EDUCATING THE DAM SAFETY ENGINEERS OF TOMORROW

New Jersey Department of Environmental Protection
Office of Engineering and Construction
Bureau of Dam Safety and Flood Control

Educational Outreach Program

An educational outreach program for elementary school aged children has been developed by the Bureau of Dam Safety and Flood Control for use at the NJDEP's annual 'Take Your Kids to Work Day' and other outreach events. The program consists of a presentation, dam model demonstration, and a 'build a dam' exercise.

First, the presentation part of the program provides children with an overview of the various types of dams and spillways and explains why dams are important.

Following the presentation, a demonstration is performed utilizing a fully functional dam model that has been designed and constructed by the Bureau. The model allows children to observe how dams function and learn some various spillway types and configurations. An experiment is conducted to show the efficiency of different weir designs by timing the reduction in water surface elevation from maximum pool to normal pool (see *Experiment* details after Figure 27 for details). The attached construction guide has been prepared with material lists, design drawings, and assembly information to assist other organizations in constructing their own dam model.

Lastly, after the model has been displayed and operated, the children are split into groups to construct their own dams. For this activity the Bureau utilizes two experiments outlined in a book authored by Andrew Dunn entitled "STRUCTURES: DAMS" (Dunn, A. (1993). *Structures Dams*. New York, NY: Thomson Learning.). These experiments ('*Keeping Dams From Leaking'* and *'How A Dam Breaks'*) allow children to build dam embankments and observe the effectiveness of various dam building materials. Each group is given a different material (earth, clay, sand, and sand with plastic 'corewall') to construct an embankment in the center of a deep aluminum baking tray. Water is poured into one side of the dam and the effectiveness of each material is observed and discussed.

Lexan® Pond Dam

An Educational Tool for Students

Construction Guide

Designed and Constructed by:

New Jersey Department of Environmental Protection
Office of Engineering and Construction
Bureau of Dam Safety and Flood Control

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Rick Tamagno, P.E.

Material List for Lexan® Pond Dam:

(1) sheet Lexan® plastic (72-inches by 36-inches)
(1) can solvent cement (i.e. IPS Weld-on 3)
(1) tube Lexan® silicon sealant
(1) ½ inch (ID) 90° PVC elbow with one threaded end
(1) tubing adapter to fit into threaded end of ½ inch 90° PVC elbow (see figure 19)
(1) 1 ½ inch PVC male threaded fitting
(1) 1 ½ inch PVC female threaded fitting
(1) piece 1 ½ PVC pipe - 2 ft. length
(1) piece ½ PVC pipe- 5 ft. length
(2) ½ inch PVC 90° fittings
(1) ½ inch PVC Tee fitting
(1) ½ inch PVC ball valve
PVC cleaner and glue
(1) landscaping pond pump (i.e. Beckett Corp. M400AUL)
(1) very large bucket or small trash can
(1) tube of Silicon caulk (attaching embankment and stone)
10 feet of 5/8 inch inside diameter flexible clear tubing
(1) 1 inch pipe clamp (for clear tubing inlet connection)
Material to construct embankment (i.e. 1 inch thick rigid foam insulation)
Material to construct spillways (i.e. wood, plastic)
Various small stone for emergency spillway / outlet channel
Paint and craft material for aesthetic purposes

Assembly Summary:

Cut Lexan® per attached cut sheet to specified dimensions on table saw. Drill holes for inlet and outlet per dimension sheet with appropriate hole saw. Assemble cut pieces with solvent cement in a well ventilated area to make enclosure (dry fit first to ensure proper dimensions and test solvent cement with scrap first to determine dry time). Once assembled, reapply solvent cement to all joints from the inside to ensure complete adhesion. After solvent cement has completely dried, apply Lexan® silicon sealant to all interior joints to ensure watertight seams. The exposed edges of the Lexan® enclosure will be very sharp from the table saw cuts and should be softened with a file. Attach outlet fitting to enclosure using solvent cement and inlet fittings using threaded connection. Construct embankment and spillways with preferred material and according to chosen spillway and outlet configurations. Drawings of the embankment and spillways used by NJDEP are attached for reference. Attach embankments, etc. to enclosure using silicon sealant. Assemble pump and by-pass as necessary (refer to figure 21 for example) to allow for full regulation of flow. Attach clear tubing from pump to inlet and drain pipe to drain fitting. Place pump in bucket under drain, fill with water and plug in.

Note: Follow manufacturers safety precautions for all equipment and material used.

Construction / Assembly

Figure 1: Assembling Lexan® enclosure by joining pieces with solvent cement.

Figure 2: Applying additional solvent cement to all joints to ensure adequate adhesion.

Figure 3: Finished Lexan® enclosure for the dam model. *Note* – Lexan® brand clear silicon sealant was used on the inside of enclosure at each joint after solvent had completely dried to ensure a water-tight seal.

Figure 4: Dam embankment made from a sheet of rigid foam insulation and assembled with caulk. *Note* – dam can be constructed from whatever material is deemed appropriate (i.e. solid foam block, modeling clay, etc.). This assembly procedure was a bit tedious and time-consuming!

Figure 5: Construction of emergency spillway channel with clean stone and caulk serving as 'grouted riprap'. *Note* Silicone caulking should be used as opposed to latex.

Figure 6: Painted embankment sections (later 'grass' was substituted with self adhesive matting material for aesthetic purposes). Note the cutout section in the left embankment section above for installation of the primary spillway drop box structure and discharge pipe (see Figure 7, and 11).

Figure 7: Primary spillway drop box structure and discharge pipe.

Figure 8: Solvent cement used for assembling the Lexan® enclosure.

"As-Built" Photographs

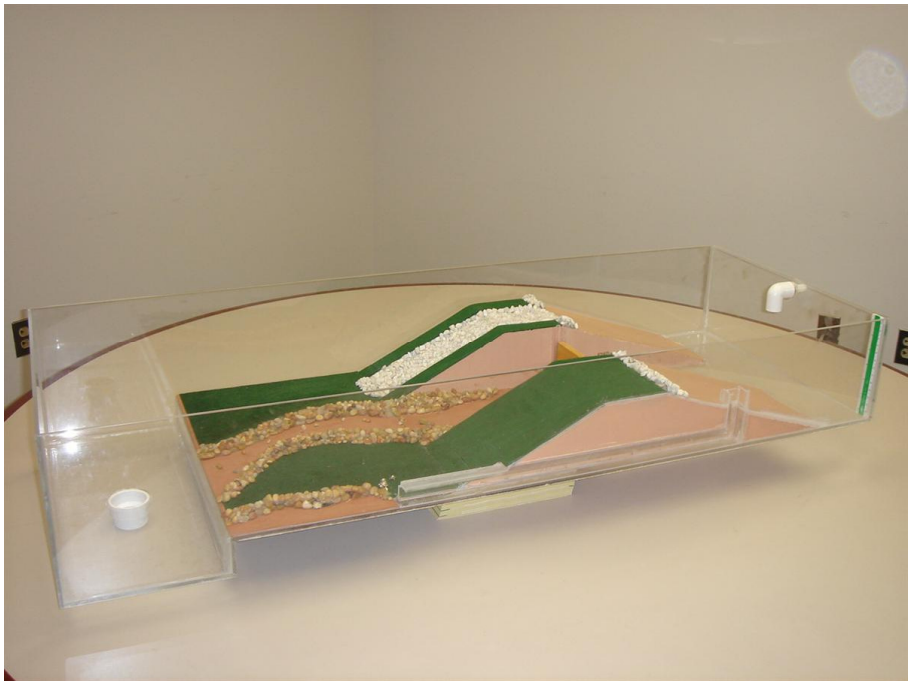


Figure 9: ' Lexan® Pond Dam' model (without pump or tubing).

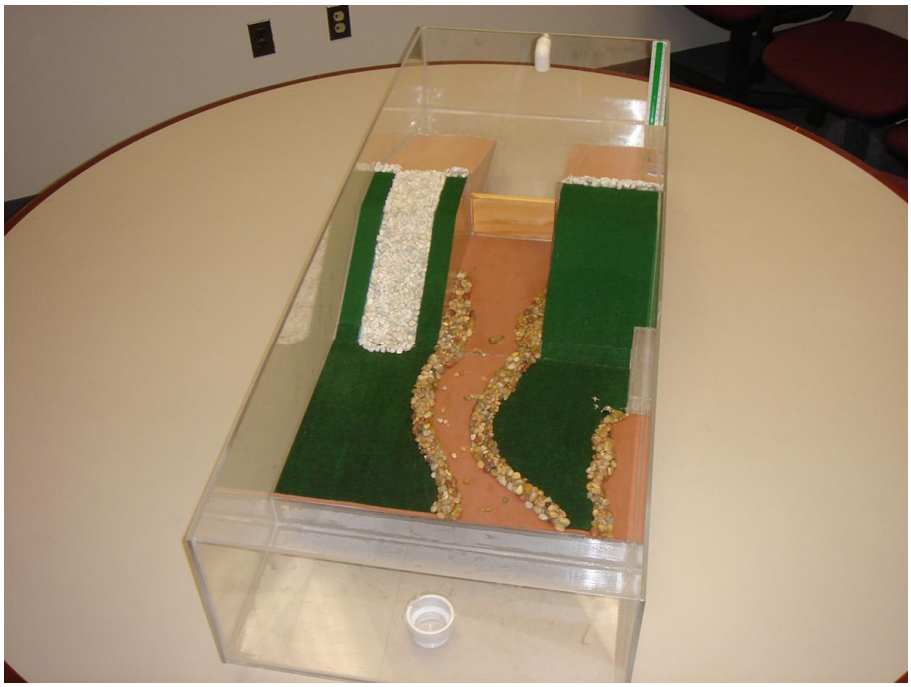


Figure 10: 'Lexan® Pond Dam' model (without pump or tubing).

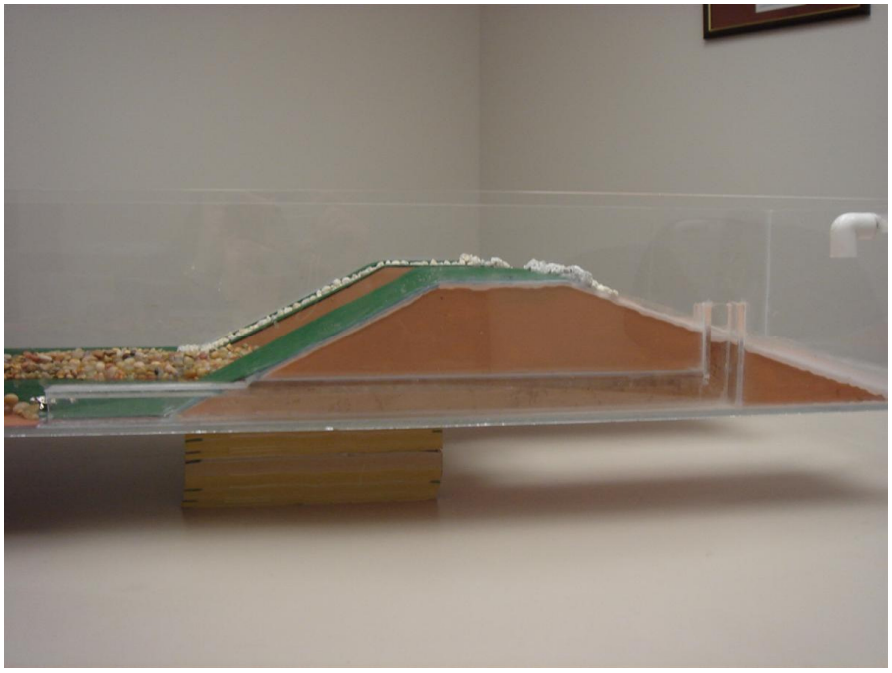


Figure 11: Side view representing a 'cross-section' through the embankment at the primary spillway dropbox and discharge pipe.

Figure 12: Longitudinal view from outlet channel looking 'upstream' showing elevation differences between dam crest, emergency spillway and secondary spillway weir (the primary spillway in this model is the dropbox structure shown in Figures 7 & 11, but cannot be seen in this photo). *Note* Secondary spillway location was designed with 'guides' on each spillway abutment wall made with two small strips of Lexan glued to the each wall to allow for sliding the weirs in and out and installing 'flashboards'. A typical broad crested weir is shown in this figure.

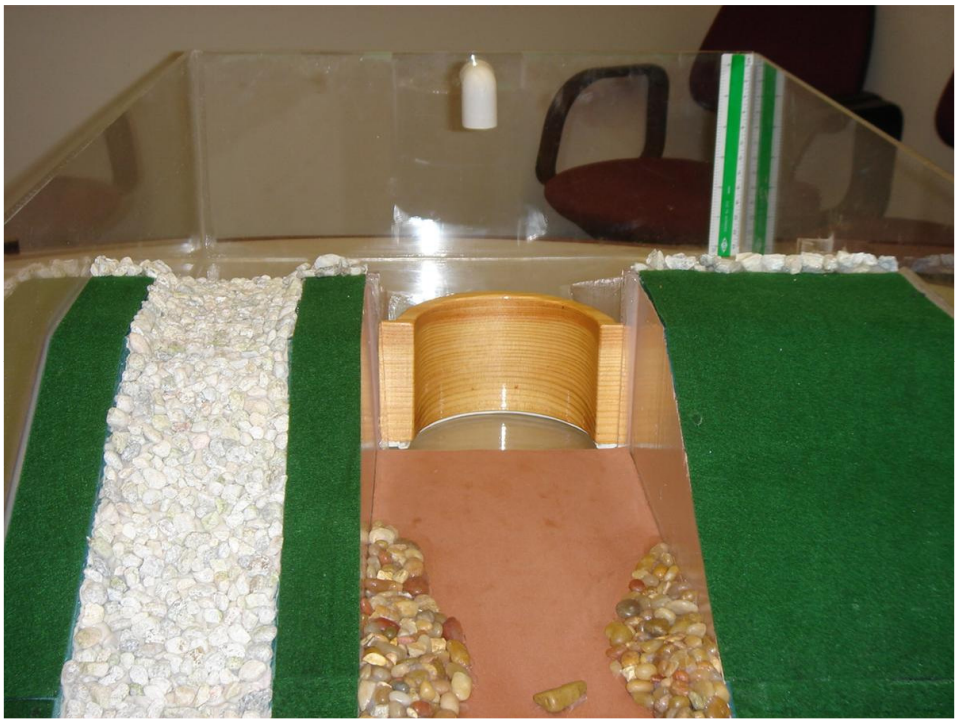


Figure 13: Semi-circular spillway weir. *Note* The bottom of each spillway was lined with pieces of self adhesive weather stripping to ensure a seal between bottom of spillway and enclosure.

Figure 14: Plan view of semi-circular spillway weir. *Note* Tabs at each end were designed to fit into the guides described in Figure 12.

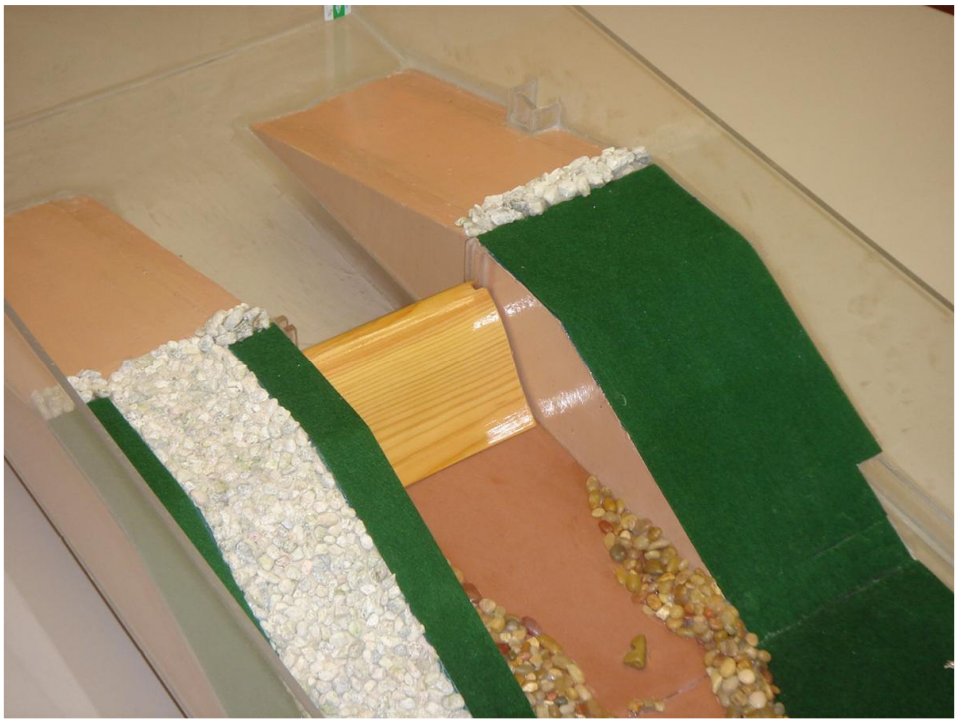


Figure 15: 'Ogee' spillway weir.

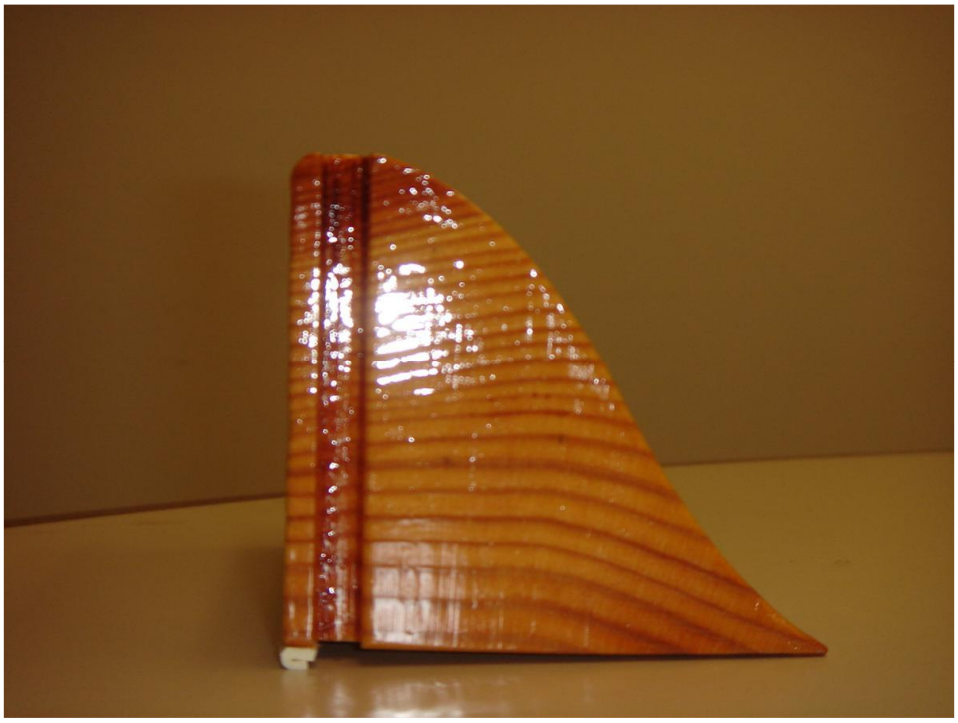


Figure 16: Cross sectional view of 'ogee' spillway weir. *Note* Tab / cutout was designed to fit into the guides described in Figure 12. All spillways should be constructed at the same height to allow for experiments demonstrating efficiency.

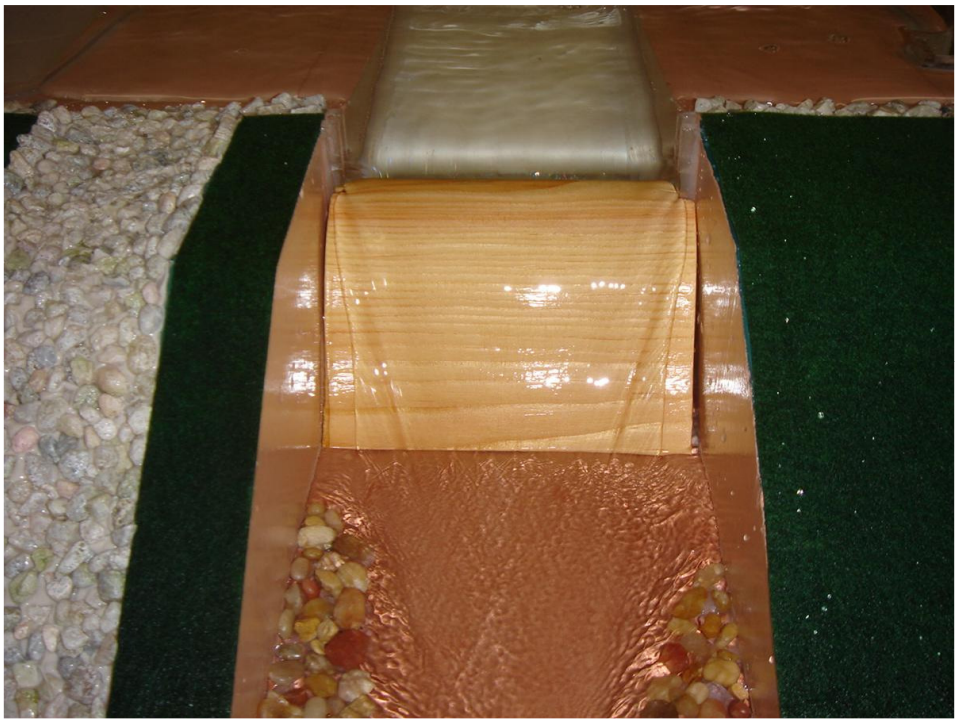


Figure 17: Flow over 'ogee' spillway weir.

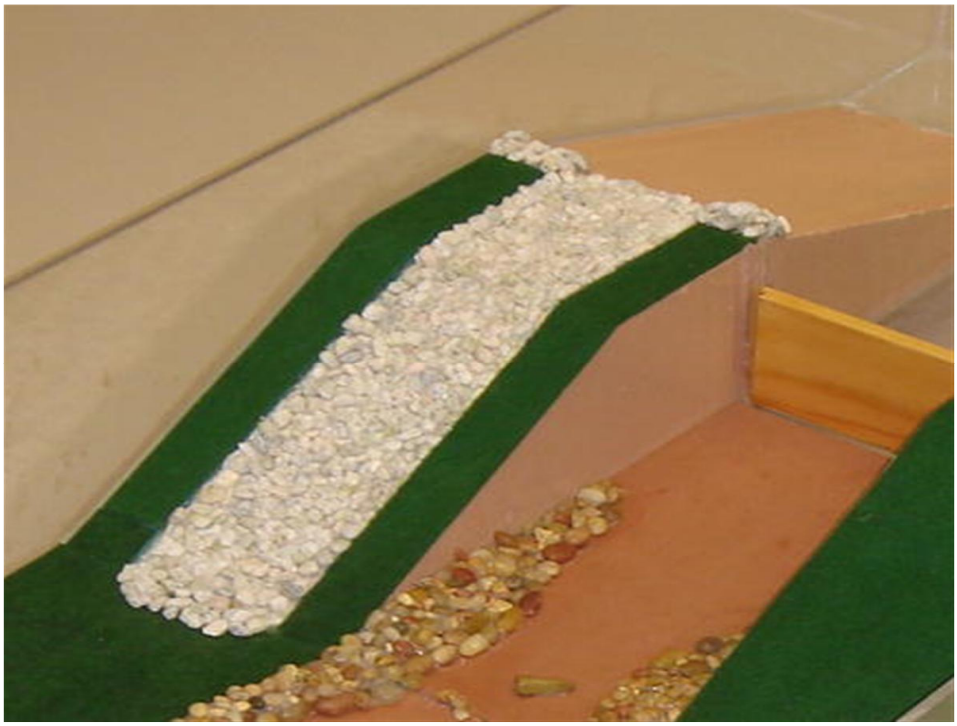


Figure 18: View of emergency spillway channel.

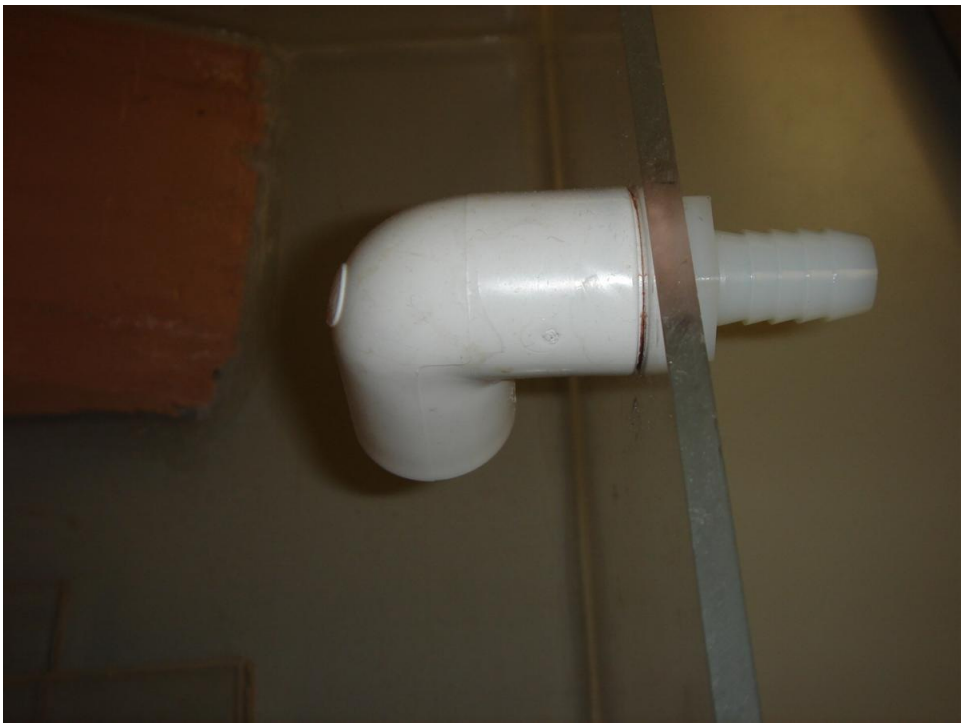


Figure 19: Inlet to model enclosure (½ inch (ID) 90° PVC elbow with one threaded end and tubing adapter) that represents inflow stream. Rubber washer may be needed to ensure tight connection.

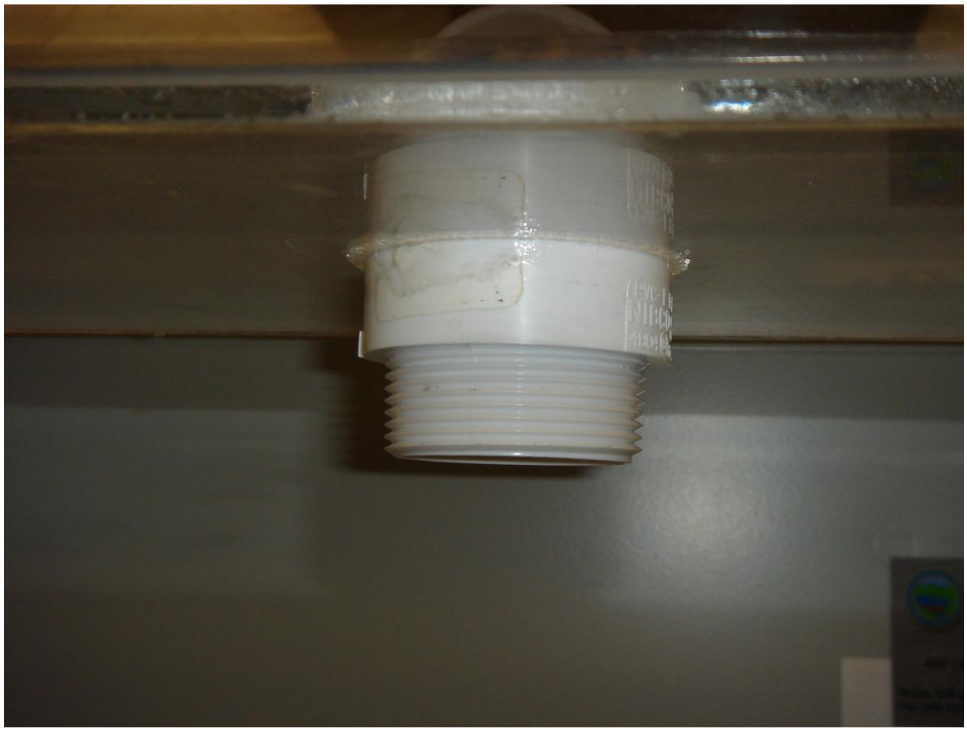


Figure 20: Outlet (1 ½ inch (ID) PVC male threaded fitting) from model enclosure in the bottom of the 'stilling basin' designed to discharge flow into a bucket for recirculation of water through the model (attached with solvent cement).

Figure 21: Pump setup that is placed in a bucket directly beneath the outlet from the model. *Note* The chosen pump had only limited ability for flow adjustment. It was found that the flow could not be regulated adequately for the purposes of this project, therefore a by-pass utilizing ½ inch (ID) PVC piping and PVC ball valve was added to allow for full regulation of flow. (This also allows the demonstrator to adjust flow without reaching entire arm into the bottom of the bucket!) The pump used for this model is a landscaping pond pump (Beckett Corp. M400AUL).

Figure 22: Discharge pipe with 1 ½ inch PVC female threaded fitting to be attached to the fitting shown in Figure 20 and placed into the bucket beneath the model (to make sure all water makes it back into the bucket).

Demonstration for "Take Your Kids to Work Day"

Figure 23: Fully assembled model ready for demonstration. Obvious caution should be taken when using the model and water around electricity. GFCI protected wall outlets/extension cords should be used for the pump for safety purposes (no floor outlets in case of spill).

Figure 24: Model ready for demonstration. Note the small pieces of Lexan® next to the model are used as flashboards and also to force flow over the emergency spillway or to increase head on the primary spillway drop box.

Figure 25: Demonstration using a flashboard over the secondary spillway to force flow over the emergency spillway.

Figure 26: Testing the semi-circular weir.

Figure 27: No – he is not a paid actor!

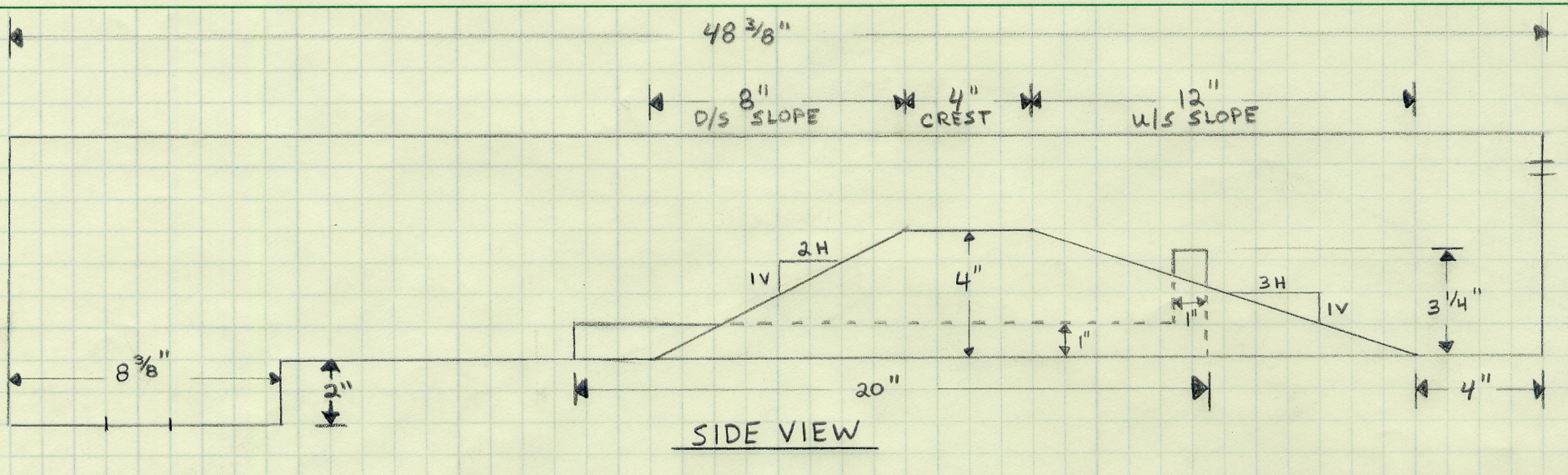
Experiment:

An experiment can be conducted to show the efficiency of different weir designs. The primary spillway dropbox is blocked and a flashboard is installed at the secondary spillway to allow the water surface to reach the maximum pool level (defined by the emergency spillway crest). The pump is shut off - then the flashboard is removed and the children use a stop watch to time how long it takes for the flow to pass over the various weirs until the pond level returns to normal pool.

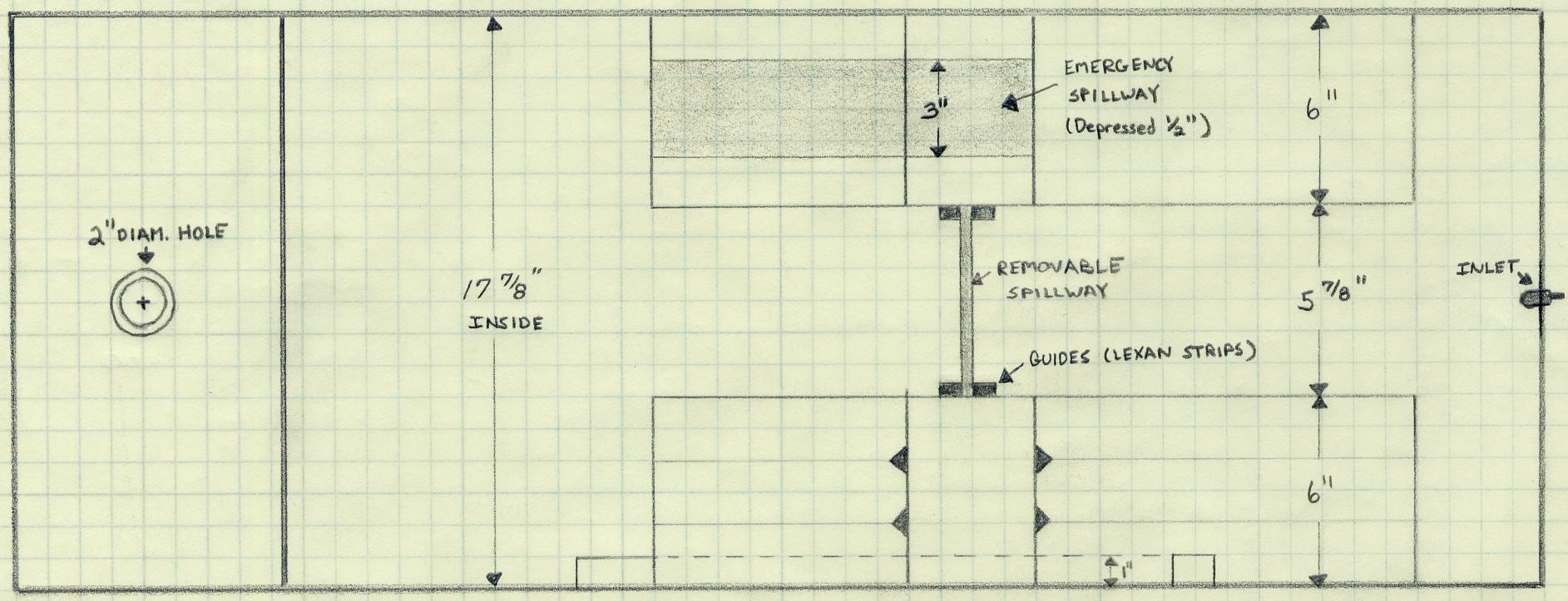
LEXAN POND DAM

AS-BUILT DRAWING

NJDEP



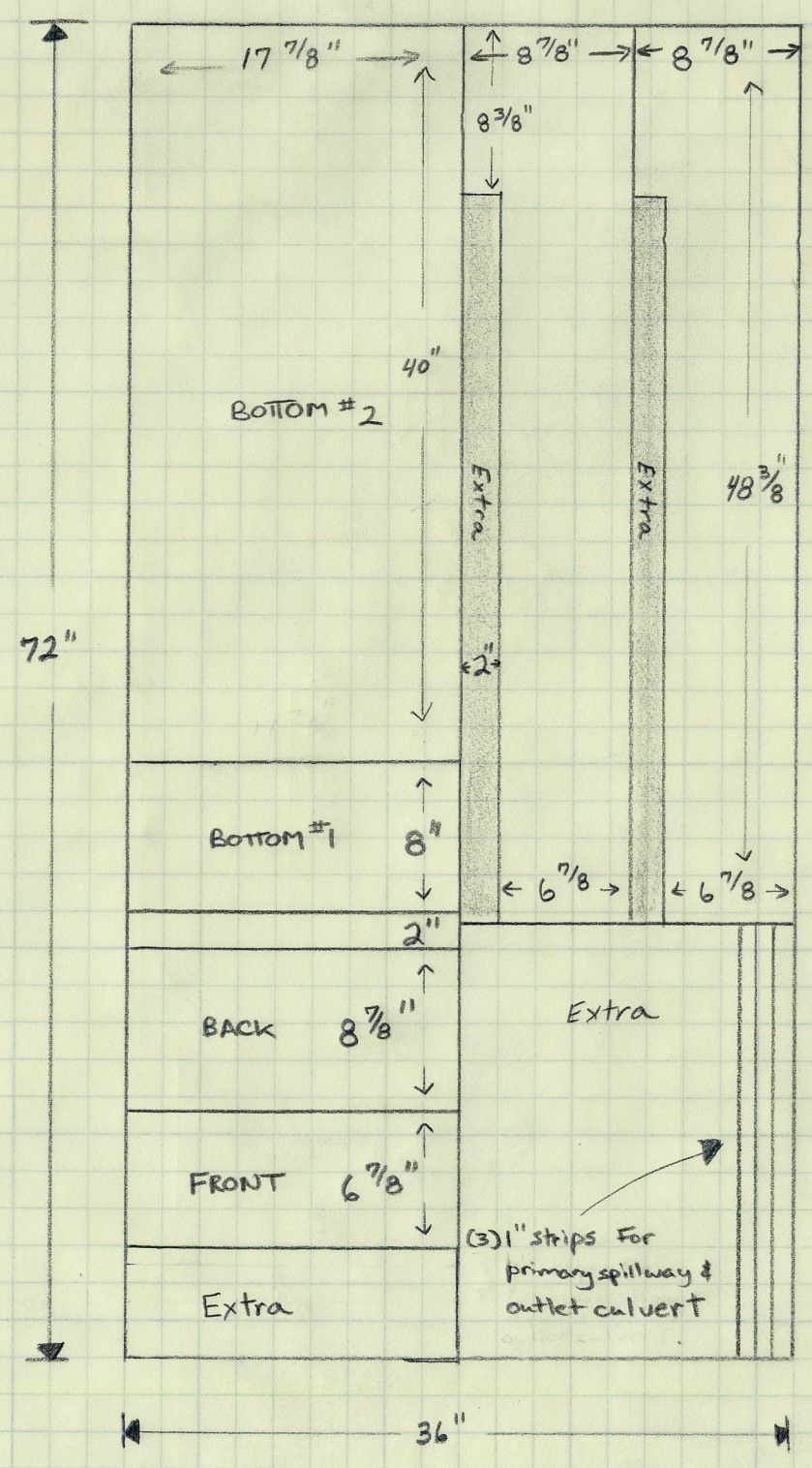
SIDE VIEW

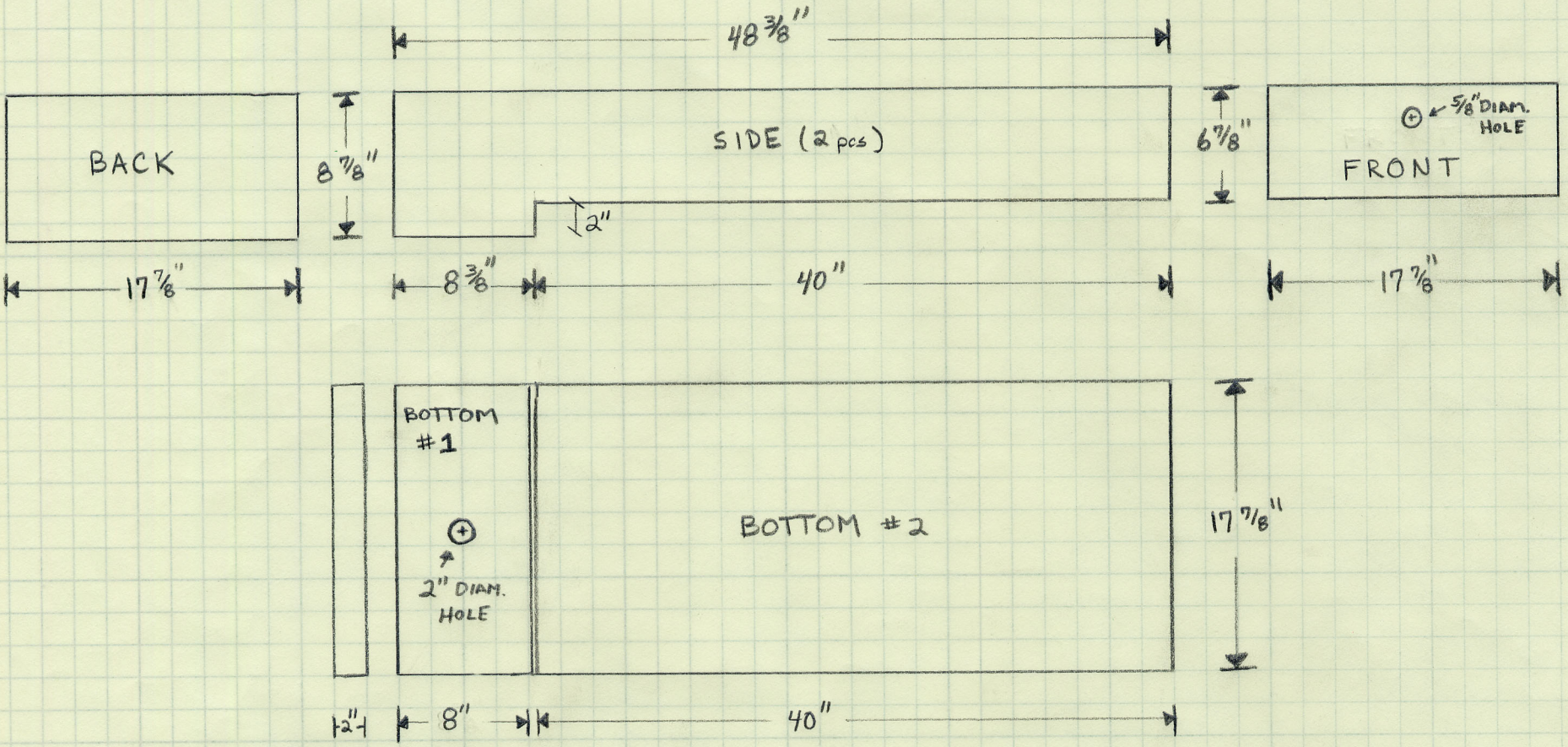


PLAN VIEW

C30
1/6

LEXAN PLASTIC (3/16" THICK)
SHEET DIMENSION 72" x 36"



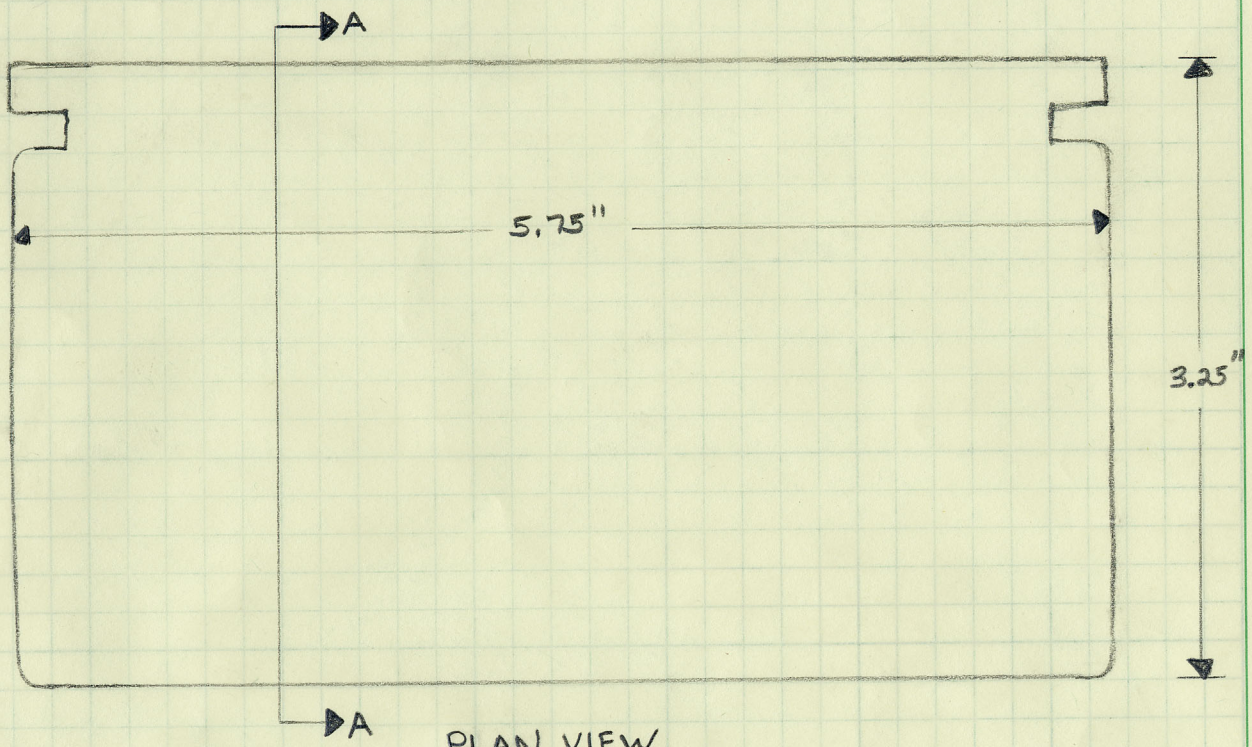


* PRIMARY SPILLWAY & CULVERT : 1" WIDE STRIPS WITH LENGTHS OF 20", 19", 3.25", 2.25", 2.25"

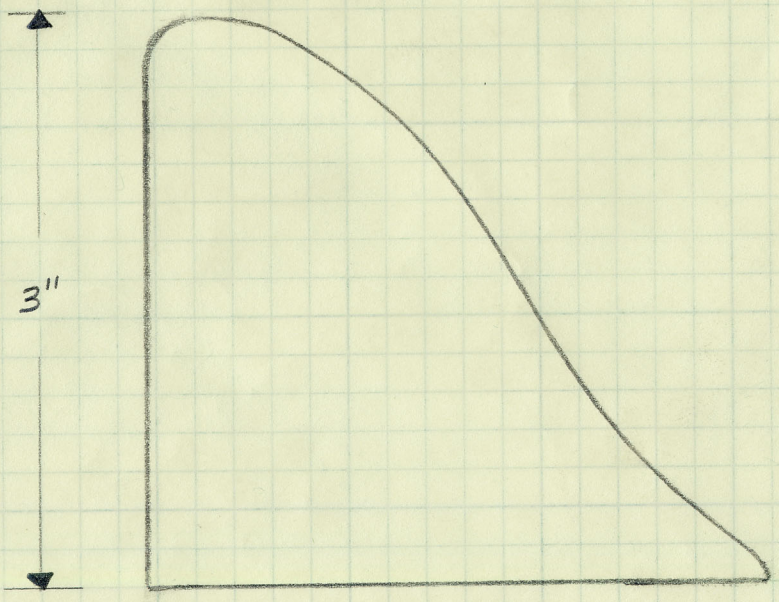
LEXAN POND DAM | DIMENSION SHEET | NJDEP

CTO 3/16

OGEE SPILLWAY



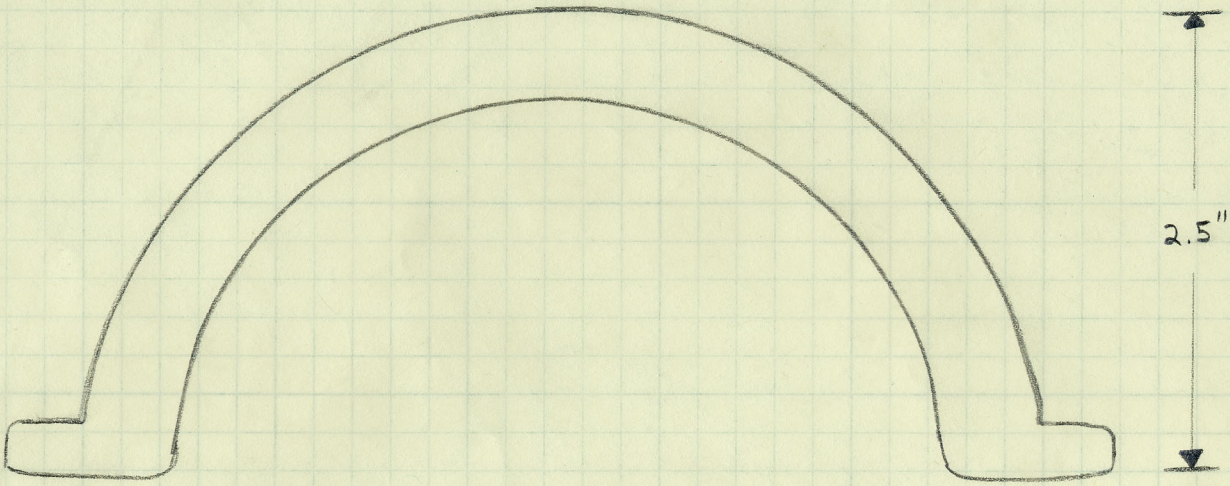
PLAN VIEW



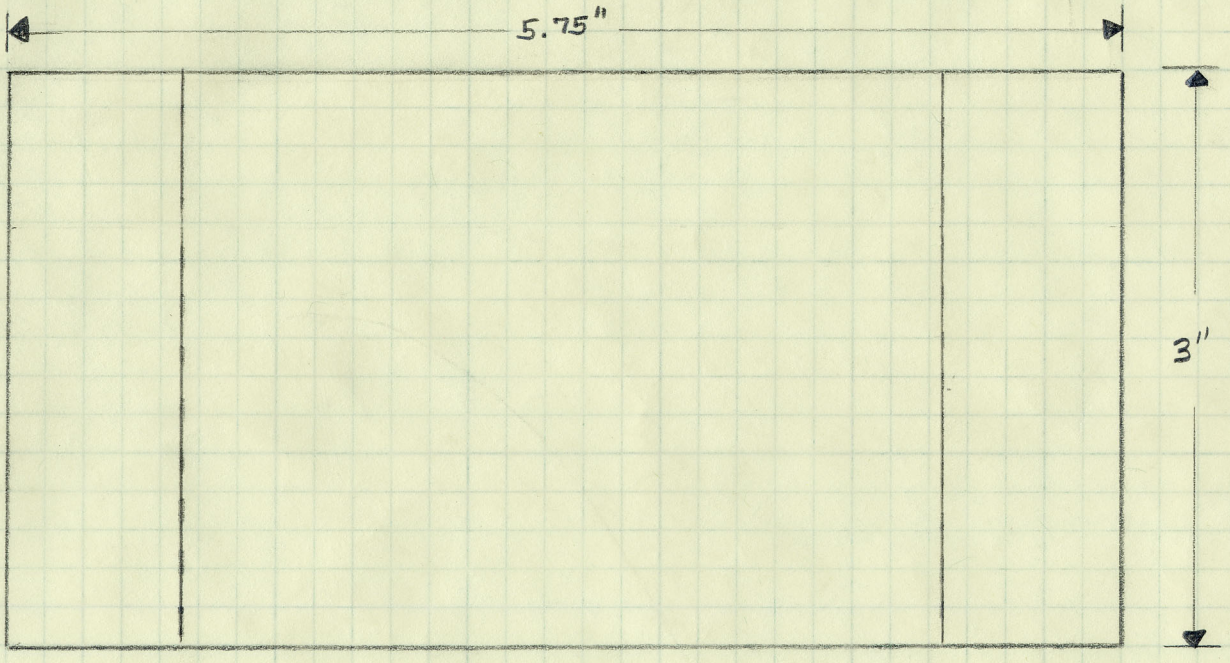
CROSS-SECTION A-A

NOTE: ALL SPILLWAYS FOR NJDEP'S MODEL WERE CONSTRUCTED FROM WOOD (FIR) USING A BANDSAW AND COATED WITH POLYURETHANE.

SEMI-CIRCULAR SPILLWAY

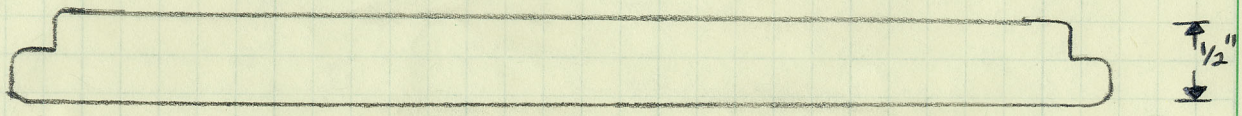


PLAN VIEW

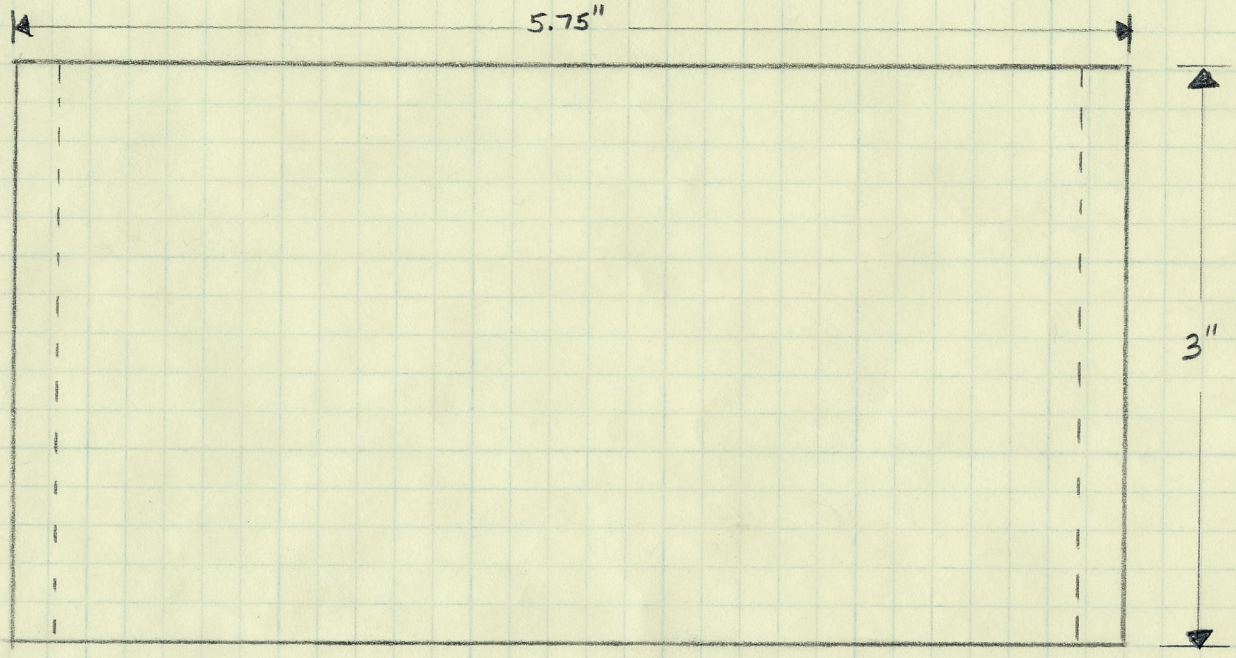


PROFILE VIEW

BROAD CRESTED SPILLWAY



PLAN VIEW



PROFILE VIEW