## WATERMAN RESERVOIR DAM, SMITHFIELD (111)

GZA reviewed available DEM files associated with Waterman Reservoir Dam (Figure 1), including records of an inspection by the DEM in March, 2000. The dam has historically been classified by DEM as having a **Significant Hazard** potential.

## 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 Peter H. Baril and David M. Leone, accompanied by DEM senior engineer Paul Guglielmino, P.E., visited the site and the downstream river valley on April 2, 2002. A field checklist from the reconnaissance is provided in **Attachment I** and selected photographs are provided in **Attachment II**.

### 1.10 Site Description

Waterman Reservoir Dam is located on the Stillwater River in the Town of Smithfield, Providence County, Rhode Island (See Locus Map, Figure 1). The following identification numbers are associated with the dam:

- Army Corps of Engineers Number RI03103
- DEM ID Number 111

The dam has a total length of approximately 4,630 feet, and a maximum height of approximately 19 feet. The dam consists of a winding earthen embankment which forms the majority of the eastern-facing reservoir shoreline, with a 201-foot wide main spillway near the right abutment of the dam embankment (east of Route 116). The spillway crest (overflow weir section) consists of stone blocks. At the time of GZA's visit, the spillway discharge channel was composed of exposed soil and loose fill and appeared to be susceptible to erosion. A gatehouse and discharge channel is present near the dam's left abutment. Pertinent engineering data, as obtained from the DEM dam information database, is provided in **Table 1**.

Waterman Reservoir Dam and its impoundment are used for recreation. The landuse around the dam and reservoir is predominantly residential. There is a private access roadway near the dam's left abutment, associated with the adjacent condominium complex.

**TABLE 1. Pertinent Engineering Data**

| | |
|---|---|
| **Dam** | |
| Type | Earth Embankment |
| Length | Approximately 4,630 feet |
| Height | 19 feet |
| Drainage Area | 9 sq.mi. |
| **Elevation (feet above approximate MSL)** | |
| Normal Pool (Spillway) | Unknown |
| Top of Dam | Unknown |
| **Storage (Acre-feet)** | |
| Normal Pool | 2,430 |
| Top of Dam | 3,750 |
| **Main Spillway** | |
| Type | Concrete / Masonry Broad Crested |
| Length of Weir | 201 feet |

## 1.20 Downstream Description

Waterman Reservoir Dam is located on the Stillwater River, which flows through the Town of Smithfield. There is residential and commercial development on the overbanks of the Stillwater River from the dam to its confluence with Stillwater Reservoir. Several small former mill dams are located on the Stillwater River, downstream of the dam.

### 1.21 Downstream Dams

There are three small dams on the Stillwater River, downstream of Waterman Dam:

- Greenville Mill Pond Dam (112) is located near the intersection of West Greenville Road and Route 44, about 0.3 miles downstream of Waterman Dam. It is a 16-ft high, 440-ft long earthen embankment and masonry structure which impounds 60 acre-feet of water.

- Knight Mill Pond Dam (113) is a 7-ft high, 330-ft long earthen and masonry dam located about 0.73 miles downstream of Waterman Dam.

- Stillwater Mill Pond Dam (114) is a 15-ft high, 200-ft long earthen and masonry dam located about 1.03 miles downstream of Waterman Dam.

1.22 Downstream Bridges

There are two major roads over the Stillwater River and/or Waterman Reservoir Dam spillway channel that may be impacted by a potential dam failure:

- Putnam Pike / Route 44 (and West Greenville Road on-ramp) is located about 0.3 miles downstream of Waterman Dam and immediately downstream of Greenville Mill Pond Dam.

- Austin Avenue is located about 1.27 miles downstream of Waterman Dam.

In addition to these structures, there are additional structures over the Stillwater River that are not expected to be affected by a dam failure at Waterman Reservoir Dam, in GZA's opinion. See Section 2.30 for additional information.

1.23 Downstream Development

The land use of the floodplain of the Stillwater River is predominantly residential, with some commercial development near Putnam Pike and Austin Avenue. The immediate downstream floodplain is a wooded wetland with residential development along its edge, including the condominium complex adjacent to the dam's left abutment. Downstream of Route 44 / Putnam Pike, the Stillwater River is impounded by a series of dams (described in Section 1.21). Wooded wetland continues along the river, particularly along the left bank and floodplain. Route 44 runs more or less parallel to the river, on the right overbank. Residential development is prevalent along the river overbanks downstream of Austin Avenue. A nursing home has been constructed along the banks of the river, about 1.0 mile downstream of the dam.

## 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 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. For Waterman Reservoir Dam, primarily an earth embankment structure, a time to failure of 0.5 hrs and a trapezoidal breach shape (0.5 H : 1.0 V) was utilized. Such an earthen embankment dam is assumed to fail due to piping under fair weather circumstances. The average breach width was assumed to equal three times the height of the dam, or about 57 feet.

## 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 is approximately 13,810 cfs. The outflow is approximately 2,200 percent of the published FEMA 100-year flood estimate of 610 cfs and 1,500 percent of the FEMA 500-year flood estimate of 920 cfs for the Stillwater River at the outlet of Waterman Reservoir.

## 2.30 Estimated Approximate Flood Impact Area

Several 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 Stillwater River downstream of Waterman Reservoir Dam is relatively gently sloping, eventually reaching its confluence with the Stillwater Reservoir. Typical Mannings "n" roughness coefficients used in the analysis generally ranged from 0.030 to 0.035 for the channel areas, and 0.050 to 0.085 for the overbank areas. These values are consistent with the range of values used in the FEMA Flood Insurance studies for the downstream communities.

The SMPDBK analysis was ended prior to the confluence of Stillwater Reservoir, approximately 3.0 miles downstream of Waterman Reservoir Dam. The relatively small

flood wave, approximately 6 ft high at this point, is expected to remain within the banks of the Stillwater River downstream of the model extents.

2.32 Potential Effects of Dam Break

Results of the analysis indicate a peak flood depth at the immediate toe of the dam of about 10 feet. As the flood wave progresses downstream, it is expected to attenuate. Thus, peak flood depths are predicted to decrease to about 6 ft about 2.5 miles downstream of the dam. It is likely that the failure of Waterman Reservoir Dam would result in the domino failure of the three small mill dams (discussed in Section 1.23) on the Stillwater River. Flooding may also occur on Putnam Pike / Route 44 and the nursing home located on the left overbank of the Stillwater River would likely experience flooding.

## 2.40 Recommended Hazard Potential Classification

GZA recommends that Waterman Reservoir Dam be classified as ***High Hazard*** based on the aforementioned analyses, site / downstream valley reconnaissance, site-specific GIS mapping and other existing data, and professional judgment. A potential dam failure of Waterman Reservoir Dam would result in probable loss of human life, and cause major economic losses to the downstream vicinity. The major issue in the hazard classification of Waterman Reservoir Dam is the presence of the nursing home about 5 to 10 feet above the river channel about 1.0 mile downstream, a portion of which is likely to be subjected to flood flows, jeopardizing human life. The potential impact areas also include damage to small downstream dams, possible submergence and washout of Route 44 (resulting in the possibility of loss of life considering its proximity to the dam and well-traveled nature), and potential damage to the culvert beneath Austin Avenue.

# ATTACHMENT I

# FIELD RECONNAISSANCE CHECKLIST

# DAM HAZARD POTEN. .L FIELD CHECKLIST

| | | | |
|---|---|---|---|
| Name of Dam: | Waterman Dam | RI DEM ID NO. | 111 |
| Location: | Smithfield / Glocester (Town / County) | Stillwater River (River or Stream) | |
| | Smithfield (Downstream Communities) | Woonasquatucket River (Major Confluence) | |
| Classification Data: | Intermediate (Size) | | 1837 (Date Built) |

| | | | |
|---|---|---|---|
| PHYSICAL DATA: | Earthen Embankment (Type of Dam) | 19 ft (Height of Dam) | 4,630 ft (Length of Dam) |
| | Broad Crested Masonry (Type of Spillway) | 201 ft (Length of Spillway) | |
| | Recreation (Purpose of Dam) | At Spillway Crest (Pool at Inspection) | 2,430 ac-ft (Normal Pool Storage Capacity) |
| | U/S: 3:1 D/S: 2:1 (Embankment Slopes (H:V)) | Likely Bedrock (Foundation (if known, note rock/soil surroundings)) | 3,750 ac-ft (Maximum Pool Storage Capacity) |

| Name | Title/Position | Representing |
|---|---|---|
| Peter H. Baril | Associate Principal / Hydrologist | GZA GeoEnvironmental, Inc. |
| David M. Leone | Asst. Project Mgr / Hydrologist | GZA GeoEnvironmental, Inc. |
| Paul W. Guglielmino | DEM Dam Safety Senior Engineer | RIDEM Office of Compliance & Inspection |
| Ron DePault | President | Citizens for the Preservation of Waterman Lake Assoc. |

DATE OF INSPECTION: 4/2/2002

WEATHER: Clear TEMPERATURE: 55 deg. F

Name of Dam: Waterman Dam I.D. No.: 111 Inspection Date: 2-Apr-02

| | | | |
|---|---|---|---|
| STRUCTURAL CONDITION | 1 | Concrete Condition | Stone masonry blocks @ spillway crest: joints irregular, blocks drifting apart. |
| | 2 | Outlet Condition | Gates are operable & serve as main source of release |
| | 3 | Unusual Movement | None observed. |
| | 4 | Seepage / Wet Area | Downstream toe of dam wet or inundated across most of embankment length |
| | 5 | Embankment Slides/Erosion | None observed. |
| | 6 | Vegetation / Pest Control | Some burrows; trees recently cut |
| DAM & IMMEDIATE DOWNSTREAM AREA | 7 | Vicinity Description | Residential |
| | 8 | Dam Roads & Utilities | None. |
| | 9 | Discharge Channel | Natural stream channel; wooded banks, wide channel |
| | 10 | Structures (Gatehouses, etc.) | Gatehouse at upstream face near left abutment |
| | 11 | Adjacent Land Use | Residential / Wooded |
| | 12 | Adjacent Population Density | Moderate residential development, condominium complex adjacent to left abutment |
| | 13 | Downstream Constrictions | None observed. |
| | 14 | Downstream Access / Use | No formal access to downstream area |
| | 15 | Property / Infrastructure / Utility Description & Distance | Ray Stere property on natural high ground between dam embankments; otherwise, none. |
| GENERAL DOWNSTREAM AREA | 17 | Land Use Classification | Mixed residential / commercial |
| | 18 | Population Density | Low to moderate suburban development in floodplain |
| | 19 | Property / Infrastructure | Residential development on river overbanks. |
| | 21 | Downstream Dams | Greenville Mill Pond Dam; Knight Mill Pond Dam; Stillwater Mill Pond Dam |
| | 22 | Downstream Bridges | Route 44 |
| | 23 | Upstream Dams | None. |
| | 24 | Channel Description (depth, Manning's n, width, overbank) | Shallow, wide channel. Wooded banks, typical Manning's n. |

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

# ATTACHMENT II

# FIELD PHOTOGRAPHS

**Description:** Photo 1. View of gatehouse and embankment near left abutment of dam.

**Description:** Photo 2. View of downstream channel from gatehouse.

**Description:** Photo 3. Typical embankment section of Waterman Dam.

**Description:** Photo 4. View of spillway from left spillway abutment.

**Description:** Photo 5. View of spillway discharge channel.

**Description:** Photo 6. View of spillway and embankment left of spillway.

**Description:** Photo 7. View of downstream channel with assisted living facility in background.

# ATTACHMENT III

# SMPDBK OUTPUT SUMMARY

SIMPLIFIED DAMBREAK MODEL (SMPDBK) VERSION: 9/91
BY D.L. FREAD, J.M. LEWIS, & J.N. WETMORE - PHONE: (301) 427-7640
NWS HYDROLOGIC RESEARCH LAB W/OH3, 1325 EAST-WEST HIGHWAY,
SILVER SPRING, MD 20910

***** DISTANCE TO PRIMARY POINT OF INTEREST MOVED TO THE CROSS SECTION
***** CLOSEST TO THIS LOCATION (MI 2.93)

DATA FOR THIS DAM IS AS FOLLOWS:

| | | |
|---|---|---|
| TYPE OF DAM (IDAM) | EARTH | |
| DAM BREACH ELEVATION (HDE) | 335.00 | FT |
| FINAL BREACH ELEVATION (BME) | 316.00 | FT |
| SURFACE AREA OF RESERVOIR (SA) | 270.00 | ACRES |
| FINAL BREACH WIDTH (BW) | 57.00 | FT |
| TIME OF DAM FAILURE (TFM) | 30.00 | MINUTES |
| NON-BREACH FLOW (QO) | 10.00 | CFS |
| DISTANCE TO PRIMARY PT OF INTEREST (DISTTN) | 2.93 | MILES |
| DEAD STORAGE EQUIV. MANN. N (CMS) | .50 | |

CROSS SECTION NO. 1

| | | | | |
|---|---|---|---|---|
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 316.0 | 320.0 | 330.0 | 340.0 |
| TWIDTHS(FT) (BS) | 57.0 | 100.0 | 400.0 | 600.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .035 | .035 | .060 | .060 |

CROSS SECTION NO. 2

| | | | | |
|---|---|---|---|---|
| REACH LENGTH (D) | .75 MI | | | |
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 261.0 | 265.0 | 270.0 | 280.0 |
| TWIDTHS(FT) (BS) | .0 | 20.0 | 400.0 | 600.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .035 | .035 | .060 | .060 |

CROSS SECTION NO. 3

| | | | | |
|---|---|---|---|---|
| REACH LENGTH (D) | 1.17 MI | | | |
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 242.0 | 246.0 | 250.0 | 260.0 |
| TWIDTHS(FT) (BS) | .0 | 20.0 | 300.0 | 500.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .035 | .035 | .060 | .060 |

CROSS SECTION NO. 4

| | | | | |
|---|---|---|---|---|
| REACH LENGTH (D) | 1.52 MI | | | |
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 232.0 | 236.0 | 240.0 | 250.0 |
| TWIDTHS(FT) (BS) | .0 | 20.0 | 700.0 | 900.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .035 | .035 | .060 | .060 |

CROSS SECTION NO. 5

| | | | | |
|---|---|---|---|---|
| REACH LENGTH (D) | 2.52 MI | | | |
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 209.0 | 210.0 | 220.0 | 230.0 |
| TWIDTHS(FT) (BS) | .0 | 300.0 | 350.0 | 400.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .035 | .035 | .060 | .060 |

CROSS SECTION NO. 6

| | | | | |
|---|---|---|---|---|
| REACH LENGTH (D) | 2.93 MI | | | |
| FLOOD DEPTH (FLD) | 2.00 FT | | | |
| ELEV.(FT) (HS) | 207.0 | 210.0 | 220.0 | 230.0 |
| TWIDTHS(FT) (BS) | 500.0 | 550.0 | 600.0 | 650.0 |
| INACTIVE TW(FT) (BSS) | .0 | .0 | .0 | .0 |
| MANNING N (CM) | .060 | .060 | .060 | .060 |

AN ASTERISK (*) BESIDE A PARAMETER IMPLIES THAT A DEFAULT VALUE WAS COMPUTED

NAME OF DAM: WATERMAN NAME OF RIVER: STILLWATERE

| 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 | 13814. | 325.46 | 9.46 | .50 | .04 | 6.14 | 2.00 |
| .75 | 11459. | 271.20 | 10.20 | .64 | .14 | 8.04 | 2.00 |
| 1.17 | 11146. | 252.63 | 10.63 | .76 | .26 | 8.38 | 2.00 |
| 1.52 | 10955. | 241.15 | 9.15 | .86 | .36 | 8.63 | 2.00 |
| 2.52 | 10846. | 214.66 | 5.66 | .93 | .51 | 7.57 | 2.00 |
| 2.93 | 10737. | 213.38 | 6.38 | .99 | .61 | 6.96 | 2.00 |

ANALYSIS IS COMPLETE

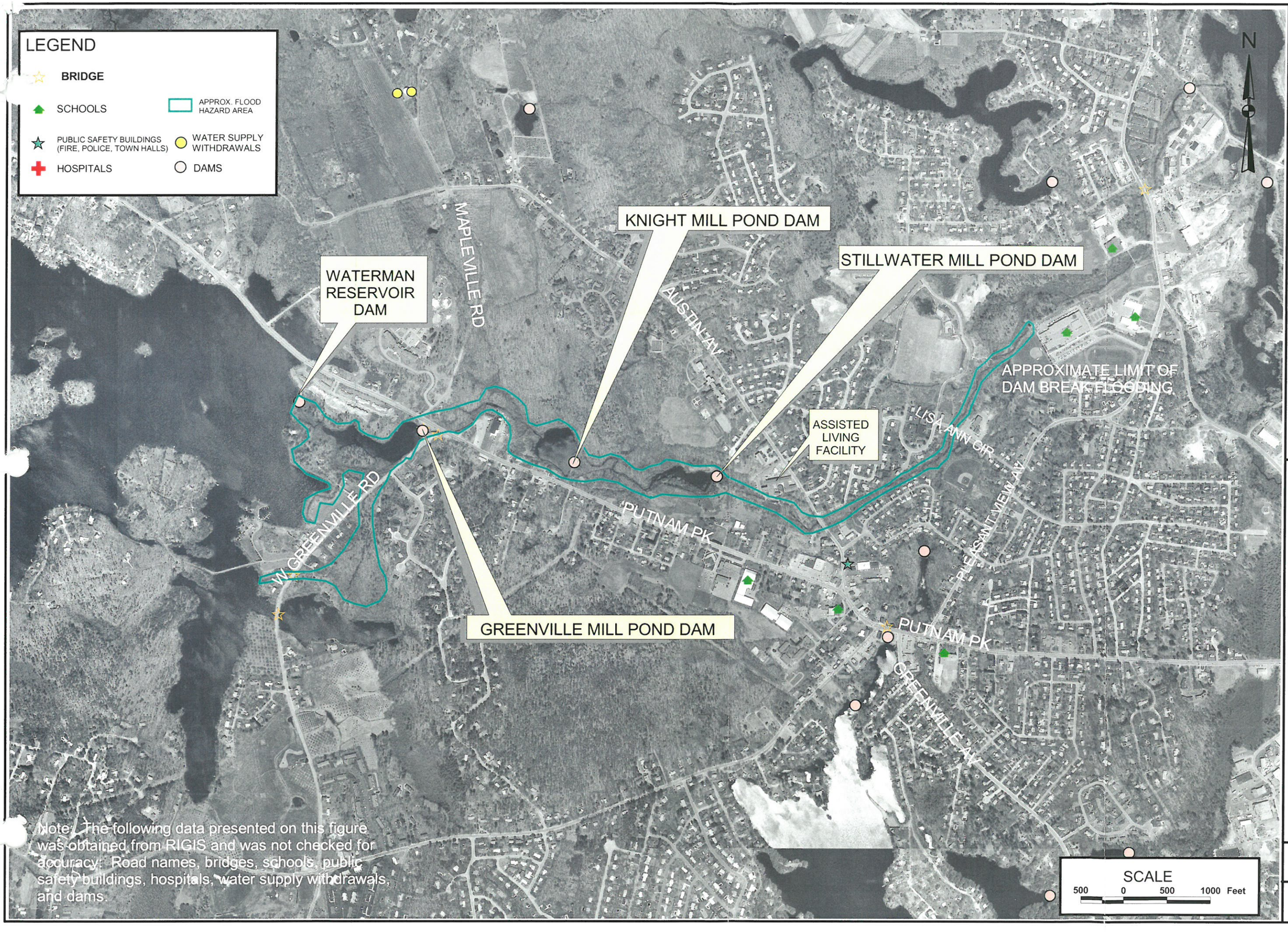
# FIGURES

# FIGURES


**FIGURE 1. LOCUS MAP**
**WATERMAN RESERVOIR DAM**
**SMITHFIELD, RI**

SCALE
500 0 500 1000 Feet

RHODE ISLAND DEM
OFFICE OF COMPLIANCE & INSPECTION




GZA

SOURCE RIGIS

DATE OF MAP: APRIL 1997

DAM HAZARD POTENTIAL CLASSIFICATION MAP

WATERMAN RESERVOIR DAM
SMITHFIELD, RHODE ISLAND

GZA NO. 17085

FIGURE 2