360
HORSESHOE DAM

HORSESHOE DAM, SMITHFIELD (360)

Horseshoe Dam (Figure 1) has been classified by DEM as having a **Significant Hazard** potential. The following report summarizes GZA's evaluation of the dam's potential impact area due to failure of the dam.

1.00 SUMMARY OF SITE AND POTENTIAL DOWNSTREAM IMPACT AREA

In addition to compiling background information and GIS mapping data, GZA performed field reconnaissance of the dam and its associated downstream area (Figure 2). GZA representatives David M. Leone and Bryant B. Furtado visited the site and the downstream river valley on May 31, 2007. A field checklist from the reconnaissance is provided in **Attachment I** and selected photographs are provided in **Attachment II**.

1.10 Site Description

Horseshoe Dam is located on the North Branch Pawtuxet River in the Town of Scituate, Providence County, Rhode Island (See Locus Map, Figure 1). The following identification numbers are associated with the dam:

- DEM ID Number 360
- NID ID Number RI 03004

The dam is an earthen embankment structure that primarily consists of a 240-ft long horse shoe-shaped broad crested stone masonry spillway. The maximum height of the dam is about 12 ft, and the total length is approximately 240 feet. Danielson Pike (Route 6) traverses the top of the dam. Pertinent engineering data, as obtained from the DEM dam information database, is provided in **Table 1**.

The purpose of the dam and its impoundment is water supply. The dam impounds a regulating reservoir located immediately upstream of Scituate Reservoir, the main water supply reservoir for the Greater Providence Area. As such, there is typically little difference in upstream and downstream water surface elevation at Horseshoe Dam (i.e., limited head at the dam to generate a dam break flood wave). The water supply system is owned by the City of Providence and it is operated by the Providence Water Supply Board Providence Water.

TABLE 1. Pertinent Engineering Data

Dam	
Type	Earthen/Masonry
Length	Approximately 240 feet
Height	Approximately 12 feet
Drainage Area	22 square miles
Elevation (feet above approximate MSL)	
Normal Pool (Spillway)	+/- 288 ft

Top of Dam	+/- 299 ft
Storage (Acre-feet)	
Normal Pool	1,314
Top of Dam	1,935
Primary Spillway	
Type	Horseshoe Masonry Weir
Weir Length	Approximately 240 ft

1.20 Downstream Description

Horseshoe Dam is located immediately upstream of Scituate Reservoir on the North Branch Pawtuxet River in the Town of Scituate. Discharge from Horseshoe Dam flows directly into the Scituate Reservoir. Danielson Pike passes along the top of the dam.

1.21 Downstream Dams

Gainer Memorial Dam (RIDEM 161) impounds the Scituate Reservoir. The dam is a 109-foot high, 3,200-foot long earthen embankment structure located approximately 6 miles downstream of Horseshoe Dam.

1.22 Downstream Bridges

There is a bridge on Danielson Pike that spans over the headwaters of the Scituate Reservoir.

1.23 Downstream Development

The primarily uninhabited, undeveloped Scituate Reservoir shoreline comprises the downstream area..

2.00 DAM HAZARD POTENTIAL ASSESSMENT

To further evaluate the extent of flooding due to a potential dam failure, GZA performed a limited hydraulic investigation of the hypothetical dam break flood. The analysis was performed with the National Weather Service (NWS) Simplified Dam Break (SMPDBK) model, which estimates the peak dam break flood outflow, peak water surface elevations, and the timing of the flood wave as it travels downstream, given breach characteristics specific to the dam and the geometry of the downstream channel and overbank. SMPDBK output summaries are provided in **Attachment III**.

Please note that the approximate extent of hypothetical dam break flooding generated with SMPDBK is not generally applicable for emergency planning nor other hydraulic design purposes. Detailed hydraulic modeling using state-of-the-practice unsteady flow models such as the NWS DAMBRK or FLDWAV computer programs, which is not in the scope of

this study, should be performed when generating inundation maps for Emergency Action Plans or for use in spillway design / inflow design flood (IDF) studies.

2.10 Potential Dam Failure Mechanisms and Breach Description

As specified by the DEM, the simplified hypothetical dam failure analysis assumed starting pool elevations in the impoundment coincident with the top of dam elevation and average stream flow conditions prevailing (i.e., assumed about 1 to 2 cfs per square mile of drainage area). Dam breach parameters such as time of breach formation, breach shape, and the average width of the breach were selected according to these conditions and based upon the type of materials used in constructing the dam, in accordance with the recommended range of values published in the Federal Energy Regulatory Committee (FERC) guidelines and based on engineering judgment. GZA assumed that the probable mode of failure of the Horseshoe Dam was along the earth embankment, with a time to failure of 30 minutes and a trapezoidal breach shape (0.5 H : 1.0 V) utilized. Because the breach was assumed to occur at the embankment section of the dam, the average breach width was assumed to be three times the height of the dam (about 12 ft).

2.20 Estimated Peak Outflow from Dam Break

The peak outflow from the hypothetical dam break was estimated using the breach outflow approximation equation developed by the National Weather Service as part of their SMPDBK computer model (see Attachment III), using the breach parameters described above and top-of-dam pool reservoir characteristics.

The estimated peak breach outflow of approximately 4,500 cfs is comparable to the peak FEMA 500-year flood discharge at Gainer Memorial Dam on the North Branch Pawtuxet River (4,722 cfs).

2.30 Estimated Approximate Flood Impact Area

Two riverine cross sections, developed by GZA from USGS 7.5 minute quadrangle maps, were input into the SMPDBK model to preliminarily estimate approximate peak water surface elevations. The results of the analysis are provided as the approximate inundation area depicted in **Figure 2**.

2.31 Downstream Extent of Flooding

The SMPDBK analysis was ended at Scituate Reservoir, immediately downstream of Horseshoe Dam. Scituate Reservoir is significantly larger in surface area and storage than the reservoir impounded by Horseshoe Dam. GZA estimated that the available surcharge storage capacity above the spillway elevation (i.e. 284 feet) within Scituate Reservoir is approximately 51,000[1] acre-feet, or about 26 times the maximum storage of Horseshoe

[1] Department of Army, N.E. Division Corps of Engineering, *Phase I Inspections Report, National Dam Inspection Program, Gainer Memorial Dam (RI 03001)*, November 1978.

Dam reservoir. The estimated surcharge storage capacity at Scituate Reservoir is therefore capable of containing the maximum volume of Horseshoe Dam reservoir.

2.32 Potential Effects of Dam Break

GZA estimated that the water surface elevation within Scituate Reservoir may rise by about a half of foot if Horseshoe Dam were to fail. The hypothetical dam breach flow is not expected to result in any damage or loss of life in downstream areas. The dam failure would, by default, result in loss of the regulating reservoir used for municipal water supply, and also the destruction of Danielson Pike (Route 6) which traverses top of the dam.

FIGURES

GZA	PROJ. MGR.: DML DESIGNED BY: BBF REVIEWED BY: PHB OPERATOR: BBF DATE: 10-22-07	HORSESHOE DAM	JOB NO. 01.0017085.30
		SITE LOCUS	FIGURE NO. 1

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Horseshoe Dam - 360

FLOOD WAVE DISSIPATES WITHIN SCITUATE RESERVOIR

Scituate Reservoir

LEGEND

- BRIDGE
- SCHOOLS
- PUBLIC SAFETY BUILDINGS (FIRE, POLICE, TOWN HALLS)
- HOSPITALS
- APPROX. FLOOD HAZARD AREA
- WATER SUPPLY WITHDRAWALS
- DAMS

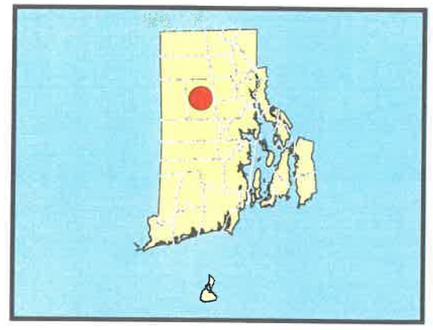
N W E S

SOURCE

DIGITAL AERIAL OTHOPHOTOGRAPHY PROVIDED BY THE RHODE ISLAND GEOGRAPHIC INFORMATION SYSTEM, (RIGIS) AND THE RHODE ISLAND DEPARTMENT OF TRANSPORTATION, (RIDOT). ORTHOPHOTO IMAGES WERE ORIGINALLY PRODUCED BY CHAS. H. SELLS UNDER CONTRACT TO THE (RIDOT). THE IMAGES WERE OBTAINED ON APRIL 14, 2003 AND WERE RELEASED IN NOVEMBER 2005.

RIGIS

0 250 500 1,000 Feet



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GZA

HORSESHOE DAM
SCITUATE, RHODE ISLAND

DAM FAILURE INUNDATION MAP

Proj. Mgr.: DML Designed By: BBF Reviewed By: PHB Operator: BBF	Dwg. Date: 10-22-07 Job No.: 17085.30	Figure No.: 2

ATTACHMENT I

FIELD RECONNAISSANCE CHECKLIST

INUNDATION MAPPING FIELD CHECKLIST

Name of Dam:	Horseshoe Dam	RI DEM ID NO.	360
Location:	Scituate (Town)	Pawtuxet River-North Branch (River or Stream)	
	Smithfield (Downstream Communities)	Stillwater Reservoir (Major Confluence)	
Classification Data:	Large (Size)		1920 (Date Built)

PHYSICAL DATA:	Earth/Rockfill/Concrete (Type of Dam)	12 ft (Height of Dam)	240 ft (Length of Dam)
	Arch shape- broad crested (Type of Spillway)	240 ft (Length of Spillway)	
	Water Supply (Purpose of Dam)	±1-in over spillway (Pool at Inspection)	1314 (Normal Pool Storage Capacity)
		2.5 ft (Freeboard)	1935 (Maximum Pool Storage Capacity)

Name	Title/Position	Representing
David M. Leone	Project Mgr / Hydrologist	GZA GeoEnvironmental, Inc.
Bryant B. Furtado	Project Engineer	GZA GeoEnvironmental, Inc.

DATE OF INSPECTION: 5/31/2007

WEATHER: Mostly cloudy TEMPERATURE: ±70 F

STRUCTURAL CONDITION	1	Masonry Condition	Submerged- could not observe.
	2	Outlet Condition	Submerged- could not observe.
	3	Unusual Movement	None observed.
	4	Seepage / Wet Area	Submerged- could not observe.
	5	Embankment Slides/Erosion	None observed.
	6	Vegetation / Pest Control	N/A.
DAM & IMMEDIATE DOWNSTREAM AREA	7	Vicinity Description	Danielson Pike at top of dam - within Scituate Reservoir.
	8	Dam Roads & Utilities	Danielson Pike at top of dam - within Scituate Reservoir.
	9	Discharge Channel	To Scituate Reservoir.
	10	Structures (Gatehouses, etc.)	None.
	11	Adjacent Land Use	Roadway/reservoir.
	12	Adjacent Population Density	Low - some commercial development.
	13	Downstream Constrictions	Culvert below Danielson Pike; Downstream is Scituate Reservoir.
	14	Downstream Access / Use	None.
	15	Property / Infrastructure / Utility Description & Distance	None.
GENERAL DOWNSTREAM AREA	17	Land Use Classification	
	18	Population Density	
	19	Property / Infrastructure	
	21	Downstream Dams	
	22	Downstream Bridges	
	23	Upstream Dams	
	24	Channel Description (depth, Manning's n, width, overbank)	

Flood wave would dissipate within Scituate Reservoir immediately downstream.

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

ATTACHMENT II

FIELD PHOTOGRAPHS

HORSESHOE DAM (RI DEM # 360)

Photo 1. Looking at Horseshoe Dam road embankment (Danielson Pike) from right abutment

Photo 2. Looking at Horseshoe Dam spillway from top of dam. Note high tailwater elevation from Scituate Reservoir.

Photo 3. Looking downstream toward Scituate Reservoir from top of dam.

ATTACHMENT III

SMPDBK OUTPUT SUMMARY

HORSESHOE DAM (360)

THE DATA FOR THIS DAM IS AS FOLLOWS:

TYPE OF DAM (IDAM)	CONCRETE GRAVITY	
DAM BREACH ELEVATION (HDE)	299.00	FT
FINAL BREACH ELEVATION (BME)	287.00	FT
SURFACE AREA OF RESERVOIR (SA)	242.00	ACRES
FINAL BREACH WIDTH (BW)	36.00	FT
TIME OF DAM FAILURE (TFM)	30.00	MINUTES
NON-BREACH FLOW (QO)	30.00	CFS
DISTANCE TO PRIMARY PT OF INTEREST (DISTTN)	.10	MILES
DEAD STORAGE EQUIV. MANN. N (CMS)	.50	

CROSS SECTION NO. 1
FLOOD DEPTH (FLD) 5.00 FT

ELEV.(FT) (HS)	284.0	285.0	286.0	291.0
TWIDTHS(FT) (BS)	12000.0	13000.0	14000.0	15000.0
INACTIVE TW(FT) (BSS)	.0	.0	.0	.0
MANNING N (CM)	.080	.080	.080	.080

CROSS SECTION NO. 2
REACH LENGTH (D) .10 MI
FLOOD DEPTH (FLD) 5.00 FT

ELEV.(FT) (HS)	283.9	285.0	286.0	291.0
TWIDTHS(FT) (BS)	12000.0	13000.0	14000.0	15000.0
INACTIVE TW(FT) (BSS)	.0	.0	.0	.0
MANNING N (CM)	.080	.080	.080	.080

RVR MILE FROM DAM	MAX FLOW (CFS)	MAX ELEV (FT-MSL)	MAX DEPTH (FT)	TIME(HR) MAX DEPTH	TIME(HR) FLOOD	TIME(HR) DEFLOOD	FLOOD DEPTH(FT)
.00	4519.	284.66	.66	.50	.00	.00	5.00
.10	4419.	284.55	.65	.84	.00	.00	5.00

ANALYSIS IS COMPLETE