M. W. TINDER
COMMISSIONER OF HIGHWAYS

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

December 13, 1954

ADDRESS REPLY TO

ATTENTION: D. 2. 1.
D. 1. 7.

MEMO TO: D. V. Terrell
Director of Research

Last year when results of the state-wide acid water survey were reviewed from the standpoint of policies governing drainage pipe installations, the permanency of bituminous coatings on metal pipe was a point that remained undecided. No exception was taken to the conclusion that metal was adequately protected as long as the coating or pavement remained intact, but most of those attending the review meeting doubted whether the performance of coatings on a few pipe placed in the main highway system 25 or 30 years ago was representative of performance that could be expected from coatings on a variety of metal pipe placed since the beginning of the Rural Secondary program.

As a result of this concern, Mr. Bray requested that a fairly extensive survey of Rural Secondary projects be made to determine the conditions that existed. This was done by E. M. West during the past summer, and his findings are contained in the attached report. Almost 300 bituminous-coated culverts on 51 Rural Secondary roads were inspected. The roads were in 26 widely scattered counties, and the dates of installation ranged from 1949 to 1952 - about the extent to which a sampling of the R. S. program could be taken. All sizes of pipe and pipe arches were represented, and a few uncoated multiplate arches were included because of the convenience for inspection.

In essence the survey showed that on practically all pipe correctly installed the coatings and pavements were in excellent condition except at the ends, and at points where sustained wetting and drying has occurred. Invariably light - and particularly direct sunlight - has caused cracking of the bituminous material, so that only those pipes with ends shaded are free from severe cracking. This, of course, is mainly a result of exposure to ultra violet light, an influence to which unmodified asphalt cements have notoriously little resistance. Fortunately deterioration of this sort extends into the pipe only a short distance, and on the pipe inspected (maximum age about 6 years) there was no evidence of removal of the asphalt or deterioration in the metal, even though some of the cracks were deep enough to expose the metal. Conditions might have been different had any of the pipe been carrying acid water.

Scaling of the asphalt to slight depths was caused by frequent and sustained wetting and drying. This appeared most often along the elevation of low flow or the "trickle" line in culverts where flow is continuous but variations in the water level are very small except during periods of heavy runoff. Scaling in this manner extended throughout the length of the culvert. Normally the scales adhered and were not removed, particularly where flow was confined to the bituminous pavement. Wherever the culvert had been installed incorrectly and the pavement was not in the invert, scaling damage to the bituminous coating was always severe, provided the wetting and drying conditions prevailed.

Insofar as bituminous coatings and pavements are concerned, I doubt that there is a significant difference between those applied today and the ones applied by comparable manufacturers 25 or 30 years ago. Construction conditions which favored shading, heavy silting in most of the coated culverts that were found, and the installation of pipe in positions that did not permit continuous flow account for the absence of cracking and scaling in the structures which were studied in the acid water survey. All these locations were revisited this fall to correlate circumstances in the earlier and the recent studies.

The report contains some other observations about drainage structures that are worthwhile, and in addition it brings up to date our records of the test installation at Mortons Gap - which was started four years ago in conjunction with the acid water study. Progressive deterioration in some of the sections is evident, and another pipe has been removed since the last report was made. In brief the experiment continues to point up the often-told story about the cleaning power of acids in drainage systems, which closes with the admonition "..... don't use sulphuric acid - it eats hell out of the pipes."

Respectfully submitted,

L. E. Gregg

L. E. Gregg
Assistant Director of Research

LEG:ddc
Copies to: Research Committee
Mack Galbreath (3)

Commonwealth of Kentucky
Department of Highways

AN INVESTIGATION OF BITUMINOUS COATINGS AND PAVEMENTS ON CORRUGATED METAL CULVERTS

(Rural Secondary Projects 1949-1951)

by

Eugene M. West
Research Engineer

Highway Materials Research Laboratory
Lexington, Kentucky

November, 1954

INTRODUCTION

The object of this inspection was to determine the efficacy of bituminous coatings and paved inverts on corrugated metal pipe and culverts installed on Rural Secondary Projects during the past few years. The study originated after earlier investigations had led to recommendations concerning the resistance of various types of pipe and culvert materials in the presence of acid-bearing waters.*

One of the conclusions from the acid-water survey was that "bituminous-coated metal pipe is resistant to acid corrosion as long as the coating insulates the metal from contact with acids." The condition of bituminous-coated pipe located in the primary and secondary roads which were surveyed in 1952 conveyed the impression that these coatings could be relied upon to adhere well and protect the metal for periods upward from 15 years. This was based not only on the few (approximately 30) coated pipe in the roads surveyed that year, but also on information obtained from surveys in other states. The pipe represented in the 1952 survey ranged up to 30 years in age.

When recommendations contained in the report on the work were considered from the standpoint of policies that should be applied to cross drains and entrance pipes on various classes of roads, there was some doubt about the comparability of coatings placed on pipe more than 15 years ago and the coatings applied to pipe in recent years. This was based on occasional observations made by others on Rural Secondary Projects where the pipe had been installed since 1948. Numerous failures of coatings were reported.

* See Report No. 2 on "A Survey of Acidity in Drainage Waters and the Condition of Highway Drainage Installations", by J. H. Havens, Highway Materials Research Laboratory, December 1952.

Inasmuch as the acid-water surveys had not included any roads in the Rural Secondary class, there was no basis for direct comparison between the older and the more recent coatings. As a result, the Division of Research was asked to extend its observations of bituminous-coated pipe to include many of those installed since the beginning of the Rural Secondary program. This is the report of those observations, supplemented by data from the drainage test installation at Morton's Gap which was started in April 1951, and on which the last report was made in December 1952.

GENERAL CONSIDERATION

Selection of Culverts

Locations of coated and paved pipes were selected through a review of final estimates on Rural Secondary Projects dating from the beginning of the Rural Secondary program in 1948 to and including 1951. Only those roads for which the records indicated use of bituminous coated corrugated metal (BCCM) pipe were considered.

Inspections were made on the majority of these roads, the principal exceptions being cases where there were more than two or three such projects in a county, or where the projects were very close together. An att empt was made to spread the inspections in order to include reasonably representative samples from all the areas in which culverts of this type had been used. General locations of roads on which inspections were made are shown in Fig. 1.

Inspection Procedure

At the outset it was decided that an analysis of each structure by some physical test on the material or by some definite yardstick of performance would not be feasible. A reasonable alternative was to make a complete inspection of representative culverts on the roads chosen for study, and from that record as much field information as could be obtained through inspections of the inside coating and pavement in its entirety and the outside coating wherever possible. The evaluation included not only visual observations as such, but also a superficial test for adhesion by which attempts were made to peel the coating or pavement. In addition, resistance to penetration was roughly estimated by use of

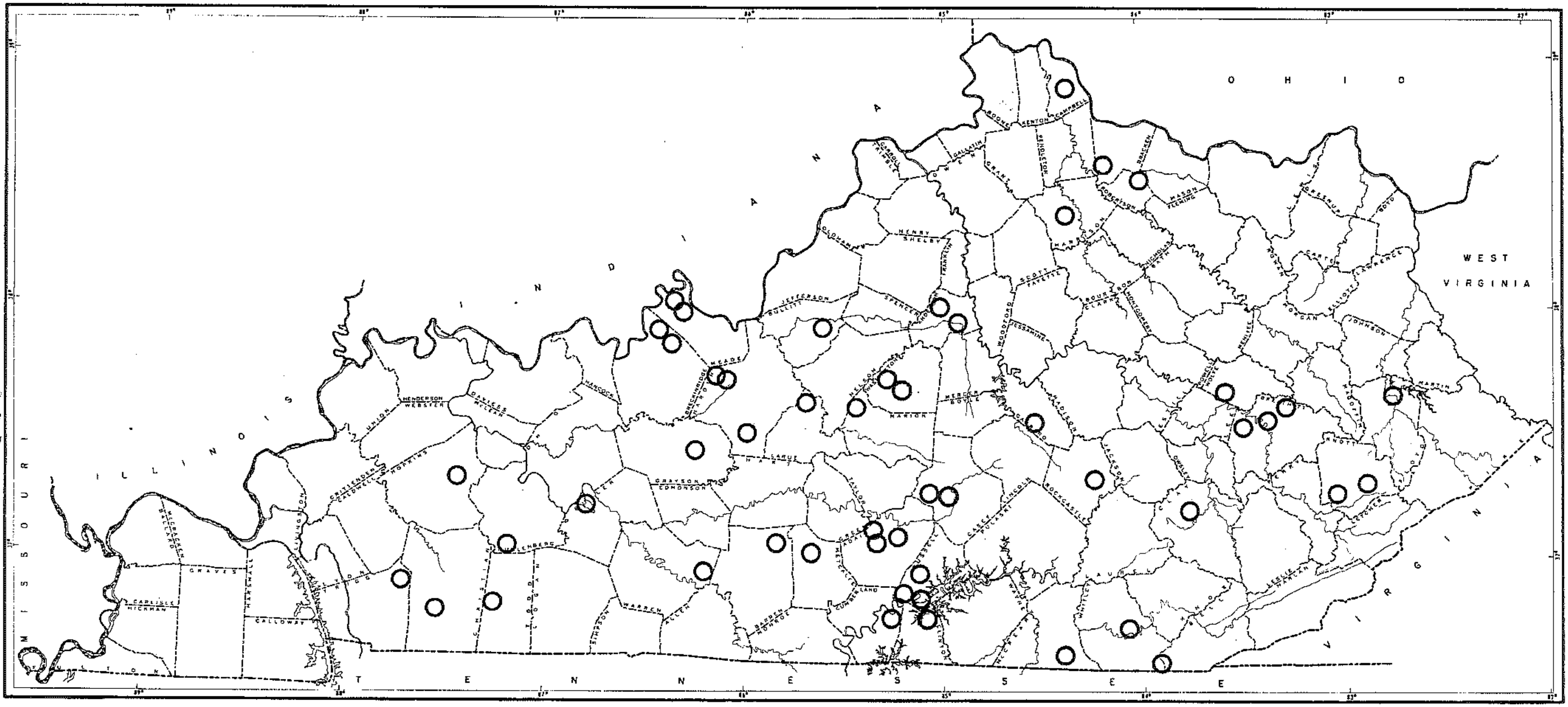


Fig. 1 - Locations of Rural Secondary Roads on Which Inspections Were Made.

a knife blade - the result proving some measure of hardness or dryness of the coating material. Photographs showing the general conditions encountered, were taken at each location and kept as a visual record of the inspections.

Whenever the presence of acid water at a culvert site was definitely suspected, the pH was measured with methyl orange or methyl red, and the value recorded. Drops of methly orange were placed in the water for the range of acidity of pH 3.1 to pH 4.4 and methyl red for the range of 4.4 to 6.0. Since the majority of streams associated with the culverts studied were dry at the time of inspection, the pH test had limited application. When possible, these tests were conducted in pools of water elsewhere in the stream, but always close to the culvert involved.

Note was made of any situation thought to have had some influence on the condition of the coating and pavement observed at the time of inspection. In addition, these data included information relating to suggested improvements as well as comments on errors in construction.

Records

Since there was no standard procedure for this type of field study, it was decided that performance of the culverts would be judged according to conditions set forth in an inspection form (See Fig. 2). The form was designed to include: (1) a full description of the structure, (2) the date of installation, (3) general classification of as much of the drainage area that it was feasible to observe in the field, and (4) apparent condition

INSPECTION NO. _______

Bituminous Coated
Coated & Paved
Paved Invert

LOCATION ____

____

____

Date Installed ________ Dia. ____ Gage ____ Pipe Arch No. _____ Lgth. _____

Grade _____ Est. Cover _____ (Skewed, Beveled, Headwall) Gen. Cond: ___

FLOW:
Continuous ________
Frequent ________
Intermit ________
Filling ________
Erosion:
Sand ________
Gravel ________
Boulders ________
Shale ________

TYPE DRAINAGE:
Cult. Land ________
Pasture ________
Hilly Wooded ________
Wooded Swamp ________
Farmyard ________
Sewage ________
Mine Water ________
pH Paper ________
pH Meter ________
Water Sample ________

MAINTENANCE CONDITION:
Excellent ________
Very Good ________
Good ________ Fair ________
Poor ________
Pvt. Alin. ________
Type Soil:
Black Loam ________
Clay ________
Shale ________
Sandy ________

COATING CONDITION

ASPHALT:
Adhesion Excellent ________
Adhesion Good ________
Ashesion Fair ________
Adhesion Poor ________
Coating Checked ________
Percent Missing ________
Average Thickness ________
Could be Stripped ________

SPELTER:
Like New ________
Pin Point Rust ________
Tubercular Rust ________
Spelter Gone ________
Loose Scaly Rust ________
Heavy Pitting ________
Perforated ________

PAVEMENT:
Adhesion Excellent ________
Adhesion Good ________
Adhesion Fair ________
Adhesion Poor ________
Longitudinal Cracks ________
Circumferential Cracks ________
Width of Cracks ________
Depth of Cracks ________
Percent Missing ________
Ave. Thickness over Crests ________

INSPECTION DATE ________

INSPECTED BY ________

GENERAL COMMENTS: ____

____

____

Fig. 2 - Sample of Inspection Form used in recording data for the present study.

of the coating and pavement. Provision was made for some features that could influence the degree of performance as well as for symptoms of failure.

Even though the spelter coating of metal was not directly related to bituminous coatings, effort was made to note the condition of the spelter where metal had become exposed on BCCM pipe. Also, in a few instances where an uncoated pipe having the same service life was located close to a coated pipe, both were inspected for the purpose of comparison. Another type structure - the uncoated metal arch fabricated on the site - was encountered on several occasions and incidental observations were made at those locations because of its function and similarity to the structures in question.

Information from the inspection forms are summarized in Table 1 in the Appendix. Much of the original material has been abbreviated in the table, particularly in the column headed Remarks, the intent being to save space and eliminate comments in the field notes that had no particular bearing on coatings or pavements for corrugated metal pipe.

RESULTS OF FIELD OBSERVATIONS

After inspections had been completed on a few of the roads it was evident that certain features in the performance of the coatings and pavements were common to all the installations. Although deterioration is undoubtedly progressive, the tendency toward development of these features was independent of the age of the pipe, all of which were from 2 to 5 years old at the time. Also it was independent of location in the state, and with the exception of ponding it was independent of location with respect to various features of the stream.

The most significant influences were manner of placement of the culvert at the time of construction, shading or lack of shading at the inlet and outlet, slope of the pipe under some circumstances, and maintenance conditions. This, of course, did not apply to the uncoated structures which were included for reasons previously mentioned.

Condition of the Coating

In all but a few of the BCCM structures the overall condition of the coating ranged from good to excellent. There were a few cases where dripping had occurred (but never to any great extent), indicating that adhesion was reasonably good but temperature susceptibility of the bituminous material was too great. In some culverts there was evidence of slight checking of the coating in the end portion. However, in no instance did this action expose the metal. In many cases, scratching and scarring of the coating (caused by improper handling) was found.

The outside coating of structures of any age was usually cracked and flaking off, except when the exposed part of the pipe was located in a shaded area. Almost invariably the outside coating on that portion of pipe buried within the fill was rapidly deteriorating or completely removed. However, there were no locations where additional deterioration such as removal of the spelter and consequent rusting was noted.

There were two special cases of extreme deterioration in coatings, which were caused by service conditions for which the coatings were not intended. These are covered specifically later under headings dealing with improper placement and burning of drift.

Condition of Pavement

In approximately 90 percent of the locations the pavement was in an excellent state almost throughout the entire length of the culvert. At the extremities (for varying distances in from the inlet and outlet ends) cracking in the invert was prevalent. Sometimes the cracking pattern extended an appreciable distance back into the pipe - from a few inches in small structures to several feet in large arches.

Deterioration of this type was dependent upon exposure to light, and particularly to direct sunlight. Ends of pipe which were shaded, such as the one shown in Fig. 3, were generally free from cracks in the pavement. On the other hand, end openings that were fully exposed invariably showed pronounced cracking of the pavement. This was so whether the culvert consisted of a circular pipe (Fig. 4 and 5) or an arch (Fig. 6). The extent of cracking was influenced by both the size of opening and the thickness of pavement. As one would expect, cracks extended farther

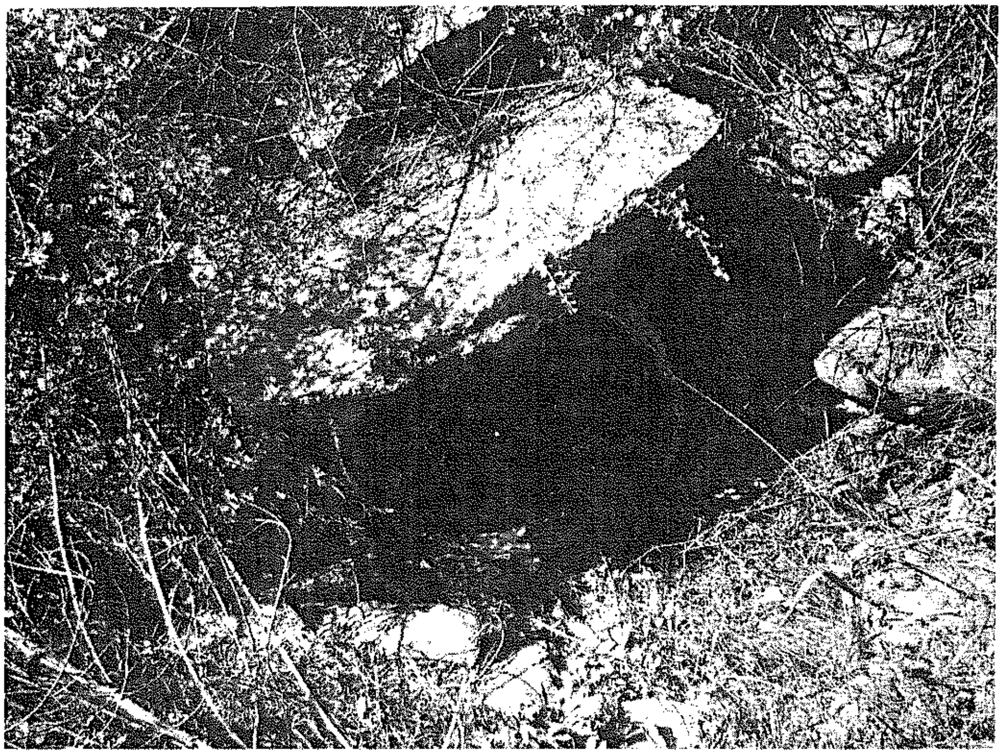
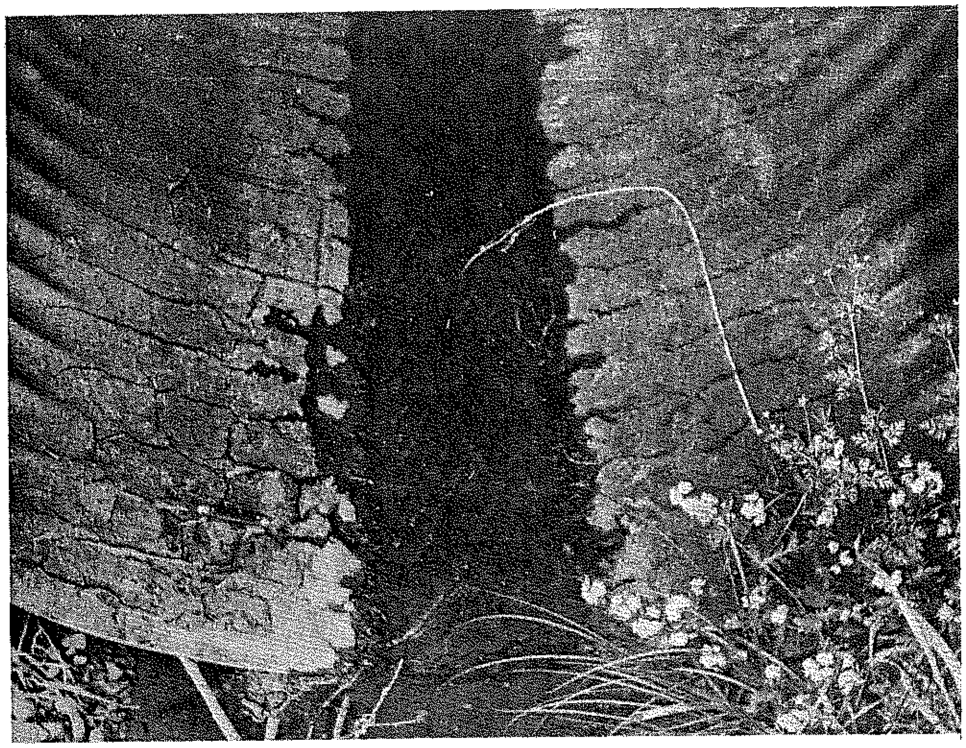
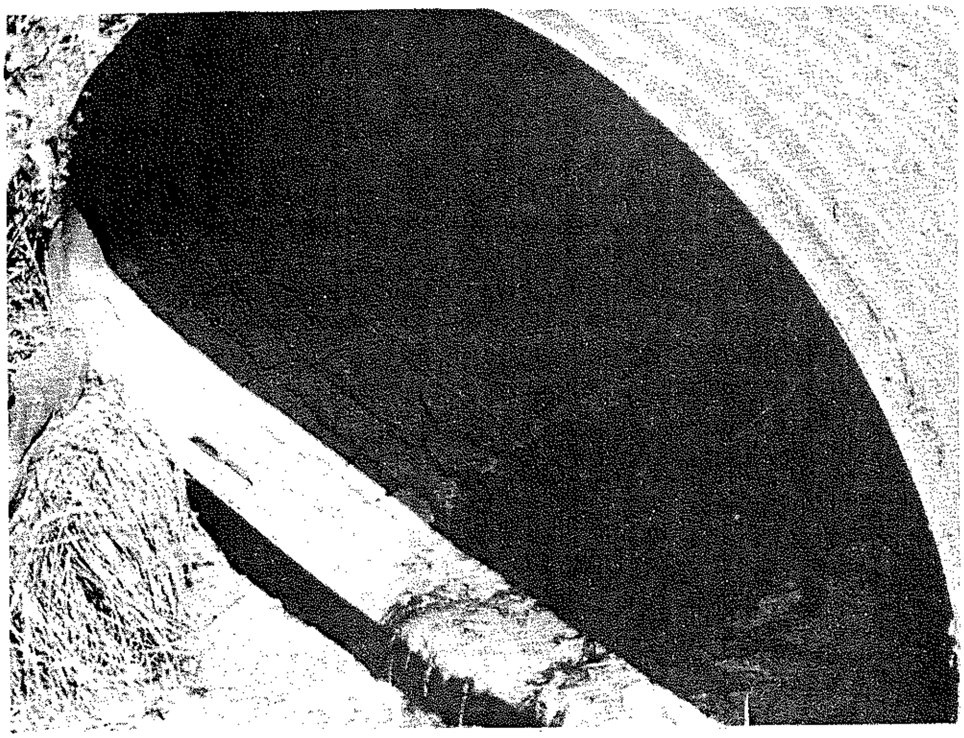


Fig. 3 - Inlet of a 24-in. diameter coated and paved culvert completely shaded by overhanging rock. No scaling was evident, and only minor cracking had occurred for a distance of 3 to 5 in. These conditions were typical of all coated and paved pipe which were shaded and placed on sufficient slopes to prevent ponding of water at the inlet and outlet.

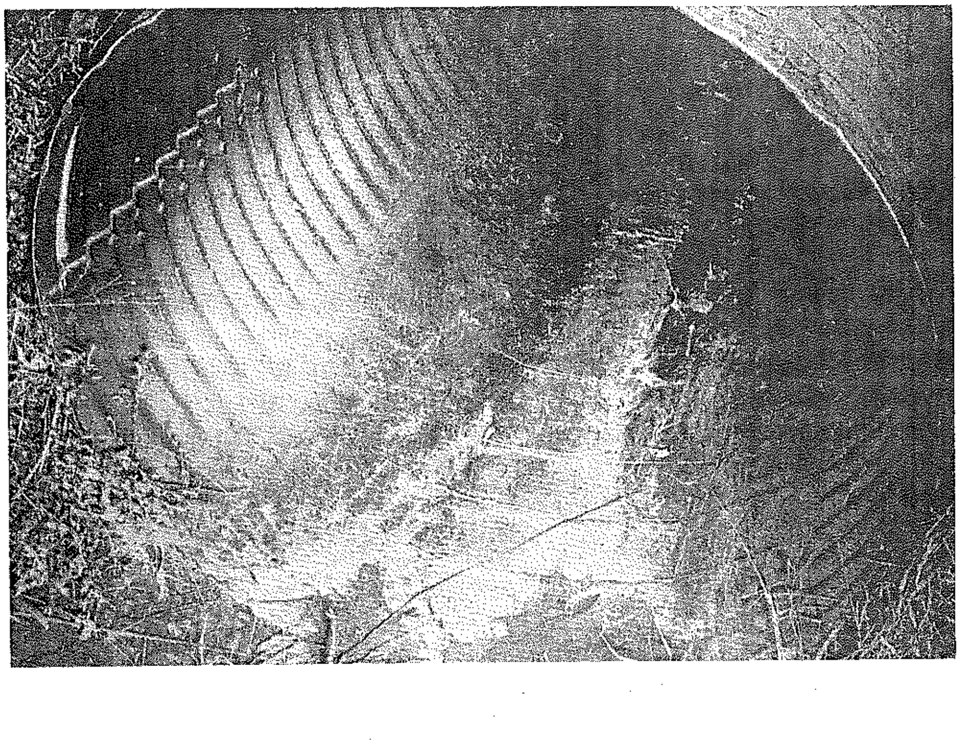


(a)

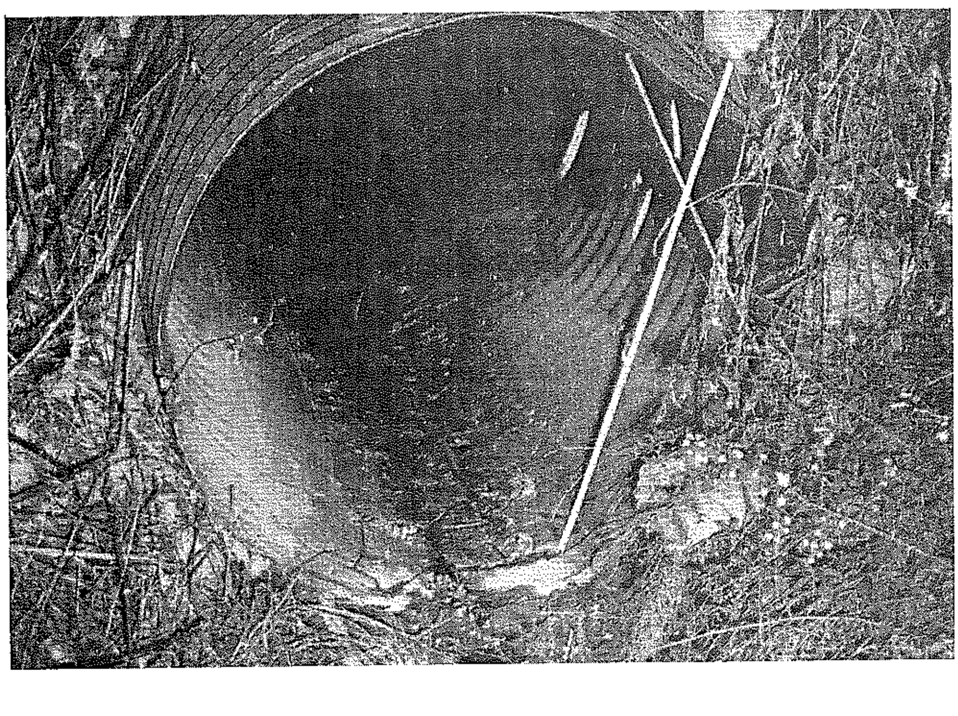


(b)

Fig. 4 - Outlet ends of (a) 42-in. diameter pipe and (b) 58x36-in. pipe arch, both installed in 1949. Note the cracking patterns in the paved inverts.

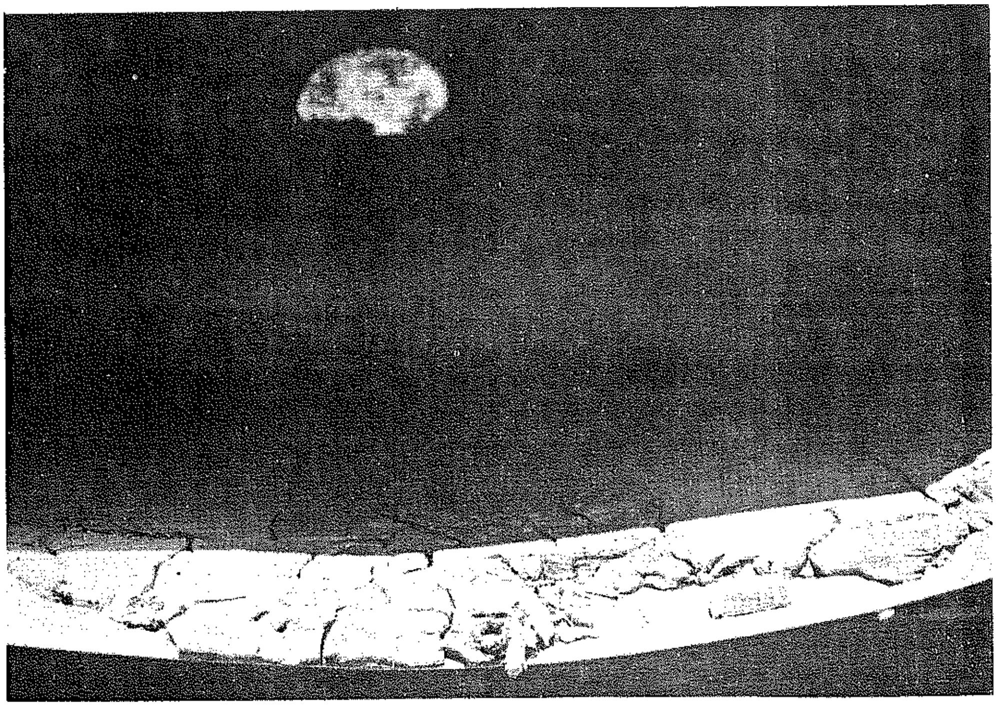


(a)

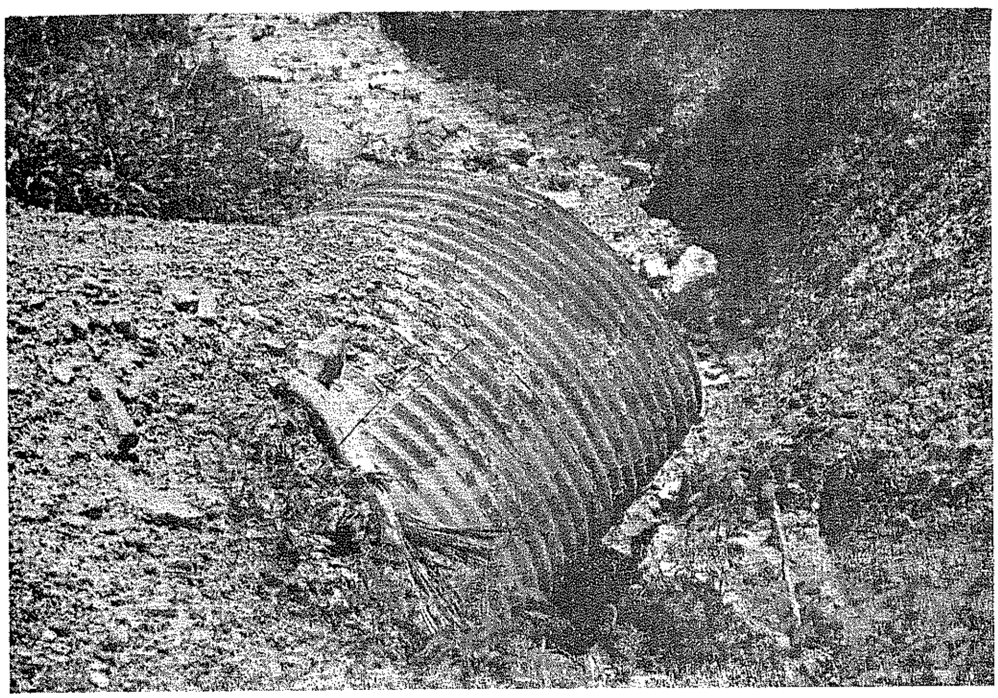


(b)

Fig. 5 - Inlet (a) and outlet (b) ends of a 42-in. diameter coated and paved pipe placed in 1952. Cracking was pronounced, but deterioration had not progressed to the extent indicated for the pipe in Fig. 4 which had a greater period of exposure.



(a)



(b)

Fig. 6 - Views of a 34x59-in. coated and paved pipe arch showing (a) cracking of the pavement at the outlet, and (b) scaling of the outside coating at the same end of the arch. Date of installation - 1950.

toward the interior of the culvert as the size increased, and the widths of individual cracks were greater in the pavements having the greater thicknesses.

The direction of cracking was both longitudinal and circumferential, and usually occurred at each corrugation in the end portion that was exposed. At the extreme edge of a large, thickly paved culvert the cracks were as great as 3/8-in. wide, and in some cases deep enough to expose the spelter. This condition receded to the point where cracks became mere lines and disappeared farther back into the pipe. Usually adhesion remained good, even near the outer edge and seldom could these polygons of weathered asphalt be peeled off by hand.

A different type of deterioration, which obviously resulted from ponding of water at an end of the pipe is shown in Figs. 7, 8, and 9. Here scaling is associated with the cracking that occurred through exposure to light. The scaling condition existed invariably where ponding had occurred, and apparently it was dependent upon alternate wetting and drying at a relatively slow rate.

Generally scaling caused by ponded water was localized, since the possibilities for ponding are limited even in a culvert on 0 percent gradient. However, in a pipe having relatively low flow most of the time with slight fluctuations in the water surface, a favorable condition for wetting and drying exists throughout its entire length. Thus, scaling has occurred in several of the pipes at the general level of low flow or the so-called "trickle line". This is illustrated in Fig. 9.

Usually scaling action had progressed for only a slight distance into the bituminous pavement, and the scales were well attached to the

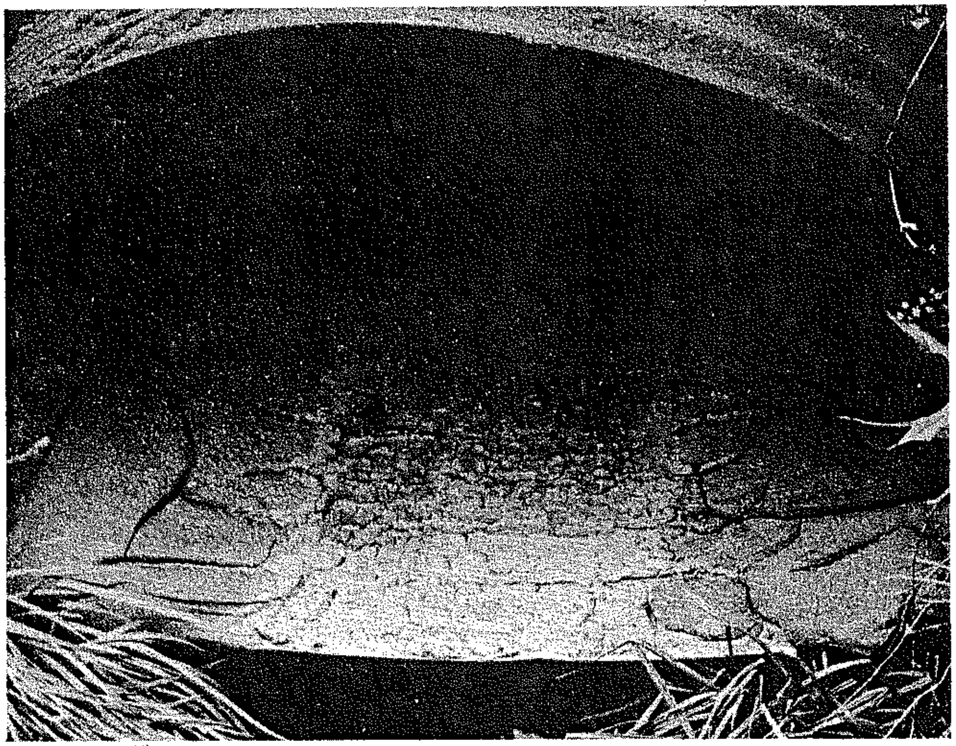
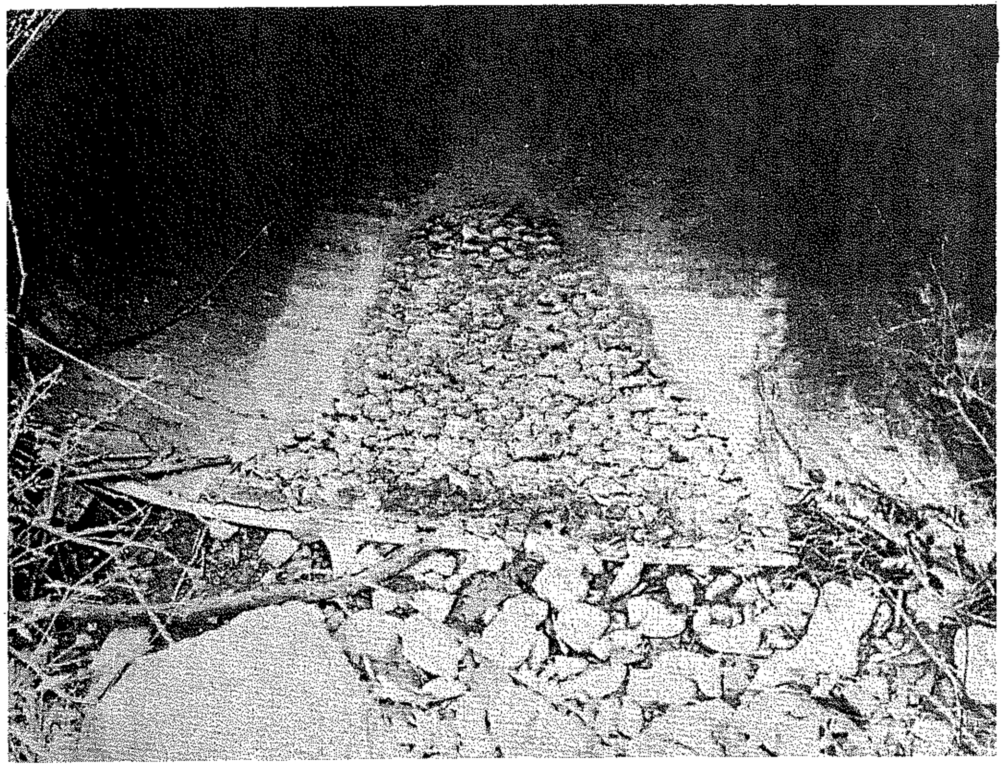
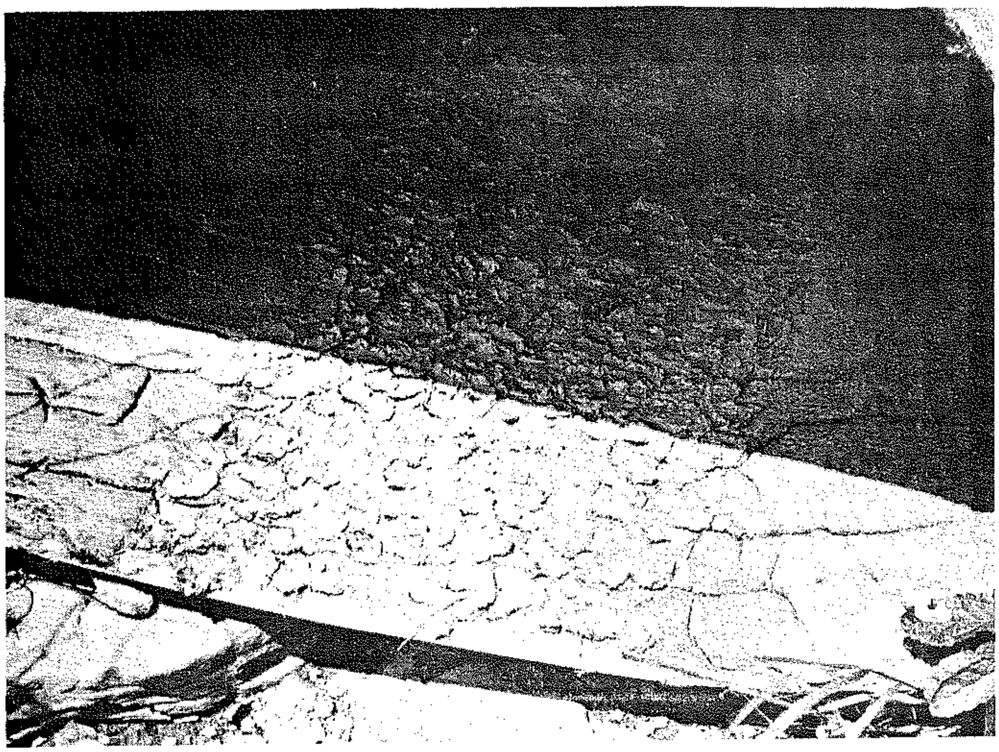


Fig. 7 - Combined scaling and cracking at the outlet of a 44x26-in. pipe arch installed in 1949. In some way this end of the structure had been bent upward providing for intermittent ponding to a slight depth, and consequent wetting and drying.



(a)



(b)

Fig. 8 - Scaling at both the inlet (a) and outlet (b) of a 65x40-in. pipe arch installed in 1949. Associated cracking was more extensive at the outlet than at the inlet, which is not subjected to direct sunlight.

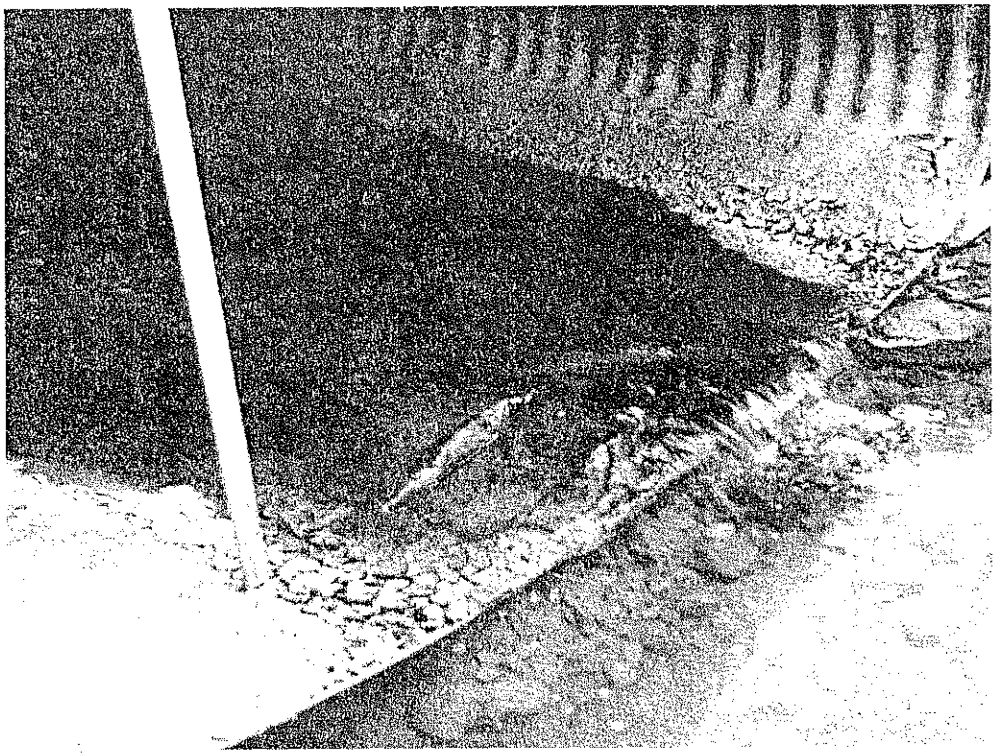


Fig. 9 - Scaling along the edges of the low water level or "trickle line" in the paved invert of a 72x44-in. pipe arch installed in 1949. This condition extended throughout the entire length of the culvert.

underlying bituminous material. Still there were indications that the deterioration might be appreciably progressive with time, and that scaling does encourage failure of the underlying pavement. There were some locations where the dry scales had hardened enough to become brittle, and undoubtedly they could be broken off by the scouring action of silt and debris.

At many locations where silting had occurred to appreciable depth the usual symptoms of deterioration were not evident. Obviously the accumulated material has insulated the pavement and prevented exposure to both sunlight and wetting and drying.

Improper Placement of the Paved Invert

In about 30 percent of the culverts inspected, the paved section had not been laid so that it formed the culvert invert. Instead, the pavement was shifted to one side or the other, and sometimes even to the top of the structure. Often this was the apparent cause of coating failure, since there were no cases of failure in the coating when the pavement had been properly placed in the invert.

Abuses of this nature led to peeling and scaling of the coating with subsequent exposure of the spelter. As a rule, when the pavement was positioned incorrectly and there was reasonably continuous low flow, a portion of the bituminous coating was scaled and some of the coating had been completely removed throughout the entire length of the culvert at the trickle line. Damage to the coating was always confined to a strip approximately 4 inches wide in small culverts and as much as one foot wide in large sections. A typical example of misplaced pavement is shown in Fig. 10.

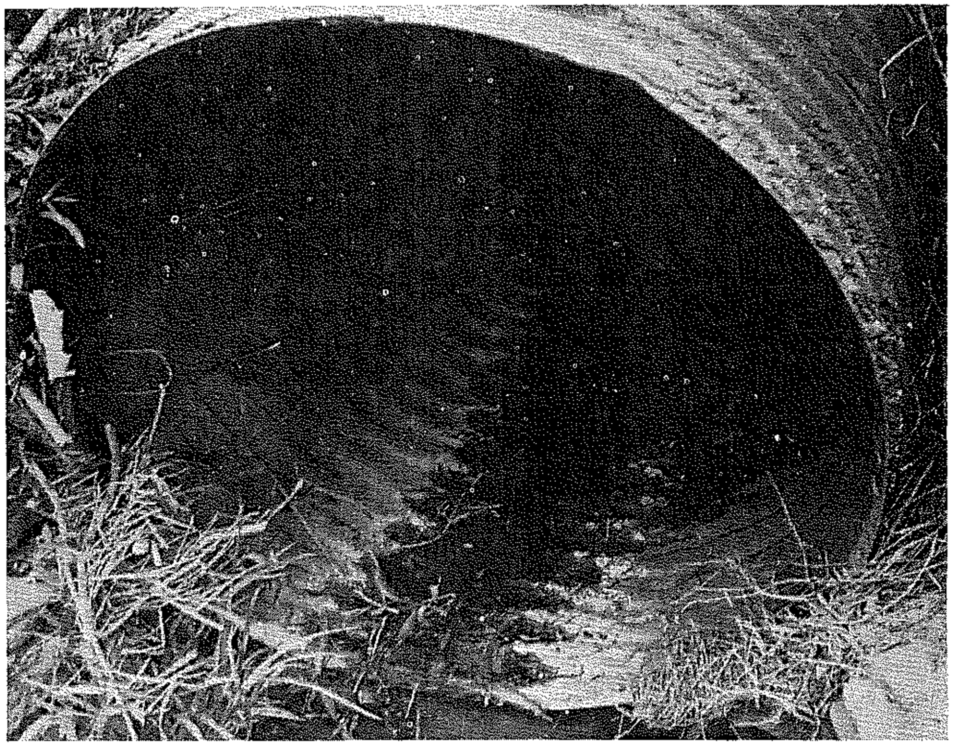


Fig. 10 - Coated and paved pipe placed with the invert shifted almost 90 degrees to the left. The knife (see arrow) marks the lower edge of the pavement. Water has flowed on the coating since installation of the pipe in 1949, and considerable scaling has occurred in the trickle line.

Damage to Coating and Pavement Caused by Fire

Although damage to bituminous coatings and pavements caused by the burning of drift has no bearing on the ordinary performance of these materials, some aspects of this type damages are worth recording since two such incidents were encountered during the inspections. In at least one of the two locations there was evidence that the drift was burned by someone other than highway maintenance crews, indicating that probably the drift was blocking drainage to the extent of its becoming a nuisance.

Some of the effects of burning drift are illustrated by Fig. 11 and 12. The structures were installed in 1949, and about two years later the drift was burned. Both ends of the archs are now covered with rust, and much of the protective coating is gone even from the interior of the pipe adjacent to the one in which the burning occurred. Where rusting was severe, even the spelter was no longer available to provide protections.

Plain Multi-Plate Pipe Arches

Inasmuch as they were so easily accessible, a number of uncoated, multi-plate pipe arches were included in the inspection. The condition of the spelter on these structures of uncoated metal was of fundamental concern.

In the majority of cases there was evidence of rusting which generally covered the entire invert portion. As a rule, the rust pattern was a "pin point" type. Occasionally rusting had progressed to a point where scaling of the spelter had spread throughout the invert. Because of the obvious vulnerability of the metal to corrosion by acids whenever they may be present, water at each of the sites inspected was checked for acidity. There was no indication of acid at any of the locations.

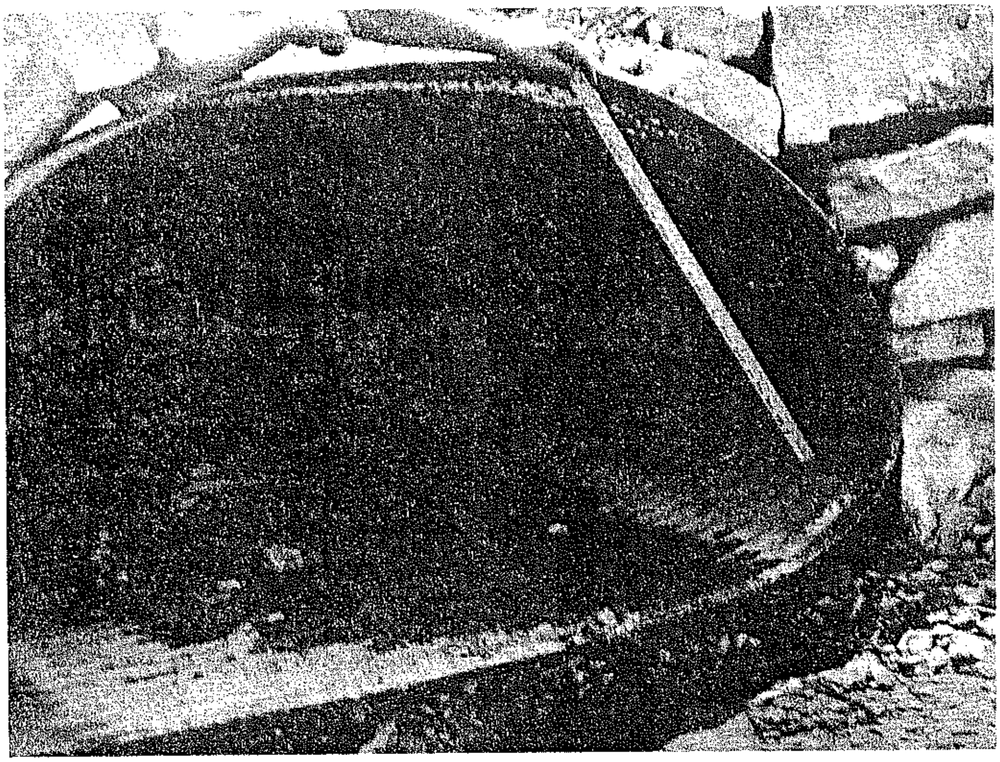


Fig. 11 - Outlet end of 72x44-in. pipe arch in which drift has been burned. Although it is not evident in the photograph, the entire bituminous coating has been destroyed and only fragments of the pavement remain in the invert. Extensive rusting was present throughout the pipe at the elevation indicated by the pointer, and on the inside crown of the structure. Date of installation - 1949.

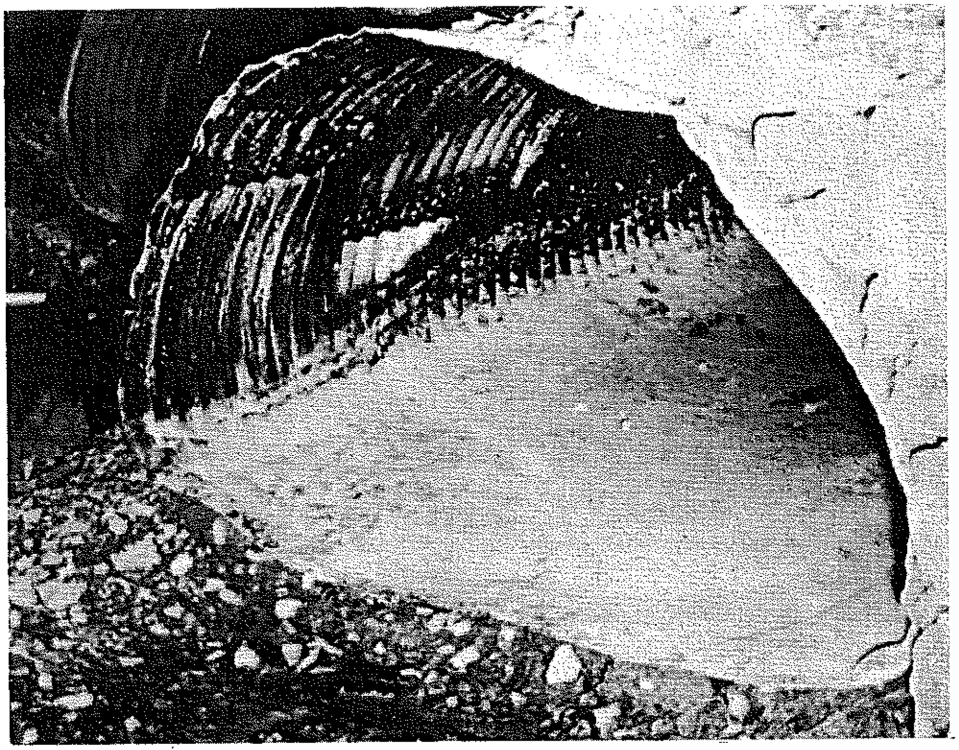


Fig. 12 - Outlet end of a companion 72x44-in. pipe arch placed alongside the arch shown in Fig. 11. The pavement was in good condition, but much of the coating on the left side had been removed by intense heat from fire in the adjacent structure.

Even without acid as a factor, the general condition of inverts in these somewhat major structures gave the impression that protective coatings at least similar to those placed on smaller culverts should be developed for the low-flow portions of multi-plate arches.

Miscellaneous Observations of Field Practice

An appreciable percentage of the culverts inspected had ends that were scarred, bent, partially collapsed, or completely broken off. Undoubtedly most of this type damage was caused by graders changing direction while pulling a nearby ditch, or in a few instances it could have been caused by mowing machines. The ends of some pipe are so obscured by their surroundings it is difficult to locate them, especially where there is dense plant growth. Under such circumstances the marking of culverts by posts, or the clearing of vegetation or debris would help avoid damage.

A number of locations illustrated the importance of care in bedding and backfilling at the time of construction. Occasionally large pipe arches were severely deformed and distorted in shape although there was no evidence of collapse. On the other hand, some pipe with insufficient cover were collapsed, and in a few cases the outlet was higher than the inlet indicating poor bedding conditions during construction.

TEST INSTALLATION AT MORTONS GAP

In the course of inspections on Rural Secondary Projects in the western part of the state, the drainage pipe test installation at Mortons Gap was observed and general performance conditions evaluated. This test installation, developed as a part of acid water investigations*, was well over four years old and pipe at that location were at about the median age of projects involved in the coating condition survey.

Because of the general differences in objectives of the studies, and the fact that acidity of water at the Mortons Gap site is almost always very high, no direct comparison between the two sets of conditions was intended. However, a progress report on results from Mortons Gap has not been made in written form within the past two years, and the opportunity thus afforded to combine material of similar nature is convenient.

The test installation originally consisted of 16 sections of 24-in. pipe. Two sections of each of the different types were installed in the following order, beginning at either end (See Fig. 13).

1. Reinforced concrete
2. Vitrified clay
3. Corrugated metal, asbestos bonded bituminous coated and paved
4. Corrugated metal, half-coated and paved
5. Corrugated metal, plain galvanized
6. Corrugated metal, full double coating without paving
7. Corrugated metal, full coated and paved according to Kentucky Special Specification No. 1-R
8. Corrugated metal, galvanized, asbestos bonded with bituminous seal coat

* See Report No. 2 on "A Survey of Acidity in Drainage Waters and the Condition of Highway Drainage Installations", issued by the Research Laboratory in December, 1952.

During the interim, as noted in the summaries of inspection that follow, some of the sections of pipe failed and were removed.

Inspections Previously Reported

Twelve inspections (or events), including the one at the time of the installation, have been reported previously. In essence the results were as follows:

1951 - April 25 - Date of installation. Specific resistance of water - 280 ohms.

May 22 - Date of first inspection. Specific resistance of water - 260 ohms. Spelter gone from plain galvanized metal pipe.

July 16- Water tested 235 ohms. Invert eaten out of corrugated metal, plain galvanized sections. Concrete pipes showed slight etching.

August 20 - Water tested 240 ohms.

October 18 - Routine inspection; no significant changes.

1952 - March 9 - Water tested 300 ohms.

April 15 - Heavy rain dislodged several sections of pipe and deposited silt in the channel.

April 29 - Installation restored. Galvanized metal sections not replaced. Water tested 290 ohms.

June 18 - Routine inspection; no significant changes.

August 4 - Water tested 268 ohms.

August 28 - Routine inspection; no changes noted.

October 5 - Water tested 265 ohms. Concrete pipe beginning to show visible evidence of progressive corrosion. Aggregate exposed in the invert, but no appreciable reduction in thickness of material observed.

At the inspection on October 5, 1952, the vitrified clay sections and variously coated metal sections remained virtually unaffected, except at those points on metal pipe where the protective coatings had been scarred during placement. The half-coated galvanized metal sections showed some scarring where the uncoated portion was in contact with fill material. This was interpreted as a mild form of corrosion.

Inspections Not Previously Reported

In the period since 1952, inspections have been less frequent than they were prior to that time. This was partially because a basis for estimating the need for attention had been established, and partially because all the inspections were combined with other work by Research Laboratory personnel in the general vicinity of Mortons Gap. Four inspections were made, with the essence of results being as follows:

1953 - July 7 - Routine inspection; water tested 267 ohms. No changes noted.

September 7 - Full double coating gone in invert of one (upstream) section of pipe No. 6, metal corroding.

1954 - July 22 - Full double coated section(No. 6 from upstream end) removed with invert eaten out.

August 18 - Water tested 275 ohms. Pipe sections in the lower half of the installation were heavily silted. The pipe removed and reset. Downstream channel cleared to prevent silting if possible.

This being the latest inspection the following conditions observed in the upstream half of the installation are pertinent:

Fig. 13 - Test installation at Mortons Gap

Fig. 14 - Interior of reinforced concrete pipe. Exposure of coarse aggregate has resulted from corrosion and removal of mortar by acid water. Date-August, 1954 Age - 4-1/3 yr.

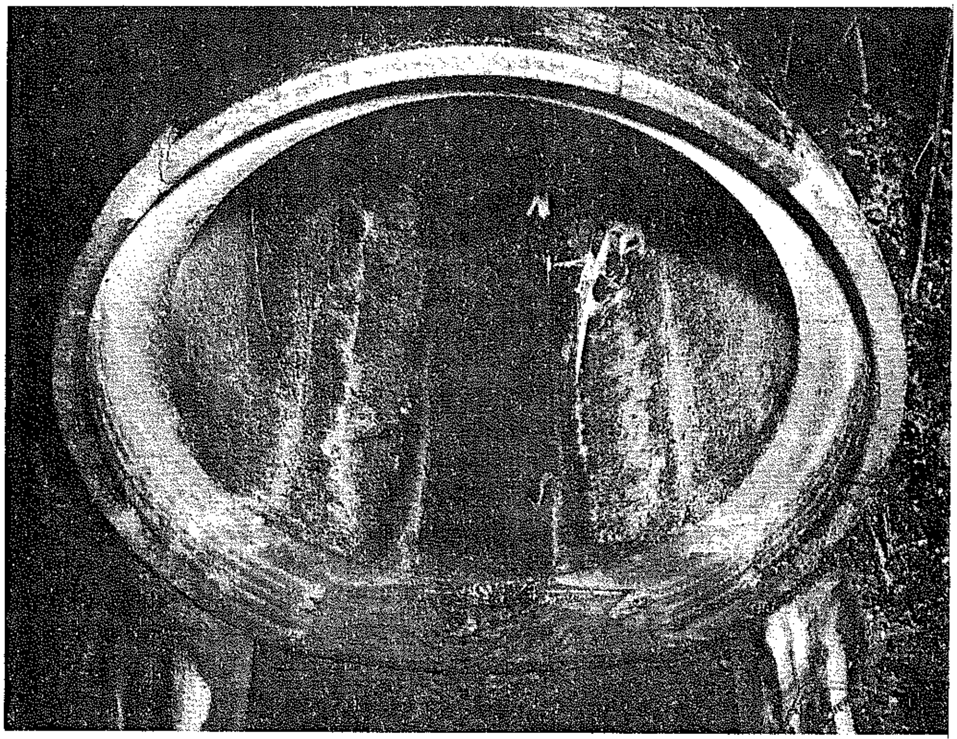


Fig. 15 - Vitrified clay pipe. Although staining and discoloration are evident at the edges of the flow line, structurally the pipe is in excellent condition. Date - August 1954; Age - 4-1/3 yr.

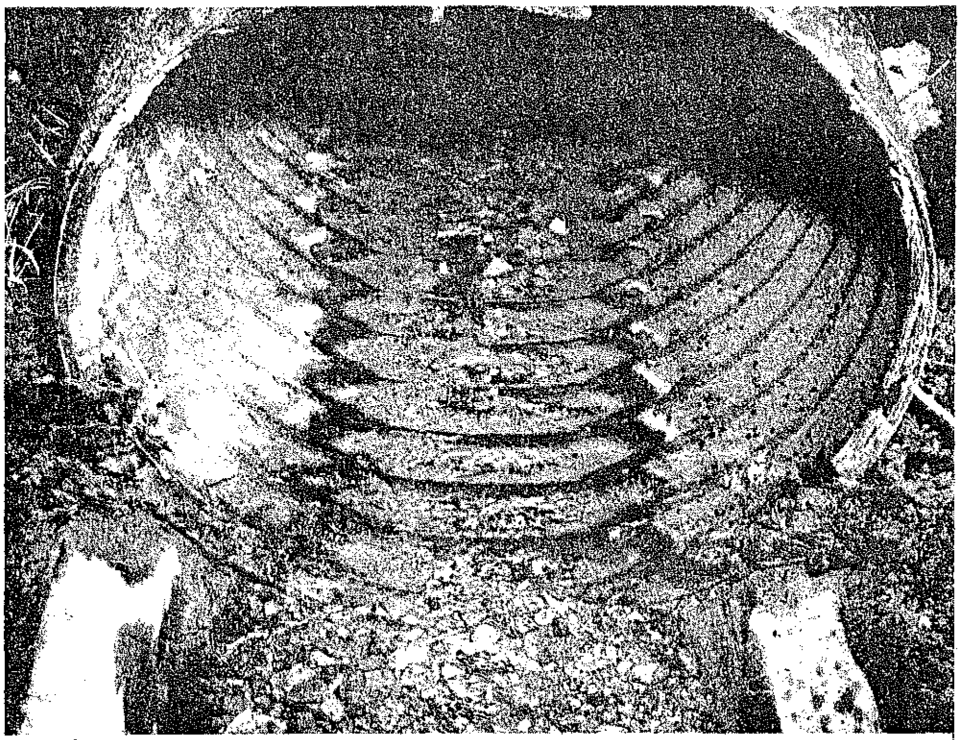


Fig. 16 - Corrugated metal, asbestos-bonded, bituminous coated and paved pipe. The flow line has been obscured by silt but the pavement in the invert has remained smooth and intact. There is no evidence of any deterioration. Date - August, 1954; Age 4-1/3 yr.

1. Reinforced concrete - In these two sections of pipe considerable corrosion has caused removal of mortar and exposure of the aggregate. (See Fig. 14) In this case, the aggregate used was Ohio River Gravel, and in view of other similar inspections, it is believed that corrosion would have progressed further had the coarse aggregate been limestone.

2. Vitrified clay - Both sections of pipe were in excellent condition with no visible deterioration (See Fig. 15).

3. Corrugated metal, asbestos bonded, bituminous coated and paved - Both sections were in excellent condition with no visible deterioration (See Fig. 16).

4. Corrugated metal, half-coated and paved - The pavement and coating in the remaining section was in excellent condition, and there was no evidence of corrosion in the upper portion or crown since that has not been exposed to the acid water flow (See Fig. 17). During periods of high flow the acidity is greatly reduced.

5. Corrugated metal, plain galvanized - Both sections removed and abandoned after two months of service.

6. Corrugated metal, full double coating without paving - Removed July 23, 1954, with invert eaten out (See Fig. 18).

7. Corrugated metal, full coated and paved according to Kentucky Special Specification No. 1-R. - As illustrated in Fig. 19, the coating was peeling at several points in this pipe, and there was evidence of serious rust at places where the coating was removed.

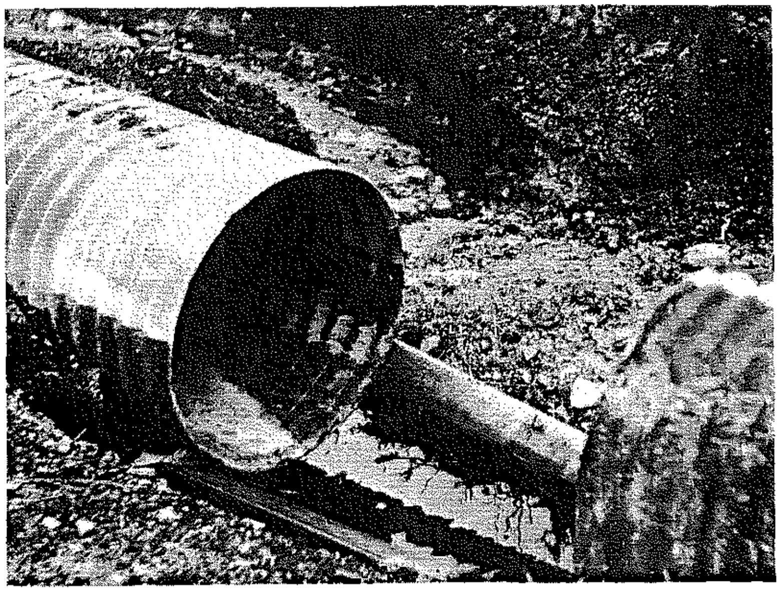


Fig. 17 - Corrugated metal, half-coated and paved pipe. Note that the pavement and coating are in excellent condition. Date - August , 1954; Age 4-1/3 yr.

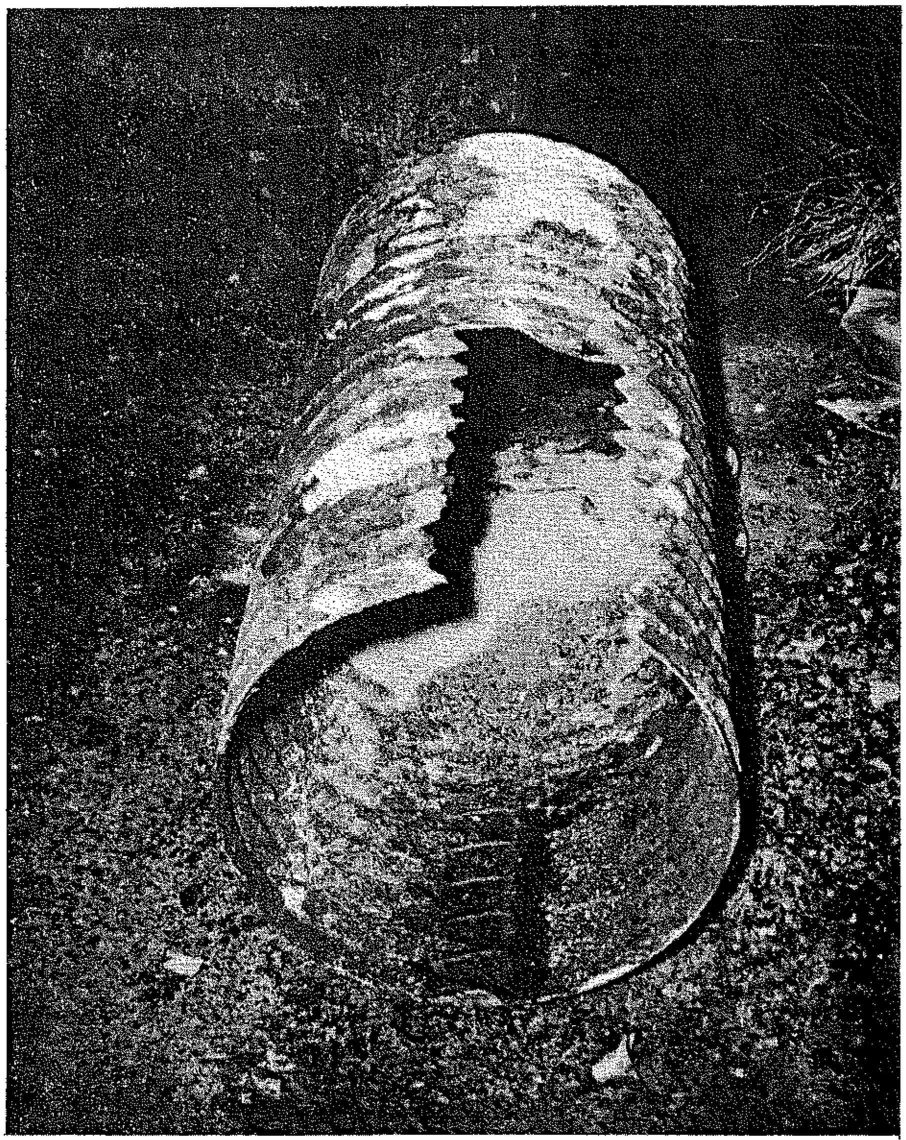


Fig. 18 - Upstream section of corrugated metal pipe, full double coated without pavement. Note that part of the invert has been eaten away by corrosion (pipe is rotated 180 degrees). Date - August 1954. Date of removal - July 1954; Age at failure - 4-1/4 yr.

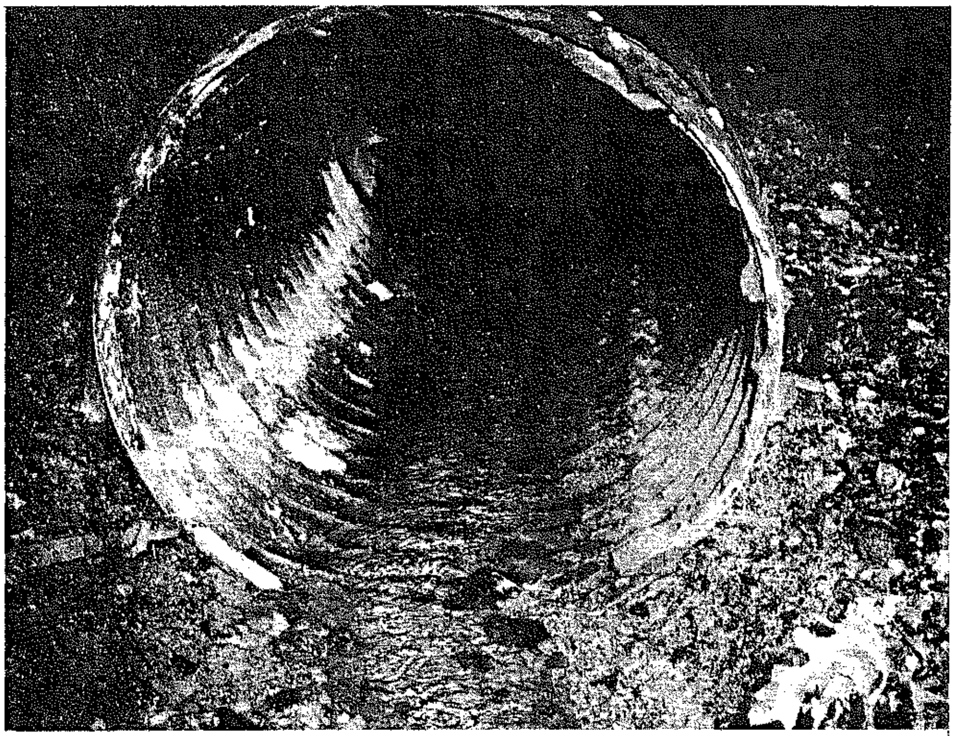


Fig. 19 - Corrugated metal pipe, full coated and paved according to Kentucky Special Specification No. 1-R. The coating has peeled at some points immediately above the pavement in the invert. Rusting has occurred to a minor extent in areas where the coating is missing. Date - August 1954; Age 4-1/3 yr.

8. Corrugated metal, galvanized, asbestos bonded with bituminous seal coat - Although there was no evidence of deterioration whatsoever on the inside of this section, the seal coat outside appeared very dry and tending to flake off or peel.

SUMMARY AND CONCLUSIONS

The performance of coatings on the inside of culvert pipe in the Rural Secondary System was good in every case where the culvert had been properly installed. Coating failures that were observed, resulted from one or more of the following: (1) abuse in handling and transportation, (2) improper positioning of the paved invert during installation, and (3) intentional burning of drift material within or adjacent to the pipe.

Apparently the fairly generalized peeling of coating material on the inside of one section of pipe No. 7 (corrugated metal full coated and paved according to Kentucky Special Specification No. 1-R) at the Mortons Gap installation has no connection with any of the influences mentioned above, and no direct cause is evident at this time. The exposed metal is far enough above low flow to avoid water of high acidity, but there is considerable rusting at places thus exposed.

Coatings on the outside of metal pipe lose adhesion, even when the pipe is covered by earth fill. Inasmuch as the coatings merely become loose but are not removed from pipe within the fill, no particular damage results at least within the period represented by the Rural Secondary projects inspected. Whenever a coated pipe projects beyond the earth fill, cracking, scaling, and removal of the bituminous material occurs within a relatively short period of time particularly if the pipe is exposed to direct sunlight. Even here the loss of protection has no inherently serious consequences, provided the spelter remains undamaged.

Pavements in metal pipe are giving dependable protection to the metal surface, except at the ends where exposure to light is rigorous and at points where ponding or low flow has developed frequent wetting and drying conditions. Cracking results from the exposure to light and scaling results from wetting and drying. Scaling has hardly impaired the protective ability of any of the pavements within the 2-to 6-year period of service, and because of the fact that the material scales to very slight depths, probably the time required to reform and remove several successive layers is great.

On the other hand, cracking starts at a very early age and some of the cracks carry through to the metal within a few years at the most, particularly where the pipe is exposed to direct sunlight. Even when cracks were pronounced there was no visible deteioration of metal beneath. That applies to situations where there was essentially no acidity in the water. Obviously in cases where there is appreciable acidity the chances for serious corrosion of metal at the base of the cracked pavement are great.

A full evaluation of protective coatings on metal drainage pipe would involve more than superficial observations such as those contained in this survey, and probably additional observations at many more culverts would merely confirm the results that have been obtained. The sample in this case is considered representative of the conditions that prevail.

Even though the service conditions are realistic, the lack of uniformity in installation, exposure, and probably manufacture, limit the possibility for estimating what can be expected from this type protective coating, and how it can be improved.

Inherently asphalts are vulnerable to deterioration under exposure to light, heat, and in some respects moisture. Unfortunately there is no reliable measure of the way or the extent to which deterioration occurs under a given set of circumstances. However, as demonstrated by the performance of asphaltic pavements for roads, by the performance of asphaltic coatings containing asbestos or rock wool fibers (and other features of fabrication), by pipe subjected to considerable depths of silting, or by mineralized asphaltic coatings in roofing materials, there are possibilities for creating favorable insulating conditions under which asphaltic coatings can perform to maximum advantage so far as weathering is concerned.

The extent to which basic concepts can be applied to coatings and pavements for metal pipe is, of course, within the province of manufacturers. Improved treatment for the ends of pipe seems especially needed, and no doubt that is a problem of which the industry is aware. From the standpoint of the Department, better service from drainage structures in the corrugated metal categories would be achieved if:

1. More care was used in positioning culverts with paved inverts at the time of construction;

2. Pipe were set slightly below grade so that a limited amount of silting (perhaps as much as 6 inches) would occur in the course of subsequent stream action;

3. The ends of culverts were plainly marked and guarded against damage from maintenance equipment and passing vehicles; and

4. Uncoated metal arches were given a protective coating - perhaps a pavement - in the invert at the time of installation.

It was noted during the inspections that corrosion in the inverts and at the base was extensive on most of the metal arches observed. In view of the size of arch culverts and the investment they represent, it appears inconsistent to be unduly concerned with coatings and pavements on several minor conduits when on the same road a single structure having no protection whatsoever is equal to all the minor conduits as a group. Probably the life of several arches now in service could be extended if their inverts were suitably paved and the lower portions of the sides suitably coated.

APPENDIX

INDEX TO CULVERT LOCATIONS
(Accompanying Table 1)

Inspection No.	County	Rural Secondary Project No.
1-7	Meade	82-203-2
8-14	Breckinridge	14-193-6
15-18	Breckinridge	47-453-1
19-26	Hardin	47-719-2
27-35	Grayson	43-555-1
36-43	Larue	62-341-1
44-50	Anderson	3-231-2
51-54	Anderson	3-211-2
55-64	Bullitt	15-351-1
65-69	Washington	115-189-2
70-76	Washington	115-269-1
77-82	Harrison	49-312-1
83-89	Campbell	19-491-1
90-98	Bracken	12-286-1
99-105	Robertson	101-121-1
106-110	Marion	78-362-1
111-119	Casey	23-261-1
120-124	Garrard	40-246-1
125-132	McCreary	74-213-1
133-137	Russell	104-218-1
138-143	Russell	104-238-1
144-147	Russell	104-238-1
148-152	Clinton	27-206-1
153-156	Adair	1-330-1
157-161	Adair	1-310-1
162-165	Adair	1-430-1
166-169	Taylor	109-348-1
170-174	Taylor	109-288-1
175-183	Rockcastle	102-337-2
184-191	Whitley	118-740-1
192-199	Bell	7-224-3
200-207	Clay	26-145-3
208-215	Metcalfe	85-244-1
216-222	Barren	5-452-1
223-229	Warren	114-528-1
230-231	Simpson	107-205-1
232-238	Todd	110-426-1
239-246	Christian	24-665-1
247-252	Trigg	101-74-1
253-260	Hopkins	54-640-1
261-267	Muhlenberg	89-543-1
268-272	Butler	16-256-1
273-279	Wolfe	119-223-1
280-287	Breathitt	13-407-1
288-292	Breathitt	13-427-1
293-297	Knott	60-298-1

TABLE 1 - SUMMARY OF DATA FROM ALL INSPECTIONS

Inspection No.	Installation: Coated and Paved	Installation: Year Installed	Installation: Size (Inches)	Installation: Grade	Flow: Continuous	Flow: Frequent	Flow: Intermittant	Flow: Filling	Eros'n: Sand	Eros'n: Boulders	Eros'n: Shale	Eros'n: Gravel	Type Drainage: Cultivated Land	Type Drainage: Pasture	Type Drainage: Hilly Wooded	Type Drainage: Mountainous Wooded	Type Drainage: Wooded Swamp	Type Drainage: Farmyard	Type Drainage: Sewage	Type Drainage: Mine Water	Maint. Cond.: Excellent	Maint. Cond.: Very Good	Maint. Cond.: Good	Maint. Cond.: Fair	Maint. Cond.: Poor	Condition of Inlet & Outlet – Coating: Adhesion Excellent	Coating: Adhesion Good	Coating: Adhesion Fair	Coating: Adhesion Poor	Coating: Coating Checked	Coating: Could Be Stripped	Pavement: Adhesion Excellent	Pavement: Adhesion Good	Pavement: Adhesion Fair	Pavement: Adhesion Poor	Pavement: Longitudinal Cracks	Pavement: Circumferential Cracks	Pavement: Width of Cracks	Pavement: Depth of Cracks	REMARKS
1	x	1949	24	M			o						o	o	o							o					o			o			o			o	o	1/8	Metal	Pavement eroded in flow line
2	x	1949	24	S			o						o	o									o				o			o				o	o	o	o	1/8	Metal	Pavement can be stripped to base metal.
3	x	1949	18	F																					o															Silted beyond inspection
4	x	1949	18	F			o								o									o		o	o					o						0	0	
5		1949	18	M					o	o					o								o																	Concrete polished in invert - erosion evidence on sill
6		1949	24	M			o						o	o							o																			Concrete excellent condition
7		1949	24	M			o						o	o							o																			Concrete excellent condition
8	x	1949	18	F			o		o				o	o										o					o		o				o	o	o	1/4	Metal	Can peel pavement
9	x		42	M			o						o	o										o		o								o			o	1/4	Metal	Scaling in invert at inlet - can be peeled
10	x		2-36	F			o		o			o	o	o										o		o							o			o	o	3/8	Metal	Evidence of erosion - checked crack pattern
11	x		48	M			o						o	o										o			o						o			o	o	1/8		Evidence of abrasive wearing
12	x		2-42	F			o		o			o	o	o											o		o							o		o	o	1/4	Metal	Silting badly
13	x	1949	18	F			o	o					o												o	o	o							o		o	o	3/8	1/4	Could not peel pavement - No abrasive wear
14	x		24	F			o						o	o											o	o						o								No evidence of deterioration
15	x	1949	24	F			o						o	o								o				o						o					o	1/32	1/32	
16	x		18	F			o		o				o		o									o		o						o					o	1/64	1/64	Evidence of erosion - 50% of flowing gone
17	x		24	F			o		o				o	o	o								o	o		o							o	o		o	o	1/2	Metal	Outlet and inlet 10-20% erosion
18	x		66x38				o		o			o	o	o									o			o										o			Metal	No erosion at inlet - outlet end severely cracked erosion evident in flow line.
19	x		42	F			o	o					o	o				o									o							o		o	o	3/8	Metal	
20	x		42	F									o										o				o					o				o	o			Excellent condition
21	x		18	F			o						o												o	o								o		o	o		Metal	Can peel - flaking in invert
22	x		18	F			o						o	o										o				o		o						o	o			
23	x		18	F																					o		o	o												Silted 1/2 full (cannot inspect pavement).
24	x		18	F																					o		o	o												Silted 1/2 full (cannot inspect pavement).
25	x		18	F			o						o																o	o	o				o	o	o			Pavement almost completely gone - can peel - pavement and coating appears brittle.
26	x		18	F			o						o											o		o	o								o	o	o			Water standing in pipe (slight erosion - 10-20% missing)
27	x	1951	18	F			o						o	o									o			o	o					o	o				o	1/32	1/32	Very good condition
28	x		30	F			o					o	o	o				o					o			o						o								Abrasion possible - no wear evident
29	x		24	F			o		o			o		o												o										o	o	1/32	1/32	Outside coating excellent
30	x		18	F			o		o			o		o									o	o		o						o								Small evidence of pavement wear.
31	x		18	M			o		o			o		o										o		o						o								Wear or loss of pavement slight - 10% at flow line. Culvert on concrete sill. Sill eroded, (3/8"), more than pavement.
32	x		18	F			o						o	o									o	o			o						o							Abrasive materials settling out
33	x		18	F			o	o					o	o	o										o	o						o								Pool at outlet and some silt in barrel.
34	x		18	F			o	o					o	o											o															Silted up
35	x		24	F			o		o			o	o	o										o		o						o								No evident wear from abrasion
36	x	1949	24	F		o	o								o		o	o					o	o				o		o					o	o	o		Metal	Can peel sheets hand size from pavement. Seems to be chemical disintegration.
37	x		66x38	F		o							o	o	o			o						o		o							o			o	o	1/4	Metal	No evident wear from abrasion
38	x		24	F			o							o	o			o									o								o	o	o		Metal	Pavement scaling - can be peeled with fingers.
39			123x77	F	o				o			o	o	o	o			o																						Concrete above shows no abrasion or acid. Possible abrasion on metal (entire invert)
40	x		66x38	F			o																		o		o													Silted half full with sand and gravel.
41	x		66x38	F	o				o			o			o													o		o	o			o		o	o	3/8	Metal	Coating - inside good - exterior coming off. No erosion wear on pavement (pooled).
42	x		24	F			o	o							o									o			o		o	o	o		o							Side coating acting as invert. Scaling in flow.
43	x														o									o			o		o	o	o		o							Side coating acting as invert. Scaling in flow.
44	x	1949	30	M			o			o				o			o							o	o	o	o						o	o		o	o	3/16	Metal	Outside coating flaking off with fingers. 40% of pavement eroded at flow line (chemical).
45	x		18	M			o						o	o								o				o	o			o			o	o		o	o	1/8	Metal	Outside coating checked - some peeling . Inside coating excellent.
46	x		18	F			o							o	o			o					o				o			o					o	o	o		Metal	Pavement - first 4' feet peeling to base metal. Outside coating 5-6% missing.- cracking.
47	x		24	M			o							o	o			o						o		o	o							o	o	o	o	3/16	Metal	Pavement flaking off on ends (4').
48	x		24	F			o					o			o							o				o	o							o	o	o	o	1	Metal	Pavement - can peel large sections out. Pavement dry - shrinkage cracks in weathering.
49	x		72-44	F	o						o		o	o								o					o	o		o				o	o	o	o	3/16	Metal	Flaking badly in wet and drying area.
50			Arch	F	o								o	o							o	o																		100' above coating arch.
51	x	1949	36	F			o		o			o		o			o					o				o					o	o			o	o	1/8	1/4	Chemical erosion and trickle line. Outside coating scaling - 25% gone. Pavement scaling - 50% of last 6' . Ends gone. Evidence of full flow.
52			58x36				o						o	o	o			o				o																		No wear - some abrasion force possible.
53	x		36	F			o						o	o								o													o					Pavement not in invert - (side). Spelter gone in invert the entire length. Algae action.
54	x		58x36	F			o						o			o	o			o	o				o								o	o	o	1/2	Metal	Outside coating checked.
55	x	1950	30	F			o		o			o			o			o	o			o			o	o					o	o			o	o	1/16	1/16	Trickle line disintegration - 15% on ends only. Algae action.
56	x		18	F			o		o	o		o	o	o								o				o	o						o			o	o	1/4	Metal	Coating on outside checked.
57	x		59x34	F			o		o	o	o	o	o	o			o	o	o				o	o			o						o	o		o	o	1/2	Metal	Trickle line disintegration in entire length. Algae condition.
58			77x57	F									o	o																										Silted 2' deep, oversized.
59	x		18	F			o		o	o	o	o			o								o			o	o						o			o	o	1/32	1/32	First 1' on ends only (cracks).
60	x		24	F			o		o			o	o		o								o	o		o						o	o							Outlet shaded - no end cracks.
61			159x96																																					Pooled in invert - oversized - wasted material.
62			Arch	F			o		o	o		o	o	o	o							o																		Spelter breakdown due to abrasion.
63	x		48"	F			o		o			o	o	o	o											o	o						o			o	o	1/4	Metal	25% erosion length trickle line. Full flow.
64	x		36	F										o			o									o								o		o	o	1/4	Metal	Pavement 50% gone in trickle line. Wet and dry flaking.
65	x	1949	42	F		o	o					o		o	o		o						o				o					o	o					3/8	Metal	Trickle line erosion 10-20%. Checked pattern 4' both ends. Outside coating dry. Peeling off, 20%.
66	x		42	F		o	o		o			o		o	o		o						o			o	o						o			o	o	1/2	Metal	Trickle line erosion 10%. Circumference cracks length of pipe, outside coating peeling off - 10%.
67	x		24	F			o					o	o	o										o			o		o	o		o					o	1/8	1/32	Outside coating peeling off. Coating in trickle gone or easily raked off. Spelter gone and pin point rust. Paved invert on side.
68	x		42	F					o			o	o	o			o	o				o	o			o	o		o	o	o			o		o	o	1/4	Metal	Outside coating peeling off. Coating in trickle gone or easily raked off. Spelter gone and pint point rust. Paved invert on side. Pin point rust length of trickle line.
69		1949	Arch	F																																				Galvanic silt rust on bolts only.
70	x	1949	44x25	F			o		o				o	o				o	o			o	o			o	o		o	o		o	o			o	o	1/2	Metal	Scaling last 2' of ends (pavement). Outside coating only (stripped).
71	x		2-30	F									o	o				o								o	o						o	o		o	o	1/32	1/32	Pooling in barrel (silting).
72	x		44x25	F									o	o			o	o							o		o								o				Chunks of pavement lying in silted culvert.
73	x		36	F			o		o			o	o	o				o					o				o		o	o	o					o	o			Coating acting as invert, scaling to metal.
74	x		50x32	F			o						o	o				o					o				o	o					o			o	o	1/2	Metal	Minor wet and dry scaling.
75	x		44x25	F																				o	o		o													Silted 1/2 full (impossible to inspect).

Inspection No.	Coated and Paved	Year Installed	Size (Inches)	Grade	Flow: Continuous	Flow: Frequent	Flow: Intermittant	Flow: Filling	Eros'n: Sand	Eros'n: Boulders	Eros'n: Shale	Eros'n: Gravel	Type Drainage: Cultivated Land	Type Drainage: Pasture	Type Drainage: Hilly Wooded	Type Drainage: Mountainous Wooded	Type Drainage: Wooded Swamp	Type Drainage: Farmyard	Type Drainage: Sewage	Type Drainage: Mine Water	Maint. Cond.: Excellent	Maint. Cond.: Very Good	Maint. Cond.: Good	Maint. Cond.: Fair	Maint. Cond.: Poor	Coating: Adhesion Excellent	Coating: Adhesion Good	Coating: Adhesion Fair	Coating: Adhesion Poor	Coating: Coating Checked	Coating: Could Be Stripped	Pavement: Adhesion Excellent	Pavement: Adhesion Good	Pavement: Adhesion Fair	Pavement: Adhesion Poor	Pavement: Longitudinal Cracks	Pavement: Circumferential Cracks	Width of Cracks	Depth of Cracks	Remarks
76			142x90						o		o	o																												Dull in invert. Pin point rust in invert at trickle line.
77	x	1952	24	M			o							o	o								o	o	o	o						o	o					0	0	Outside coating not exposed to sun.
78	x		18	F			o		o			o		o	o									o	o	o	o						o			o	o	1/4	Metal	Scaling in flow line. Wet and dry coating in pavement; dry and brittle.
79	x		24	S			o		o			o		o	o								o			o	o					o	o				o			2-5% erosion in trickle line.
80	x		18	S			o							o	o			o					o			o						o								Excellent condition.
81	x		18	S			o		o			o	o	o									o	o		o						o					o	1/32		Cracks inches from end. High cut shade culverts.
82	x		18				o		o			o		o	o										o	o						o					o	1/32		Cracks inches from end. High cut shade culverts.
83		1950	123x77	F			o							o	o								o																	Used as cattle crossing.
84	x		36	F			o		o			o		o	o							o	o			o						o					o	1/32		Well protected ends.
85	x		24	F			o		o			o		o	o								o			o				o		o	o							Checked 1' from end inside and out. (Light)
86	x		18	F			o		o		o	o		o	o							o	o			o						o								Checked coating outside. Sheltered inside and out.
87	x		18	F			o		o			o	o	o	o									o	o				o	o	o				o	o	o	1/4	Metal	Scaling in invert. Outside coating completely missing under soil. Coating and pavement in poor condition.
88	x		72x44	F		o	o						o	o	o								o			o				o			o			o	o	1/32		Scaling is light. Outside coating off where exposed soil. Pool reflects radiation. Breakdown in ends.
89			93x64	F		o	o		o	o		o	o	o	o									o	o															High abrasive force. 60 pound rocks in culvert. Two truck loads of rock inside pipe.
90	x	1949	18	F			o	o					o	o				o						o	o		o			o	o		o	o		o	o	1/32		Invert on side, coating in invert off, peel to metal. Coating off adjacent to soil.
91	x		18	F			o	o					o		o								o	o	o	o	o						o							Coating and pavement in good condition. Loose scaly rust and scarred sections on end, scarred by machinery.
92	x		24	F				o		o	o				o								o	o			o			o	o		o	o		o	o	1/8	Metal	Scaling and cracking on ends in pavement. Outside coating gone under ground line.
93	x		24	F				o						o									o				o			o	o			o		o	o	1/16	Metal	Invert in top, coating gone in flow line, pin point rust.
94	x		18	M				o						o	o										o		o			o	o		o							Inlet end 3/4 full of silt. Outside coating gone, pavement scaling on ends. Pavement on side.
95	x		18	F			o	o						o	o										o		o			o	o		o			o	o			Coating gone in trickle line only. Pavement cracks on ends only, last foot.
96	x		18	F			o							o	o									o	o															Pavement outside, coating gone in flow line, filling with gravel.
97	x		48	F			o			o					o										o		o													Two truck loads of boulders in barrels, top sagged. Boulders up to forty pound size, pavement on side at 7:00
98	x		36	F			o			o	o	o			o										o	o	o						o							Pavement not in invert, coating holding up well. Poor alignment, no inspection.
99	x	1949	30	F			o						o	o									o	o		o	o						o			o	o	1/32		Pavement on side 10:00.
100	x		65x40	F			o							o	o								o				o			o	o		o	o		o	o	1/4	Metal	Coating in flow line to bare metal. Pavement 25% missing on the end 3'. Outside coating cracked and peeling. Samples taken of scaling, cracked section.
101	x		58x36	F								o	o		o			o						o	o					o	o									Silted 6" -1' deep through pipe. Coating disintegration at flow line.
102			93x64 95x64																																					No drainage area, waste of material.
103	x		43x27	F							o	o		o	o									o			o	o					o				o	1/32	1/32	Coating dripping badly. Pavement good at inlet, and outlet submerged.
104	x		18	F						o	o	o		o	o									o	o		o					o	o			o	o			Pavement cracks first 2' from ends. Outside coating scarred by mower.
105	x		30	F			o						o	o				o																				1/8	Metal	East end shaded and good, west end radiation cracks in pavement, last 2'.
106		1949	93x64	F																																				Spelter dull in flow line, abrasion in flow line. Trickle flow under arch.
107	x		30				o		o					o	o								o				o						o			o	o	1/8	Metal	Invert at 9:00 - inlet at 3:00. Outlet coating gone in flow line. Outside coating gone.
108			107x72"	F		o									o								o																	Considerable abrasion action possible.
109	x		18	F			o							o	o								o			o						o								Excellent condition - end shaded - full flow.
110	x		18	F			o		o					o	o								o			o	o					o	o			o	o	1/8	1/8	Checked on inlet end exposed to sun, outlet excellent where shaded.
111	x	1949	44x72	F		o	o		o	o		o		o	o				o					o			o						o			o	o	1/8	1/8	Pavement weathering in end above flow line. Flow line pavement is good.
112			44x72	F		o	o		o	o		o		o	o				o					o																Large blisters of spelter coming off inside in top. Oxidation along pattern of fill on outside. Outside spelter gone. Rust in advanced stage. May have been coated and burnt out.
113	x		44x72	F		o	o		o	o		o		o	o				o					o		o	o						o			o	o	1/8	1/8	Jigsaw cracking in inlet and outlet paving. Outlet end burnt, inside and outside coating ran off. -
114	x		44x72	F		o	o		o	o		o		o	o				o					o		o							o			o	o	1/8	1/8	Paving same as inspection 111.
115	x		18	F			o							o	o								o				o			o	o		o			o	o	1/8	Metal	Inlet shaded - excellent condition. Outlet end exposed - poor condition in last three feet - cracked and deteriorated in flow line last 3'.
116			159x96	F		o						o	o	o	o																									Invert completely covered by scaly rust. Several plain arches in this area all rusted. Possibly 5 years of life remaining. Abrasion.
117	x		66x39	F			o						o	o	o								o				o			o	o		o			o	o	1/4	Metal	Typical weathering on inlet and outlet ends.
118	x	1949	34x59	F			o						o	o	o			o					o	o				o		o	o	o								Silted in pavement - Coating missing at flow line, blistering. Pavement excellent under the mud - like new.
119	x		34x59	F			o						o	o	o								o				o						o			o	o	1/4	Metal	Typical end condition, radiation weathering.
120	x	1950	52x30	F		o	o							o	o									o		o	o						o		o	o	o	1/8	Metal	Adhesion poor 2' from ends. Checking and peeling, scaling in invert, ends exposed to radiation.
121	x		59x34	F		o							o	o	o			o					o				o						o		o	o	o	1/4	Metal	Checked badly in pavement on ends - deep
122	x		59x34	F		o							o	o	o			o					o				o						o		o	o	o	1/4	Metal	Scaling in last 3' in invert - both ends.
123	x		66x38	F			o						o					o						o		o						o				o	o	1/4	Metal	Typical weathering condition in the end.
124	x		66x38	F			o						o					o						o		o						o				o	o	1/4	Metal	In invert flow line - radiation exposure drift and trash due to stock fence.
125	x	1949	18	F			o	o	o			o		o	o								o	o			o						o			o	o	1/32	1/32	Weathering first 6" from end.
126	x		18	F			o	o	o			o	o		o									o			o						o			o	o	1/32	1/32	Weathering first 6" from end. Trickle line erosion.
127	x		24	F			o		o			o	o	o	o								o	o			o			o	o		o	o						Typical weathered ends and erosion and trickle line.
128	x		142	F		o							o	o	o			o						o																35% silted full of sand.
129			142x90	F		o							o	o	o			o						o																Invert advanced tubercular rust 2' up on sides of arch over entire area.
130	x		18	F			o	o	o			o			o								o				o		o				o							Inlets shaded in excellent condition. Outlet pavement typical cracks on end. Rust on rolled bead on end of culvert.
131	x		18	M			o		o			o			o												o		o	o	o		o							Inlet shaded in extreme and excellent condition. Outlet exposed typical weathering pattern.
132	x		18	M			o	o	o			o			o								o	o			o						o							Coating good - pavement weathered light - 6" from ends.

TABLE 1 - (CONT'D.)

Inspection No.	Coated and Paved	Year Installed	Size (Inches)	Grade	FLOW: Continuous	FLOW: Frequent	FLOW: Intermittent	FLOW: Filling	EROS'N: Sand	EROS'N: Boulders	EROS'N: Shale	EROS'N: Gravel	TYPE DRAINAGE: Cultivated Land	TYPE DRAINAGE: Pasture	TYPE DRAINAGE: Hilly Wooded	TYPE DRAINAGE: Mountainous Wooded	TYPE DRAINAGE: Wooded Swamp	TYPE DRAINAGE: Farmyard	TYPE DRAINAGE: Sewage	TYPE DRAINAGE: Mine Water	MAINT. COND.: Excellent	MAINT. COND.: Very Good	MAINT. COND.: Good	MAINT. COND.: Fair	MAINT. COND.: Poor	CONDITION OF INLET & OUTLET – COATING: Adhesion Excellent	COATING: Adhesion Good	COATING: Adhesion Fair	COATING: Adhesion Poor	COATING: Coating Checked	COATING: Could Be Stripped	PAVEMENT: Adhesion Excellent	PAVEMENT: Adhesion Good	PAVEMENT: Adhesion Fair	PAVEMENT: Adhesion Poor	PAVEMENT: Longitudinal Cracks	PAVEMENT: Circumferential Cracks	PAVEMENT: Width of Cracks	PAVEMENT: Depth of Cracks	REMARKS
133	x	1949	48	F		o	o		o			o	o	o				o					o				o			o	o					o	o	3/8	Metal	Inlet coating as invert peeling - Pavement at 9:00. Outlet exposed cracking and flaking last 2' in pavement. Outside coating checking badly.
134	x		18	F			o		o			o	o	o	o								o			o	o					o	o							In excellent condition - in shaded and protected by fill and trees from radiation.
135	x		42	F		o			o			o	o	o	o							o	o			o	o					o								In shaded from radiation. Wet and dry flaking and pavement in trickle line, Pavement at 7:30.
136			93x64	F		o							o	o	o							o																		Invert of arch completely rusted - tubercular. Spelter completely gone. Acid taste - shows no acid. Abrasion possible. Large spots of rust around bolts insides.
137	x		42			o							o	o				o			o	o				o	o					o	o							Pavement at 5:00.
138		1950	77x56	F	o								o	o	o							o																		Spelter gone and invert - tubercular rust - No acid - red clay rock area. Abrasive force light.
139	x		18	F			o								o								o				o						o			o	o	1/8	Metal	Invert end in excellent condition, shaded. Outlet end pavement radiation cracks, scaling and flaking in invert trickle line.
140	x		18	F			o					o			o								o			o						o								Excellent condition - both ends shaded.
141	x		60	F		o			o			o			o								o			o	o			o	o		o			o	o	1/4	Metal	No acid - badly weathered cracks in both ends of pavement. Some sag in top - approximately 1'. No scaling, but evidence of erosion in flow line. Outside coating gone under fill.
142	x		59x34	F			o		o			o		o	o			o						o		o	o													Wet and dry flaking on ends of pavement. Typical where sun radiation load is present.
143			93x64 93x64	F																																				Rust in flow line - left arch badly deformed at outlet end, due to improper placing - no acid. 1-2' sag due to rock fill.
144		1950	77x57 77x57	F					o			o	o	o	o			o	o						o															Right barrel silted 2' deep. Left barrel invert rusted - no acid by test.
145			170x104	F																																				Some rust - partially protected by gravel bar in structure approximately 6" deep.
146	x		48				o		o			o			o									o			o			o	o		o		o	o	o	1/2	Metal	Pavement badly checked first 4' and last 4'. Typical weathering on outlet scaling and etc. Flaking and poor adhesion at outlet. Outside coating dry and scaly.
147	x		24			o			o	o		o			o								o			o	o						o							Excellent condition - inlet and outlet protected by deep fill and cut.
148	x	1950	18				o								o												o													1/2 full of silt - no pavement inspection.
149	x		18	F			o		o			o			o											o	o					o	o							Excellent condition - inlet and outlet shaded.
150	x		18	F			o		o			o			o								o			o						o								Excellent condition - inlet and outlet shaded.
151	x		54	F		o	o								o								o			o	o					o	o							No cracks - no peeling - excellent condition - ends in shade. Some evidence of deterioration in trickle line - no acid outside coating good.
152	x		42	F			o		o			o			o								o			o	o					o	o							Excellent in every way. As good as day installed. Shaded by trees and fill.
153	x	1949	24	F			o		o	o	o	o	o	o	o								o			o	o						o			o	o	3/8	Metal	Outside coating good - typical weathering at waterline on ends by radiation. Pavement at 3:00.
154	x		24	F			o						o	o									o	o			o						o			o	o	1/8	Metal	Both ends exposed - typical cracking of pavement and scaling in flow line. Cover insufficient.
155	x		18	F			o		o			o	o	o										o			o						o							In excellent condition - vines covered both ends. shielded from weather and high enough to avoid water from standing in pipe.
156	x		18	F									o	o										o			o			o	o		o			o	o	1/8	Metal	Coating missing where pavement invert is not in bottom. Outlet pavement at 8:00. Typical weathering To spelter - spelter dull.
157	x	1949	24	F			o							o	o								o				o						o							Sag in culvert 1'. Water standing in center. Last 2' paving cracked and scaling. At end foot coating good except where paving slightly coated. Pavement at 6-30 - paving in top of inlet. Outside coating good except where mistreated in handling.
158	x		52x30	F			o						o												o	o	o													Coating good - Pavement silted. Impossible to inspect.
159	x		18	F			o								o									o			o						o							Typical flaking at outlet - inlet good - shielded by shade and vegetation.
160	x		59x34	F			o										o							o			o						o			o	o	1/8	Metal	Typical weathering - both ends scaling; crack ing first and last 3'.
161	x		54	F		o	o							o	o			o					o				o						o			o	o	1/2	Metal	Typical cracking first and last three feet. Sag in top - 1'.
162	x	1949	18	F			o		o						o		o							o			o		o	o	o		o							Outlet - silted - not inspect pavement outside. Coating peeling outside of inlet - pavement eroded at trickle line - coating good.
163	x		52x30	F			o						o	o	o								o				o						o			o	o	1/8	Metal	Typical pattern, but slight outlet due to light deposit of sand. Coating good inside and outside.
164	x		36	F			o		o			o	o	o									o				o						o			o	o	3/8	Metal	Flaking in pavement (ends) Outside coating good - side indicates full flow and possible overflow.
165	x		72x44				o		o			o	o	o	o			o								o	o						o		o	o	o	1/2	Metal	Typical in ends - cracked badly - scaling in trickle line. Outlet coating good. Deep hole in outlet.
166		1950	77x57	F							o	o																												Silted - outlet end. Heavy abrasion action - calcarious limestone and shale. Large gravel deposits.
167	x		18	F			o		o			o	o	o									o	o			o						o			o	o	1/32	1/32	Slight cracks at outlet cracks - no peeling. Inlet partially silted.
168	x		24	F			o		o			o	o	o											o		o					o	o			o	o	1/32	1/32	Outlet silted - inlet very slight cracking.
169	x		24	M	o									o				o					o			o	o					o	o							Excellent condition - no cracking. Continous flow from spring house and ends are protected by shade.
170	x	1950	59x34	F		o	o								o							o				o	o					o	o			o	o	1/32	1/32	Inlet excellent condition - shaded by heavy trees. Outlet partly shaded. Cracked and scaling last 6".
171	x		24	M			o		o			o		o				o					o	o			o						o			o	o	1/32	1/32	Pavement flaking in the ends. Cracking first foot on ends. Exposed to weather, and wet and dry conditions.
172			107x72	F								o																												Heavy rust in flow line. Considerable gravel in rock bottom channel. Channel fairly steep.
173	x		18	M		o	o							o	o								o	o		o	o					o	o							Excellent conditions - ends shaded. No wet or dry action.
174	x		94x46	F			o		o			o	o	o				o						o		o	o					o	o							Outlet ends too low. Silted 1/2 full. Coating and pavement excellent on inlet end. Outside coating very good.
175	x	1950	18	M			o									o					o						o						o							Pavement completely gone and trickle line - not through scaling and cracking, but through chemical action or chem. disintegration. Excellent rough stone headwall protection.

TABLE 1 - (CONT'D.)

Inspection No.	Coated and Paved	Year Installed	Size (Inches)	Grade	Flow				Eros'n				Type Drainage								Maint. Cond.					Condition of Inlet & Outlet – Coating						Condition of Inlet & Outlet – Pavement								Remarks
					Continuous	Frequent	Intermittant	Filling	Sand	Boulders	Shale	Gravel	Cultivated Land	Pasture	Hilly Wooded	Mountainous Wooded	Wooded Swamp	Farmyard	Sewage	Mine Water	Excellent	Very Good	Good	Fair	Poor	Adhesion Excellent	Adhesion Good	Adhesion Fair	Adhesion Poor	Coating Checked	Could Be Stripped	Adhesion Excellent	Adhesion Good	Adhesion Fair	Adhesion Poor	Longitudinal Cracks	Circumferential Cracks	Width of Cracks	Depth of Cracks	
176	x		18	M			o						o	o				o			o						o						o	o		o	o	1/32	1/32	Last foot of pavement hardening with slight cracking. Inlet end in excellent condition.
177	x		18	M			o		o			o				o						o					o						o			o	o	1/8	Metal	Typical cracking in outlet exposed 2'. Chemical erosion in trickle line.
178	x		24	M			o							o		o						o	o			o	o			o	o	o	o			o	o	1/8	Metal	Outlet typical cracking. Inlet in excellent condition, Shaded and walled. Erosion in trickle line, abrasion. Outside coating cracked in fair condition.
179	x		24	M			o							o	o					o		o	o				o			o			o			o	o	1/8	Metal	Typical weathering on paving, slight erosion, outside coating cracked. No erosion on exposed spelter.
180	x		123x77	F	o	o					o																							o	o					Rust, no acid from test - Abrasion possible. Rust in the invert.
181	x		24	M			o		o			o			o											o	o					o	o			o	o	1/32	1/32	Slight cracking at outlet, sandstone erosion, sag in the middle. Outside coating excellent.
182	x		34x59	M			o		o			o			o								o					o	o	o	o				o	o	o	1/8	Metal	Inside pavement at inlet shaded, weathered outlet end. Cracked heavily, pavement very soft with loss adhesion. Outside coating has no adhesion, flakes off easily. It appears that coating was placed over oil. High run off, scour possible; no evidence of rust.
183			66x38	F			o		o			o		o	o							o	o																	
184	x	1950	66x38	F			o						o	o	o								o	o			o						o			o	o	1/8	1/8	1½' of sag in center; slight weathering at inlet end, cracking slight at outlet - some erosion in flow line.
185			107x72 107x72	F		o	o		o			o	o	o	o								o																	No acid by pH test.
186	x		24				o	o							o								o	o			o													Silted no inspection on paving.
187	x		36				o	o	o			o		o	o										o		o		o	o	o									Collapsed - silted half full. Outside coating almost gone. Laid on side.
188			72x44 72x44	F			o		o			o	o	o	o									o																One arch silted half full other arch rusted over entire invert. No acid indicated by test.
189	x		18	F			o								o												o		o	o	o		o			o	o	1/8	Metal	Shaded inlet, good condition. Outlet end exposed to sun. Outside coating flaking off. Typical weathering no acid - eroded trickle line.
190	x		66x38	F			o	o																			o						o			o	o	1/4	Metal	Scaling in pavement on ends, deep fill, sheltered
191	x		24	F			o	o	o			o	o	o	o								o	o		o	o					o	o							Shaded excellent condition
192	x	1950	18				o		o			o				o							o	o			o			o	o		o			o	o	1/8	Metal	End cracks on pavement. Outside coating badly scarred.
193	x		18	S			o									o							o	o			o						o	o		o	o	1/8	Metal	Pavement end cracks, exposed.
194	x		18	S			o		o			o				o							o				o						o			o	o	1/8	Metal	Pavement end cracks on inlet.
195	x		24	S																							o													Half collasped at end, silted up.
196	x		36	S			o		o			o				o							o			o	o					o	o							Excellent condition, no cracks and no wear.
197	x		18	S			o	o								o											o													Inlet collasped - scarred - rock blocking end. Coating good.
198	x		18	S			o		o			o				o						o	o			o	o					o	o							Coating in pavement excellent - shaded.
199	x		48	S			o							o		o							o			o	o			o	o	o	o			o	o	1/4	Metal	Pavements ends cracking. Outlet velocity very high - has been sand bagged at outlet to prevent erosion. Outside coating scouring off.
200	x		24	S			o		o			o				o							o	o			o			o	o		o			o	o	1/8	Metal	Typical weathering cracks in inlet pavement - outside coating dull and peeling on exposed ends.
201	x		36	M			o		o			o				o							o	o		o	o			o			o			o				Pavement at 7 o'clock - typical conditions where coating acts as pavement. Coating peeling in trickle line - elsewhere coating is excellent. Outside good.
202	x		36					o		o			o				o							o	o			o			o			o			o			Typical weathering on outlet pavement exposed to sun. Pavement at 3 o'clock. Severe weathering. Pavement peeling - coating peeling in trickle line - spelter good. Outside coating peeling.
203	x		48				o									o							o	o			o			o			o			o				Severe weathering on ends for 2'. Coating weathered where exposed to sun, dull and dry.
204	x		42	M			o	o	o			o		o	o								o	o			o			o			o			o				Typical weathering. Pavement at 11 o'clock - coating gone in flow line. (Tuberculin in flow line).
205	x		36				o							o		o								o			o						o							Inlet end excellent condition. Outlet end - coating gone or never coated, spelter gone with rust.
206	x		36	F			o		o			o		o	o			o					o							o										Pavement at 2 o'clock. Coating acting as paving - outside coating fair- some cracking. Outlet end not coated. Tuberculin rust, advanced stage.
207	x		66x33	M			o							o	o			o					o	o			o						o			o				Typical weathering - cracking and scaling - outside coating good - slight rust on lip where coating is scarred.
208	x	1950	59x34	F			o		o			o		o	o		o					o	o				o			o			o			o	o	3/8	Metal	Some sag in center. Wetting and drying flaking in trickle line, at inlet and outlet. Outside coating - dull and cracking. No metal showing.
209	x		24	F			o								o									o			o						o							Pavement at 5 o'clock typical weathering condition at outlet. Inlet paving and coating good.
210	x		18	M			o		o			o		o	o							o	o	o		o	o					o	o							Typical - coating good - some slight checking and scaling a few feet on ends in invert.
211	x		18	F			o						o	o										o			o						o							Partly collapsed at inlet. Coating good - silt over pavement at outlet - pavement good at inlet.
212	x		18	F			o							o	o								o	o			o						o							Overflows roadway - culvert half full of silt. Pavement good - coating good.
213	x		72x44	M		o	o							o	o								o				o						o			o	o	1/8	1/8	Few cracks first 2' - overall pavement condition excellent - no checks or peeling - outside coating excellent.
214	x		18	M			o							o									o	o			o									o	o	1/4	1/4	Typical weathering on ends. Coating good outside.
215	x		18	F			o							o									o				o						o							Some weathering and paving at inlet end. Paving good in shaded outlet end.
216	x	1950	30	F		o	o							o	o								o				o						o							Pavement typical - invert slightly off. sink hole topography. Typical weathering.
217	x		18	F																							o						o			o	o	1/4	Metal	Outside coating. Adhesion poor - spelter good - typical weathering.condition. Inlet and outlet exposed.
218	x		30	M			o		o			o		o	o								o	o			o						o			o	o	3/16	Metal	Typical weathering conditions. Outlet high and exposed, has 5' free fall at outlet. Dug large hole. One joint of concrete pipe at inlet end. No weathering on metal. Pavement not in invert.
219	x		24	F			o						o	o				o						o	o		o													Water standing in pipe - some silt.
220	x		18	F			o							o	o									o	o		o													Silted up - outlet end burned out. Silted badly at outlet
221	x		18	M			o		o		o			o	o									o	o		o													Silted up - 1/3.

TABLE 1 - (CONT'D.)

	INSTALLATION				FLOW				EROS'N				TYPE DRAINAGE								MAINT. COND.					CONDITION OF INLET & OUTLET: COATING						CONDITION OF INLET & OUTLET: PAVEMENT								REMARKS
Inspection No.	Coated and Paved	Year Installed	Size (Inches)	Grade	Continuous	Frequent	Intermittant	Filling	Sand	Boulders	Shale	Gravel	Cultivated Land	Pasture	Hilly Wooded	Mountainous Wooded	Wooded Swamp	Farmyard	Sewage	Mine Water	Excellent	Very Good	Good	Fair	Poor	Adhesion Excellent	Adhesion Good	Adhesion Fair	Adhesion Poor	Coating Checked	Could Be Stripped	Adhesion Excellent	Adhesion Good	Adhesion Fair	Adhesion Poor	Longitudinal Cracks	Circumfer'ial Cracks	Width of Cracks	Depth of Cracks	
222	x		18	S			o							o				o					o				o						o							No cracks - ends fairly shielded. Pavement slightly off invert.
223	x		18	M				o	o			o	o										o				o						o			o	o	1/4	Metal	Paving good - shielded by silt and gravel. Full flow. Typical weathering at outlet - cracks.
224	x		18	M			o		o			o	o	o										o			o						o			o	o	1/8	Metal	Cracking through in very good shielded condition - erosion in pavement - outlet end and no chance of wetting and drying in outlet end. Inlet collapsed. Outside coating good.
225	x		18	S	o		o						o	o									o	o			o						o							Good - no weathering - shielded - Outside coating good.
226	x	1950	18				o						o	o									o				o						o							Coating in pavement good - in excellent shape.
227	x		36	F			o		o				o	o									o				o						o							Outside coating good. Typical weathering. excessive scaling and falking in trickle line. Extreme flaking in outlet. Coating perfect - all exposed - spelter good.
228	x		36				o						o	o									o			o	o					o	o							Shaded - excellent condition both ends due to shade.
229	x		42	F			o			o		o	o	o									o			o	o						o							Typical weathering. extreme flaking condition - no evidence of wetting and drying. Small crack s indicates material may be too dry, last 3' to 4'. Outlet end free and 3' of fall. Some boulders in barrels.
230	x	1949	18	F			o						o	o										o			o						o			o	o	1/8	Metal	Invert at 5 o'clock. Typical weathering on ends. Very little drainage on this road.
231	x		18	F			o		o			o		o	o							o				o	o						o			o	o	1/8	Metal	Paving at outlet at 5 o'clock. Typical weathering outlet end shaded - in excellent shape.
232		1949	42x28 42x28				o						o	o									o																	No rust.
233	x		66x38	M			o					o	o	o									o				o	o					o			o	o	1/4	Metal	Outside coating fairly good. Typical cracks on pavement on ends. No scaling - no wet and dry action. No ponding.
234	x		18				o		o			o	o	o									o			o	o					o	o							Shielded ends - No cracks in pavement. Excellent condition.
235	x		18	M			o					o	o		o								o	o		o	o						o							Excellent condition - shielded by vines and vegetation.
236	x		18	M			o						o	o				o									o						o							Good condition. Shielded at inlet - typical weathering at outlet - exposed end.
237	x		18	M			o						o	o				o					o				o													No cracks at shielded inlet. Protected inlet and outlet - size good.
238	x		18	M			o						o	o										o	o		o						o							Full flow due to silted inlet - Inlet end torn and partially collapsed. Inlet pavement fair.
239	x	1949	24	F			o						o										o				o						o			o	o	1/4	Metal	Weathered inlet - cracking and peeling at inlet. Pavement at 7 o'clock at outlet. Outside coating good. No rust on exposed spelter.
240	x	1949	18	F	o			o					o											o	o	o	o						o							Coating good. Typical weathering at inlet. Outside coating good.
241	x		30x17		o			o					o										o			o	o													Silted in pavement - and impossible to inspect pavement - coating good.
242	x		59x34	F			o						o	o									o			o	o						o							Outside coating good - inside very good. Silted - impossible to inspect pavement.
243	x		30x17	F			o						o										o				o						o			o	o	1/32	1/32	Typical weathering. Small cracks on end of pavement.
244	x		30x17	F			o						o														o						o			o	o	1/4	Metal	Free out fall - outlet pavement cracked - outside coating good.
245	x		66x38 66x38	F			o						o	o								o	o				o						o			o	o	1/2	Metal	Typical weathering on ends - no peeling or scaling - no wet or dry condition.
246	x		39x34 39x34	F			o						o	o									o				o						o			o	o	3/8	Metal	Typical cracking on ends.
247	x	1949	24	M			o	o				o		o	o								o	o			o						o							Coating burned on outside - inside coating good - silted.
248			93x64	F		o	o					o		o			o	o					o	o																No evidence of rust.
249			77x57	F										o			o	o																						Cut off on skew. Rust in invert. No acid.
250	x		30x17	F			o							o									o				o													Wet and dry flaking scaling at inlet and outlet. Culvert low and pooled at outlet. Coating good.
251	x		30	F			o		o			o		o									o			o	o						o							Typical weathering on ends. Coating good inside and out with slight evidence of erosion.
252			77x57	F			o						o	o											o															Half full of silt and mud - looks good elsewhere.
253		1949	18	F			o						o												o									o		o	o	1/2	Metal	Outlet and inlet ends partially collapsed. Severe cracking of pavement. Peeling in large squares. Outside coating scarred off.
254	x		18	F			o						o										o	o			o						o	o						Severe cracking in pavement; outlet which is exposed. Inlet sheltered and therefore, nd cracking so severely. Outlet end damaged by grader. Full flow.
255			77x57	F			o						o		o								o	o																No rust - some silt and outlet. Culvert laid too low.
256	x		18	M			o						o		o	o								o			o						o	o		o	o	1/2	Metal	Severe cracking in pavement. Pavement in culverts on this section of road are thicker than usual. Cracking very wide.
257	x		24	F			o		o				o											o					o											Standing full of water. Coating good. Pavment impossible to inspect.
258	x	1949	18	F			o	o		o			o	o								o	o			o						o								Extreme cracking - pavement peeling in large chunks.
259	x		24	F			o	o	o	o	o		o			o						o	o			o	o						o							Pavement peeling off. Coating adhesion seems to be bad. Puddling in culvert deteriorating coating. Wetting and drying affect. Culvert partially collapsed at inlet.
260	x		18	F			o						o	o			o					o	o			o	o					o	o							Pipe cut by grader. Has insufficient cover. Pavement in pipe deeply cracked. Extremely bad - as has been typical of this road. Wide cracks penetrates to metal. Pavement seems to be thicker causing more severe cracking. Paving seems very dry. Outside coating mostly gone.
261		1949	77x57	F			o		o	o	o		o	o	o							o	o																	Scour action. Complete rust in trickle line. Outside spelter good. No acid.
262	x		18	M			o								o									o	o	o							o							Typical weathering at outlet. Cracking and scaling in trickle line. Coating excellent. Inlet end needs cleaning. End projects too far into the cut.
263	x		18	S										o	o			o					o										o							Perfect condition. Shielded by cut and vegetation. Outside coating good.
264	x		18	F			o	o	o			o			o									o	o		o						o							Paving good. Coating fair - protected by clay silt and invert. Outside coating gone.
265	x		18	M			o	o					o	o				o					o	o			o						o					1/8	Metal	Coating good. Typical weathering. Flaking outside

TABLE 1 - (CONT'D.)

Inspection No.	INSTALLATION: Coated and Paved	INSTALLATION: Year Installed	INSTALLATION: Size (Inches)	INSTALLATION: Grade	FLOW: Continuous	FLOW: Frequent	FLOW: Intermittant	FLOW: Filling	EROS'N: Sand	EROS'N: Boulders	EROS'N: Shale	EROS'N: Gravel	TYPE DRAINAGE: Cultivated Land	TYPE DRAINAGE: Pasture	TYPE DRAINAGE: Hilly Wooded	TYPE DRAINAGE: Mountainous Wooded	TYPE DRAINAGE: Wooded Swamp	TYPE DRAINAGE: Farmyard	TYPE DRAINAGE: Sewage	TYPE DRAINAGE: Mine Water	MAINT. COND.: Excellent	MAINT. COND.: Very Good	MAINT. COND.: Good	MAINT. COND.: Fair	MAINT. COND.: Poor	CONDITION OF INLET & OUTLET – COATING: Adhesion Excellent	COATING: Adhesion Good	COATING: Adhesion Fair	COATING: Adhesion Poor	COATING: Coating Checked	COATING: Could Be Stripped	PAVEMENT: Adhesion Excellent	PAVEMENT: Adhesion Good	PAVEMENT: Adhesion Fair	PAVEMENT: Adhesion Poor	PAVEMENT: Longitudinal Cracks	PAVEMENT: Circumferential Cracks	PAVEMENT: Width of Cracks	PAVEMENT: Depth of Cracks	REMARKS
266	x		30	F				o					o	o									o													o	o	3/8	Metal	Wetting and drying. flaking. Typical cracking pattern. Outside coating good. culvert set low on grade. Puddling at outlet allowing wetting and drying for weathering.
267	x		18	F			o						o	o									o			o	o						o	o						Pavement at 3 o'clock at outlet. Severe weathering of pavement. Coating excellent. Inlet good condition shielded. Outlet high and exposed.
268	x	1949	24	F			o						o		o		o						o				o						o							Typical weathering. Slight flaking in trickle line. Pavement flaking in large chunks.
269	x		72x44	F			o						o	o	o							o					o							o						Typical weathering conditions. Some wetting and drying; flaking in flow line. Coating good. Outlet cracking severe. Large sheets of pavement missing. Spelter dull. Pinpoint rust where exposed.
270	x		58x36	F			o						o	o									o				o						o							Typical weathering of pavement at both ends. Wet and dry flaking. Small amount of algae growth. Pinpoint rust where exposed.
271	x		19	M			o						o	o				o					o			o	o					o	o							Excellent condition. Ends are shielded and no wet or dry action.
272	x		36	F			o							o	o								o			o	o						o							Typical weathering - cracks not as severe as usual. Some chemical action - not acid. Coating good. Culvert is 1/2 corrugated metal and 1/2 concrete.
273	x	1949	24	F			o						o	o	o									o			o						o							Cracking first 6". Otherwise shaded. In deep fill. Pavement slightly out of invert.
274	x	1949	24	M			o							o	o								o			o	o					o								Excellent condition. Inlet shaded - coating and pavement best condition.
275	x	1949	18	F			o								o									o	o		o						o	o		o	o		Metal	Outlet silted 1/2 full and is high. Last 6' exposed. Outlet trickle line cracked to metal.
276	x	1949	18	M			o								o									o	o		o						o							Silt in bottom seems to be protecting pavement. Slightly weathered.
277	x	1949	30			o	o		o				o	o	o								o				o						o	o						Coating not in invert. Coating is checking and peeling in flow line. Pavement good.
278	x	1949	59x34	F		o	o		o				o	o	o							o	o				o						o			o	o	3/8	Metal	Typical weathering and scaling in invert.
279	x	1949	52x30	M		o	o						o	o	o								o			o						o								Excellent condition. No cracks or peeling.
280	x	1949	77x57	M		o	o							o	o								o			o	o					o	o							Slight cracking in inlet. Small patches of scaling. Very good condition.
281	x	1949	65x44	F			o						o	o	o								o			o	o					o	o							Excellent condition. No cracks or peeling.
282	x	1949	48	M		o	o							o	o								o			o	o					o	o							Spelter excellent - exception - one piece is missing and a spot is rusted.
283	x	1949	24	M			o							o	o								o			o	o					o	o							Invert at 9 o'clock. Coating and pavement excellent.
284		1949	77x57	F		o									o								o																	Advanced stage of tuberculin rust on entire flow line. No mine water. 30% gone.
285	x	1949	30	F			o							o	o								o			o						o								Excellent condition.
286	x	1949	74x57 74x57	F		o	o							o	o								o			o						o				o	o	1/8		Excellent condition at inlet. Outlet typical cracks.
287	x	1949	48	M		o	o								o								o			o	o					o	o							Good condition.
288	x	1949	48	M		o	o						o	o	o								o			o	o					o	o							Excellent condition.
289	x	1949	42	M			o	o							o								o			o						o								Excellent condition.
290	x	1949	18 18				o								o								o			o	o					o	o							Excellent condition. No cracking, checking or scaling.
291	x	1949	48	M		o	o							o	o								o			o	o						o							Typical checking at outlet,where exposed to afternoon sun. Inlet excellent.
292	x		142x90 142x90		o	o							o	o	o									o																One arch completely rusted in invert. The other is silted 1/3 full. Recommend paving this out.
293	x	1949	48				o								o								o			o						o								Perfect condition. No cracks or checks. Best seen so far.
294	x	1949	24	M			o								o								o			o	o					o	o							In good condition. Slight evidence of checking.
295	x	1949	24	F			o								o								o			o	o					o	o			o	o			Cracks present in protruding outlet.
296	x		18	S			o								o								o			o	o					o	o							Good shape - no cracks.
297	x		24				o								o								o			o	o					o	o							Good shape - no cracks. Outside excellent.