTAL	NUMBER C	ORE BOXES			1000	
				15. ELEVAT	TION GROUN		No. of Concession, Name of Street, or other Persons, Name of Street, or ot			
6. DIRECTION VERTICAL			DEG. FROM VERT	16. DATE	HOLE	STAR	TED	COMPLET 5	-24-9	5
7. THICKNESS	OF OVERBURD	EN		17. ELEVAT				- 14		
8. DEPTH DR	ILLED INTO ROC	K		18. TOTAL			BORING			
9. TOTAL DEF	PTH OF HOLE 1	.4 feet						200		
ELEVATION	DEPTH LEGE	The same of the sa	(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS ne, water g, etc. if		oth of
0		Open Incip of C/S	crack to 2-in ient crack les core	depth		N56				
-1.4	1.40	Locat 1 1/2 nat Natur Numer Air e No se	ed at joint 50 -in max. size ural/ crushed al Ls FA ous entrapped ntrained gregation 950395	Ls CA						

Figure B-8. Log for north seawall core N56

DRILLIN	NG LOG	DIVISION	NAD	INSTALLATIO	N	- 1000		SHEET 1		
1. PROJECT				10. SIZE AND TYPE OF BIT 4-in 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
		y's Vict	ory					SL)		
2. LOCATION (Coordinates or	Station)		12 MANUE	ACTUPEDIS	DESIGNATION	ON OF DRILL			
3. DRILLING AC	GENCY			- IZ. MANUF	ACTORER'S	DESIGNATION	OR OF DRILL			
	HETT H	T. T. B. L. of	77.5 15 15	13. TOTAL	NO. OF OV	ER-	DISTURBED	UNDISTURBED		
The Park Street of the Street	As shown on	drawing title	N45	BURDE	SAMPLES	TAKEN	1 2 2 2 2 2	THE RESERVE OF THE PARTY.		
and file nu 5. NAME OF D			.,.0	14. TOTAL	NUMBER C	ORE BOXES		1.22		
J. HAML OF D	MILLER			15. ELEVAT						
6. DIRECTION	OF HOLE	PER STATE	Service of the service of			START	TED	COMPLETED		
VERTICAL D	INCLINED	0	DEG. FROM VERT	16. DATE I	HOLE			5-24-95		
7. THICKNESS	OF OVERBURD	EN		17. ELEVAT						
B. DEPTH DRIL	LED INTO ROC	K		18. TOTAL			BORING			
9. TOTAL DEPT	TH OF HOLE 1	.3 feet		19. SIGNAT	UKE UF IN	SPECIOR				
			CLASSIFICATION OF MATERIA	ALS	% CORE	BOX OR		REMARKS		
ELEVATION	DEPTH LEGE	ND	(Description)		RECOV- ERY	SAMPLE NO.	(Drilling tin	ne, water loss, depth o		
0	0.00 8	Finis	shed top surfa	ce		N45				
0			ace crack		FAIT	1423				
141	-		eal vertical		E 33					
F-1/25	100		ntion				7-35-7-1			
St. 100 12	-000	8 व				15 49 19	15356			
		3.8								
1 2 2 2 3 3		28								
1 1 1 1 1 1 1 1	208	AS					19 9 000			
401113		æ				- 11				
113- 70	18:00	C/S			1 1 3 3	11-75	11111111			
97 23	200	0.9					-			
HH2 1	- 20	3			11000		17.50			
THE STATE OF	-100	00			1000		The state of the s			
The state of	_2676	8					1131111			
	86.0				-	1000	Del Tolling			
-1.3	1.30	EOB :	1.3-ft new		1000		the test			
						-	PER ST			
A BY		Locat	ted at joint 4	4/45						
171 153		1 1/3	2-in max. size	To Ch			24 8 175			
- THE			tural/ crushed	I LS CA						
- 14 -1 3			ral Ls FA entrapped voi	ids						
3-1-1-3		Air	entrained							
			egregation				7.00			
		2.0 5.	-33				1,3-12-3			
	_	CTD :	#950394							
4 12-14		2000					1-11-11			
LE TETTE										
		111111111111111111111111111111111111111								
THE WIT	-									
	-									
1-11	-	14								
1344	-									
1-1-1										
		Part In								
					1 (3 %					
	-				1 1 1					
	-	2, 4 2 1				A PLUM				
		Aug.								

Figure B-7. Log for north seawall core N45

DRILL	ING LOG	DIVISION	NAD	INSTALLATI	ON	1111)		SHEET 1 OF 1 SHEETS
1. PROJECT	Per	ry's Vict	A CONTRACT	10. SIZE A			in OWN (TBM OR M	
2. LOCATION	(Coordinates							
3. DRILLING				13. TOTAL	NO. OF O	VER-	DISTURBED	UNDISTURBED
4. HOLE NO. and file i		drawing title	N38	BURDE	N SAMPLES	TAKEN		
5. NAME OF		63800		14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER			S	
5. DIRECTION	OF HOLE					STAR	TED	COMPLETED
VERTICAL	□ INCLINE	D 0	DEG. FROM VERT	16. DATE				5-24-95
	S OF OVERBUR			17. ELEVAT			BORING	
	ILLED INTO RO				URE OF IN		DOMINO	
. TOTAL DEF	TH OF HOLE (0.6 feet	LASSIFICATION OF MATERIA	N.S	# CODE	BOY OR		REMARKS
ELEVATION	DEPTH LEG	END	(Description)		% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	ne, water loss, depth of g, etc. if significant)
	0.0 0 0 0 0 0 0 0 0 0	8000 0800 0000 0800 0000 0800	hed top surfa			N38		
-0.6	0.60	7/38 ength CA Ls CA voids ds						

Figure B-6. Log for north seawall core N38

DRILLI	NG LOG	DIVISION	NAD	INSTALLATIO	N	1	-	SHEET 1		
1. PROJECT	THE		A STATE OF THE STA	10. SIZE AND TYPE OF BIT 4-in 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
2 LOCATION	Peri (Coordinates	ry's Vict	cory	11. DATUM	FOR ELEV	ATION SHO	WN (TBM OR MS	SL)		
			STATE OF THE PARTY	12. MANUF	ACTURER'S	DESIGNATION	ON OF DRILL			
3. DRILLING A	GENCY		CONTRACTOR OF THE PARTY.	17 707	10 07 1	r.c.	DISTURDED	LUNDICTUDOSO		
4. HOLE NO.	7 4	drawing title	N30	13. TOTAL BURDER	NO. OF OV	0.000	DISTURBED	UNDISTURBED		
5. NAME OF I				14. TOTAL	NUMBER C	ORE BOXES				
	OF HOLE		THE PERSON NAMED IN	15. ELEVAT	ION GROUN	The same of the sa		Looveren		
5. DIRECTION VERTICAL		0 0	DEG. FROM VERT	16. DATE	HOLE	STAR	IED	5-24-95		
. THICKNESS	OF OVERBURE	DEN		17. ELEVAT	Contract Con		DODING			
B. DEPTH DRI	LLED INTO RO	CK		18. TOTAL 19. SIGNAT	San	A STATE OF THE PARTY OF THE PAR	BORING			
. TOTAL DEP	TH OF HOLE	1.3 feet					3000	N. P. Ster D. Street		
ELEVATION	DEPTH LEG	END	(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS ne, water loss, depth of g, etc. if significant)		
0		C/S	shed top surfa	ce		N30				
-1.3	1.30	EOB	1.3-ft new	1						
		1 1/ na Natu Some Air No s CTD Petr et	ted at joint 2 2-in max. size tural/ crushed ral Ls FA entrapped voi entrained egregation #950392 ography - Acid ched shows no reaction rims	l Ls CA						
	_									

Figure B-5. Log for north seawall core N30

DRILL	ING LOC	;	DIVISION	NAD	INSTALLATI	ON	-	4/1	SHEET 1 OF 1 SHEETS
1. PROJECT	D	~~~	la Wiat		10. SIZE				
2. LOCATION		_	's Vict	ULY	TI. DATUM	FOR ELEV	ATION SH	OWN (TBM OR M	SL)
3. DRILLING					12. MANUE	ACTURER'S	DESIGNA	TION OF DRILL	A SECTION OF THE PARTY OF THE P
			-	The state of the state of	13. TOTAL			DISTURBED	UNDISTURBED
4. HOLE NO.		n on dr	rawing title	N22	BURDE	N SAMPLES	TAKEN		
5. NAME OF					14. TOTAL				
6. DIRECTION	OF HOLE				15. ELEVAT	ION GROUN	ND WATER		COMPLETED
VERTICAL		LINED	o	DEG. FROM VERT	16. DATE	HOLE			5-24-95
7. THICKNESS	S OF OVERE	BURDEN			17. ELEVAT			D. BODING	
8. DEPTH DR					18. TOTAL 19. SIGNAT			R BURING	
9. TOTAL DE	PTH OF HO	LE 1.	Section Contracts	LASSISIONATION OF MATERIA					THE RESERVE OF THE PARTY OF THE
ELEVATION	DEPTH	LEGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.		REMARKS ie, water loss, depth of g, etc. if significant)
0	0.0	8 18	Finis	hed top surfac	ce	17 (3)	N22		
	-	Dec	1	3/4 :				1000	
	-	0		ces 3/4-in rei	in-		12/20		
	-	204	Poor	consolidation					
		000		und steel corrosing of	unner	1000			Baltin
		8%	bar		upper	136-6		38340	
		30 %							
	1 4							1000	
	<u> </u>	a a						113/13	
		900							
	-6	333							13333341371
		888							The same of the sa
-1.4	1.40		EOB 1	.4-ft new					
	-		Locat	ed at ladder r	-2222				
	-			-in max size	ecess			1	
	-			ural/ crushed	Ls CA			D. Price W.	
			TO A CONTRACTOR OF THE PARTY OF	al Ls FA ntrained					
197116			Numer	ous entrapped	air				
-3.3				gregation cal and horizo	ntol				
12 1	_			ipient cracks	nicai				
	-		Crack	s go through C					
	-			ion rim around e CA				with the same	
					1 121 15			1190 113 1	
			CTD #	950391	train				
			144 3		14.3				
	_								
			3/3						
	-								
	-	- 7							
		3.57							
40,000			TE HILL						

Figure B-4. Log for north seawall core N22

DRILLI	NG LOG	DIVISION	INSTALLATIO	N			SHEET 1 OF 1 SHEETS
1. PROJECT	Perry	's Victory	10. SIZE AI			TO VN (TBM OR M	
2. LOCATION	(Coordinates or					- Marine - 200 - 310	
3. DRILLING	AGENCY		12. MANUF	ACTURER'S	DESIGNATIO	ON OF DRILL	
	(As shown on d	rawing title N21	13. TOTAL BURDEN	NO. OF OV		DISTURBED	UNDISTURBED
and file n	THE RESERVE THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLU	NEI	14. TOTAL	NUMBER C	OPE BOYES		
S. NAME OF	DRILLER		15. ELEVAT				
6. DIRECTION VERTICAL		DEG. FROM VERT	16. DATE H		START	ED	COMPLETED 5-24-95
7. THICKNESS	OF OVERBURDER		17. ELEVAT	ION TOP O	F HOLE		
	LLED INTO ROCK		18. TOTAL			BORING	THE PARTY OF THE PARTY.
9. TOTAL DEP	TH OF HOLE 1 .	65 feet	19. SIGNAT	URE OF IN	SPECTOR		S. Short be brilled by
ELEVATION	DEPTH LEGEN	CLASSIFICATION OF MATERIA (Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE	(Drilling tin	REMARKS ne, water loss, depth of ag, etc. if significant)
	Bar Bar			ERT	NO.	weatherin	g, etc. if significant)
0	0.0	Finished top surfa Fracture to 1-in d			N21		
		c/s					
		c/s					
-1.65	1.65	EOB 1.65-ft new					
		Located near mid-lof monolith 1 1/2-in max. size natural/crushed Natural Ls FA Numerous entrapped Air entrained No segregation	e d Ls CA				
		CTD #950390					
	-						

Figure B-3. Log for north seawall core N21

DRILLING LOG	DIVISION	NAD	INSTALLAT	ION		BILL STORY	SHEE	T 1 1 SHEETS
1. PROJECT Perry	's Victor			AND TYPE O		-in lown (TBM OR M		J. J. LETS
2. LOCATION (Coordinates or				0.00000		TION OF DRILL		
3. DRILLING AGENCY						DISTURBED	LINDS	STURBED
4. HOLE NO. (As shown on dr	awing title	N11		NO. OF O		DISTORDED	OND	STORBED
5. NAME OF DRILLER				NUMBER C	AND STREET	MINES.		
6. DIRECTION OF HOLE			15. ELEVA	TION GROUN		RTED	COMPLET	ED
	o	_ DEG. FROM VERT	16. DATE				750	24-95
. THICKNESS OF OVERBURDEN			-	CORE REC		R RORING		
B. DEPTH DRILLED INTO ROCK			The State of the S	TURE OF IN		AND DESCRIPTIONS		
. TOTAL DEPTH OF HOLE 1								
ELEVATION DEPTH LEGEND	2	SIFICATION OF MATER (Description)	IALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.		REMARKS te, water l g, etc. if	loss, depth of significant)
-1.2 1.2	White e surfa Incipie to 1. Crack a C/S EOB 1.2 Located 1 1/2-i natur Natural Some en Air ent CTD #95 Petrogr	-ft new at joint 1 n max. size al/ crushed Ls FA trapped air rained air	old Ls CA		N11			

Figure B-2. Log for north seawall core N11

DRILLI	NG LOC	G DI	VISION	NAD	INSTALLATIO	N		11 1/1	SHEET 1 OF 1 SHEETS
1. PROJECT					10. SIZE A	ID TYPE O	F BIT 4 -	in	Name and Address of the Owner, where the Owner, which is the Owner, which is the Owner, where the Owner, which is the Owner, where the Owner, which is the Owner, wh
2. LOCATION			s Vict	ory	11. DATUM	FOR ELEV	ATION SHOW	WN (TBM OR MS	SL)
Z. LUCATION	Coordina		211011)		12. MANUF	ACTURER'S	DESIGNATION	ON OF DRILL	
3. DRILLING A	GENCY		1000					Children and	
4. HOLE NO.	(As show	n on dra	wing title		13. TOTAL BURDEN	NO. OF OV		DISTURBED	UNDISTURBED
and file n		n on did	anig inio	N10	DONDE	JAMI LLJ	INCLIN		
5. NAME OF	DRILLER	1 2000		Chicago and the same of	14. TOTAL				
6. DIRECTION	OF HOLF				15. ELEVAT	ON GROUN	START	FD	COMPLETED
VERTICAL		LINED [DEG. FROM VERT	16. DATE H			20	5-24-95
7. THICKNESS			7000		17. ELEVAT		The state of the s	BORING	
8. DEPTH DRI	LLED INTO	ROCK			19. SIGNAT	INDENDATE PROPERTY	200 Control of the Co	BONING	
9. TOTAL DEP	TH OF H	DLE O f	The Control of the Co					Trans.	FORTH WATER
ELEVATION	DEPTH	LEGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tin	REMARKS ne, water loss, depth of g, etc. if significant)
0	0.0		Rubb]	le			N10		
			Locat	ted at joint 9/	10				
			Tota:	l Disintergrati	on			(A) (A) (A)	7/62/33
THE			Grave	el size pieces					
		1	CTTD :	#950388					
			CID 1	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			8 8 8		THE ROLL TO STREET
							Total S	STATE OF STA	
		120				13.7	1776		
						all had		43.73	
			7 333				1 1 1 1 1	LIGHT THE	
	-						1	1000	
			(Zieli				125		CHARLES THE STREET
								2 50	
									TO BE LEWIS TO THE
						1	1- F	HELL	
	1								
	1								
			72.77						131-101-1
	_		1.3-1			15-5			
	_								4 5 A LIFE R. T.
			75					1 2011	
								1 - 2 - 2	The state of the
	_						-		
	_								
	_								
FLEET									
1.3							4		
-4310						1	4		
THE REL			12 17						×
Carried States			-					1	

Figure B-1. Log for north seawall core N10

DRILL	ING LO)G	DIVISION	NAD	INSTALLAT	ION			SHE	2	EETS
1. PROJECT]	Perry	's Vict		10. SIZE	AND TYPE	OF BIT 4	-in own (TBM OR MS		4. 5/11	
2. LOCATION		The second second second			The second			in the second		3 373	
3. DRILLING	AGENCY							TION OF DRILL	1		
4. HOLE NO.		wn on dr	awing title	N40	INCLUSION MADE AND ADDRESS.	NO. OF O		DISTURBED	UNI	DISTURBED	43
5. NAME OF						NUMBER C			11 2		
6. DIRECTION	OF HOLE				15. ELEVA	TION GROUP		RTED	COMPLE	TED	
VERTICAL	O IN	CLINED I	·	DEG. FROM VERT	16. DATE	100100000	30000		110000000000000000000000000000000000000	-24-95	
7. THICKNES			17 7 17 17	The same of the sa		CORE REC		R BORING	7770		
8. DEPTH DR			35 feet			TURE OF IN	and the second second		1000	F1 (2 15)	11411
			С	LASSIFICATION OF MATERIA	ALS	% CORE	BOX OR		REMARK		100
ELEVATION	DEPTH	LEGEND		(Description)		RECOV- ERY	SAMPLE NO.	(Drilling tim weathering	e, water , etc. if	loss, depth significant	n of
0	0 _		Silic	d Surface eous FA stand ief, some sca	ing in ling		N40				-
-0.35	0.35		EOB 0	.35-ft	10000	MAG	944	100			
			Locat	ed at joint 4	0/41						
	-			max. size sil ural CA	iceous						F
	-	13.7	The second secon	eous FA							-
	_		The state of the s	consolidation			1154	13.3			-
			No se	gregation				110000			
			CTD #	950398			8-11	135			
	_							1000000			
	=										
	-										
	-		4.77								-
								10000			-
	_	- 37	15 5								
1.314	-			,							
	/ -								×		-
											-
											-
						1					
11/4/17	_					P = 11 = 1					
	-										
	-										_
	-										
	-										-
											-
					No. of London						-
	-										

Figure B-11. Log for north seawall core N40 (Old Seawall)

DRILLI	NG LOC	3 0	IVISION	NAD	INSTALLATIO	N	II Fin		SHEET 1
1. PROJECT	D	ern	s Vict		10. SIZE A				OF 1 SHEETS
2. LOCATION				JLY	- II. DATUM	FOR ELEV	ATION SHO	WN (TBM OR MS	L)
				CANADAR CRES	12. MANUF	ACTURER'S	DESIGNATI	ON OF DRILL	
3. DRILLING A	GENCY				13. TOTAL	U.S. Common Common		DISTURBED	UNDISTURBED
4. HOLE NO.	(As show	n on dre	awing title	97	THE RESERVE THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN	SAMPLES		The second second	
and file n				S7				N/A	N/A
5. NAME OF	DRILLER				14. TOTAL 15. ELEVAT				
6. DIRECTION	OF HOLE				15. ELEVAI	ION GROUN	STAR	TED	COMPLETED
VERTICAL				DEG. FROM VERT	16. DATE				5-24-95
7. THICKNESS	OF OVER	BURDEN			17. ELEVAT			POPING	
8. DEPTH DRI	LLED INTO	ROCK				TURE OF IN		BORING	
9. TOTAL DEP	TH OF HO	DLE 0 . :	25 feet						Della Control of the Control
ELEVATION	DEPTH	LEGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS ie, water loss, depth of g, etc. if significant)
0	0.0_	0 40	b	shed top surfa	ce	17-19	S7		
0.25		800 Se) 25_f+					
-0.25	0.25			0.25-ft					
				ted at joint 7			100		
	-			e reaction pro paste surface					
	-			2' is highly					
	-		fra	actured					
	-			0.25' is rubbl					
	-			<pre>2-in max. size tural/ crushed</pre>					
	-			ral Ls FA	LIS CA	1000		Para Maria	1982 N. J. S.
	-		THE RESIDENCE OF THE PARTY OF T	rous entrapped	voids	11333			
	-		Air	entrained			1000		
			No se	egregation		1236			
			CTD :	#950372				THE E 100	
							1		
		15				3453	7 8 8 8	FEM JOSE-	
	-					19919		13	
								1	
De la Cal						100		The state of	
								198 75	
BEI ER							1 -1		
CHARLES TO							1		
			12.38						
HE HE			-						
1 9 7	1								
12-14-15	-								
	-								
FEET OF	-								
	-								
	-	1							
	-					1 1-12			
	_					1 5. 10		1-1-1-3	
The state of									
		10 Part							

Figure B-12. Log for south seawall core S7

DRILL	ING LO	G	DIVISION	NAD	INSTALLATI	ON	11.50		SHEET 1 OF 1 SHEETS
1. PROJECT	D	erry	's Vict		10. SIZE	ND TYPE O	F BIT 4	HOWN (TBM OR MS	
2. LOCATION				021					
3. DRILLING	AGENCY				12. MANUI	ACTURER'S	DESIGN	ATION OF DRILL	
4. HOLE NO.	(As show	n on d	rawing title	S8		NO. OF O		DISTURBED NT / 7	UNDISTURBED NT / 7
and file r				50	14. TOTAL	NUMBER C	ORE BO	N/A XES	N/A
					15. ELEVA	TION GROUN		R	COMPLETED
6. DIRECTION VERTICAL			o	DEG. FROM VERT	16. DATE	HOLE	31	ARTED	5-24-95
7. THICKNESS						CORE REC		OR BORING	
8. DEPTH DR	- 11 - 11 - 11 - 11 - 11 - 11 - 11 - 1		FF foot			TURE OF IN	COLUMN TO SERVICE STATE OF THE PARTY OF THE		
9. IUIAL DEF	I OF HO	1	55 feet	LASSIFICATION OF MATER	IALS	% CORE	вох о	R	REMARKS
ELEVATION	DEPTH	LEGEN		(Description)		RECOV- ERY	SAMPL NO.		e, water loss, depth of , etc. if significant)
-1.55	1.55		C/S	hed top surface .55-ft New ed near joint -in max. size shed/ natural al Ls FA ous entrapped ntrained gregation	7/8 Ls CA		S8		
			CTD #	950373					

Figure B-13. Log for south seawall core S8

DRILLI	NG LOC	3 DIV	VISION	NAD	INSTALLATIO	N	No.		SHEET 1 OF 1 SHEETS
1. PROJECT	P	erry'	s Vict	ory	10. SIZE A			WN (TBM OR MS	
2. LOCATION							ATTOM SITE	THE CITY OF MIS	
3. DRILLING A		n on dray	vina title		13. TOTAL		ER-	DISTURBED	UNDISTURBED
and file n		70 G02 F03G0		S16		GAMI ELS	THOLI	N/A	N/A
5. NAME OF	DRILLER			Charles St.	14. TOTAL				
6. DIRECTION	OF HOLE		-		15. ELEVAT	ION GROUN	D WATER	TED	COMPLETED
VERTICAL		LINED [DEG. FROM VERT	16. DATE I		21 200		5-24-95
7. THICKNESS	OF OVER	BURDEN			17. ELEVAT			200	
8. DEPTH DRI	LLED INTO	ROCK			18. TOTAL			BORING	
9. TOTAL DEP	TH OF H	DLE 0.3	5 feet		100		5. 2010N		TO A SECTION AND PARTY.
ELEVATION	DEPTH	LEGEND	C	(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS ne, water loss, depth of g, etc. if significant)
0	0.0_	860 80 80 00 00 00 00 00 00 00 00 00 00 00	Finis	hed top surfa	ce		S16		
-0.35	0.35		EOB 0	.35-ft					
			Locat	ed near joint					
	-			'is highly			100	F 0 000	05.0 18.
	-			ctured					
	-			.35' is rubbl		1	1 36	PASSAGO I	
	-			max. size cru	shed/				
	-			ural Ls CA				1001 1145	
	_			al Ls FA entrapped voi	de				
	=			entrapped voi	.us				
	_			gregation					
				33		1	1 11 11 11		
	_		CTD #	950374				17170 17	
									-
	_						I BOOK	1-91, 3:4	3-31-3-1
							100		1911 - 1913
								1	
100	Page 17							12 1220	1 2 2 2 2 2
1.04.1.4								10 1000	
HE WAS								PART OF A ST	THE PERSON
	-								
								A China	
	-								SE ZOTO CO DE VIL
	1								
1-4723 -	-								
	-								- FEBRUARY ST
La Fin	=	100							
	-								
	-								
	-	-					4		
	_							18 4 2 5 1	
The Ex									

Figure B-14. Log for south seawall core S16

DRILL	ING LOG	DIVISION	NAD	INSTALLAT	ION	17.416	Bo. 19 (17)	SHEET 1 OF 1 SHEETS
1. PROJECT	Dor	mula Wiet			AND TYPE		The second secon	
2. LOCATION	(Coordinates	ry's Vict	JULY				OWN (TBM OR M	31)
3. DRILLING	AGENCY			12. MANU	FACTURER'S	DESIGNAT	TON OF DRILL	THE RESERVE AND
					NO. OF O		DISTURBED	UNDISTURBED
 HOLE NO. and file r 		drawing title	S16/17	BURDE	N SAMPLES	TAKEN	N/A	N/A
5. NAME OF	DRILLER	- Alexander			NUMBER C		S	
6. DIRECTION	OF HOLE			16. DATE		STAR	TED	COMPLETED
VERTICAL			DEG. FROM VERT	400 000000	TION TOP O	E HOLE		5-24-95
	ILLED INTO RO				CORE REC	The second second second	BORING	
William Co. S. S. S. S.		0.7 feet		19. SIGNA	TURE OF IN	SPECTOR	3 3 73 73	C. S. S. St. Williams
ELEVATION		SIN A RESERVE	CLASSIFICATION OF MATERIA	ALS	% CORE RECOV-	BOX OR SAMPLE	(Drilling tim	REMARKS ne. water loss, depth of
0	0.0	00	(Description) shed top surfa		ERY	NO.	weathering	e, water loss, depth of g, etc. if significant)
	1	100 mm						
-0.7	0.70	EOB 0	.7-ft			NE L		
3 3		Locat	ed at joint 1	6/17				
		1-in nat Natur Numer Air e	portion) intaction max. size crustural Ls CA al Ls FA ous entrapped ntrained gregation	shed/				
		S16 (Verti fra aro	portion) cal & horizons ctures through und aggregates little entra:	n and				
		No se Aggre	entrapped air gregation gate like S17					
	=							
								f- (- f-)

Figure B-15. Log for south seawall core S16/17

DRILLI	NG LOC	3 DI	VISION	NAD	INSTALLATIO	NO	- 010		SHEET 1	7.
1. PROJECT	P	erry'	s Vict		10. SIZE A			WN (TBM OR MS	OF 1 SHEE	
2. LOCATION		Name of the last			THE DATE	TON ELLY	ATION SHO	WH (IBM OK MS	-)	
3. DRILLING	AGENCY					NO. OF OV		ON OF DRILL DISTURBED	UNDISTURBED	
4. HOLE NO.		n on dra	wing title	S17A		N SAMPLES		N/A	N/A	1
5. NAME OF					14. TOTAL	NUMBER C	ORE BOXES			
C DIDECTION	OF HOLF				15. ELEVAT	TION GROUN				
6. DIRECTION VERTICAL				DEG. FROM VERT	16. DATE	HOLE	STAR	TED	5-24-95	100
7. THICKNESS	OF OVER	BURDEN			_	TION TOP O				
8. DEPTH DR	ILLED INTO	ROCK				CORE RECO		BORING		
9. TOTAL DEF	TH OF H	DLE O f	eet		I I I I I I I I I I I I I I I I I I I		J. LOTOR			
ELEVATION	DEPTH	LEGEND		(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS le, water loss, depth g, etc. if significant	of
	0.00		Rubbi Locat Some thi CA 1 1/2 nat Natu: Some Some No se	ted at joint 1 vertical crac rough and arou	7/18 ks nd Ls CA		S17A			

Figure B-16. Log for south seawall core S17A

DRILI	ING LOG	DIVISION	NAD	INSTALLATI	ON	1988		SHEET 1 OF 1 SHEETS
1. PROJECT	Perm	y's Vict		10. SIZE A	ND TYPE	OF BIT 4"	OWN (TBM OR MS	THE RESERVE OF THE PARTY OF THE
2. LOCATION	(Coordinates o		.021			-		
3. DRILLING	AGENCY			12. MANUI	FACTURER'S	DESIGNAT	ION OF DRILL	THE PARTY OF
4 HOLE NO	. (As shown on	drawing title		The second second	NO. OF O		DISTURBED	UNDISTURBED
and file	number)	drawing line	S17B				N/A	N/A
5. NAME OF	DRILLER			14. TOTAL	NUMBER C		5	
6. DIRECTION			DEC 5001 USA	16. DATE		STAR	TED	COMPLETED
7 THICKNES	S OF OVERBURD		DEG. FROM VERT	17. ELEVA	TION TOP C	OF HOLE		5-24-95
	RILLED INTO ROC			The state of the s	CORE REC	MATERIAL (1992)	BORING	
9. TOTAL DE	PTH OF HOLE 1	.2 feet		19. SIGNA	TURE OF IN	ISPECTOR		CONTRACTOR SECTION
ELEVATION	DEPTH LEGE	Y003	(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS e, water loss, depth of , etc. if significant)
-1.2	1.20	Hairl dep agg C/S EOB 1 Locat 1 1/2 nat Natur Numer Air e No se	ne crack to in the through regate 2 New ed at joint 17 in max. size ural/ crushed al Ls FA ous entrapped entrained gregation 950377	l-in 7/18 Ls CA		S17B		

Figure B-17. Log for south seawall core S17B

DRILLI	NG LO	G D	IVISION	NAD	INSTALLATIO	NO	4,000	-	SHEE	т 1	
1. PROJECT	P	erry	s Vict		10. SIZE A				OF	1	SHEETS
2. LOCATION				OLY	11. DATUM	FOR ELEV	ATION SHO	OWN (TBM OR MS	L)		7.75
3. DRILLING			THE.		12. MANUF	ACTURER'S	DESIGNAT	ION OF DRILL			
J. DRILLING	OLITOI				13. TOTAL	NO. OF .0\	/ER-	DISTURBED	UND	STURE	ED
4. HOLE NO.		n on dro	wing title	S20		N SAMPLES		N/A			V
and file n				220	14. TOTAL	NUMBER C	ORE BOXE			N,	/A
J. HAME OF					15. ELEVAT	ALDRESS AND ALL	Carlo de Carlo de la Carlo de				
6. DIRECTION					16. DATE	HOLE	STAF	RTED	COMPLE	TED	
VERTICAL	-			DEG. FROM VERT		1000			5	-24	-95
7. THICKNESS		S. C.			17. ELEVAT	CORE REC	CATALOGRAPHICA CONTRACTOR	P BORING	1		
8. DEPTH DRI						TURE OF IN		, poniiro			
9. TOTAL DEP	TH OF H	OLE 0.2	A CHILDREN								
ELEVATION	DEPTH	LEGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS te, water e, etc. if		depth of
0	0.00	35	Finis	shed top surface	ce		S20				
0.2	0.20	white the	FOR ().2-ft			Ton.	HE WAR			
-0.2	0.20		EOB (10.000			
	-		Locat	ted at joint 1	9/20						78.3
			Rubbl					THE PARTY NAMED IN			
	-			rous entrapped							
	_			entrained voi		1					
	-		The state of the s	ids		1100					
	-		Fract	tures through	and						
	-		17150000	ound CA			1				
	-			max. size nat ushed Ls CA	ura1/		141				
	-		12277.5753	ral Ls FA			1				
	1000							1			
			CTD :	#950379							
								1			
	_							Tolono			
	_			ography - Whit	е			112-11			
	-			action was tringite		1-200	150	PERSONAL PROPERTY.			
	_		EL	cringice			1 100	1 1 1 1 1 1 1			
	-	-	1 1111								
						1		- History			71.7-
	-	1				1400					
	-						1	The state of			
	_										
	-	-	1:13								
	-	-	1 11								
	-		1 3 3								
	-	-									
	1	-									
	-	-									
	-		1111					A HARRIE			
	160										
	-										
THE REAL PROPERTY.	-										
	-	-									

Figure B-18. Log for south seawall core S20

DRILL	ING LOG	DIVISION	NAD	INSTALLATI	ON		PR 15 17	SHEET 1 OF 1 SHEETS
1. PROJECT	Darre	via Wiet		10. SIZE	ND TYPE	OF BIT 4"	WAL (TON OF 1)	
2. LOCATION	Perr (Coordinates or	y's Vict	JULY	11. DATUM	FOR ELEV	ATION SHO	WN (TBM OR M	SL)
				12. MANUI	ACTURER'S	DESIGNAT	ION OF DRILL	THE RESERVE THE PARTY OF THE PA
3. DRILLING	AGENCY			13. TOTAL	NO. OF O	VER-	DISTURBED	UNDISTURBED
_	(As shown on	drawing title	S27		N SAMPLES		N/A	N/A
5. NAME OF			227	14. TOTAL	NUMBER C	ORE BOXE		N/A
				15. ELEVA	TION GROUP			
6. DIRECTION			DEG. FROM VERT	16. DATE	HOLE	STAR	TED	COMPLETED
FOR AN AGENCY	S OF OVERBURDE		DEG. FROM VERT	17. ELEVA	TION TOP O	F HOLE		5-24-95
	RILLED INTO ROCK	8/	THE REAL PROPERTY.	18. TOTAL	CORE REC	OVERY FOR	BORING	
	PTH OF HOLE 1			19. SIGNA	TURE OF IN	ISPECTOR		THE RESERVE OF THE PERSON NAMED IN
			LASSIFICATION OF MATERIA	ILS	% CORE	BOX OR		REMARKS
ELEVATION	DEPTH LEGEN		(Description)		RECOV- ERY	SAMPLE NO.	(Drilling tim	ne, water loss, depth of g, etc. if significant)
-1.5	1.50	Incip thr	hed top surfactores ough and around .5 New			S27		
		1 1/2 nat Natur Numer Some No se	ed at joint 2' -in max. size ural/ crushed al Ls FA ous entrapped entrained air gregation 950378	Ls CA				

Figure B-19. Log for south seawall core S27

DRILLI	NG LOG	DIV	ISION	NAD	INSTALLATIO	N			SHEET	1 .	users.
1. PROJECT	Pe	rry's	s Vict	ory	10. SIZE AI			WN (TBM OR MS		1 2	HEETS
2. LOCATION									-,		
3. DRILLING A	9000	on draw	ring title	927	13. TOTAL		ER-	DISTURBED	UNDIST	URBED	
and file n				S37	44 70711			N/A		N/A	
5. NAME OF	DRILLER				14. TOTAL 15. ELEVAT		NAME OF TAXABLE PARTY.	5			
6. DIRECTION	OF HOLE	170.9		The last speed made of the	100		STAR	TED	COMPLETE	D	
VERTICAL	- INCLI	NED [DEG. FROM VERT	16. DATE I				5-2	24-9	5
7. THICKNESS				weeks for the property than I	17. ELEVAT			BOBING			
8. DEPTH DRI					19. SIGNAT			DOMING	SECTION SEC		
9. TOTAL DEP	TH OF HOL	£ 1.2									
ELEVATION	DEPTH L	EGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tim	REMARKS e, water lo	ss, de	pth of
0	0		7/8-:	shed top surfaction ical crack to reinforce in steel reinforce, slightly rus	rebar		S37				
-1.25	1.25		Local 1 1/2 na Natu Nume Some	ted at joint 37 2-in max. size tural/ crushed ral Ls FA rous entrapped entrained air egregation	Ls CA						
	=		CTD	#950380							
			no	ography - Fractondurable aggree a porous dolor mestone	gate						
	-		-								

Figure B-20. Log for south seawall core S37

1. PROJECT 2. LOCATION		DIVISION	NAD	INSTALLAT	ION			SHEET 1
2. LOCATION	ING LOG			10. SIZE	AND TYPE C	F BIT 4		OF 1 SHEETS
27 22 27 27		y's Vict	ory	11. DATUM	FOR ELEV	ATION SH	OWN (TBM OR MS	SL)
	(Coordinates o	, Sidnon)		12. MANU	FACTURER'S	DESIGNAT	TION OF DRILL	No. of Concession, Name of Street, or other Designation of Concession, Name of Street, or other Designation,
3. DRILLING	AGENCY			47	NO 05 0	/CD	DISTURBED	UNDISTURBED
4. HOLE NO.	(As shown on	drawing title	840		NO. OF ON			
and file i	number)		S49	14 TOTAL	NUMBER C	OPE BOVE	N/A	N/A
5. NAME OF	DRILLER				TION GROUN			
6. DIRECTION		- Land		16. DATE	HOLE	STAI	RTED	COMPLETED
VERTICAL			DEG. FROM VERT		TION TOP O	E HOLE		5-24-95
The sale of the sa	S OF OVERBURD				CORE REC		R BORING	
		.55 feet		19. SIGNA	TURE OF IN	SPECTOR		
3. IOIAL DE	THE OF HOLE O		LASSIFICATION OF MATERIA	ALS	% CORE	BOX OR		REMARKS
ELEVATION	DEPTH LEGE	ND	(Description)		RECOV- ERY	SAMPLE NO.	A STATE OF THE STA	e, water loss, depth of
0	0.00	Finis 500 000 000 000	hed top surfa	ce		S49		
-0.55	0.55	EOB 0	.55-ft	J 1 17				
		Numer cra agg 1 1/2 nat Natur Some Some	ed at joint 4 ous incipient cks through regate and pa -in max. size ural/ crushed al Ls FA entrapped air entrained air reaction aro	ste Ls CA				

Figure B-21. Log for south seawall core S49

DRILLING LOG DIVISION NAD						INSTALLATION					1
1. PROJECT Perry's Victory						10. SIZE AND TYPE OF BIT 4" 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)					
2. LOCATION						TT. DATOM	FOR ELEV	ATION SHO	WN (IBM OR MS	SL)	
3. DRILLING A	wing title	CEOA		12. MANUFACTURER'S DESIGNATION OF DRILL 13. TOTAL NO. OF OVER- DISTURBED UNDISTURBED BURDEN SAMPLES TAKEN					Very work		
and file number) S52A 5. NAME OF DRILLER						14 TOTAL	WILLIAMS C	ODE DOVE	N/A		N/A
5. NAME OF	DRILLER				200	14. TOTAL 15. ELEVAT	National Confession of the Con	NAME OF TAXABLE PARTY.	2		
6. DIRECTION			1000	DEC. FROM	VERY	16. DATE H	IOLE	STAR	TED	COMPLETE	ALLON TOTAL
VERTICAL		LINED C		DEG. FROM	VERI	17. ELEVAT	ION TOP O	F HOLE		5-	24-95
7. THICKNESS B. DEPTH DRI	Control of the Control					18. TOTAL			BORING		
9. TOTAL DEP	A STATE OF THE PARTY OF THE PAR		5 feet			19. SIGNAT	URE OF IN	SPECTOR		61 679	A PROPERTY.
ELEVATION	DEPTH	LEGEND		CLASSIFICATION OF	E CONTRACTOR OF THE PARTY OF TH	S	% CORE RECOV- ERY	BOX OR SAMPLE	(Drilling tin	REMARKS ne, water lo	oss, depth of ignificant)
0	0.00	23-23 23-23 23-23 23-23 23-23	Finis	shed top s		e	ERT	NO. S52A	weatherin	g, etc. if s	ignificant)
-0.25	0.25		Local Rubbi Diago fra agg Nume: Some Some Pri 1 1/2 na Natu: CTD Petri	approx. 0. ted at joi le onal incip actures th gregate an rous entra entrained white rea oduct in v 2-in max. tural/ cru ral Ls FA #950382 ography - re filled tringite	nt 51 ient rough d pas pped air ction oids size shed	./52 ite voids i					

Figure B-22. Log for south seawall core S52A

DRILI	ING LOG	DIVISION	NAD	INSTALLATI	ON	THE	48 4 10	SHEET 1 OF 1 SHEETS		
1. PROJECT	Perr	y's Vict		10. SIZE	ND TYPE O	F BIT 4	OWN (TBM OR M			
2. LOCATION	(Coordinates or						TION OF DRILL	The state of the s		
3. DRILLING	AGENCY			12. MANUI	ACTURERS	DESIGNAL	Sale of the Sale	100000000000000000000000000000000000000	100	
A HOLE NO.	. (As shown on	drawing title		13. TOTAL NO. OF OVER- DISTURBED UNDISTURBED						
and file	number)		S52B	N/A N/A						
5. NAME OF	DRILLER			14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER						
6. DIRECTION			DEG. FROM VERT	16. DATE	HOLE	STAF	RTED	COMPLETED		
	S OF OVERBURDE		DEG. FROM VERT	17. ELEVA	TION TOP O	F HOLE		5-24-95		
8. DEPTH DR		CORE REC		R BORING						
9. TOTAL DE	PTH OF HOLE 1	feet		19. SIGNA	TURE OF IN	ISPECTOR				
ELEVATION	DEPTH LEGEN	COLUMN TO THE PARTY OF THE PART	(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling time	REMARKS ie, water loss, depth of g, etc. if significant)		
-1	1.00	Petro Pe	steel reinford .O-ft new ed at joint 5: -in max. size ural/ crushed al Ls FA entrapped air ntrained 950383 graphy - Acid hed indicated ative reaction	cing 1/52 Ls CA		S52B				

Figure B-23. Log for south seawall core S52B

DRILLI	NG LOG	DIV	ISION	NAD	INSTALLATIO	N			SHEET 1
1. PROJECT		ELIVER DEVICE	10. SIZE AND TYPE OF BIT 4 "						
2. LOCATION	Vict	ory	11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
2. 200					12. MANUF	CTURER'S	DESIGNATION	ON OF DRILL	
3. DRILLING A	GENCY				13. TOTAL				
4. HOLE NO.	4. HOLE NO. (As shown on drawing title						ER- TAKEN	DISTURBED	UNDISTURBED
and file no		S60A				N/A	N/A		
5. NAME OF I			14. TOTAL		DANS I THURSDAY				
6. DIRECTION	OF HOLE				15. ELEVAT		START	TED .	COMPLETED
VERTICAL INCLINED DEG. FROM VERT					16. DATE H				5-24-95
7. THICKNESS					17. ELEVAT			BORING	
8. DEPTH DRII					19. SIGNAT		THE RESIDENCE AND ADDRESS OF	DONING	
9. TOTAL DEP	TH OF HO	LE 0.5							
ELEVATION	DEPTH	LEGEND		(Description)	LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tin	REMARKS ne, water loss, depth of ig. etc. if significant)
0	0.0_		Finis	shed top surfac	ce		S60A		
-0.5	0.50		Locat Vert: fra 1 1/2 nat Natur White ard Some No se CTD: Petro re AS:	ted at joint 5; ical incipient acture 2-in max. size tural/ crushed ral Ls FA e reaction pro- ound CA entrapped air entrained air egregation #950384 ography - Whit action product R associated w w index chert	Ls CA duct				
	-								

Figure B-24. Log for south seawall core S60A

DRILLING LOG DIVISION NAD				INSTALLAT	TION	SHEET 1 OF 1 SHEETS				
1. PROJECT				10. SIZE AND TYPE OF BIT 4 "						
0.100100	The state of the s	ry's Vict	ory	11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
2. LOCATION	(Coordinates	or Signon)		12. MANU	FACTURER'S	DESIGNA	TION OF DRILL			
3. DRILLING	AGENCY	A CONTRACTOR OF THE PARTY OF TH	and were the second to the					The second secon		
4. HOLE NO. (As shown on drawing title					NO. OF O'		DISTURBED	UNDISTURBED		
and file		ardwing inte	S60B				N/A	N/A		
5. NAME OF	DRILLER	and the same	and the same of		NUMBER C					
6. DIRECTION	OF HOLE			15. ELEVA	TION GROUP	-	RTED	COMPLETED		
VERTICAL		ED 🗆	DEG. FROM VERT	16. DATE	HOLE			5-24-95		
7. THICKNESS	S OF OVERBU	RDEN			TION TOP C	THE RESIDENCE AND ADDRESS OF THE PARTY OF TH				
8. DEPTH DR	ILLED INTO RO	оск		O TOTAL DESIGNATION OF THE PERSON OF THE PER	CORE REC	CONTRACTOR CONTRACTOR	R BORING			
9. TOTAL DE	PTH OF HOLE	1.1 feet		15. 31017	TORE OF IN	STECTOR				
FLEVATION	DEPTH LE	Contract Con	LASSIFICATION OF MATERIAL	S	% CORE	BOX OR		REMARKS		
ELEVATION	DEPTH LE	GEND	(Description)		RECOV- ERY	SAMPLE NO.	(Drilling tim	ne, water loss, depth of g, etc. if significant)		
0	0.0	Finis	hed top surfac	e	1	S60B	2012			
1331		300								
N. B. L. L. B. B. B. L. B.			cal incipient					THE REAL PROPERTY OF		
1 3 3		C1000000000000000000000000000000000000	ctures through length of cor			100				
10.33			rough CA parti							
	19						A STATE OF	The Control of the		
	1 1	3				33.				
M 13 To										
		36 Pt					000000			
	P	10				1.76	10. 5 K St. 4			
	00	-000		100		THE PERSON NAMED IN		A CONTRACTOR OF THE		
-1.1	1.10	EOB 1	.1-ft							
	-	Locat	ed at joint 59	160		1 1 1 1 1				
	-		-in max size	, 00	1-15 (6)	-				
	-	nat	ural/ crushed	Ls CA						
	-		al Ls CA			7-7-1-9				
1000	-		entrapped air entrained air							
	-		white reaction					-		
	-		ducts in voids				13 17 18			
	-	OFF II	050305		1000					
		CID #	950385		THE REAL PROPERTY.	411				
	7				THE PULL	1 32	VI 33.55			
	-	The state of			1 7-4	8 39	4- 1914			
			graphy - Coars							
			regate particl	es						
		are	porous							
		-13					7-2-1-1			
		100								
		Table Bellio				1 = 1				
					15.0					
		The state of					A			
1 74.3		0 - 100					11 1 12			

Figure B-25. Log for south seawall core S60B

DRILLI	NG LOG	DIVISION	NAD	INSTALLATIO	N	-	-	SHEET 1		
1. PROJECT				10. SIZE A	ND TYPE O	F BIT 4 II		OF 1 SHEETS		
	Perry (Coordinates or	's Vict	ory	10. SIZE AND TYPE OF BIT 4 " 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)						
				12. MANUF	ACTURER'S	DESIGNATION	ON OF DRILL			
3. DRILLING A	GENCY			13. TOTAL	NO OF OU	ED-	DISTURBED	UNDISTURBED		
4. HOLE NO.	(As shown on o	Irawing title	960	_	N SAMPLES		-			
and file n	umber)		S68	44 70711	MINISTS C	005 55	N/A	N/A		
5. NAME OF	DRILLER			15. ELEVAT	NUMBER C	Experiment of the second				
6. DIRECTION	OF HOLE	N-1-1-1				START	TED	COMPLETED		
VERTICAL	□ INCLINED	o	DEG. FROM VERT	16. DATE	HOLE			5-24-95		
7. THICKNESS	OF OVERBURDE	N		The state of the state of the state of	TION TOP O	-				
B. DEPTH DRI	LLED INTO ROCK		THE RESIDENCE OF THE PARTY AND	NAME OF TAXABLE PARTY.	CORE REC	HALL TAXABLE PARTY	BORING			
9. TOTAL DEP	TH OF HOLE 1	4 feet		137 313117	TORKE OF THE	J. LOTOR				
ELEVATION	DEPTH LEGEN	Total Control of the	(Description)	ALS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	(Drilling tin	REMARKS ne, water loss, depth of g, etc. if significant)		
0	0.0	Fini	shed top surfa	CO		S68	weatherin	g, etc. II significant)		
0	0.0	8 11111	once cop surra	30		500				
	1000	20					1			
		C/S				100				
	1000	5			The state of					
	- 600	1			1000		STEER.			
	- DX-00	20			1 79		70 35			
	1 - 280	0			The same					
		86								
		3				-				
		0					1112			
	- 500	Ď			1 Vereil		P-5 - 33			
	1 2 8	2			1000					
	- 88 k	8								
-1.4	1.40	EOB	1.4-ft new	11111						
	-	Loca	ted near mid-1	ength		1	M. Sylver			
			monolith				THE PARTY			
		1 1/	2-in size natu	iral/			E E CORE			
	4	cr	ushed Ls CA				1 3-233			
		The contract of	ral Ls FA			3 1 1 1				
			entrapped all entrained							
			egregation							
	-					115	1017			
		CTD	#950386		S P III					
	_									
	_									
	_									
		- 7.3								
	THE STATE OF THE S						451.50	the second state		

Figure B-26. Log for south seawall core S68

DRILL	ING LOG	IVISION NAD	INSTALLATI	ON			SHEET 1 OF 1 SHEETS	
1. PROJECT	Perry'	s Victory	10. SIZE AND TYPE OF BIT 4-in 11. DATUM FOR ELEVATION SHOWN (TBM OR MSL)					
2. LOCATION	(Coordinates or St					ION OF DRILL		
3. DRILLING	AGENCY				M200370002000	Self the South	Lugierunge	
	(As shown on dra	wing title S72	13. TOTAL NO. OF OVER- DISTURBED UNDISTURBED BURDEN SAMPLES TAKEN					
and file n		~.~	14. TOTAL	NUMBER C	ORE BOXES	S		
6. DIRECTION	OF HOLE		15. ELEVAT	TION GROUN	ND WATER	TED	COMPLETED	
VERTICAL		DEG. FROM VERT	16. DATE				5-24-95	
	OF OVERBURDEN		17. ELEVAT	THE PARTY OF THE P	The state of the s	BORING		
	ILLED INTO ROCK	foot	THE STATE OF THE S	TURE OF IN			Description of the last	
ELEVATION	DEPTH LEGEND	CLASSIFICATION OF MATERIA	LS	% CORE RECOV-	BOX OR SAMPLE	(n-in-	REMARKS	
ELEVATION		(Description)	100	ERY	NO.	weathering	e, water loss, depth of the contract of the co	
0		Reinforcing steel tie wire, some corrosion C/S Short specimen Reinforcing steel, some corrosion			S72			
-1.4	1.4	Located at joint 7: 1-in size natural/ crushed Ls CA Natural Ls FA Numerous entrapped Air entrained No segregation CTD #950387						

Figure B-27. Log for south seawall core S72

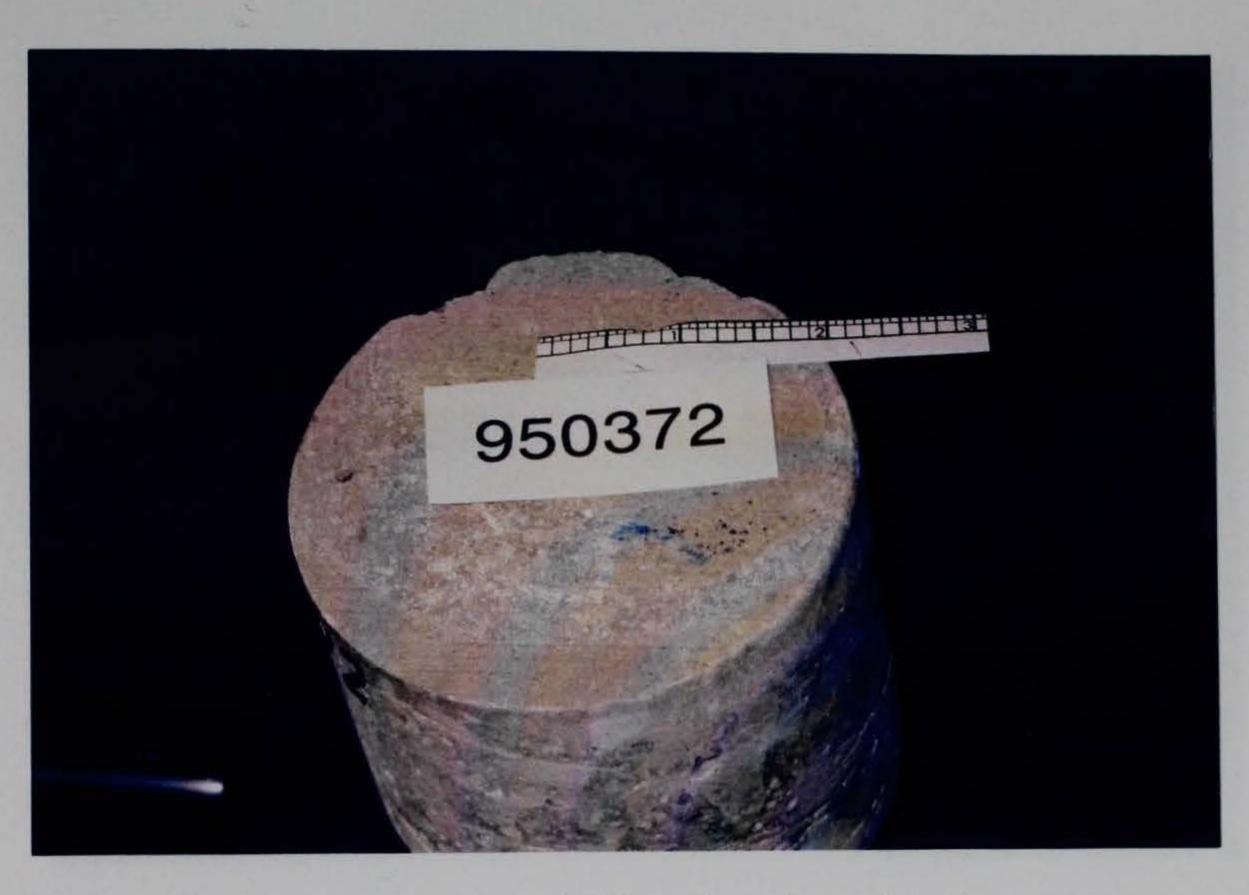


Figure B-28. Sample 950372 surface shows intact concrete

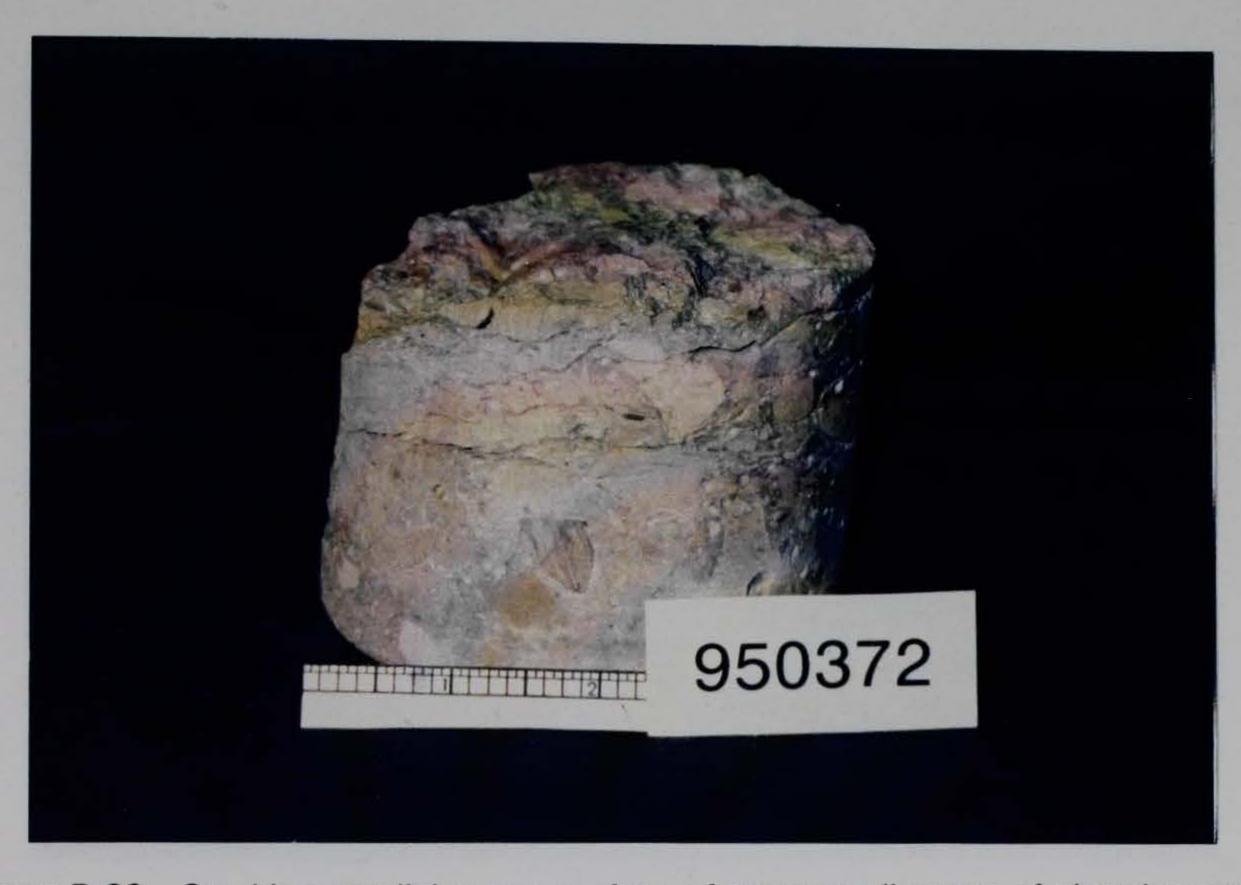


Figure B-29. Cracking parallel to top surface of structure (bottom of photo) occurs several inches below surface and cannot be detected by visual examination

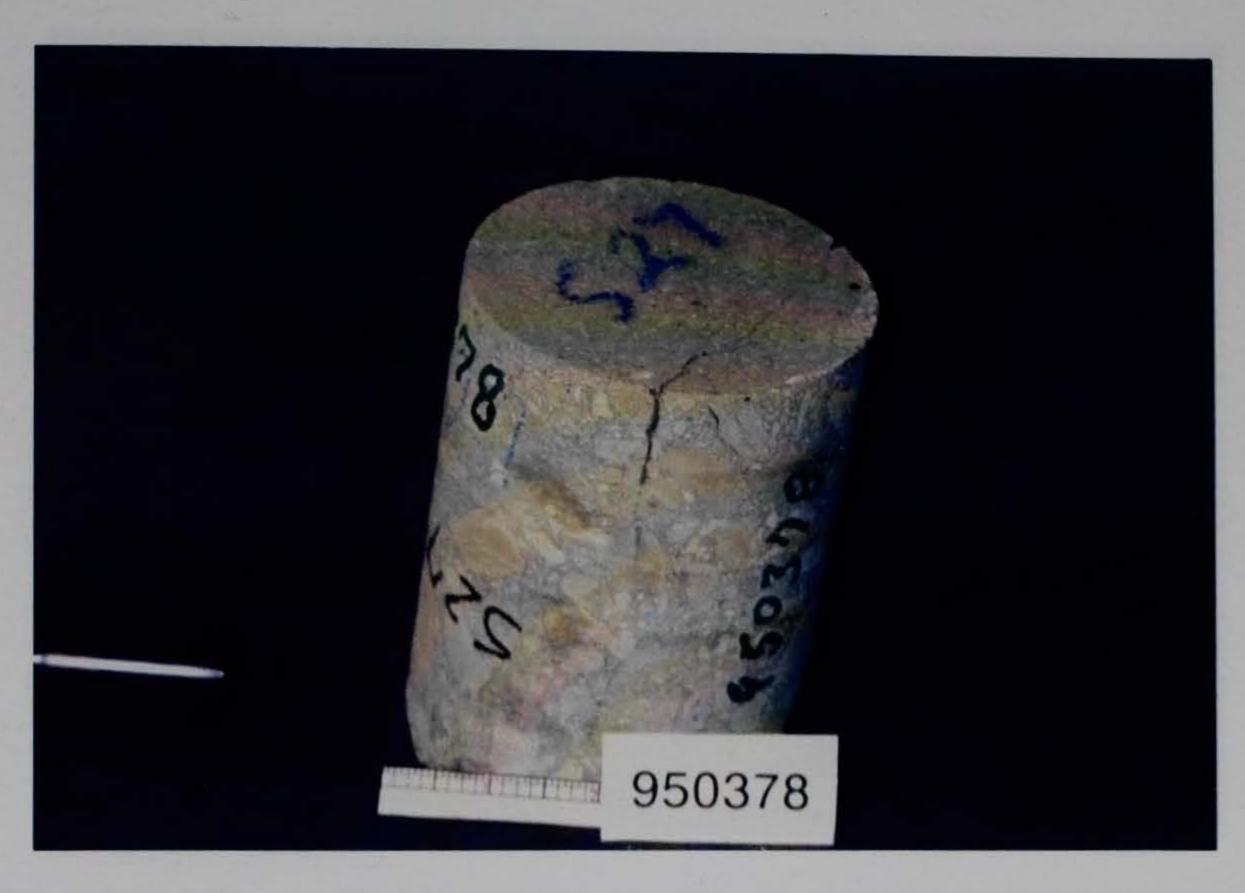


Figure B-30. Vertical crack in sample 950378 goes to the surface of the concrete



Figure B-31. Sample 950388 consists of rubble in which the fractures commonly go through aggregate particles as well as through paste

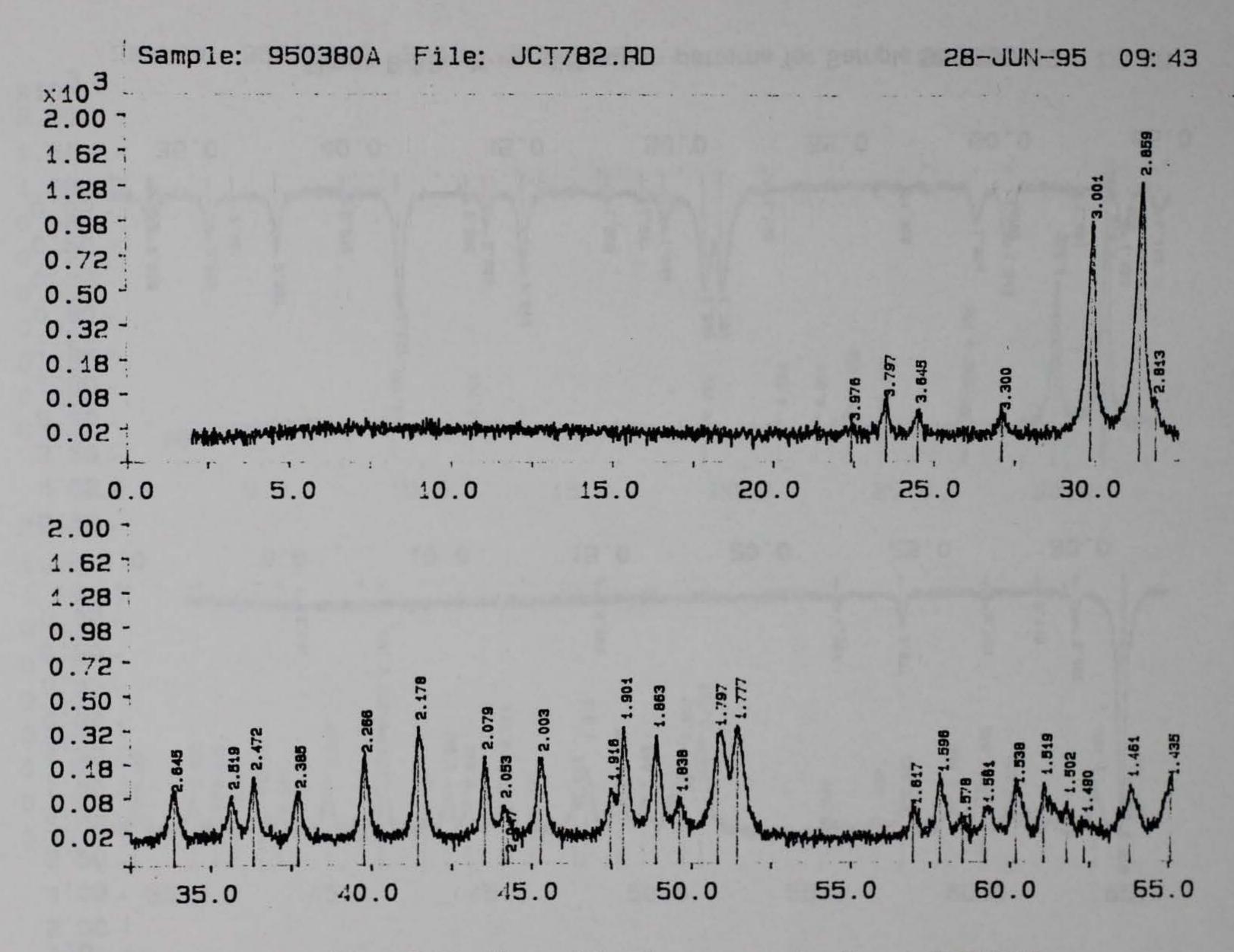


Figure B-32. X-ray diffraction patterns for Sample 950380A

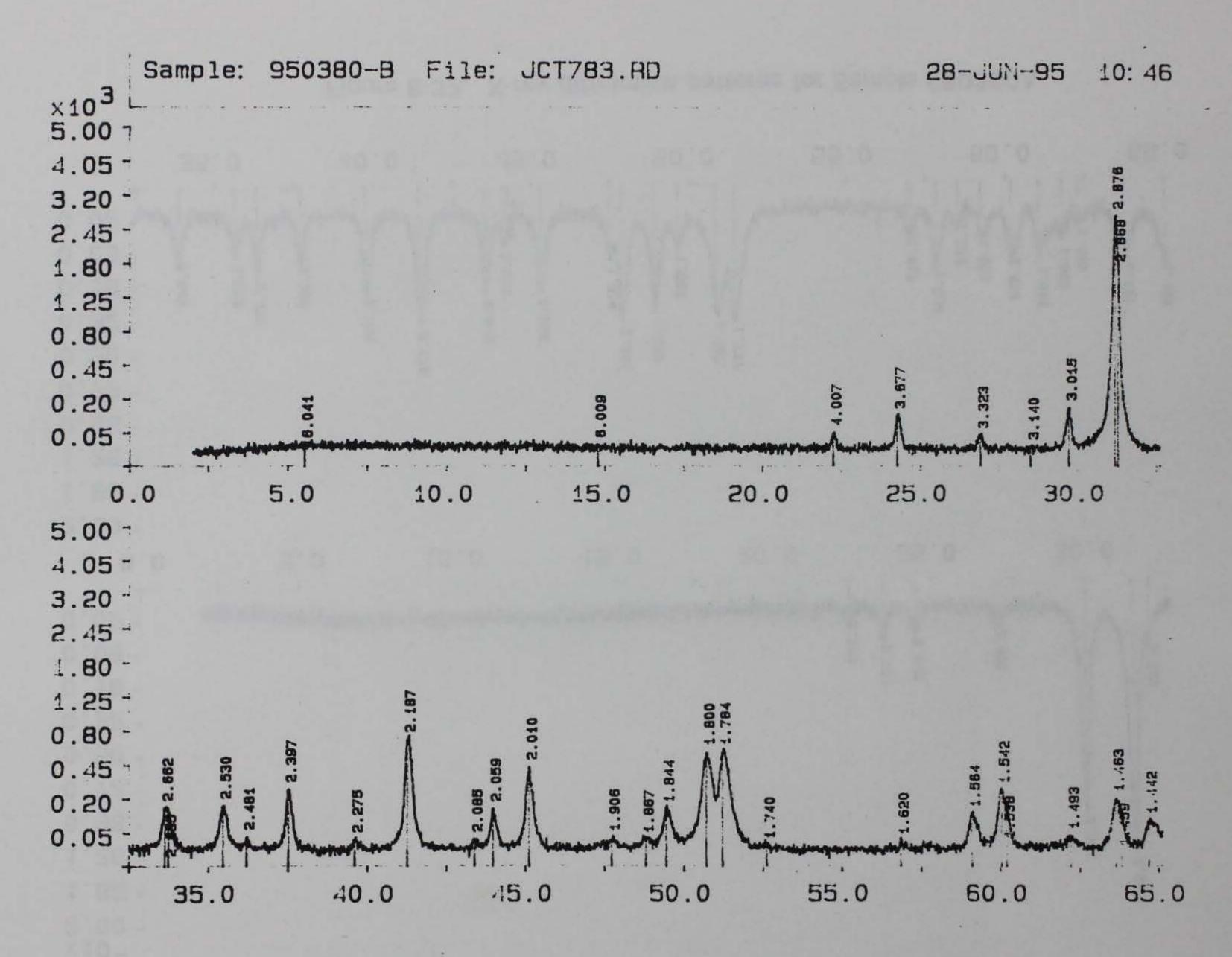


Figure B-33. X-ray diffraction patterns for Sample 950380B

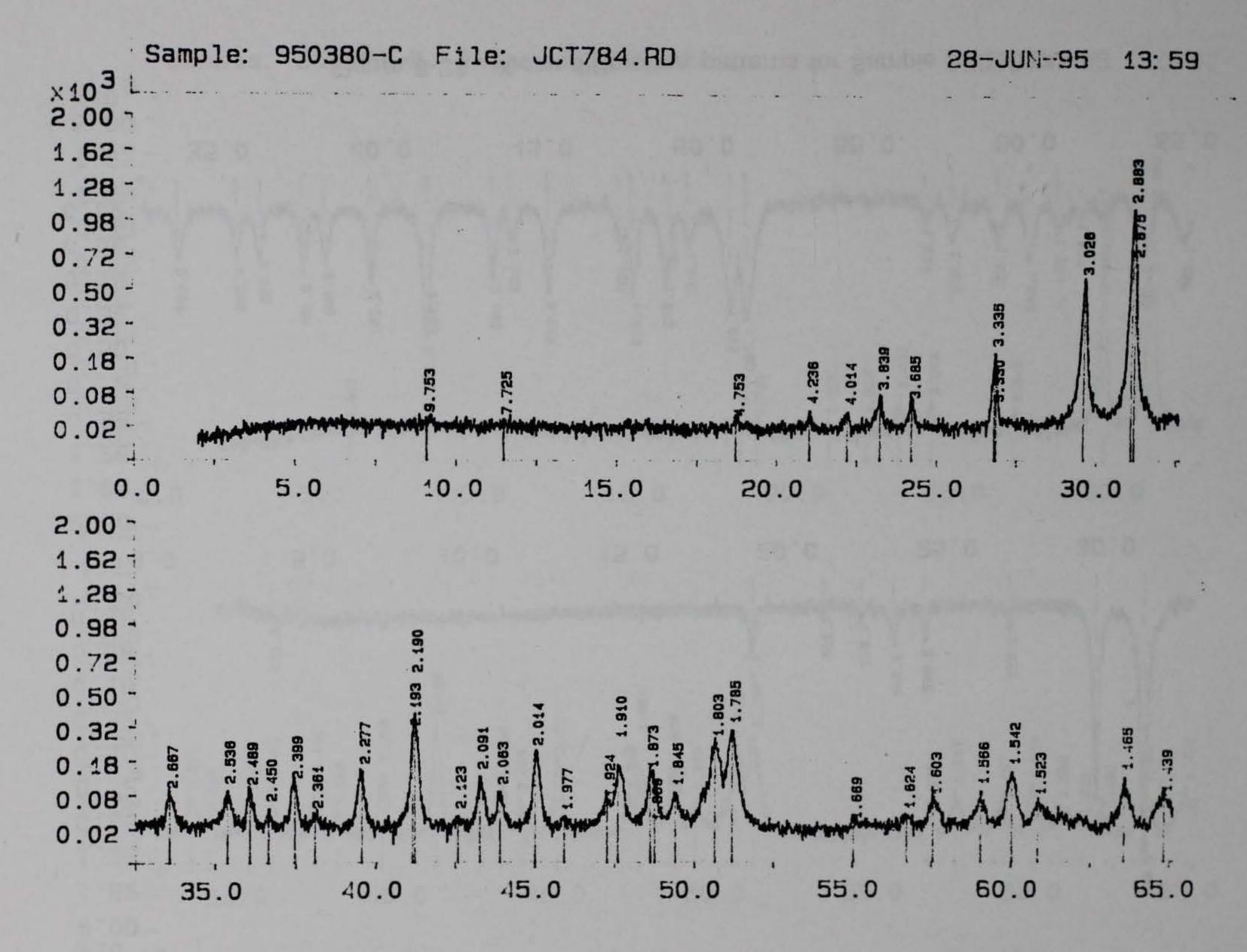


Figure B-34. X-ray diffraction patterns for Sample 950380C

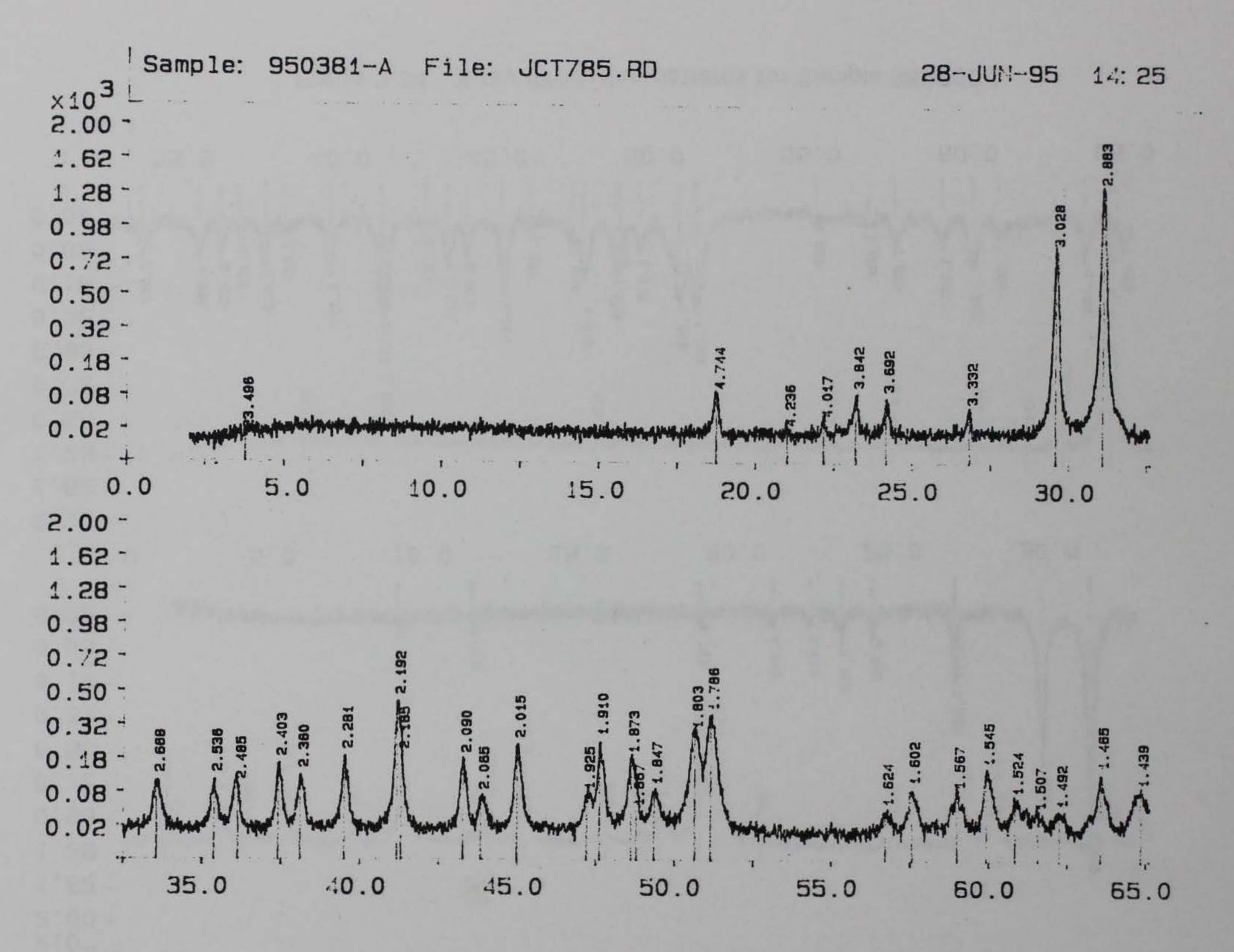


Figure B-35. X-ray diffraction patterns for Sample 950381A

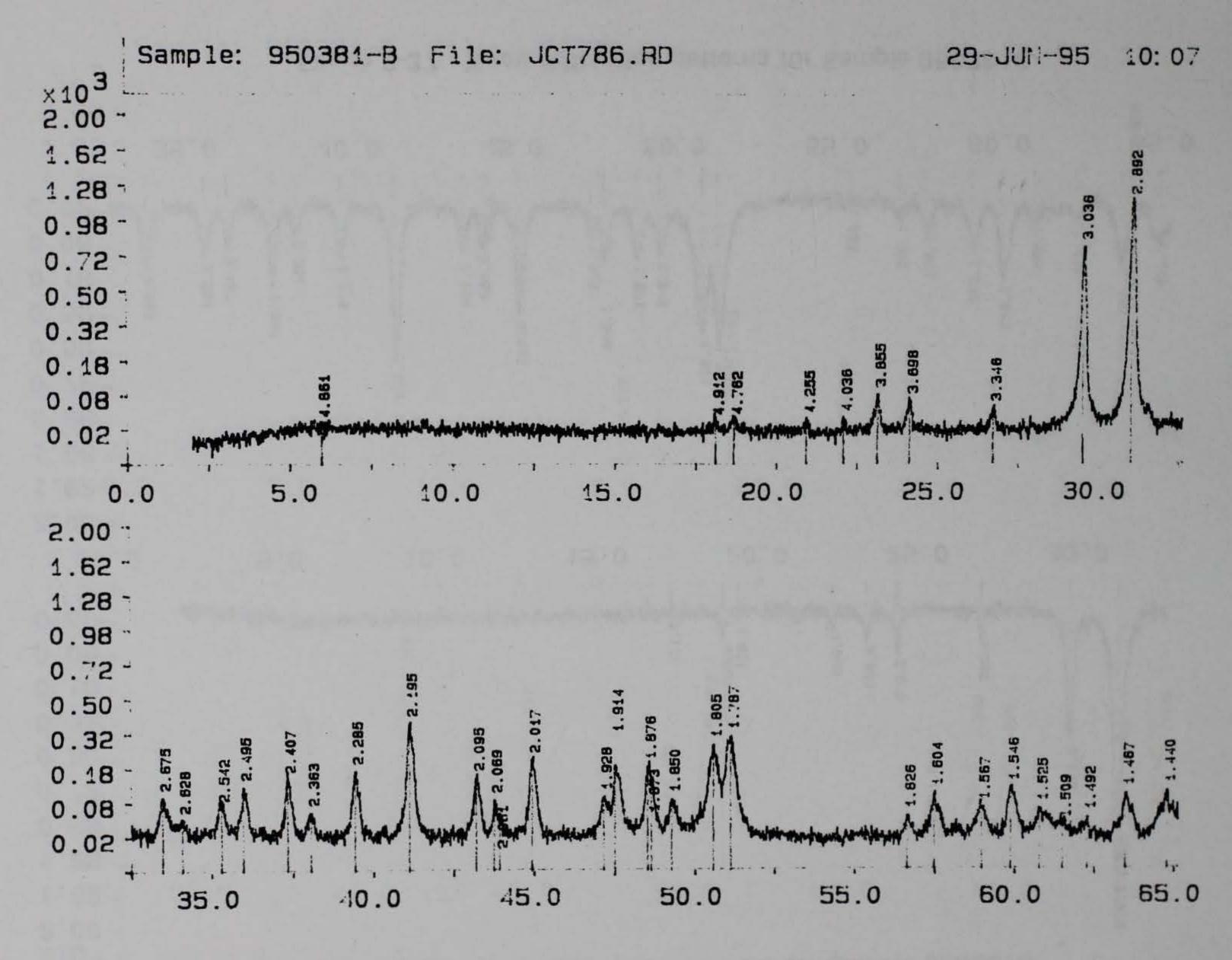


Figure B-36. X-ray diffraction patterns for Sample 950381B

Sample: 950381-C File: JCT787.AD

Figure B-37. X-ray diffraction patterns for Sample 950381C

29-JUN-95

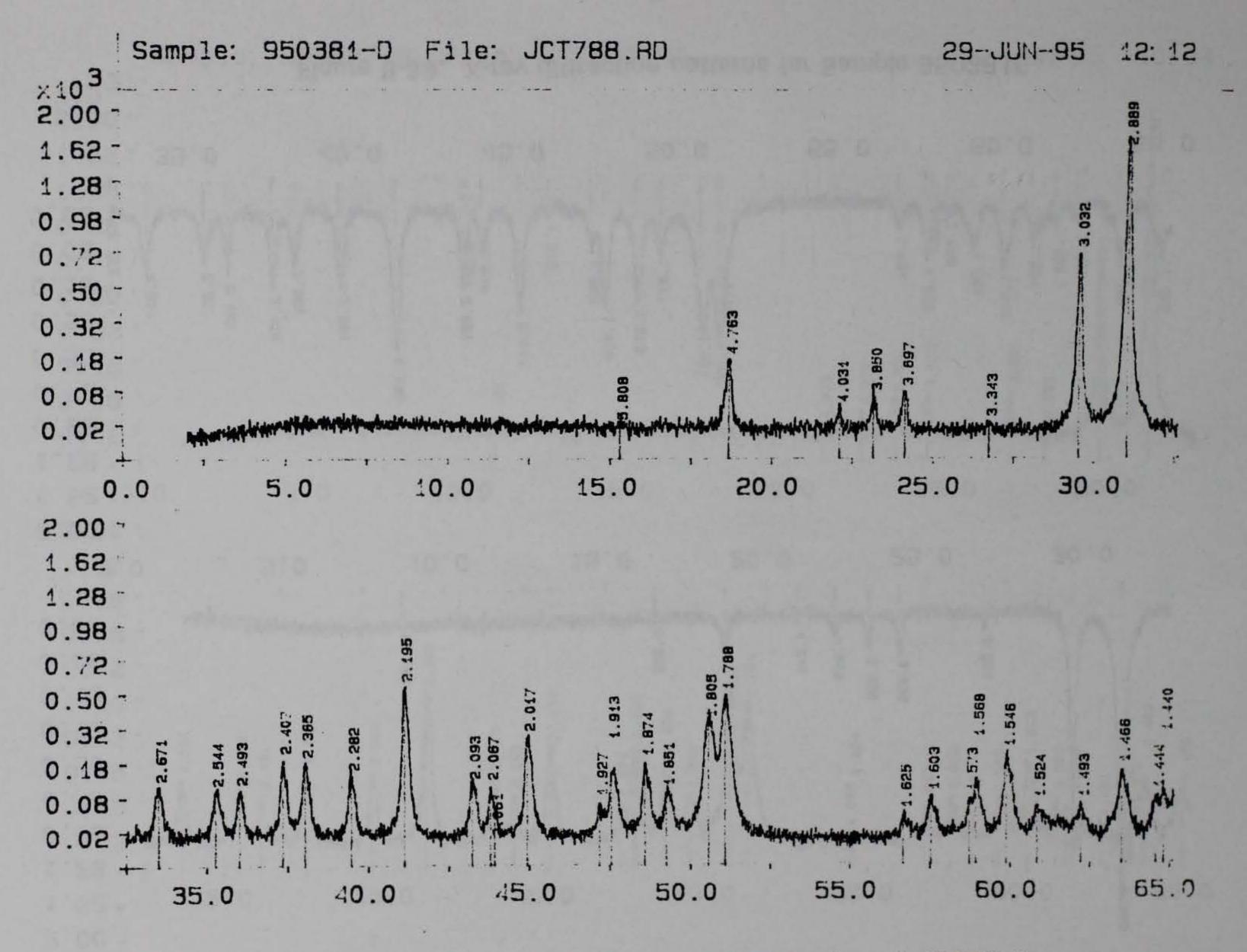


Figure B-38. X-ray diffraction patterns for Sample 950381D



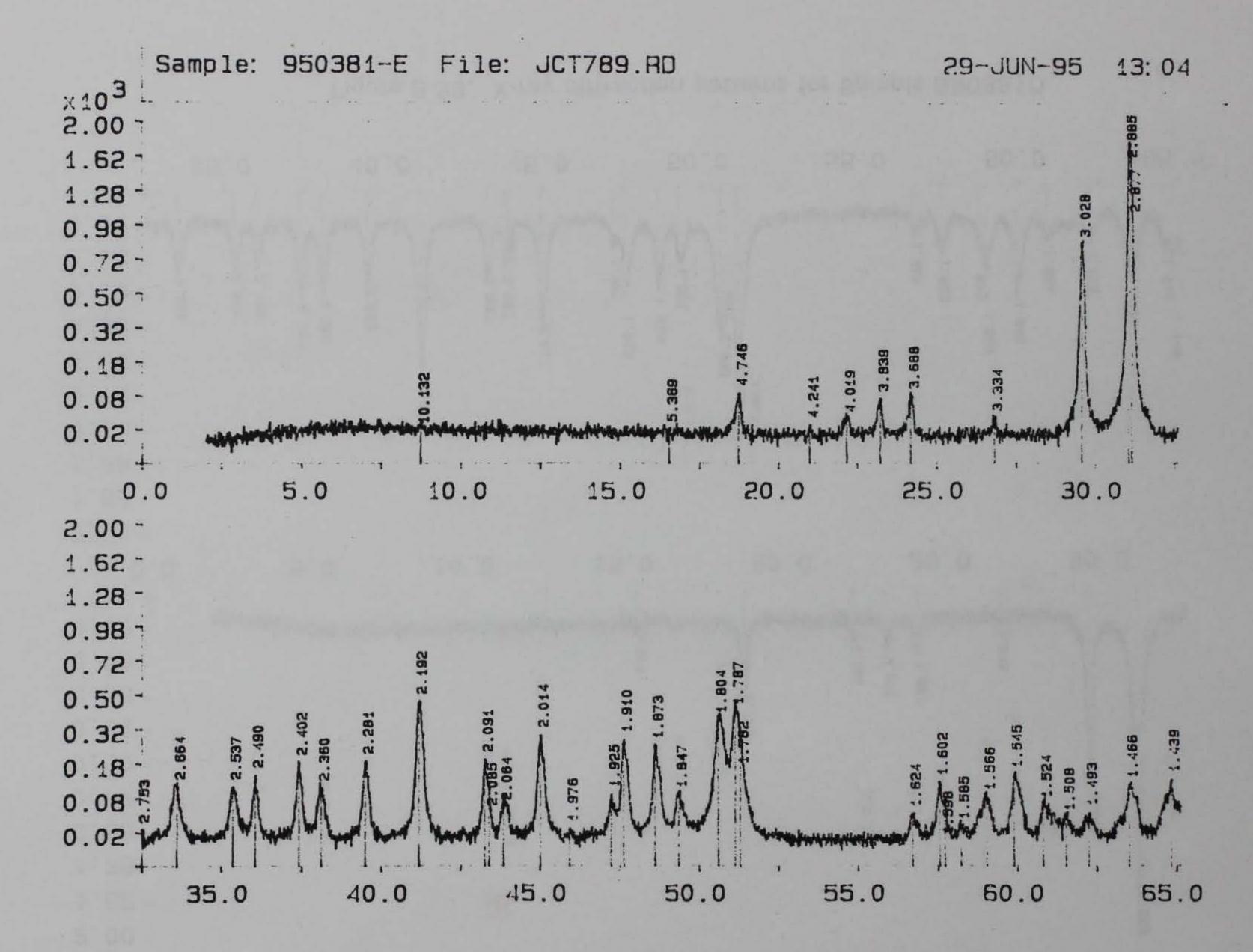


Figure B-39. X-ray diffraction patterns for Sample 950381E

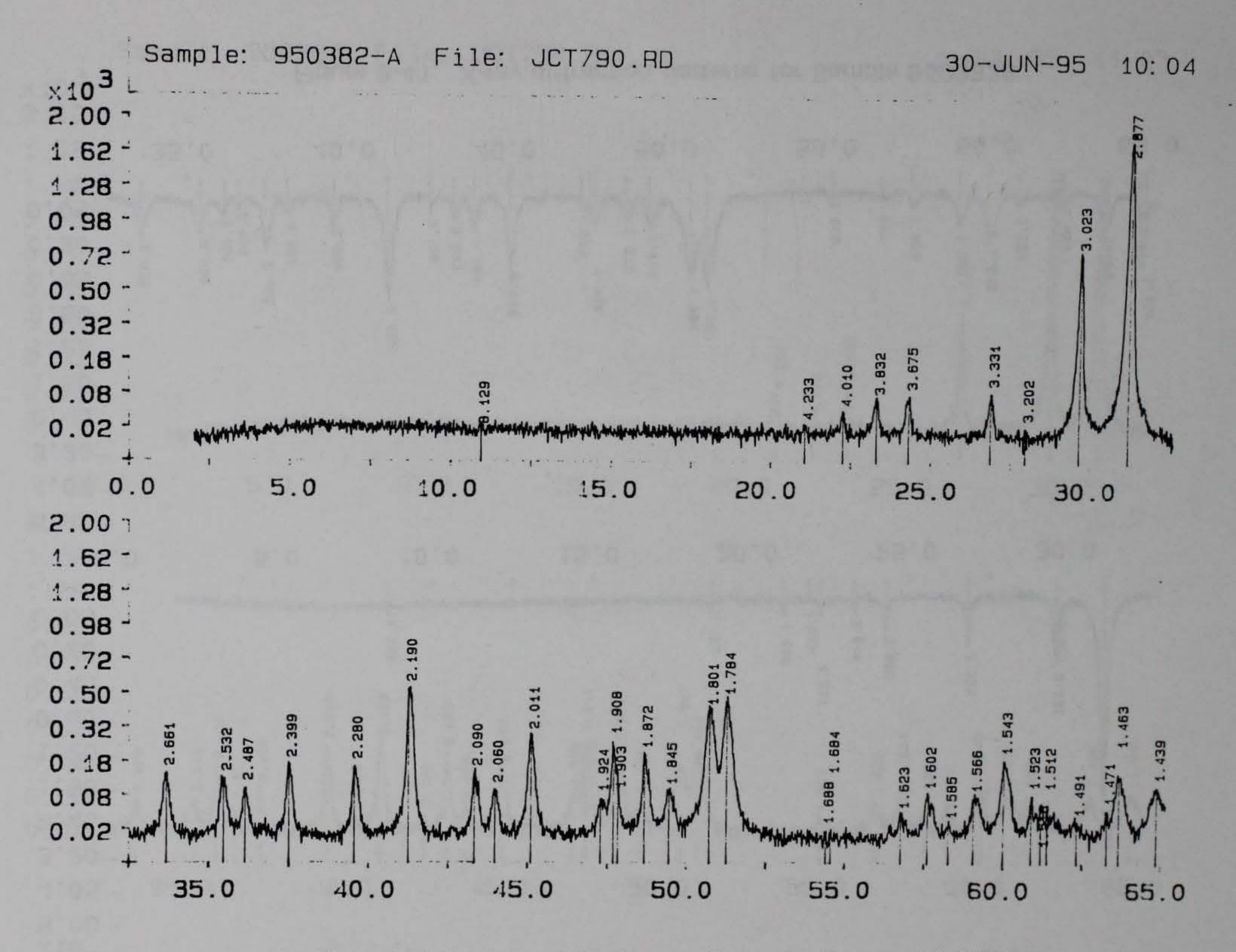


Figure B-40. X-ray diffraction patterns for Sample 950382A



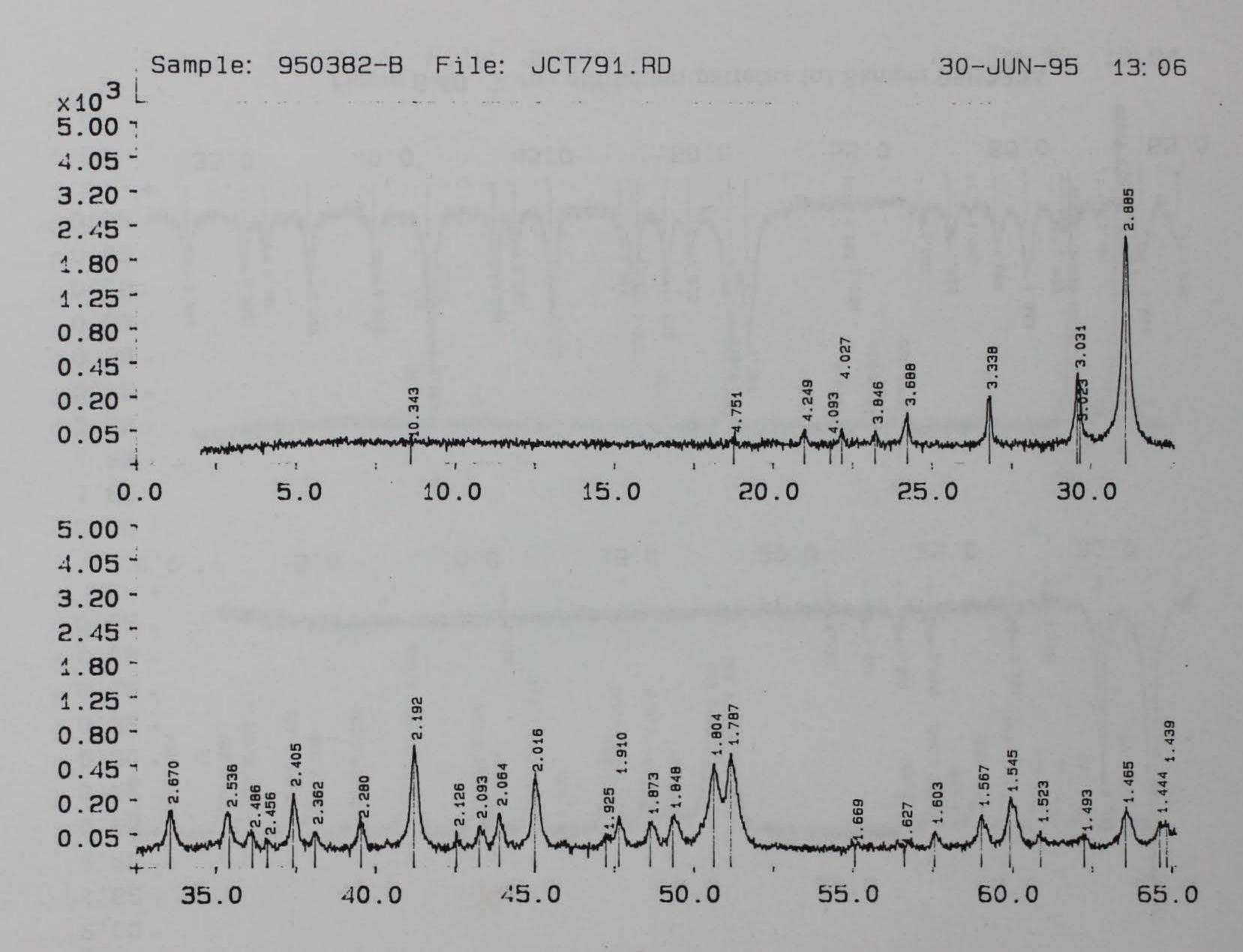


Figure B-41. X-ray diffraction patterns for Sample 950382B



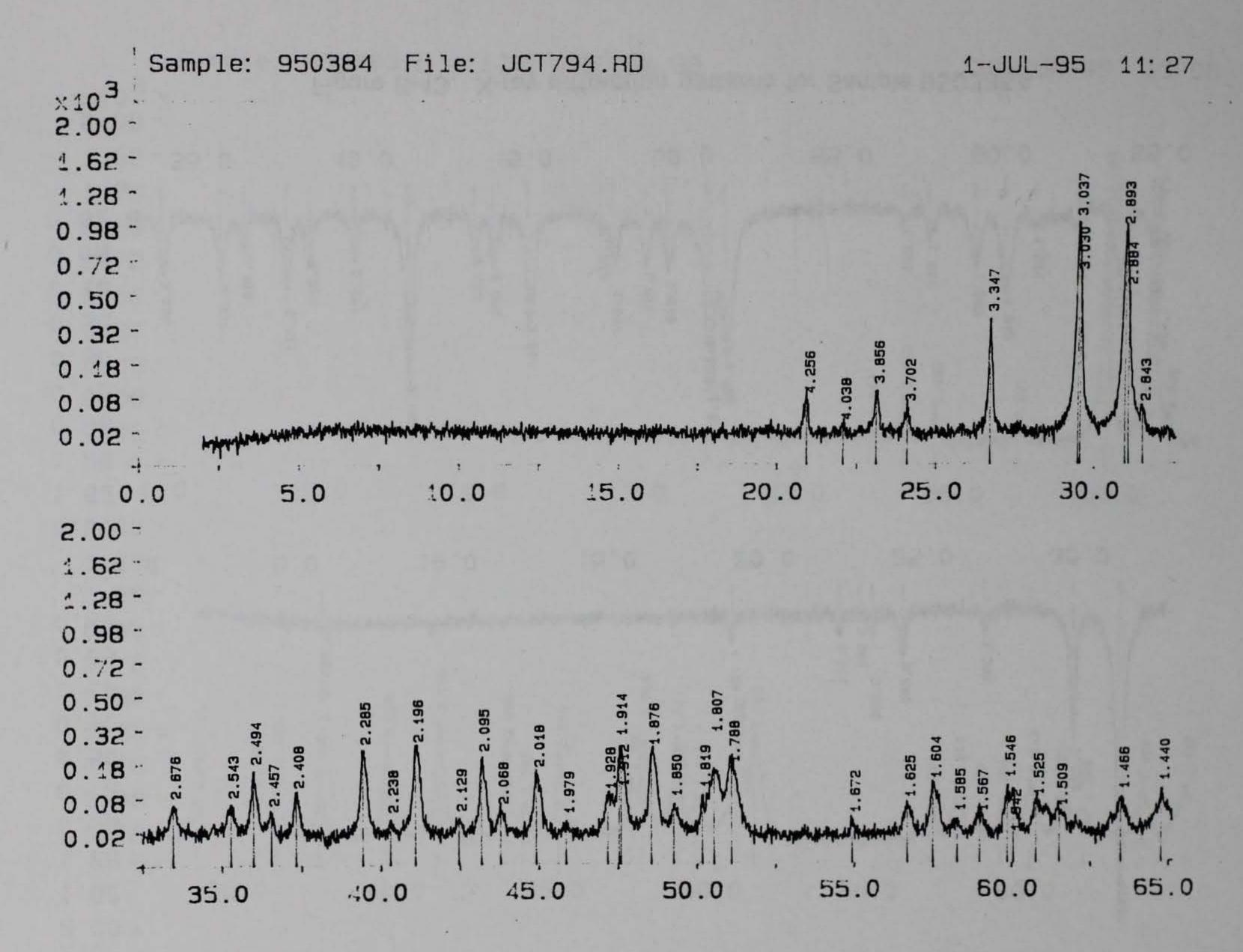


Figure B-42. X-ray diffraction patterns for Sample 950384



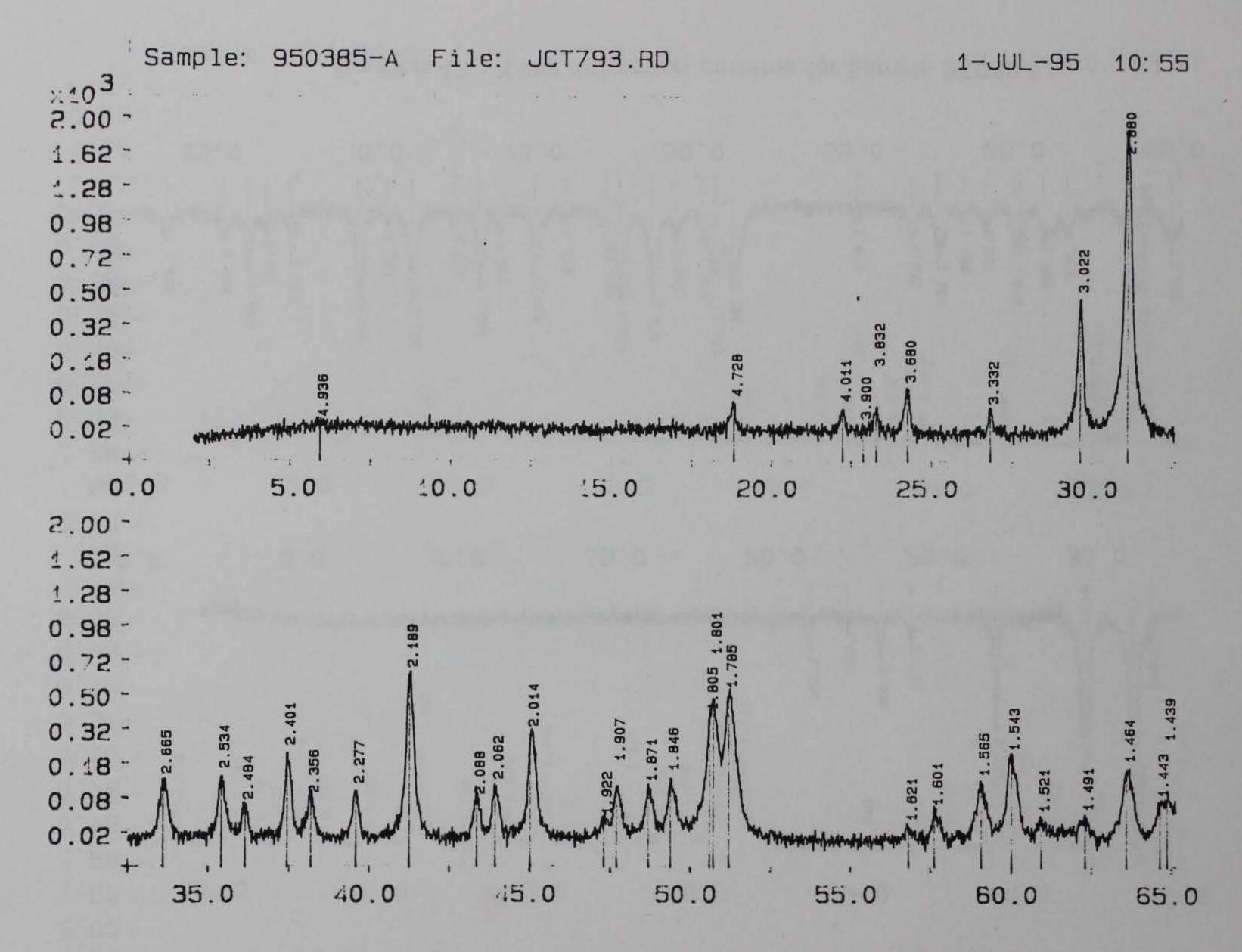


Figure B-43. X-ray diffraction patterns for Sample 950385A

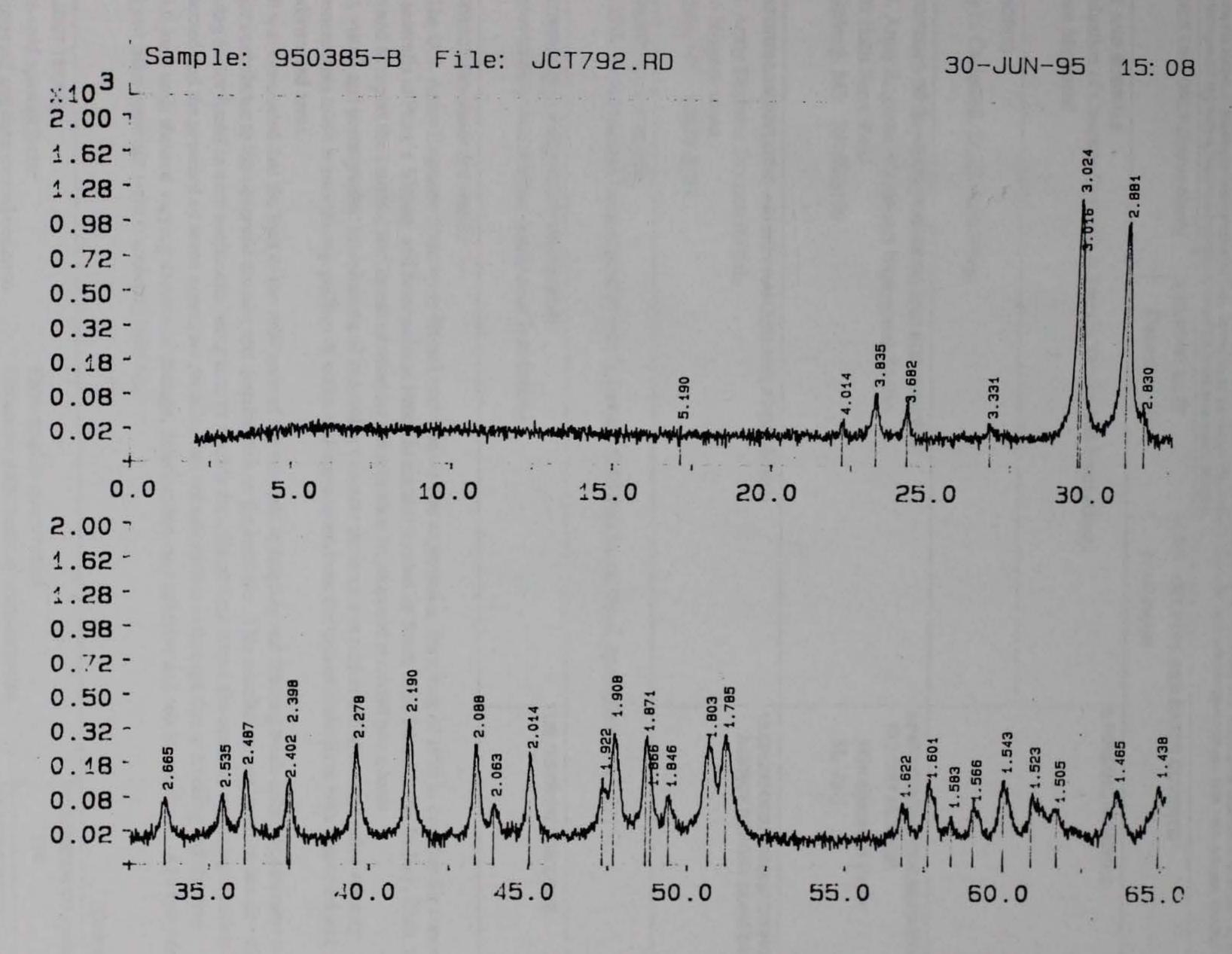


Figure B-44. X-ray diffraction patterns for Sample 950385B

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13.ABSTRACT (Maximum 200 words)

The U.S. Army Engineer Waterways Experiment Station was requested in the spring of 1995 to evaluate the concrete in the seawalls at Perry's Victory and International Peace Memorial located on South Bass Island at Put-In-Bay, Ohio, in Lake Erie and to report the cause(s) and extent of concrete deterioration an proposed remedial procedures.

A visual and photographic examination of accessible concrete surfaces was performed, ultrasonic pulse velocity measurements made across the top portion of walls, and cores taken from the tops of seawalls in both distressed and nondistressed areas.

It was concluded that the lack of the resistance of the concrete to freezing and thawing while critically saturated was the major contributor to the observed distress and deterioration in the concrete. This conclusion was based on the air-void spacing factor found in core specimens being near or outside the critical limit where the concrete would be considered protected and the presence of some aggregate particles that are susceptible to damage due to freezing and thawing.

All joint seals showed varying degrees of damage, deterioration, and adhesive and cohesive failures. At a few joints, the seal and filler materials were completely missing.

(Continued)

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Distressed and deteriorated concrete

Freezing and thawing deterioration

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Ultrasonic pulse velocity measurements

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It was recommended that the distressed and deteriorated concrete at 48 locations be considered for removal and replacement. Because of the inadequate air-void system within the remaining concrete, it was recommended that a breathable sealer be applied to monolith faces and reapplied periodically. It was also recommended that existing seals be removed and new seals installed at all joints.