

Research Report
KTC-89-50

MOUNTAIN PARKWAY EDGE
DRAIN INSPECTION
(SEPTEMBER 29-OCTOBER 5, 1989)

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EXECUTIVE SUMMARY

On September 28, 1989, the Kentucky Transportation Cabinet requested the Kentucky Transportation Center (KTC) to investigate an apparent drainage problem on the Mountain Parkway. The area of concern was a rehabilitation project starting at Milepost 16 and ending at the Stanton exit (Milepost 22). The old PCC pavement was being broken and seated and then overlaid with approximately nine inches of asphaltic concrete. Longitudinal edge drains Advanedge and Contech Stripdrain 100 had been installed prior to the breaking and seating.

The edge drains had been inspected with the borescope on July 17, 1989 and which appeared to be in good condition after installation. On September 29, 1989, KTC personnel investigated the site and observed several stained areas on the newly paved surface where calcium fines were being forced to the surface.

After studying the stained areas, it appeared they could be attributed to poor construction practices and headwall spacing. The following are some of the problems noted during inspection.

1. Faulty connection in a main line splice.
2. Faulty connection between the edge drain and the 4-inch outlet.
3. Soil and aggregate deposits in the median boxes and clogging in the 4-inch outlets.
4. Compressed 4-inch outlet pipes leading to the headwall.
5. Destruction of 4-inch outlet pipes in medians before final construction was completed.
6. Guardrail post being driven through the outlet pipes, and
7. Headwall spacing.

If the headwall spacing is decreased, less staining at the surface might be expected because the calcium carbonate fines would have a shorter distance to travel before exiting the outlet. The likelihood of the capacity of the edge drains being exceeded would also decrease. If the drain is installed properly and the capacity of the drain is not exceeded, calcium fines should exit the outlets and not be forced to the surface (in general, calcium carbonate is an indication that the drain is not fully functional since the calcium is brought to the surface by water). Calcium fines are still being deposited and crystallizing at the headwalls in Section 1, south of the Stanton Exit. The edge drains were installed in the summer of 1988 (the rigid pavement was broken and overlaid shortly there after). The amount of fines being deposited at the headwalls has decreased since 1988.

Edge drain outlets, which discharge into the median boxes, should be placed

sufficiently high to allow for sedimentation in the bottom of the box, but sufficiently low to provide a proper grade from the edge drain. A second alternative is to use headwall outlets in the medians. Steps should also be taken to insure proper installation of the edge drains and their outlets.

Introduction

On September 28, 1989, the Kentucky Transportation Cabinet requested the Kentucky Transportation Center (KTC) to investigate an apparent drainage problem on the Mountain Parkway. The area of concern was a rehabilitation project starting at Milepost 16 and ending at the Stanton exit (Milepost 22). The old PCC pavement was being broken and seated and then being overlaid with approximately nine inches of asphaltic concrete. Longitudinal edge drains Advanedge and Contech Stripdrain 100 had been installed prior to the breaking and seating.

Edge Drain Inspection

The edge drains had been inspected with the borescope on July 17, 1989, and they appeared to be in good condition after installation. On September 29, 1989, KTC personnel investigated the site and observed several stained areas on the newly paved surface where calcium fines were being forced to the surface. No calcium fines were present at the edge drain headwalls before the rigid pavement was broken. It appears that the fines are being generated from the broken concrete. Such staining is usually an indication that water is not discharging through the edge drains and/or the drains were being overcharged during heavy rains. Appendix A contains a list of all the stained areas. From September 29, 1989, through October 5, 1989, the following inspections were conducted.

Field Inspection (September 29-October 5, 1989)

On September 29, 1989, a stained area on the westbound outside shoulder (Milepost 21.25) was inspected. The edge drain was inspected with the borescope at two locations in the stained area, approximately three feet apart. At the first location, the drain appeared to be clean and no signs of distress were observed. The edge drain was opened again approximately three feet upgrade. The top four inches of the drain appeared to be open but the sides of the inner core were silted. The bottom three-fourths of the drain was filled with water. On October 2, 1989, a trench was excavated exposing the ADS drain. It was apparent the fabric surrounding the inner core was wrapped over the end of the drain core at the location of a splice.

Another stained area was observed at Milepost 20.9 at the centerline of the eastbound lanes. A 4-inch outlet at this location was traced to a median junction box. The junction box was filled with one foot of soil and aggregate which was blocking the 4-inch outlet at the bottom of the box (Figure 1). The same junction box was observed several weeks later. The edge drain outlet pipe was 75 percent clogged with calcium fines (Figure 2).

A third stained area was investigated at Milepost 20.9 on the outside shoulder of the westbound lanes. The headwall was inspected and it was noted the outlet pipe was partially collapsed and clogged with sand (Figure 3). The sand was used as a backfill medium which indicated that there was a separation in the main line. The edge drain was excavated at the junction of the four-inch outlet pipe and the edge drain. A four inch separation was observed between the outlet pipe and the edge

drain (Figure 4).

On October 3, 1989, a fourth stained area was inspected at Milepost 21.2 on the inside shoulder of the eastbound lanes. The 4-inch outlet pipe was traced in the median to a point where it had been crushed and buried, and was never connected to a median junction box for discharge (Figure 5).

Median Outlet Inspection (October 4, 1989)

On October 4, 1989, the median drains were inspected between station 894+36 to 1,056 feet east of station 1002+00. The four-inch outlet pipes had been installed up to the junction box. The junction boxes had to be raised before the edge drain outlets could be fully connected. Appendix B contains an inspection report concerning the median drains and Appendix C is a series of photographs documenting the inspection conducted on the Mountain Parkway.

LABORATORY TESTING AND ANALYSES

Samples of the newly placed asphaltic concrete surface course were collected in two locations. Constant-head permeability tests were performed on those samples in the laboratory. Three tests were conducted on each sample. Figure 6 shows the results of the average flow-versus-time curve for each sample (two samples were obtained at each site).

The average coefficient of permeability, k , for the four asphaltic concrete base samples was calculated from the laboratory permeability tests, using the following equation:

$$k = QL / Aht \quad (1)$$

where

Q = quantity of flow (cm^3) - determined from Figure 6,
 L = length of specimen (cm),
 A = area of specimen (cm^2),
 h = head loss across specimen (cm), and
 t = time (sec) - determined from Figure 7.

The average coefficient of permeability for the four samples was .000662 centimeters per second.

To determine the flow of water through the pavement and into the drain, it is necessary to solve Equation 1 for Q , yielding:

$$Q = KAht/L. \quad (2)$$

In this particular case, the following values were used for the variables in Equation 2:

$k = 0.000662 \text{ cm/sec}$
 $A = 1.0 \text{ cm}^2$
 $L = 2.29 \text{ cm (thickness of new asphalt overlay)}$

$$h = 2.29 \text{ cm (calculated from the top surface of the asphalt overlay to the bottom of the overlay)}$$
$$t = 60 \text{ sec}$$

Solving Equation 2 using these values yields the amount of water that would flow vertically through the pavement per unit of area, per unit of time. In this case,

$$Q = 0.040 \text{ cm}^3/\text{minute}/\text{cm}^2 \text{ of pavement surface.}$$

Converting to English units:

$$Q \approx 0.236 \text{ gallon/minute/linear foot of pavement,}$$

The headwall spacings at Site No. 2 were approximately 820 feet. In 820 linear feet

$$Q \approx 193 \text{ gallons/minute.}$$

The grade of the roadway at Site 2 was 3.7 percent. The manufacturer's published data indicate the capacity of the panel edge drain is approximately 24 gallons per minute at a 3.7 percent grade (Figure 7). At 820 feet between headwalls, the capacity of the drain was exceeded by more than eight times.

It is important to estimate the frequency and intensity of rainfall that would produce the quantities of flow discussed. The quantity calculated above from the permeability on the base course was:

$$Q = 0.040 \text{ cm}^3/\text{minute.}$$

This is approximately equal to 0.016 inch per minute or 0.94 inch per hour of rainfall intensity. Figure 8 shows the frequency of occurrence of this rainfall intensity for Lexington, Kentucky (the closest city for which data are available). A rainfall intensity of 0.96 inch per hour, and a duration of 60 minutes may occur one time each month. However, a rainfall of equal intensity but having a shorter duration could occur several times each month. It appears the capacity of the drains could be exceeded several times each month. Figure 9 is a design chart that may be helpful in determining headwall spacing, if the permeability and the percent grade are known.

Discussion

After studying all the stained areas on the Mountain Parkway, it appears the majority of the stained areas may be attributed to poor construction practices and headwall spacing. The following are some of the problems noted during inspection.

1. Faulty connection in a main line splice,
2. Faulty connection between the edge drain and the 4-inch outlet,
3. Soil and aggregate deposits in the median boxes, and clogging the 4-inch

outlets,

4. Compressed 4-inch outlet pipes leading to the headwall,

5. Destruction of 4-inch outlet pipes in medians before final construction is completed,
6. Guardrail post being driven through the outlets,
7. Headwall spacing.

If the headwall spacing is decreased, less staining at the surface might be expected because the calcium carbonate fines would have a shorter distance to travel before exiting the outlet. The chances of the edge drains capacity being exceeded would also decline. If the drain is installed properly and the capacity of the drain is not exceeded calcium fines should exit the outlets and not be forced to the surface (in general the calcium carbonate is an indication that the drain is not fully functional since the calcium is brought to the surface by water). Calcium fines are still being deposited and crystallizing at the headwalls in Section 1, south of the Stanton Exit. The edge drains were installed in the summer of 1988 (the rigid pavement was broken and overlaid shortly there after). The amount of fines being deposited at the headwalls has decreased since 1988.

Edge drain outlets, which discharge into the median boxes, should be raised sufficiently high to allow for sedimentation in the bottom of the box, but be sufficiently low to provide a proper grade from the edge drain. A second alternative is to use headwall outlets in the medians. Steps should also be taken to insure proper installation of the edge drains and their outlets.

Figure 6. Permeability Asphaltic Surface Course

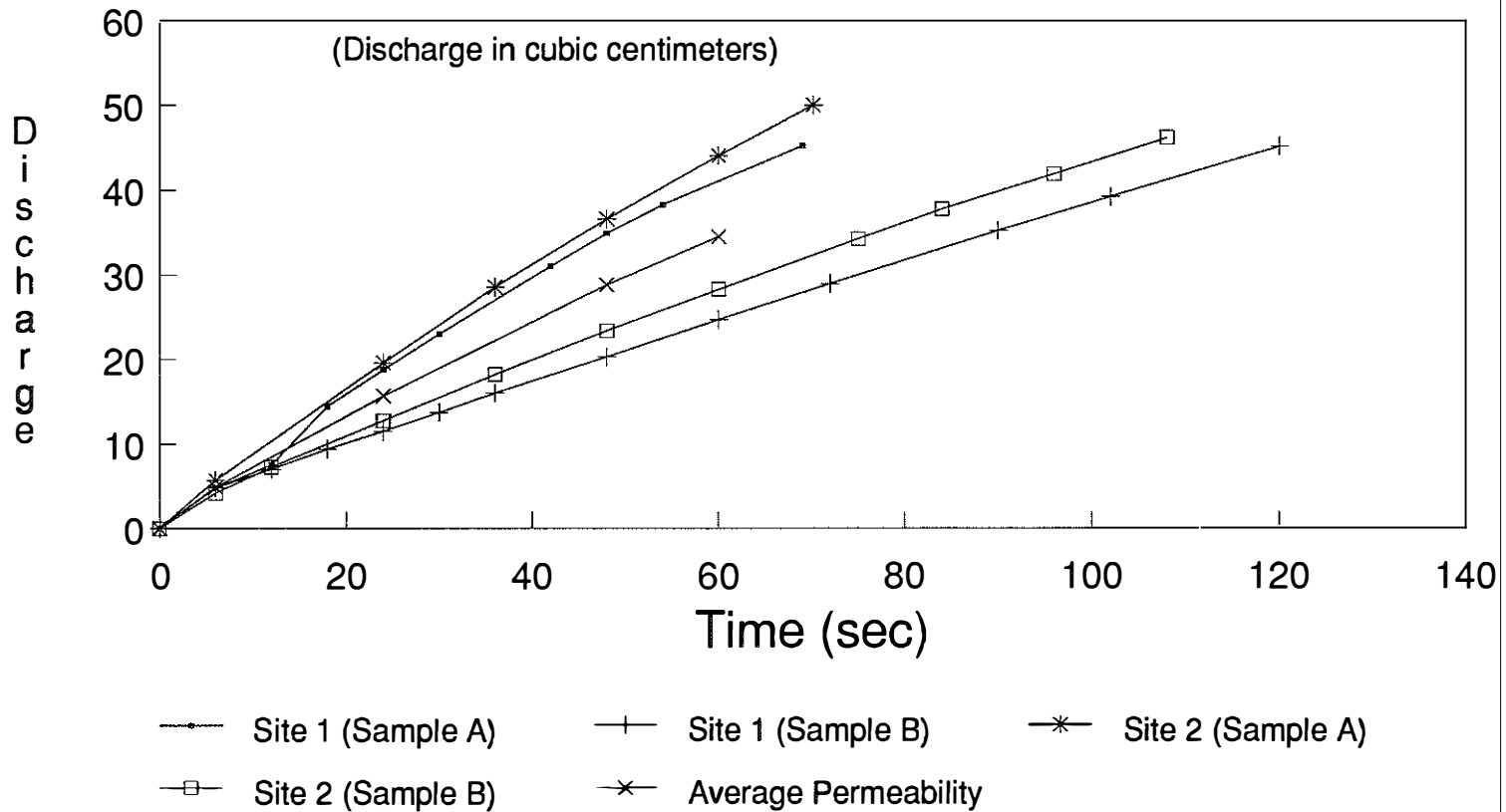


Figure 7. ADS Flow Capacity

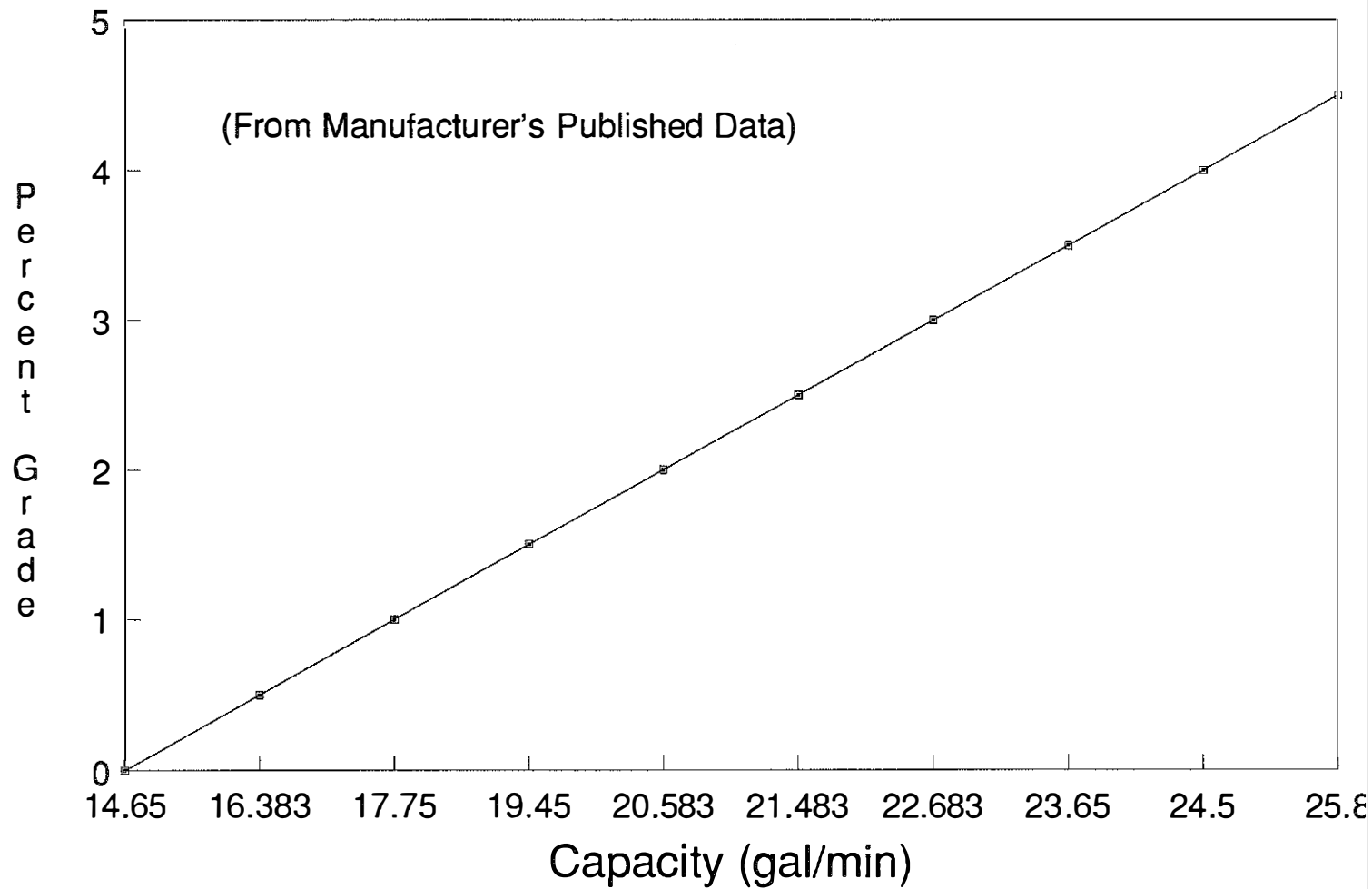


Figure 8. Intensity Duration Curves Lexington, Kentucky

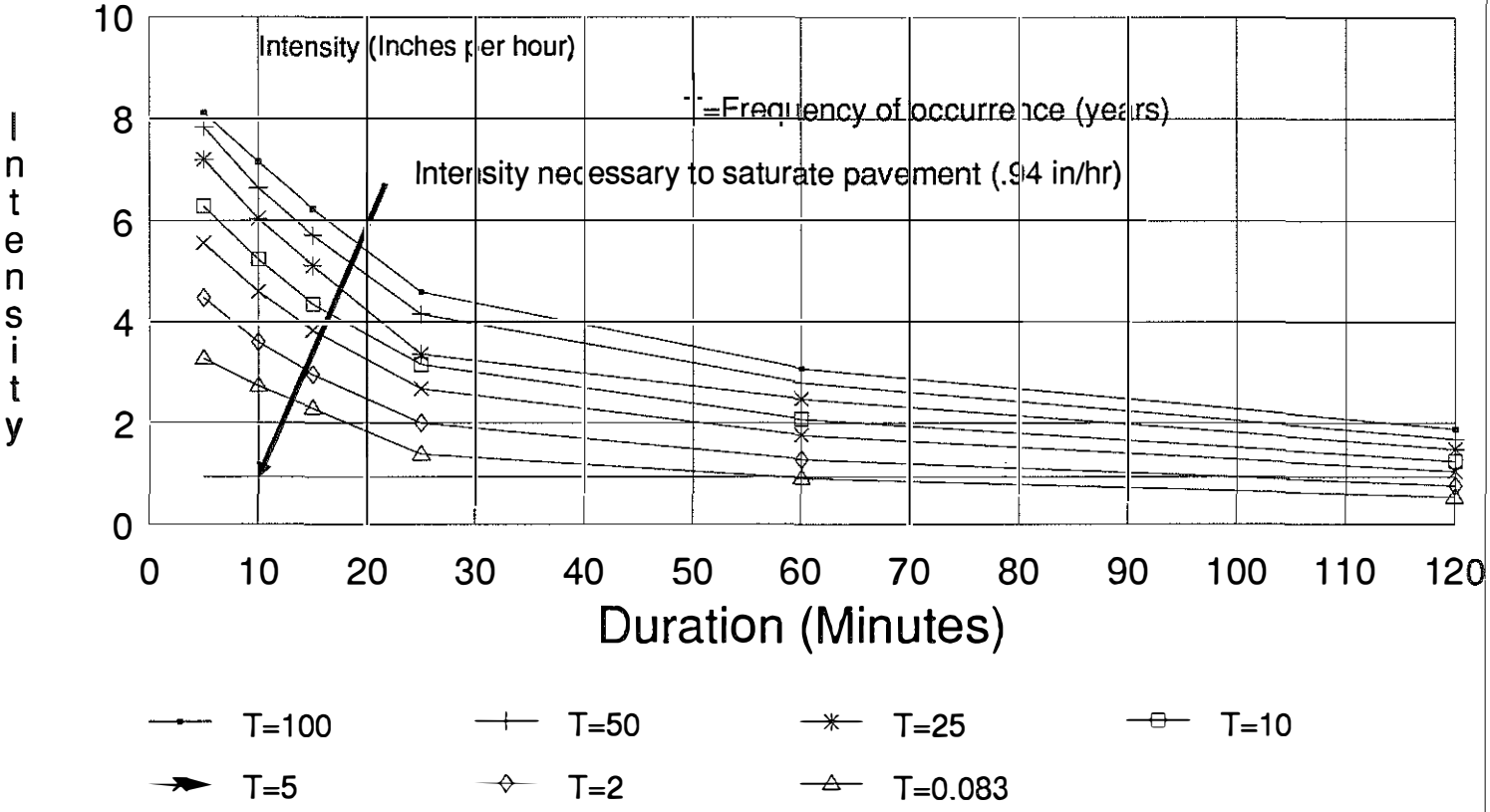
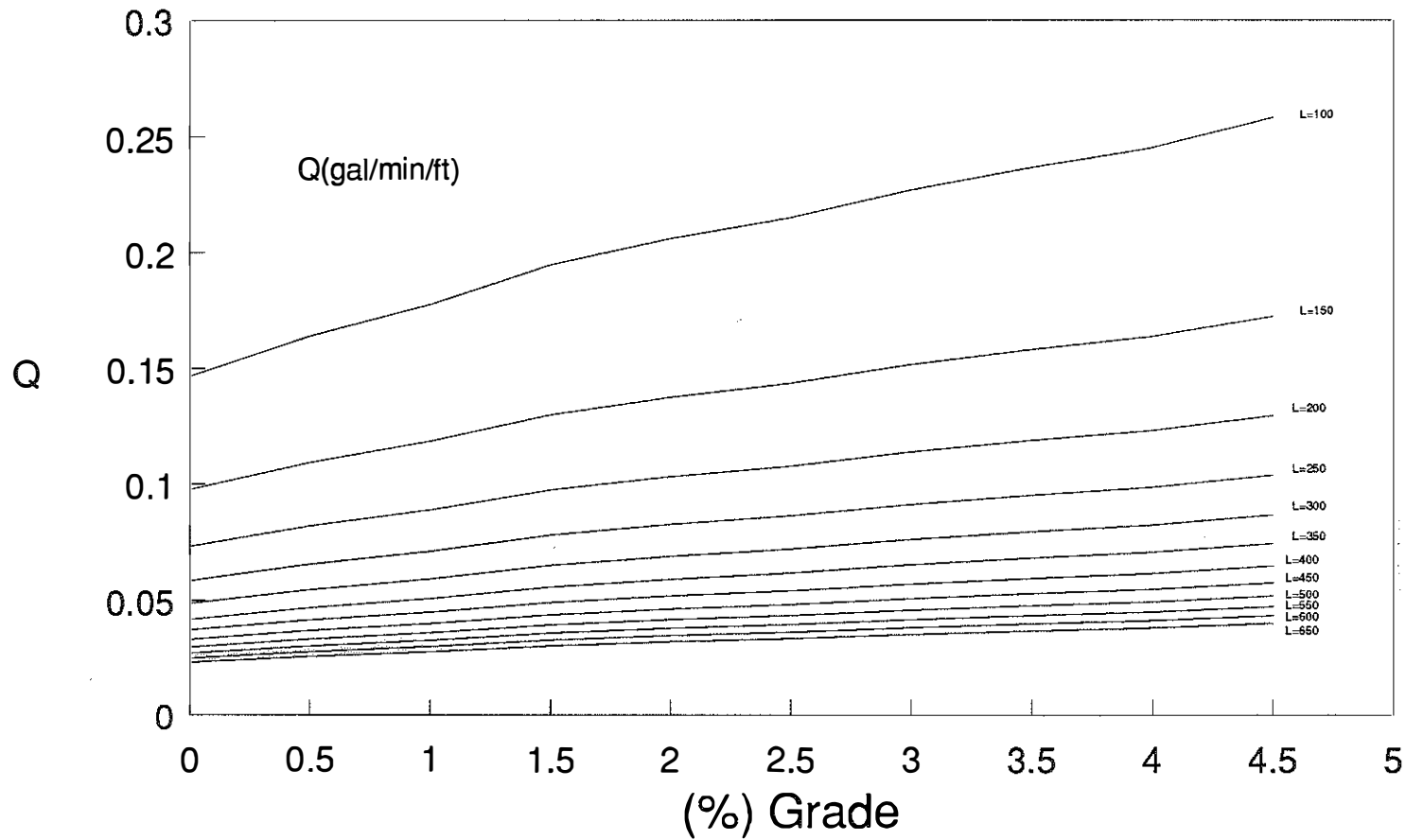


Figure 9. Headwall Spacing Chart

Chart only applies to 12-inch ADS Panel



APPENDIX A
INSPECTION OF STAINING ON THE ASPHALT SURFACE
October 5, 1989

STAIN INSPECTION

Milepost	Location and Description
19.95	Eastbound, centerline, slight super, flowing toward median.
20.36	Eastbound, centerline, slight super, flowing toward median.
20.90	Eastbound, centerline, slight super, flowing toward median.
20.95	Eastbound, centerline, slight super, flowing toward median.
21.10	Eastbound, centerline, slight super, flowing toward median.
21.20	Eastbound, centerline, slight super, flowing toward median.
22.25	Eastbound, Stanton Exit, right shoulder.
22.10	Westbound, inside shoulder.
21.75	Westbound, inside shoulder.
21.25	Westbound, outside shoulder.
21.25	Westbound, inside shoulder.
20.90	Westbound, outside shoulder.

APPENDIX B
INSPECTION OF MEDIAN OUTLET PIPES
10-4-89

1001+20.8	Eastbound is filled with silt and grass and the westbound is buried.
1002+00	Both eastbound and westbound outlets have been crushed.
1002+52.8	Both eastbound and westbound outlets have been crushed at the ground line.
1010+92	Westbound outlet has been cut into and crushed. The eastbound outlet was curved up and full of water.
1016+00	Westbound is completely buried and the eastbound is crushed and partially buried.
1056 feet east of station 1002+00	Both eastbound and westbound outlets were curved up and holding water.

**APPENDIX C
DOCUMENTATION OF MEDIAN OUTLET
INSPECTION**

MEDIUM OUTLET INSPECTION

Station	Description
894+36	Both eastbound and westbound outlet pipes have been completely flattened.
896+04.9	Eastbound outlet has been covered with a cyclopean stone. The pipe appears to be completely crushed under the stone. The outlet pipes have some loose rock in them.
896+47.2	Both eastbound and westbound outlets have been cut into, crushed, and buried.
897+00	Both eastbound and westbound outlets have been cut into, crushed, and buried.
913+00	Westbound pipe is completely buried and the eastbound outlet has been cut into, crushed, and partially buried.
921+00	Westbound pipe is completely buried and the eastbound outlet has been cut into, crushed, and partially buried.
929+00	Eastbound outlet is bent up and ponding water and the westbound is bent and crushed.
939+00	Eastbound is bent and partially crushed and the west bound is completely crushed.
942+00	Ends of the pipe were covered and ponding water under the pavement.
946+50	Westbound outlet is buried and the eastbound outlet is in good condition.
952+50	Both eastbound and westbound outlet pipes were curved up and ponding water.
958+50	Both eastbound and westbound outlet pipes are in good condition.
963+50	Westbound outlet is in good condition, but the eastbound outlet has been crushed.
998+56.8	Eastbound outlet is in good condition, but the westbound outlet has been crushed.

1001+20.8	Eastbound is filled with silt and grass and the westbound is buried.
1002+00	Both eastbound and westbound outlets have been crushed.
1002+52.8	Both eastbound and westbound outlets have been crushed at the ground line.
1010+92	Westbound outlet has been cut into and crushed. The eastbound outlet was curved up and full of water.
1016+00	Westbound is completely buried and the eastbound is crushed and partially buried.
1056 feet east of station 1002+00	Both eastbound and westbound outlets were curved up and holding water.

**APPENDIX C
DOCUMENTATION OF MEDIAN OUTLET
INSPECTION**