

Research Report
KTC 95-17

BALLAST SIZE FOR SAFE WORKING CONDITIONS
IN RAILROAD YARDS AND TERMINALS IN KENTUCKY

by

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Professor

Kentucky Transportation Center
College of Engineering
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in cooperation with

Kentucky Transportation Cabinet
Commonwealth of Kentucky

The contents of this report reflect the views of the author who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Kentucky or the Kentucky Transportation Cabinet. This report does not constitute a standard, specification, or regulation. The inclusion of manufacturer names and trade names is for identification purposes and is not to be considered an endorsement.

July 1995

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Background

During the 1994 Regular Session of the House of Representatives of the General Assembly of the Commonwealth of Kentucky, House Resolution No. 58 was introduced by Representative J. Dorsey Ridley on Monday, February 28. It basically directed the Transportation Cabinet "to identify the more appropriate grade of rock used as surface material in railroad beds and walkways" and that "any remedy proposed . . . be reported to the Legislative Research Commission no later than August 1, 1995." A copy of the Resolution is contained in Appendix A.

The issue was forwarded to the Transportation Cabinet and subsequently to the Kentucky Transportation Center at the University of Kentucky. Quick Response Study KYP 95-108, Subtask 26 was initiated. A copy of the Proposal is contained in Appendix B.

The initial activity was to identify the basic railroad network in Kentucky and select the major rail classification yards and terminals for study.

Basic Railroad Network of Kentucky

Four railroad companies account for essentially all of the mainline and significant yard operations in Kentucky. The lines are depicted in Figure 1. A description of each follows.

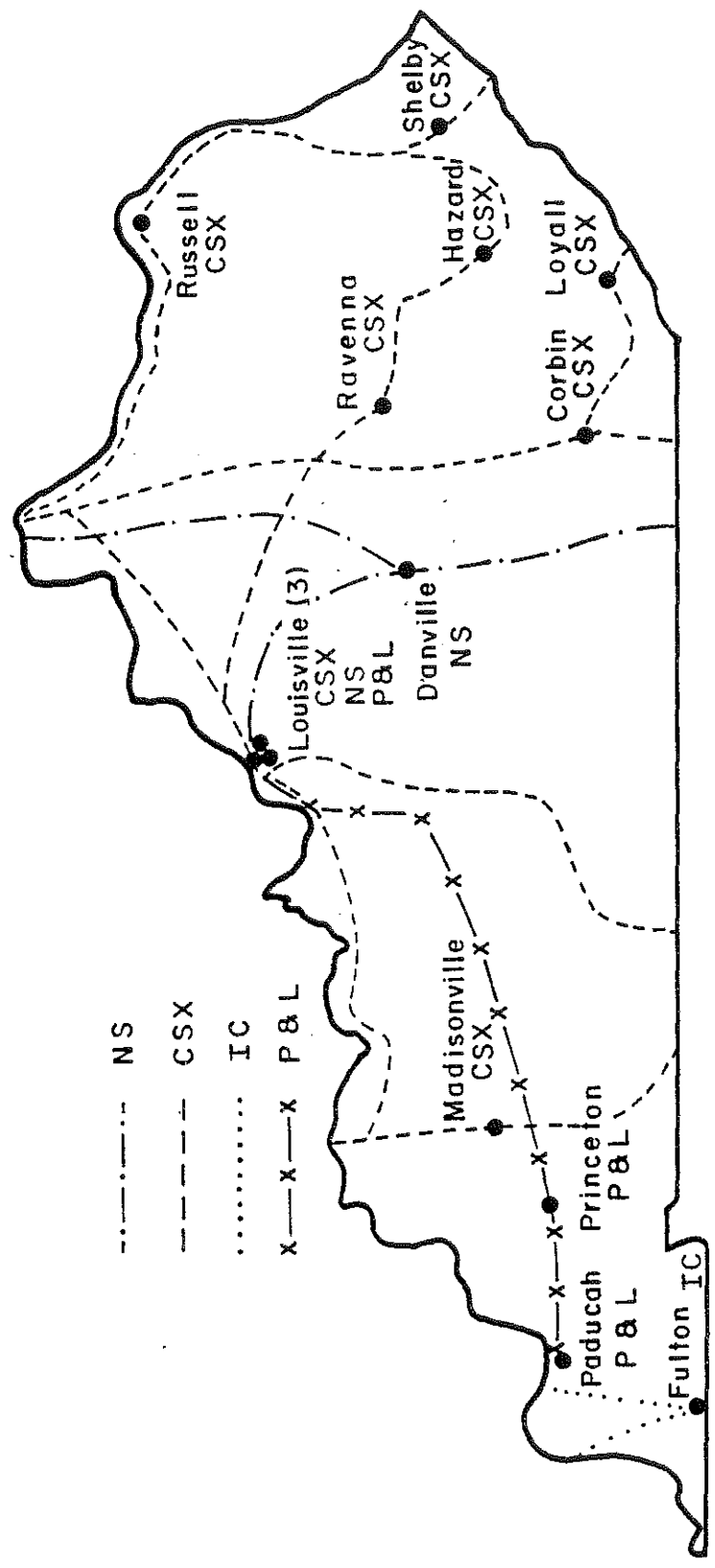


Figure 1. Basic Railroad Mainlines and Yard/Terminal Facilities in Kentucky

CSX Transportation (CSX) accounts for over half of the rail operations in Kentucky. It was formed by combining the Seaboard System Railroad and the Chessie System Railroads. A major component of the Seaboard System was the Louisville and Nashville Railroad (L&N) and a major component of the Chessie System was the Chesapeake and Ohio Railway (C&O). The L&N , and the C&O to a lesser extent, had major rail operations in Kentucky and these lines represent essentially all of CSX's extensive statewide operations.

CSX has seven mainlines crisscrossing the state. An east-west line basically follows the Ohio River from Ashland westward to Northern Kentucky (Covington), Louisville, Owensboro and Henderson. The four north-south lines include a line from Ashland to Elkhorn City in extreme eastern Kentucky which basically follows the Big Sandy River and serves several coal mine spurs; an east-central line from Cincinnati, OH through Corbin and on to Knoxville, TN; a west-central line from Louisville through Bowling Green and on to Nashville, TN; and a west Kentucky line from Henderson through Madisonville and Hopkinsville and on to Nashville, TN which also serves the West Kentucky Coal Fields. The other two lines trend southeast-northwest and primarily serve the Eastern Kentucky Coal Fields. One basically follows the Kentucky River from the Hazard area through Lexington to Louisville; the other basically serves the Cumberland River Valley from southwest Virginia through Harlan to Corbin.

Norfolk Southern Railway (NS) was formed by combining the Southern Railway System (SR) and the Norfolk and Western Railway (N&W). The N&W portions comprise only a few miles of mine spurs in extreme eastern Kentucky. The bulk of the NS's Kentucky mainlines is the former SR main north-south line in the central part of the state. It enters from Knoxville, TN and Chattanooga, TN in south central Kentucky south of Somerset and progresses northward through Somerset to Danville where it splits. One line continues northward through Lexington to Cincinnati, OH and the other northwesterly to Louisville and on to St. Louis, MO.

Although NS has only a small percentage of the rail network in Kentucky, its mainline through Louisville and Cincinnati carry tonnage comparable to many CSX's lines.

The Illinois Central Railroad (IC) has two main north-south lines in extreme western Kentucky. The line enters the state from the south at Fulton. Two lines radiate northward, one exiting the state just west of Paducah, the other farther west at Cairo, IL.

The Paducah and Louisville Railway (P&L) basically comprises the former IC east-west line and associated West Kentucky Coal spur lines. The mainline progresses from Paducah eastward through Princeton to Louisville. The P&L is in the process of being associated with CSX.

Major Rail Classification Yards and Terminals in Kentucky

The four major railroad companies identified previously, CSX, NS, IC, and P&L, operate all of the major rail yards and terminals in the state. These are listed below and are identified in Figure 1.

CSX

Russell

Shelby

Hazard

Ravenna

Loyall

Corbin

Louisville (Osborne)

Madisonville (Atkinson)

NS

Danville

Louisville Terminal

IC

Fulton

P&L

Louisville (Oak Street)

Princeton

Paducah

These fourteen yards were selected for study. Several smaller yards were also identified but were not considered to have sufficient activity to warrant study. The majority of the yards were located on CSX properties. Major yard facilities in bordering Cincinnati, OH and Evansville, IN were not included in the study since they are outside the state. A major CSX yard in northern Kentucky (DeCoursey) was not included since it is essentially closed.

Study Procedure

Meetings were held with representatives of the various unions representing the carmen, trainmen and maintenance-of-way employees. Contacts were made with the engineering departments of the four railroads, basically requesting their policies and practices for selecting ballast size for mainlines, branch lines and yard/terminals in Kentucky. Copies of the responses are contained in Appendix C.

A review was made of the current American Railway Engineering Association (AREA) Recommended Practice for selecting ballast size. Pertinent excerpts from Chapter 1 - Roadway and Ballast are contained in Appendix D.

In addition, a review was made of the Tennessee Code Annotated and Tennessee Public Service Commission Rules and Regulations Governing Railroads. Portions of the rules and regulations relating to ballast selection and safety of workers are contained in Appendix E.

Visits were made to each of the fourteen yards and terminals to obtain on-site examination of the typical conditions where the majority of the foot traffic was performed. Descriptions and size measurements of the ballast in the walking areas were noted. Photographs of the typical areas were obtained.

Site Visits and Descriptions

Arrangements were made with each company for official visits of the yards and terminals selected for study. Personnel assisting with the visits varied considerably depending on the availability at the time and the desires of the companies. Normally a representative of the engineering department or a yard/terminal official was present. Representatives of the trade unions participated at several sites. Particular efforts were made to view areas where the majority of the foot traffic occurred. Pertinent information was obtained and is discussed specific to each location.

Appendix F contains descriptions of each of the fourteen yard and terminals visited. Also included are typical photographs.

Discussion

Table 1 contains ballast gradations for the following:

AREA - American Railway Engineering Association Manual For
Railway Engineering Chapter 1 Roadway and Ballast
(see Appendix D and Figure 2)

TN CODE - Tennessee Code Annotated and Tennessee Public Service Commission Rules and Regulations Governing Railroads (see Appendix E and Figure 2)

CSX - CSX Transportation (see Appendix C)

NS - Norfolk Southern Railway (see Appendix C)

IC - Illinois Central Railroad (see Appendix C)

P&L Paducah & Louisville Railway (see Appendix C)

These gradations were recommended or specified for Yard Tracks/Walkways by the respective railroad or organization.

The Kentucky railroads basically follow the AREA recommendations. AREA recommends two different gradings for yard tracks. AREA 5 is a 1" - 3/8" size ballast and is similar in size to ASTM #56 grading. AREA 57 is a 1" - No. 4 size ballast and is the same size as ASTM #57 grading. Both have a nominal maximum size of 1"; however, AREA 57 grading has significantly more 1/2" - No. 4 size particles which serve to fill voids in the AREA 5 grading and provides a larger range of particle sizes. AREA 57 grading appears "finer" due to the inclusion of the smaller size particles, although both gradings have the same nominal maximum size of 1".

CSX specifies AREA 5 or AREA 57 for walkways. NS specifies only AREA 5 for yard tracks. IC specifies AREA 5 or AREA 57 for yard tracks. P&L specifies ASTM #57 (AREA 57) for yard, industry and lead tracks. Thus the railroads conform to the AREA recommendations for yard tracks.

Medians for the gradation ranges for the AREA 5, AREA 57 and TN CODE are depicted in Figure 2. It is clearly evident that the AREA 57 grading is finer than the AREA 5 grading. Also evident is that the TN grading is more uniform in size since, on an average, 77.5% of the particles are between 3/4" and 1/2" size.

It should be noted that mainline ballast will normally have nominal maximum sizes of 2" to 2.5" with practically no material finer than 1/2", as noted in Appendixes C and D.

Findings and Recommendations

It is recommended that the railroads in Kentucky continue to conform to the AREA recommendations of AREA 5 or AREA 57 gradings for walkways in Yards and Terminals. Based on information provided by the railroads, this recommendation is followed by the major railroads operating in Kentucky. The FRA (Federal Railroad Administration) does not regulate nor specify ballast size.

The budget was not adequate for detailed evaluation of safety issues associated with effect of ballast size on the accident rates

for railroad employees. The on-site examinations of the fourteen yards and terminals revealed that the railroads were following AREA recommendations and that ballast size was limited to typically 1" maximum size.

Table 1. Ballast Gradations Typically Recommended or Specified for Yard Tracks/Walkways

Designation for Sieve Sizes	<u>AREA</u> YARD		<u>TN CODE</u> Walkways	<u>CSX</u> Walkway		<u>NS</u> Yard	<u>IC</u> Yard		<u>P&L</u> Yards & Ind. Leads
	AREA 5*	AREA 57**		AREA 5	AREA 57	AREA 5	AREA 5	AREA 57	ASTM #57
	1" - 3/8"	1" - No.4				3/4"	SYL-5	SYL-6	1" - No.4
2½"									
2"									
1½"	100	100		100	100	100	100	100	100
1"	90-100	95-100	100	90-100	95-100	90-100	90-100	95-100	95-100
¾"	40-75		95-100	40-75		40-75	40-75		
½"	15-35	25-60	15-25	15-35	25-60	15-35	15-35	25-60	25-60
⅜"	0-15		0-10	0-15		0-15	0-15		
No. 4	0-5	0-10		0-5	0-10	0-5	0-5	0-10	0-10
No. 8		0-5			0-5			0-5	0-5
No. 10									
No. 60									
No. 200	1.0 max	1.0 max		1 max	1 max	0.5 max	1 max	1 max	

* Similar to ASTM C33 Grading Designation #56

** Same as ASTM C33 Grading Designation #57

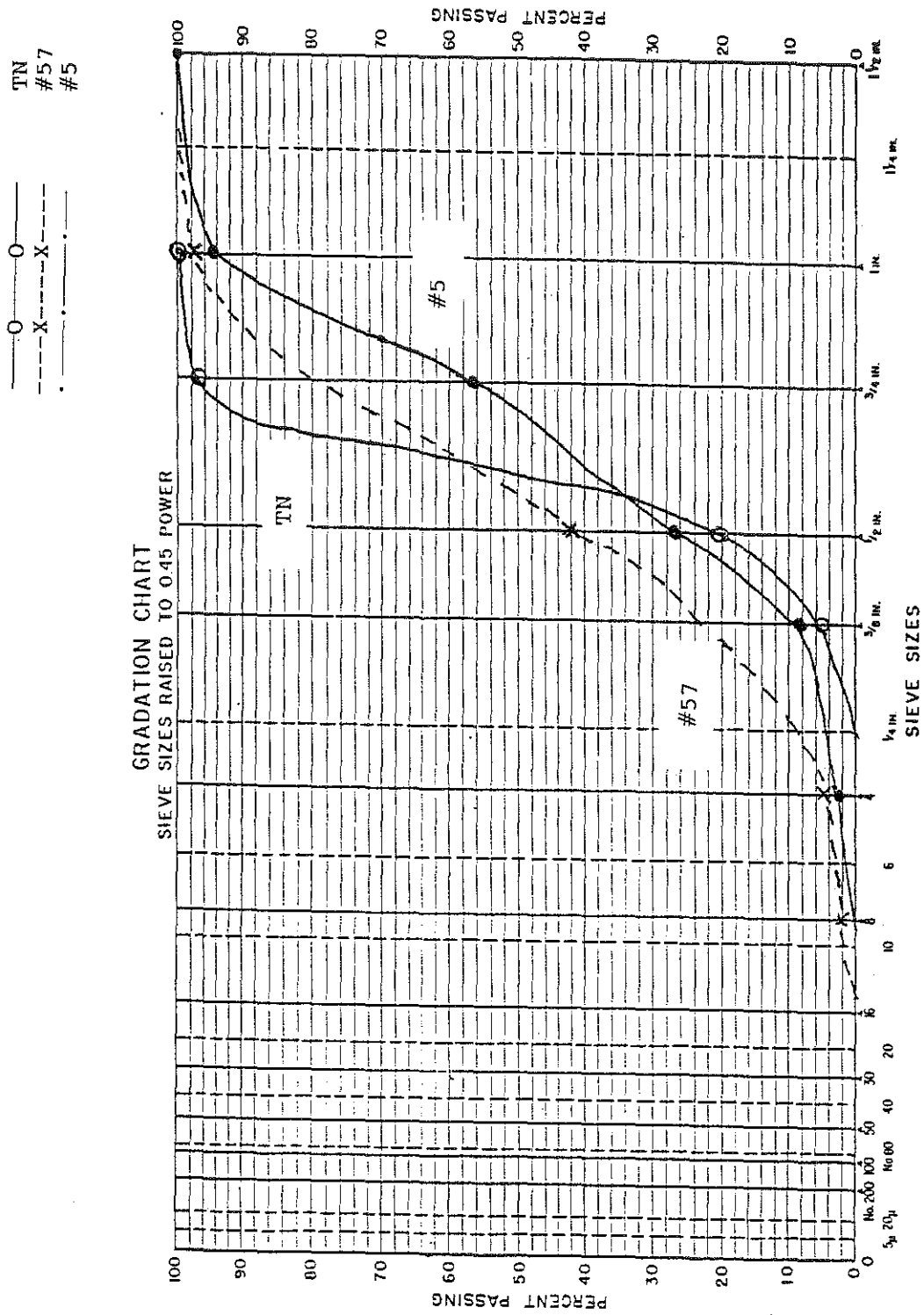


Figure 2. Median Gradation Ranges for AREA 5, AREA 57 and TN CODE Recommended/Specified Ballast Gradations for Yard Tracks/Walkways

APPENDIX

A

HOUSE RESOLUTION NO. 58

IN HOUSE

REGULAR SESSION 1994

HOUSE RESOLUTION NO. 58

MONDAY, FEBRUARY 28, 1994

Representative J. Dorsey Ridley introduced the following resolution which was ordered to be printed.

A RESOLUTION directing the Transportation Cabinet to identify the most appropriate grade of rock used as surface material in railroad beds and walkways.

WHEREAS, reducing workplace hazards is an important goal from every viewpoint; and

WHEREAS, the use of large-grade rock as surface material for railroad beds and walkways constitutes a grave workplace hazard to railroad workers; and

WHEREAS, hazardous working conditions result in accidents which contribute to lower productivity and higher operating costs;

NOW, THEREFORE,

Be it resolved by the House of Representatives of the General Assembly of the Commonwealth of Kentucky:

1 Section 1. That the Transportation Cabinet is directed to study the issue of rock
2 grade size used as surface material in railroad beds and walkways and propose legislative
3 or executive solutions to reducing the hazardous working conditions that railroad workers
4 are currently experiencing with large grade-rock. Any remedy proposed should view the
5 issue as a safety matter, taking into consideration federal railroad law, and, be reported to
6 the Legislative Research Commission no later than August 1, 1995.

7 Section 2. That the Clerk of the House of Representatives is directed to transmit a
8 copy of this Resolution to Secretary Don Kelly, Transportation Cabinet, State Office
9 Building, Frankfort, Kentucky 40601.

APPENDIX

B

RESEARCH PROPOSAL

**PROPOSAL FOR KYP 95-108
SUBTASK NO. 26**

Title: Effects of Ballast Size along Railroad Trackbeds and Walkways on the Safety of Railroad Workers.

Scope: This study will determine the relative effects on varying the size and grading of ballast (rock) typically used in and around railroad trackbeds and associated walkways on the safety of railroad workers and determine if various gradings are appropriate for their intended use as ballast. Railroad workers include train crews, switch, servicing and inspection crews, and truck maintenance crews.

Work Plan: Reviews will be made of the following American Railway Engineering Association Standards of Practice:

Committee 1 - Roadway and Ballast
Committee 5 - Track
Committee 14 - Yards and Terminals

Reviews will be made of the Federal Railroad Administration Safety Standards relative to the subject.

A literature study will be conducted to document the results of any previous studies and investigations of the subject.

Interviews will be conducted of railroad workers who routinely work in and around railroad trackbeds and walkways. Safety officials will also be interviewed. Accident rates will be obtained and reviewed.

Recommendations will be made for the most appropriate grade(s) and size(s) of ballast to improve safety on or before July 1, 1995.

Total Estimated Cost: \$9,100.

APPENDIX

C

POLICIES AND PRACTICES

FOR

SELECTING BALLAST SIZE

FOR

MAINLINES, BRANCH LINES AND YARD/TERMINALS IN KENTUCKY

CSX

NS

IC

P&L



TRANSPORTATION

D. R. Bates
Director Engineering Materials &
Work Equipment

December 6, 1994

Dr. Jerry G. Rose, P.E., Professor
University of Kentucky
261 CE/Trans Building
Lexington, Kentucky 40506-0281

Dear Dr. Rose:

It was a pleasure to finally be able to meet with you and have the opportunity to have discussions with you and Jim Cashwell regarding the Proposal for KYP-108, Subtask No. 26. I hope you enjoyed the train trip and had the opportunity to meet and talk with others as well.

As we had discussed during our meeting, when comparing CSXT's policies and practices regarding railroad ballast to the Proposal and other States' regulations, I believe we are in conformance in all areas. This is not to say that from time to time due to operational changes there are tracks that previously have not been designated as requiring walkway ballast for operation. In these instances, as we are made aware of the requirements, walkway ballast is furnished and applied. In some instances there have been tests run with different materials such as asphalt to obtain suitable walkway surfaces.

CSXT's policies and practices for a number of years have been to supply an AREA #4A (modified w/0-1% max. 3/8" or less) gradation ballast for routine track maintenance procedures. When walkway needs are identified, we have furnished either an AREA 5 or AREA 57 gradation to be applied as a top dressing material. The larger gradation material (AREA #4A) is the more desirable for normal maintenance practices for two reasons. The larger material provides for a better draining track structure and is less likely to foul with fines.

I am enclosing a copy of our Engineering booklet entitled "Specifications for Timber Crossties Switch Ties and Ballast" for your use and reference. If I can be of any further assistance please feel free to contact me at any time.

Sincerely,

Donald R. Bates

cy: J. L. Cashwell
J. P. Epting
T. P. Schmidt



SPECIFICATIONS FOR TIMBER CROSSTIES SWITCH TIES And BALLAST

MARCH 1990

If material loaded does not conform to these specifications, the Railroad must notify the supplier to stop loading until the fault has been corrected and to dispose of all defective material without cost to the Railroad.

(6) TESTING.

(A) Determinations of deleterious substances resistance to abrasion and soundness shall be made at a testing laboratory selected by the Railroad, but visual inspections and gradation test shall be made at the place of production prior to shipment as often as considered necessary.

(B) Samples of the finished product for all tests shall be representative and of sufficient weight for testing.

(7) QUALITY REQUIREMENTS.

(A) Deleterious substances shall not be present in prepared ballast in excess of the following amounts:

Material finer than No. 200 sieve	= 1%
Soft and Friable pieces	= 2%
Clay lumps	= 0.5%

(B) The percentage of wear of prepared ballast tested in the Los Angeles Machine shall not be greater than:

Granite	= 32%
Dolomite Limestone	= 28%
Except as otherwise specified by Railroad	

(C) Granite ballast is predominately considered CSX Standard, dependent upon economic evaluation. The following guidelines should be followed in determining the type of ballast application for each territorial location:

C S X TRANSPORTATION, INC.

SPECIFICATIONS FOR PREPARED RAILROAD BALLAST

(1) SCOPE.

These specifications cover the requirement for grading and other significant physical properties of mineral aggregates for prepared ballast.

(2) TYPES OF BALLAST.

Quarried Granite and Dolomite Limestone, produced in a crushing-screening plant designed to satisfy the specifications listed herein.

(3) GENERAL REQUIREMENTS.

The type and sizes of prepared ballast shall be designated by the Railroad in conformance to approved standards.

(4) HANDLING.

Processed ballast shall be handled at the producing plant in such a manner that it is kept free from segregation. It shall be loaded only into cars which are clean and free from rubbish or any substance which would foul or damage the ballast. The producer should not make repeated passes of equipment over the same levels in stock piled ballast.

Ballast shall be washed prior to loading in railcars.

(5) INSPECTION.

The Railroad reserves the right to reject any car of ballast arriving at the site for unloading that does not conform to the specification as determined by methods of test.

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1. Granite ballast should be used on lines having tonnage in excess of 25 MGT annually.
2. Dolomite Limestone ballast with maximum 24% loss (L.A. abrasion) can be used on lines having 10 MGT to 25 MGT annually based on economic evaluation.
3. Dolomite Limestone ballast with maximum 28% loss (L.A. abrasion) can be used on lines having less than 10 MGT annually, based on economic evaluation.
4. Dolomite = MgCo³ More Than 36% - Approved
Dolomite Limestone = MgCo³ 28-36% - Approved
Limestone = MgCo³ Less Than 28% - Not Approved
Slag Ballast - Not Approved

It is the Division's responsibility to evaluate annual tonnage application when ordering weekly ballast requirements (based on the above guidelines). The Chief Engineer's office will determine the best solution to be administered.

(D) The soundness of prepared ballast for use in regions where freezing temperatures are expected shall be such that when tested in the sodium soundness test, the weighted average loss shall not be in excess of 7% after 5 cycles.

(8) GRADING REQUIREMENTS.

(A) The grading of prepared ballast shall be determined by test with laboratory sieves having square openings and conforming with current ASTM Specifications, Designation E-11.

(9) PREPARED RAILROAD BALLAST FOR CSX SHALL CONFORM TO THE FOLLOWING GRADING REQUIREMENTS:

SCREEN SIZE	MAIN LINE AREA #4A	WALKWAY		BASE	
		AREA 5	AREA 57	GA BASE	CRUSHER RUN
2 1/2"	100%				
2"	90-100%				
1 1/2"	60-90%	100%	100%	100%	100%
1"	10-30%	90-100%	95-100%		
3/4"	0-10%	40-75%		60-100%	
1/2"		15-35%	25-60%		
3/8"	0-3%	0-15%			
NO. 4		0-5%	0-10%		
NO. 8			0-5%		
NO. 10				30-55%	15-45%
NO. 60				8-35%	
NO. 200				5-20%	5-12%

(10) METHODS OF TEST.

The supplier shall certify the ballast delivered to the Railroad is typical of that upon which specified tests have been made.

Samples shall be secured in accordance with the current ASTM methods of sampling. Designation D-75.

Sieve analysis shall be made in accordance with current ASTM method of test. Designation C-136.

Material finer than the No. 200 sieve shall be determined in accordance with the current ASTM of test. Designation C-117.

The percentage of soft particles shall be determined in accordance with the ASTM method of test. Designation C-235.

The percentage of clay lumps shall be determined in accordance with the current ASTM method of test. Designation C-142.

The resistance to abrasion shall be determined in accordance with the current ASTM method of test. Designation C-131, or C-535, using the standard grading most nearly representative of the size of ballast specified.

Soundness test shall be made in accordance with the current ASTM method of test. Designation C-88.

The weight per cubic foot shall be determined in accordance with the current ASTM method of test. Designation C-29.



**NORFOLK
SOUTHERN**

Norfolk Southern Corporation
99 Spring Street, S.W.
Atlanta, Georgia 30303
404 529-1470

R. F. Cothran
Assistant Vice President
Maintenance of Way & Structures

January 30, 1995

Dr. Jerry G. Rose, P.E.
Department of Civil Engineering
261 CE/Trans Building
Lexington, Kentucky 40506-0281

Dear Dr. Rose:

In response to your letter of January 17, 1995 to J. R. Zimmerman the following information is provided for use in the study on ballast addressed by Kentucky House Resolution 58.

Norfolk Southern Corporation - Maintenance of Way and Structures - Standard Procedure 020 entitled Ballast: Use, Unloading and Reporting is used system wide as a standard procedure for ballast. This standard procedure would apply to Norfolk Southern tracks in Kentucky.

Norfolk Southern Corporation Specification No. 702 - Prepared Stone Ballast dated March 6, 1990 is the current specification for ballast on Norfolk Southern.

I have included a copy of each of these above referenced documents for use, and request that a copy of the report be supplied to this office when the current study is complete.

Sincerely,

A handwritten signature in cursive script that reads 'R. F. Cothran'.

R. F. Cothran

Enclosures

Copy: Mr. P. R. Ogden
Mr. J. D. Bagley
Mr. D. A. Brown, II
Mr. R. L. Meadows, Jr.
Mr. J. R. Zimmerman

NORFOLK SOUTHERN CORPORATION MW&S STANDARD PROCEDURE	SUPERSEDED DATE 05-17-76 N&W # 45 11-01-83 SOU #020	NUMBER 020
	ISSUE DATE 11-30-87	
TITLE: BALLAST: USE, UNLOADING, AND REPORTING (7371T)	FILE NUMBER 106 106-136 160-26	Page 1 of 4

ALL PREVIOUS PROCEDURES AND INSTRUCTIONS IN CONFLICT HEREWITH ARE SUPERSEDED TO THE EXTENT OF THE CONFLICT UPON RECEIPT OF THIS PROCEDURE

SCOPE AND NATURE

To establish a uniform system for the use, unloading, and reporting use of ballast.

SPECIAL REFERENCES

MW&S Standard Procedure 390 - Maintaining Track Stability.
 Federal Railroad Administration Track Safety Standards, Subpart D, paragraph 213.103.

NS SPECIFICATIONS

Ballast used is to be approved by the Research and Tests Department.
 Ballast to be used is of two sizes.
 #3 modified - Commonly known as 2 inch ballast.
 AREA #5 - Commonly known as 3/4 inch ballast.
 #3 modified - 2 inch ballast is to be used on all tracks except yard tracks where AREA #5 - 3/4 inch ballast is to be used.

OUTLINE OF PROCEDURE

	Begins on Page		Begins on Page
1. GENERAL	1	2. UNLOADING	2
.01 Purpose of Ballast	1	3. REPORTING	3
.02 Ballast Section	1	.01 To Materials Engineer	3
.03 Ballast Depth	2	.02 AFE Reporting	4
.04 Subballast	2		

PROCEDURE

1. GENERAL.

.01 Purpose of Ballast.

Unless the track is otherwise structurally supported, an approved ballast section is used that transmits and distributes the track load to the subgrade. The ballast is to restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by rolling equipment and thermal stresses exerted by the rails. It is to provide adequate drainage and afford a means of maintaining proper cross level, surface, and alignment for the track under load.

.02 Ballast Sections.

a. Standard ballast section from end of tie to edge of slope is to be as follows:

	Jointed Rail	Welded Rail
Inside of Curve	0"	6"
Outside of Curve	6"	12"
Tangent	0"	6"

b. Sidings, yard tracks, and branch lines with welded rail must maintain the standards for welded rail ballast sections.

NORFOLK SOUTHERN CORPORATION
 MW&S
 STANDARD PROCEDURE

SUPERSEDED DATE

05-17-76 N&W # 45
 11-01-83 SOU #020

NUMBER

020

ISSUE DATE

11-30-87

FILE NUMBER

106
 106-136
 160-26

Page

2 of 4

TITLE:

BALLAST: USE, UNLOADING, AND REPORTING

(7371T)

ALL PREVIOUS PROCEDURES AND INSTRUCTIONS IN CONFLICT HEREWITH ARE SUPERSEDED TO THE EXTENT OF THE CONFLICT UPON RECEIPT OF THIS PROCEDURE

- c. Lean ballast sections must be filled in, especially before the summer months. Wherever lean ballast exists in welded rail or anywhere that insufficient ballast exists to provide a stable track, slow orders must be placed to protect the track.
- d. All tie cribs must be properly filled behind T&S, Surfacing, and Smoothing Gangs. Cribs must be filled before the gang leaves the area. In some instances it is necessary to unload ballast behind system gangs. However, the crib area must be completely filled by regulators at time track is surfaced or smoothed. When additional ballast is unloaded on the track outside of the rails, it will only be necessary to plow and sweep.
- .03 Minimum ballast depth under crossties is to be as follows:
 - a. Heavy tonnage main track 12"
 - b. Heavy tonnage other than main track 9"
 - c. Industrial track 6"
- .04 Subballast.
 No track is to be constructed without subballast. This includes industrial tracks.
- 2. UNLOADING.
 - .01 Whenever practical for T&S work, ballast is to be unloaded prior to crosstie unloading.
 - .02 Ballast unloading in advance of system gang work must not exceed the quantity as given by current instructions. Any use exceeding the current instructions will require approval of the chief engineer line maintenance.
 - .02 Ballast must not be unloaded on two parallel tracks at the same time which are to be timbered and surfaced. Ballast between tracks adversely affects tie installation by any method.
 - .03 When unloading ballast, the local communication supervisor must be notified so that communication equipment such as hot box detectors are protected.
 - .04 Ballast will not be unloaded more than 3" above top of rail for a distance of 14" from field side of rail and then the maximum height above top of rail will be 8" beyond 14" from rail. This must be checked after ballast is unloaded.
 - .05 Ballast must not be unloaded between the rails of main track and left. If it becomes necessary from derailments, hot weather, washouts, etc. to unload ballast between main line rails, it must be dressed out in a reasonable time.
 - .06 Unloaded ballast must be cleared from road crossings and any parts of switches which interfere with proper operation of the switch.
 - .07 All ballast cars must be completely unloaded before being released. Ballast left on one side of a car can cause a derailment situation. All ballast car doors must be closed and properly latched before the cars are released.
 - .08 Whenever it is necessary for employees to get inside hopper cars in order to unload ballast, it will be the responsibility of the MW&S supervisor to see that the locomotives are neither uncoupled from nor coupled to the cars until all employees are safely out of the cars and on the ground. When it becomes necessary for the locomotives to shake the cars being unloaded in order to break the ballast loose, movement will not be made until all employees inside the cars are out of the car and safely on the ground.
 - .09 When unloading a unit ballast train, the MW&S supervisor should require that a member of the train crew with a radio be on the ground during the unloading process in order to aid in communication with the engineer.
 - .10 When the ballast unloading process requires that the train operate across bridges without adequate walking room on both sides, one MW&S employee is to catch up on each side of the train in front of the unloading point prior to reaching the bridge. These employees are to be in place to resume the unloading on the other side of the bridge. In some locations, it may be required that the train be stopped for the employees to catch up. Where it is necessary to stop the train, the supervisor in charge of the unloading must handle the communications between the ground and the engineer.

NORFOLK SOUTHERN CORPORATION MW&S STANDARD PROCEDURE	SUPERSEDED DATE 05-17-76 N&W # 45 11-01-83 SOU #020	NUMBER 020
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ALL PREVIOUS PROCEDURES AND INSTRUCTIONS IN CONFLICT HEREWITH ARE SUPERSEDED TO THE EXTENT OF THE CONFLICT UPON RECEIPT OF THIS PROCEDURE

3. REPORTING.

.01 To Materials Engineer.

- a. For odd cars ballast unloading, a telephone report is to be made to the materials engineer as follows:
 - (1) Car numbers.
 - (2) Date unloaded.
 - (3) Milepost or other location designation.
 - (4) How used.
 - (5) If unloaded in a joint facility territory, the materials engineer must be provided the joint facility number and a NS Form 11123 must be promptly prepared by the field supervisor showing car numbers. If the serial number of NS Form 11123 that is used to report the ballast is known, it must be given to the materials engineer. NS Form 11123 must be promptly forwarded through channels. If for any reason, an invoice for ballast that was unloaded in a joint facility is sent to the field location, a copy should be attached to NS Form 11123.
- b. For unit ballast train unloading, a telephone report is to be made to the materials engineer as follows:
 - (1) Unloading beginning and ending times.
 - (2) Release time of empty train.
 - (3) Number of cars unloaded.
 - (4) Gang number for which train was unloaded.
 - (5) Milepost, to include prefix or suffix if applicable, where unloading started and ended.
 - (6) Condition of ballast.
 - (7) If unloaded in a joint facility territory, the materials engineer must be provided the joint facility number and a NS Form 11123 must be promptly prepared by the field supervisor showing how many cars of the unit ballast train thus used along with the unit train designation (Materials engineer can provide train designation).

If the serial number of NS Form 11123 that is used to report the ballast is known, it must be given to the materials engineer. NS Form 11123 must be promptly forwarded through channels. If for any reason, an invoice for ballast that was unloaded in a joint facility is sent to the field location, a copy should be attached to the NS Form 11123.

- c. Ballast unloaded behind production gangs, to fill in lean spots, must be so reported to the materials engineer so that it is properly charged.
- d. Non-Standard Ballast.
 - (1) Any ballast that does not appear to meet proper specification such as having excessive fines or is too large must be reported to the materials engineer.
 - (2) If the supervisor in charge of the ballast unloading determines that a sample should be taken, the sample should be at least 50 pounds and reflect the proportionate quantities of the various size stone. This sample should be submitted to the Research and Tests Department. The sample should be identified with the milepost unloaded, date unloaded, car number, quarry if known, person taking sample and purpose of sample.
- e. If a ballast car has any damage, missing parts or does not operate properly, the car should be billed to the nearest repair track by the person unloading the car. A report of the defective car is to be made to the materials engineer at the same time the unloading is reported giving the car number, the nature of the problem, and location of the repair track where sent.
- f. If a ballast train cannot be promptly unloaded due to weather conditions, the materials engineer must be promptly notified in order that disposition can be determined.

NORFOLK SOUTHERN CORPORATION MW&S STANDARD PROCEDURE	SUPERSEDED DATE 05-17-76 N&W # 45 11-01-83 SOU #020	NUMBER 020
	ISSUE DATE 11-30-87	
TITLE: BALLAST: USE, UNLOADING, AND REPORTING (7371T)	FILE NUMBER 106 106-136 160-26	Page 4 of 4

ALL PREVIOUS PROCEDURES AND INSTRUCTIONS IN CONFLICT HEREWITH ARE SUPERSEDED TO THE EXTENT OF THE CONFLICT UPON RECEIPT OF THIS PROCEDURE

.02 AFE Reporting.

- a. At the beginning of each year, by letter instruction, an AFE Number will be provided to which all program ballast is to be charged.
- b. Work Trains.
 - (1) Work train crews used for AFE ballast unloading must be advised of the AFE Number so they can show it on their time returns.
 - (2) If any ballast is unloaded in a Joint Facility territory a JOINT FACILITY WORK TRAIN REPORT must be promptly prepared and submitted.

c. Labor Distribution Sheet.

- (1) Whenever any AFE ballast is unloaded, labor used must be charged to the ballast AFE on the Labor Distribution Sheet.
 - (2) All labor used for the actual surfacing by System Gangs is to be reported on the Labor Distribution Sheet.
- FOR T&S GANGS ONLY: The labor directly involved with the surfacing operation (not the tie installation operation) is to be charged to the ballast AFE on the Labor Distribution Sheet.

APPROVED:



Assistant Vice President - Maintenance

NORFOLK SOUTHERN CORPORATION

SPECIFICATION NO. 702
PREPARED STONE BALLAST
(Granite and Limestone)

(Specification developed by the Research and Tests Laboratory,
Alexandria, Virginia)

1. Scope -

These specifications cover the requirement for grading and other significant physical properties of prepared stone ballast.

2. General Requirements -

Prepared ballast shall be crushed stone composed of hard and durable particles, free from objectionable amounts of deleterious substances and conforming to the requirements of this specification.

3. Quality Requirements -

(a) Clay lumps and friable material -

The percentage of clay lumps and friable particles when determined in accordance to ASTM Method of Test C-142 shall not exceed 0.5%.

(b) Material finer than No. 200 sieve -

Material finer than the No. 200 sieve when determined in accordance to ASTM Method of Test C-117 shall not exceed 0.5%.

(c) Sodium Sulfate Soundness -

Sodium sulfate soundness test when made in accordance to ASTM Method of Test Designation C-88 shall not, after 5 cycles, result in a weighted average loss in excess of 2.5%.

(d) Absorption -

Absorption when determined in accordance to ASTM Method of Test Designation C-127 shall not exceed 1.0%.

(e) Resistance to Degradation -

The resistance to degradation when determined in the Los Angeles Abrasion Test, ASTM Method of Test Designation C-535 (Type 2 Grading) shall not result in a percentage wear greater than 27.5% for granite and 25.0% for limestone.

(f) Flat and Elongated Particles -

The percentage of flat and/or elongated particles when determined in accordance with the U. S. Army Corps of Engineer's Test CRD-C-119 shall not exceed 5.0%.

(g) Rock Cementing Value (Limestone only) shall not exceed 200 psi (lbs. per square inch). The testing shall conform to the following procedure:

- (1) Take 350 grams of stone dust passing 100 mesh sieve. Dust is obtained by running approximately one (1) quart of pea size stone chips (retained on No. 4 sieve - pass 3/8" sieve) in standard Deval Abrasion machine for 10,000 revolutions, or 5 to 6 hours at 30 to 33 rpm with three (3) balls.

Place dust on glass surface, make a crater, add approximately 70 cc water, cover and allow to absorb for one (1) minute. Wearing rubber gloves, mix, roll, and knead for five (5) minutes to obtain a stiff dough. Adjust amount of water to obtain this. Place in air tight can for two (2) hours.

Mold 10 standard 1" diameter x 1" high cylinders. Weigh about 30 to 31 grams stiff dough (or sufficient to obtain cylinders 1" plus or minus 1/32" high) in balance. Place in mold and compress with 1475 lbs. (1877.5 psi), holding load constant for one (1) minute.

Air dry cylinders for 20 hours at room temperature, then for four (4) hours in hot air bath at 212°F. Place immediately in a desiccator for 20 minutes. Then test in a compression testing machine with a pivoted or ball socket head for uniform load distribution. Load is applied at 600 lbs. per minute.

Report average crushing strength in psi as cementing value of stone.

$$\text{Calculation: PSI} = \frac{\text{Load}}{0.7854}$$

4. Grading Requirements -

Gradation test shall be determined in accordance to ASTM Method of Test Designation C-136, utilizing square opening sieves conforming to ASTM Specification E-11. The percentage passing each sieve shall fall within the following limits for #3 (modified) and #5 ballast.

<u>Sieve Designation</u>	<u>Sieve Opening</u>	<u>#3 Ballast (Modified) % Passing Sieve</u>	<u>#5 Ballast % Passing Sieve</u>
2½"	2.5"	100	-
2"	2"	95-100	-
1½"	1.5"	30-65	100
1"	1.0"	0-15	90-100
¾"	0.75"	-	40-75
½"	0.5"	0-5	15-35
⅜"	0.375"	-	0-15
No. 4	0.187"	-	0-5
No. 200	0.0029	0.5 Max.	0.5 Max.

5. Handling -

Processed ballast shall be handled in a manner so as to assure a clean material.

Blending, stockpiling and other production and handling operations shall be managed by the producer to minimize segregation of the finished product. Stockpiling operations shall minimize as practical the breakage or excessive fall in stockpiling operations and the movement of wheeled or tracked machines over stockpiled materials shall be limited.

Processed ballast shall be washed and/or rescreened as necessary to remove fine particle contamination as defined by the specification, or as directed by the individual railway company prior to stockpiling in operations using stockpiles, or immediately prior to loading operations.

6. Loading -

The manufacturer shall arrange the required supply of rail cars, unless the purchase arrangement provides otherwise. The manufacturer shall assure the fitness of the cars for loading of the prepared materials, arranging to clean cars of deleterious materials, plug leaks and other like operations, as necessary.

7. Acceptance Testing Performed by the Vendor -

- (a) Sampling Procedure - One sample from every thousand tons of ballast shall be taken from the freight car loading belt taking a full cross-belt sample. This sampling frequency applies to both odd lot and unit train shipments. The purchaser reserves the right to specify increased sampling if necessary to accurately determine the quality of the product.
- (b) Analysis - A sieve analysis shall be performed on each sample while the freight cars are being loaded.
- (c) Report of Findings - A gradation report shall be prepared on each sample providing the following information: quarry identification, date and time, sample analysis, as required by the specification by weight passing 2½", 2", 1½", 1", ¾", ½", 3/8", or No. 4 sieve when applicable. The gradation specification shall appear on the form.
- (d) Submission of Test Results - Gradation reports shall be mailed for each train load of ballast directly from the quarry within 24 hours of train loading marked to the attention of Director, Research and Tests, Norfolk Southern Corporation, 407 South Henry Street, Alexandria, Virginia 22314, and Mr. J. R. Zimmerman, Norfolk Southern Corporation, 99 Spring Street, Atlanta, Georgia 30303.
- (e) Corrective Action in the Event of Sample Failure - In the event any individual sample fails to meet any gradation requirement, immediate corrective action shall be taken to restore the process to acceptable quality. The purchaser shall be advised in writing of the corrective action being taken. In the event of repeated failures, the purchaser retains the right to negotiate price reduction or cancel contract.

8. Inspection -

The railway company, or its representatives, reserve the right to visit the producer's facility during usual business hours unscheduled for the following purposes:

- (a) Observe sampling and testing procedures to assure compliance with the requirements of these specifications.
- (b) Obtain representative 100-lb. samples of the prepared material being produced and shipped.
- (c) Review plant inspection, methods, quality control procedures, equipment, and examine test results of current and previous tests.

The manufacturer shall provide the inspector with such assistance, materials, and laboratory testing equipment as necessary to perform production site gradation and percent passing No. 200 Mesh Sieve analysis. Performance of these tests at the time of an unscheduled inspection visit is the right, but not the duty, of the inspector.

9. Acceptance Testing Performed by Purchaser -

The purchaser reserves the right to perform all tests defined by the specification at a frequency to be defined by the purchaser, but in such a manner and frequency so as not to interfere with production levels at the quarry. In the event that a sample fails a test by the purchaser, the vendor shall be notified promptly of the unacceptability of the process, and the purchaser shall be advised in writing of the corrective action being taken.

**Illinois
Central**



Donald E. Gallery
Engineer-Track

Illinois Central Railroad
17641 South Ashland Avenue
Homewood, Illinois 60430-1345

708 206-3523
708 206 3084 Fax

Dr. Jerry G. Rose, P. E.
University of Kentucky
261 CE/Trans Building
Lexington, KY 40506-0281

Dear Dr. Rose;

Per your request dated 17 January 1995, enclosed please find our current specifications for track ballast.

You will note that as expected pedestrian traffic increases, the nominal size of the ballast decreases.

If I can be of further assistance, please advise.

ILLINOIS CENTRAL GULF RAILROAD COMPANY
 SPECIFICATION FOR DOLOMITIC LIMESTONE
 TRACK BALLAST FOR YARD TRACKS.

1. DESCRIPTION

This specification shall cover the physical and chemical properties of materials to be crushed as track ballast and the gradation of the prepared track ballast.

2. SUPERSEDEANCE

This specification supersedes all previous specifications of track ballast of crushed dolomitic limestone rock for main track use.

3. MATERIAL

In general, material to be crushed as track ballast shall be a crystalline carbonateous rock displaying well interlocked and/or cemented crystals being primarily calcite and dolomite.

Chemical Properties:

Compound	Percent by Weight
CaCO ₃	48 ± 5
MgCO ₃	43 ± 5
SiO ₂	10 Maximum
Fe ₂ O ₃	2 Maximum
Al ₂ O ₃	4 Maximum

Physical Properties:

Property	ASTM DESIGNATION	Limits
Unit Weight	C 29	85 Lbs. per Cu. Ft. Minimum
Specific Gravity	C127 (Saturated Surface Dry Basis)Property	2.60 Minimum
Absorption		2 Percent Maximum
Wear	C 131	40 Per Cent Loss Maximum
Soundness	C 88 (Sodium Sulfate Solution)	5 Cycle Loss 7 Per Cent
Soft and Friable	C 235-68	5 Per Cent Maximum
Clay Lumps	C 142	0.5 Per Cent Maximum
Material Passing No. 200 Sieve	C 117	1 Per Cent Maximum
Crushing Value	British Standards BS 812-1967	30 Per Cent Maximum

Flat or elongated particles, particles having a length equal to or exceeding five times their average thickness, shall not exceed 5%.

Particles shall be cubical in shape and display well defined angles.

4. GRADATION

The gradation for Yard Track ballast shall conform to the following:

Designation ICGRR Alternate		Percent Passing Sieve (by weight)						
		1-1/2"	1"	3/4"	1/2"	3/8"	#4	#8
SYL 5	Area 5	100	90-100	40-75	15-35	0-15	0-5	
SYL 6	Area 57	100	95-100		25-60		0-10	0-5

Sieve analysis shall be conducted in accordance with ASTM Designation C 136.

5. HANDLING AND LOADING

Prepared ballast shall be handled at the producing plant in such a manner that it is kept clean and free from segregation. It shall be washed prior to loading or being placed in stockpile. Ballast shall be loaded only into hopper-type rail cars which are in good order, tight enough to prevent leakage and waste of material, and which are clean and free from trash or other substances which would foul or damage the ballast. Loading procedures shall be designed to minimize segregation.

Unless otherwise specified, the supplier shall arrange the supply of hopper-type rail cars necessary to satisfy the demand.

6. INSPECTION

If material loaded, or being loaded, or arriving at the site for unloading, does not conform to these specifications, the Railroad shall notify the supplier to stop further loading until the fault has been corrected. All defective material shall be disposed of at no cost to the Railroad.

The Railroad shall have the right to inspect and sample, or cause the inspection and sampling by a reputable agency, the product and production of material under this specification at the plant site.

7. TESTING

The Supplier shall provide the Railroad with certified test results of the ballast gradation for every 3000 Tons of material furnished.

Tests of the physical and chemical properties shall be performed every 120 days and/or when use of a new area, face, or ledge is initiated.

Supplier shall promptly furnish Railroad a representative sample of the product, weighing not less than 100 pounds, nor more than 125 pounds, at such time as authorized representative requests and/or there is a change in area, face, or ledge used for production. The sample shall be F.O.B. Railroad transportation at the plant site. The Railroad shall arrange the testing deemed necessary at its sole cost. Reports of test results shall be furnished the supplier upon request.

8. MEASUREMENT AND PAYMENT

Track Ballast shall be measured per ton. The number of tons paid shall be the number of tons of acceptable material supplied.

The number of tons shall be determined by weighing of each car.

Payment shall be made at unit price bid per ton of track ballast, which price shall be full compensation for all labor, tools, equipment, materials, materials handled and transported, all local, state and federal taxes applicable and incidentals necessary to furnish acceptable material on board rail cars on the tracks of the Railroad.

9. PAY ITEM

The pay item shall be listed on the proposal as:

S Y L-5
or
S Y L-6



PADUCAH & LOUISVILLE RAILWAY, INC.

1500 Kentucky Avenue, Paducah, KY 42003-2893 (502) 444-4300

March 15, 1995

Dr. Jerry G. Rose, P.E.
Department of Civil Engineering
261 CE/Trans Building
Lexington, KY 40506-0281

Dear Dr. Rose;

In response to your inquiry concerning ballast sizes used by the P & L Railway, please be advised that we use crushed limestone from local quarries.

For mainline ballast MTL 2 (ASTM #3) is used. ASTM #3 has a nominal size of 2" - 1 1/2". In yard tracks, industry tracks and leads we use ASTM #57 (1 1/2" - 1").

If any additional information is required, please advise.

S.P. Walker
Manager Field Engineering
and Structures



APPENDIX

D

EXCERPTS

FROM

AMERICAN RAILWAY ENGINEERING ASSOCIATION

MANUAL FOR RAILWAY ENGINEERING

CHAPTER 1 - ROADWAY AND BALLAST

Part 2
Ballast¹

1991

FOREWORD

In the early days of the U.S. Railroad Industry, a variety of materials were used for track ballast to support the track superstructure. Almost any ballast material which could be procured on line at a low unit cost was used and considered satisfactory under the traffic loadings. As rail loadings and speed increased, track geometry deterioration became a problem for the industry.

Track geometric deviations and rail wear were recognized as major maintenance problems in the early teens. This resulted in the organization of a special joint committee sponsored by the A.R.E.A. and A.S.C.E. to study stress in the railroad track structure under the chairmanship of Professor A. N. Talbot. The committee immediately began their study of the track superstructure support, i.e., rails, cross ties, and fastenings. The study produced the "U" value as a measurement of vertical track stiffness as defined in the A.R.E.A. Bulletin, Volume 19, Number 205, March, 1918. The "U" value represents the stiffness of the track and involves conditions of the ties, ballast and roadway. Study of "U" values in the superstructure indicated that the influences of the track substructure (ballast and subballast) were significant. Thus the need for better ballast materials became more obvious.

Extensive ballast material tests were conducted by Rockwell Smith of the A.R.E.A. during the middle fifties and sixties. The test results indicated that the ballast was an integral part of the track substructure and that support in the roadbed section has a direct relationship to the quality of the ballast materials.

Today greater demands are placed on the track superstructure and substructure. Heavier wheel loads, higher operating speeds and unit train consists demand better total performance of the track system. The improvement of the performance of the substructure appears to be an economical approach to increasing the strength of the track system.

More emphasis must be placed on the quality and type of ballast materials used in the substructure. Improved geotechnical techniques and test methods together with a better understanding of soils have provided the opportunity for ongoing tests to evaluate the quality and support characteristics of ballast materials.

During the past twenty year period, extensive ballast material tests have been conducted by the railroad industry, the railway supply industry, universities and some governmental agencies. This includes the ballast and roadway tests at the A.A.R. FAST Track.

From the results of these multiple material tests and performance evaluations, improved information has been obtained on the desirable physical and chemical properties of ballast materials which will provide performance characteristics commensurate with current track loadings and cost effective maintenance requirements of the track substructure.

The following Ballast Specification is the first general revision of the A.R.E.A. Ballast Specification in over forty years. The Specification is the result of the aforementioned test data obtained in the laboratory, field testing, and the actual performance evaluation of various ballast materials in track.

The efforts to produce a definitive ballast performance specification are not complete. A laboratory test to simulate performance and evaluation of ballast materials in track has not been developed. However, ongoing current ballast tests dedicated to the correlation of laboratory tests to field performance indicate that we may be approaching our goal. The results of these testing programs could dictate further improvement of the Ballast Specification in the future.

BALLAST GRADATIONS

The gradation of a ballast material is a prime consideration for the in track performance of ballast materials. The gradation must provide the means to develop the compactive or density requirements for the ballast section and provide necessary void space to allow proper run off of ground water.

Ballast gradations should be graded uniformly from the top limit to the lower limit to provide proper density, uniform support, elasticity and to reduce deformation of the ballast section from repeated track loadings.

The A. R. E. A. mainline ballasts are graded in three sizes from 2 1/2" to 3/4", 2" to 1" and 1 1/2" to 3/4"; however, two additional gradations No. 25 and No. 4-A have been added to the specification to meet requirements of the railroads.

Rail yards and some industrial track gradations are generally graded from 1" to 3/8", (A. R. E. A. No. 5 gradation), to provide improved walkway and safety conditions along the track. The finer gradations for yard applications do not restrict track drainage as the construction practices for yard facilities provide quick run off of ground water through the means of under track and yard drainage systems.

A consideration in the selection of the proper ballast gradation is the selection of a ballast that will limit the amount of material removed from the track section during undercutting operations. Most undercutting operations remove all of the material below the 3/4" size. Limiting the amount of the 3/4" minus material in the original gradation will reduce the amount of ballast removed when undercutting operations are used to clean and restore the track ballast section.

The larger ballast gradations being used on the railroads today do not increase the cost of tamping. Mechanization has eliminated most of the necessity for manual labor in the roadway maintenance practices.

The type of ballast selected for use under concrete ties is a direct function of the track performance with the concrete tie. Extensive field tests of several designs of concrete ties have been installed on various types of ballast materials. The tests concluded that the loading characteristics of the concrete tie are quite different from the loadings imposed on wood ties on the same ballast cross section. Concrete ties which are heavier and less flexible to absorb impact loadings, transmit greater loads to the ballast section and thus create higher crushing loads on the individual ballast particles. Consequently, the selection of ballast materials for concrete ties must be very restrictive to provide satisfactory track performance. Ballast for concrete tie installations *must be limited* to either crushed granites, traprocks or quartzites.

A very important consideration is the selection of the proper gradation of the ballast material for concrete ties. The early concrete tie installations were placed on ballast materials graded to the A. R. E. A. No. 4 (1 1/2"-3/4"), resulting in good in track performance, although other ballast materials graded smaller than the A. R. E. A. No. 4 gradation did not provide satisfactory support and restraint qualities. Concrete ties placed on ballast gradations smaller than A. R. E. A. No. 4 resulted in suspect performance in the first phase of the concrete tie tests conducted at the A. A. R. FAST test facility.

Two examples of very good performance of the A. R. E. A. No. 4 gradation is the granite ballast used for the concrete tie roadway on the Florida East Coast and the granite ballast used in the concrete tie test installed by the Santa Fe several years ago near Streeter, Illinois.

Concrete ties placed on gradations conforming to A. R. E. A. No. 3(2"-1") and A. R. E. A. No. 24 (2 1/2"-3/4") have also exhibited good support qualities and performance characteristics during the second phase roadway tests at the FAST facility.

Likewise, ballast graded larger than the A. R. E. A. No. 24 gradation has performed well on the northeast corridor concrete tie installations.

2.4.4 Gradations

The following Table No. 2 outlines the recommended gradations to which the materials are to be processed for use as track and yard ballast. The grading of the processed ballast shall be determined with laboratory sieves having square openings conforming to ASTM specification E 11.

2.4.5 Ballast Materials for Concrete Tie Track Installation

The ballast materials as defined by this specification include the applicable test requirements for ballast materials for the purpose of providing support to the rail - cross tie arrangement of a concrete tie track system except that carbonate materials and slags as defined in Section No. 2.3.1 and gradation No. 57 as defined in Section 2.4.4 shall be excluded.

AMERICAN RAILWAY ENGINEERING ASSOCIATION

Table No. 2

Recommended Ballast Gradations

Size No.	Nominal Size Square Opening	PERCENT PASSING								No. 4	No. 8
		3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"		
24	2-1/2" - 3/4"	100	90-100		25-60		0-10	0-5			
25	2-1/2" - 3/8"	100	80-100	60-85	50-70	25-50		5-20	0-10	0-3	
3	2" - 1"		100	95-100	35-70	0-15		0-5			
4A	2" - 3/4"		100	90-100	60-90	10-35	0-10		0-3		
4	1-1/2" - 3/4"			100	90-100	20-55	0-15		0-5		
5	1" - 3/8"				100	90-100	40-75	15-35	0-15	0-5	
57	1" - No. 4				100	95-100		25-60		0-10	0-5

Note #1 - Gradation Numbers 24, 25, 3, 4-A and 4 are main line ballast materials.
 Gradation Numbers 5 and 57 are yard ballast materials.

APPENDIX

E

EXCERPTS

FROM

TENNESSEE CODE ANNOTATED AND TENNESSEE PUBLIC SERVICE COMMISSION
RULES AND REGULATIONS GOVERNING RAILROADS

OCTOBER 1989

TENNESSEE
CODE
ANNOTATED
AND
TENNESSEE
PUBLIC SERVICE
COMMISSION

Rules and Regulations
Governing Railroads

Keith Bissell
Steve Hewlett
Frank Cochran
Commissioners
Gordon C. Smith
Director, Transportation Division

dred percent is expected to pass a 1 inch screen, ninety-five to one hundred percent will pass the 3/4 inch screen, fifteen to twenty-five percent will pass the 1/2 inch screen and less than ten percent will be smaller than 3/8 inch.

(d) Is kept reasonably free of debris or other objects which pose a hazard to normal walking in the area.

(3) The safety or unsafety of any walkway in such areas which does not meet the standards specified in sub-section (2) above shall be determined by the Commission on a case by case basis under the procedures prescribed by law and the rules of the Commission.

(4) "The purpose of this rule is to establish standards of safety, which are to be construed not as a blanket order requiring all railroads in all circumstances to construct or reconstruct all walkways exactly in accordance with those standards, but rather as a statement of recommended practice. It is not intended to imply that other practices may not be considered safe under the circumstances of particular situations." (Effective January 1, 1970.)

Authority: T.C.A. 65-2-102. Administrative History. Original Rule certified May 9, 1974.

1220-3-1-.12 Specification of Safety Standards in Terminals, Yards and Along Rights-of-Way of Railways—Notice of New Trackage.—

1220-3-1-.11 Specification of Safety Standards in Terminals, Yards, and Along Rights-of-Way of Railways—Walkways.—

(1) In order to meet the requirements of Section 65-3-123, Tennessee Code Annotated, every commercial railroad shall maintain working areas in a safe condition in yards, terminals, within Switching Limits, and at other points where switching may be performed in the ordinary course of business.

(2) Any walkway in the area specified in sub-section (a) above shall be deemed to be safe if it:

(a) Is approximately level with the top of

the crossties for a distance of approximately 6 inches and thereafter slopes at no greater than 8 to 1 or approximately 7°;

(b) Extends for a distance of approximately ten feet from the center line of track on both sides, except where a lesser distance is otherwise provided for clearance under 65-6-201 through 65-6-208 Tennessee Code Annotated;

(c) Has a reasonably smooth surface. Stone or gravel surfacing next to main lines shall be such that one hundred percent will pass a 2 1/2 inch screen, ninety-five to one-hundred percent will pass a 2 inch screen, thirty-five to seventy percent will pass a 1 1/2 inch screen, fifteen percent or less will pass a 1 inch screen and zero to five percent will pass a 1/2 inch screen. Stone or gravel surfaces next to walkways adjacent to yard tracks, industrial tracks, team or piggy-back tracks shall be on the mixture commonly called 3/4 inch, or may be such that one hun-

(1) In order to meet the requirements of Section 65-3-123, Tennessee Code Annotated, every railroad subject to that Section shall maintain working areas in yards, terminals, within Switching Limits, and at other points where switching is performed in a safe condition.

(2) Any railroad, subject to the provisions of Section 65-3-123, Tennessee Code Annotated, constructing new trackage sidings or spur tracks shall notify the Commission prior to the commencement of any such construction, in order that the Commission may ascertain whether the same complies with the provisions of Section 65-3-123, TCA, and to enable the Commission to inspect and approve said construction prior to the institution of service thereon.

(3) Any railroad, subject to the provisions of Section 65-3-123, Tennessee Code Annotated, after having knowledge of an industry locating, relocating or expanding its present facilities and requiring new trackage or rail service by that railroad, shall notify the Commission within ten (10) days after such knowledge becomes a matter of public knowledge.

(4) Any railroad subject to the provision of Section 65-3-123, Tennessee Code Annotated, having knowledge of a private contractor installing new trackage or making repairs to present trackage to be served by that railroad shall notify the Commission within ten (10) days of such knowledge. (Effective February 1, 1970.)

Authority: T.C.A. 65-2-102. Administrative History. Original Rule certified May 9, 1974.

APPENDIX

F

DESCRIPTION OF THE FOURTEEN RAILROAD YARDS AND
TERMINALS INCLUDED IN THE STUDY

Railroad Company: P&L

Yard Destination: Oak Street

Date Visited: 4/11/95

Yard Location: Louisville

Accompanying Officials: Larry Griffin, Trainmaster

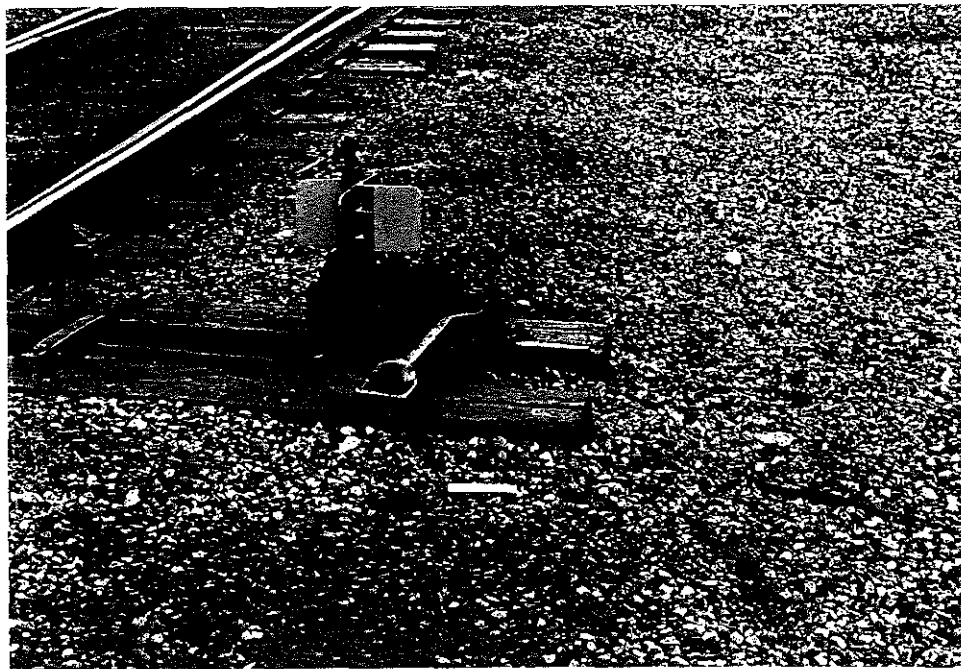
Type of Facility: Flat Switching Yard

Basic Description: This yard serves as the eastern terminus for P&L and also as an interchange with the Burlington Northern Railroad (BN). It is a former IC yard.

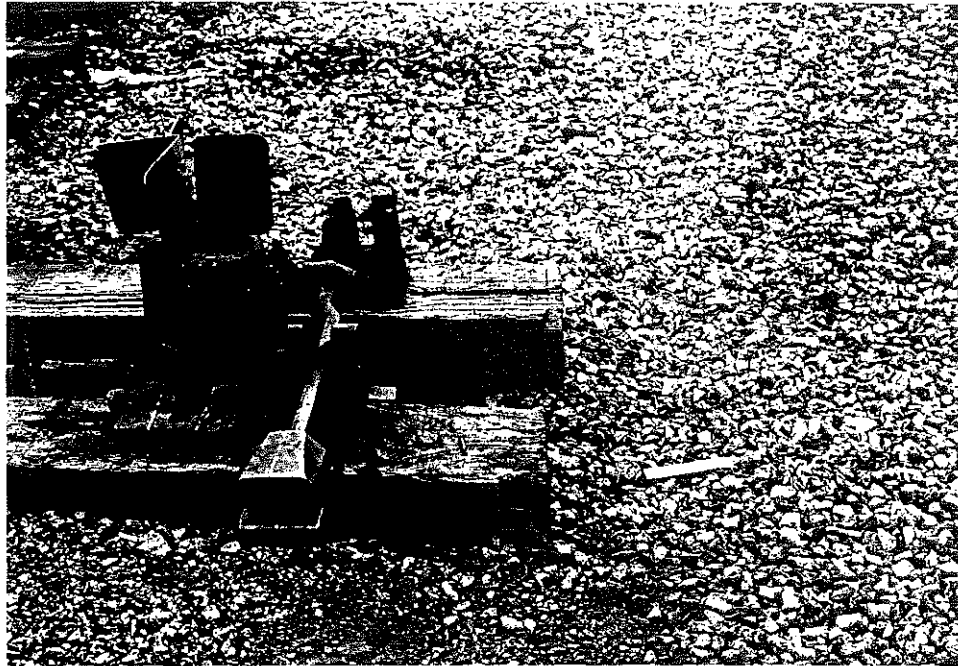
The ballast is primarily crushed limestone with varying amounts of coal and cinders at various locations. The ballast size seems to be similar to a 57 grading. The walkways are generally level with the top of ties. The yard receives light to moderate use.



Switch to Battlefield No. 3 Track



Switch to Battlefield No. 5 & 6 Tracks



BN Ramp No. 2 Track on the Texas Lead



Texas No. 2 Switch



Battlefield Yard between No. 3 & 4 Tracks

Railroad Company: NS

Yard Destination: Louisville Terminal

Date Visited: 4/11/95

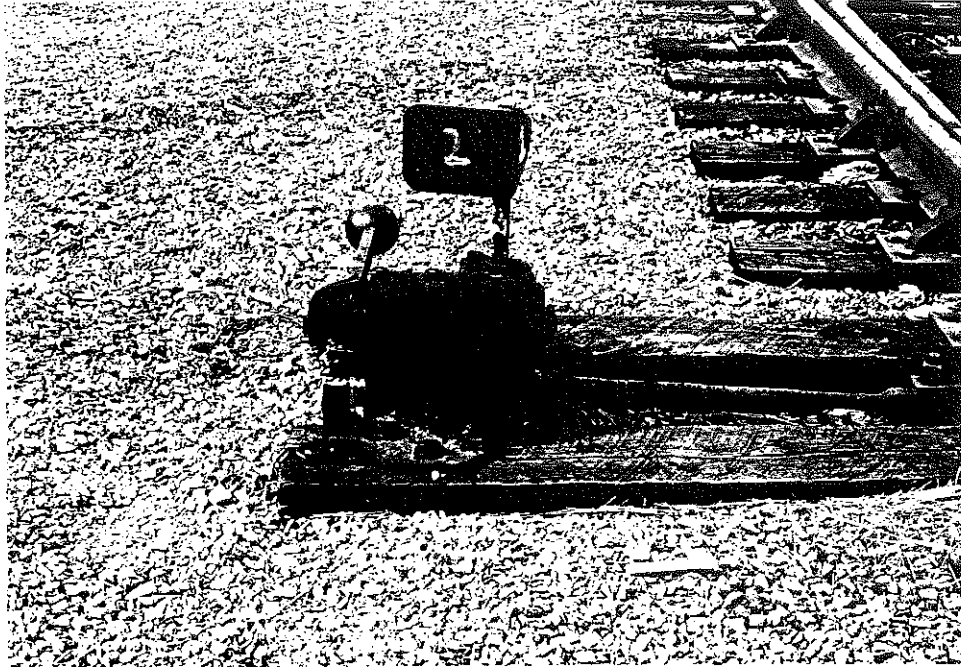
Yard Location: Louisville

Accompanying Officials: Jon B. Guess, Supt. Of Terminals

Bob Dwyer, Safety Com. Legislative Rep.

Type of Facility: Flat Switching Yard

Basic Description: The large yard also serves the Canadian Pacific (joint Soo and Milwaukee). It was formerly known as the Kentucky Indiana Terminal yard. The ballast is mainly granite and is essentially clean of contamination.



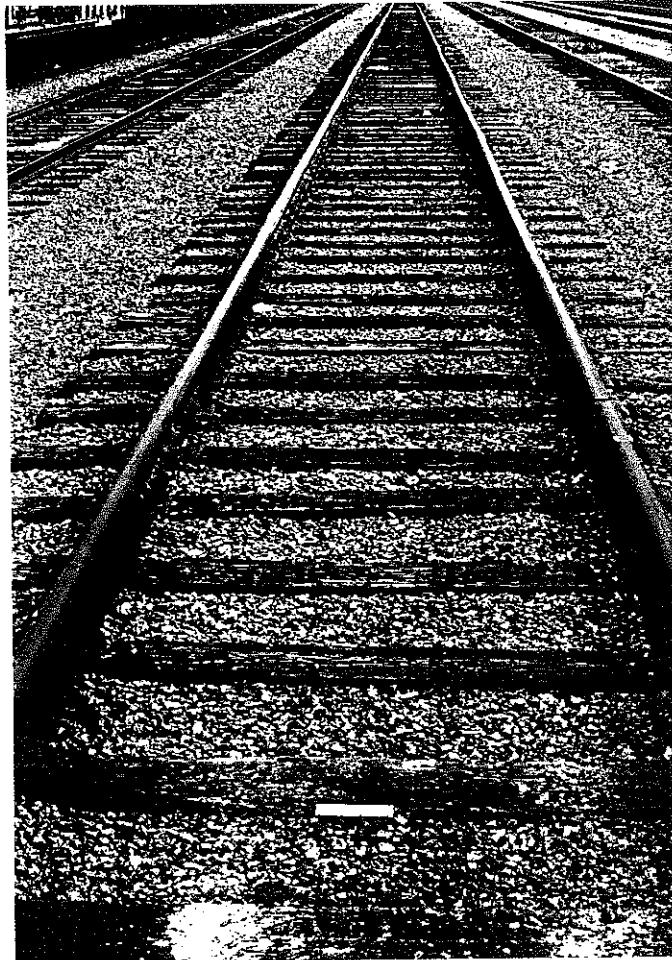
E Yard, No. 2 Switch



Switching Lead, E Yard



B Yard, No. 12 Track



F Yard, No. 5 Classification Track

Railroad Company: CSX

Yard Destination: Osborne

Date Visited: 4/11/95

Yard Location: Louisville

Accompanying Officials: Mike Lee, Division Engineer

Denny French, State Legislative Dir, M of W

Jesse Savage, Switch Maintainer

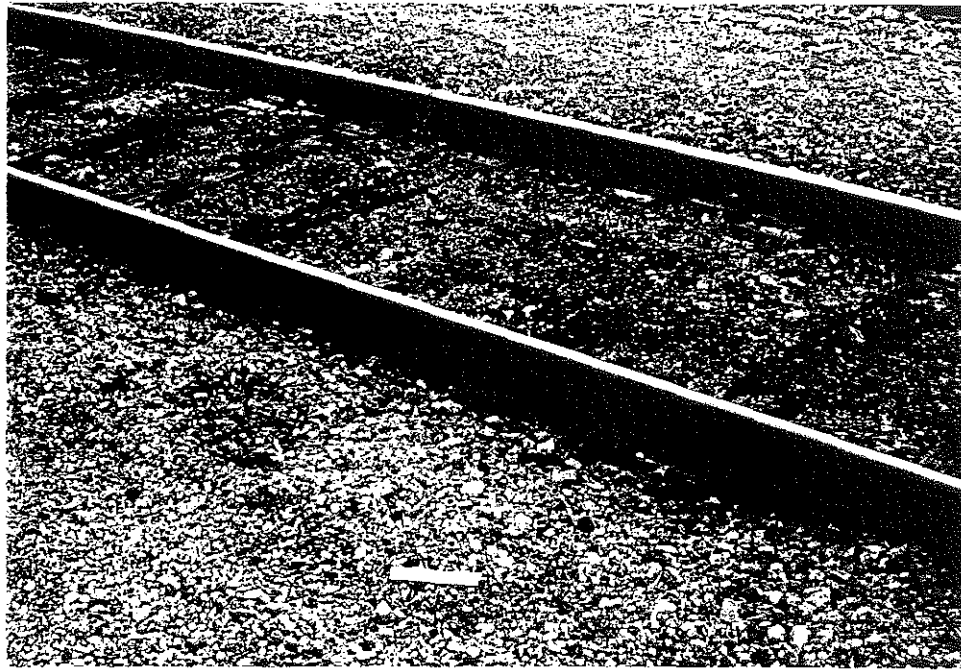
Type of Facility: Hump Switching Yard

Flat Switching Yard

Basic Description: This is a major yard on the CSX system and contains the only hump yard in Kentucky.

It serves as a classification yard for north-south and east-west traffic and has significant local traffic. A wide variety of ballast types and sizes exist here. At a few selected locations, where subgrade stability problems persist, larger size ballast than typically used in yards is evident. A specific area being the north end of Mapother Yard.

Ballast size is acceptable at most high foot traffic locations. The hump area is paved with asphalt.



North End of C Yard, Track 4



North End of C Yard, Ladder Track



North End of A Yard & N Yard



Ladder Track North End of N Yard



North End of Mapother Yard, Large Ballast



Close Up of North End of Mapother Yard, Large Ballast



South End of Mapother Ladder Track



Paved Hump Track



South End of Bowl



South End of Bowl

Railroad Company: NS

Yard Destination: Danville

Date Visited: 4/26/95

Yard Location: Danville

Accompanying Officials: Warren Jones, Terminal Trainmaster

Type of Facility: Flat Switching Yard

Basic Description: This is a major junction point for the NS system and a crew change point. Most of the traffic continues north and south. A portion of it is switched in blocks. A few local industries are served.

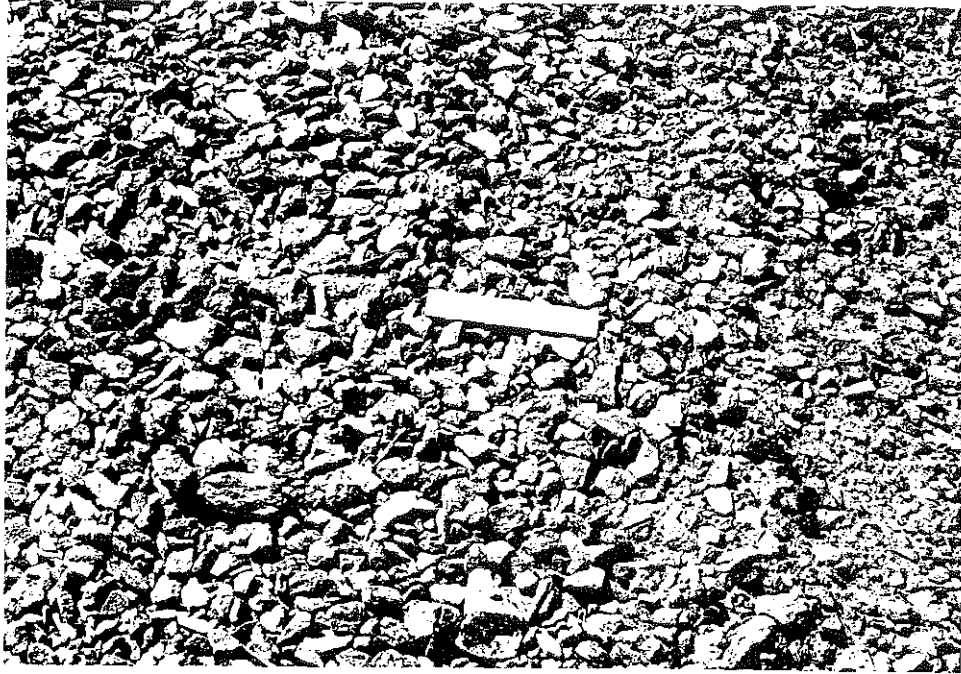
Most of the yard has been recently reworked. The granite ballast is essentially clean of contamination.



North End of East Yard Lead



Close Up of North End of East Yard Lead



Between East Yard Track 2 & 3



Between Southbound Main and West Yard #1 Track

Railroad Company: CSX

Yard Destination: Russell

Date Visited: 5/23/95

Yard Location: Russell

Accompanying Officials: J. M. Hinnant, Roadmaster

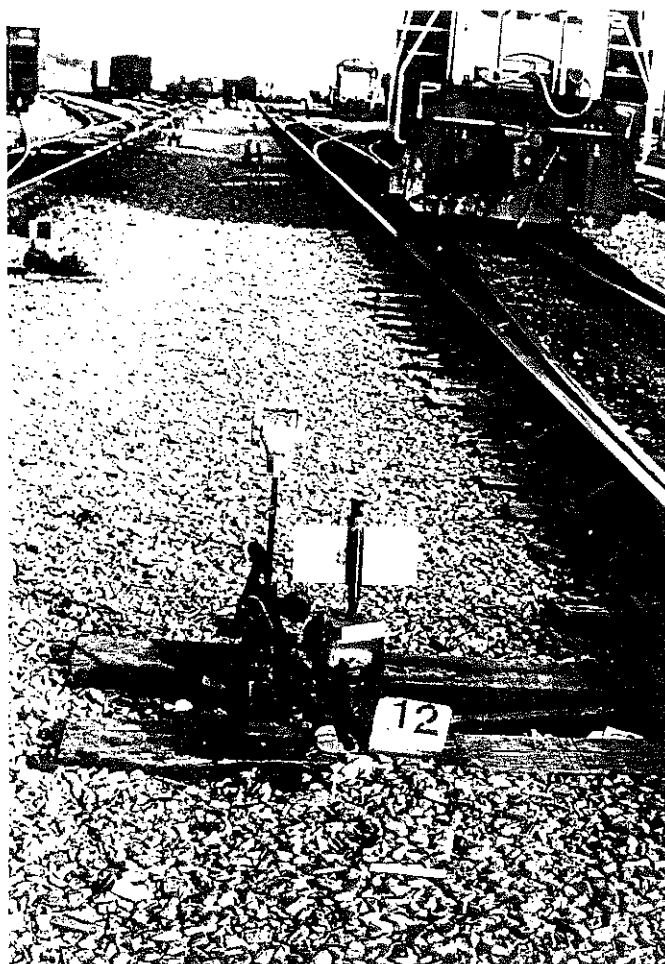
Type of Facility: Flat Switching Yard

Basic Description: This large facility serves as a marshaling yard and crew change point for CSX in northeastern Kentucky. Four mainlines converge here, east from Newport News/Washington, South from Elkhorn City, west from Cincinnati, and north from Columbus. Large manifest and coal yards, car shops and servicing facilities are included.

The ballast is primarily crushed granite and some Baker's stone. The size is acceptable.



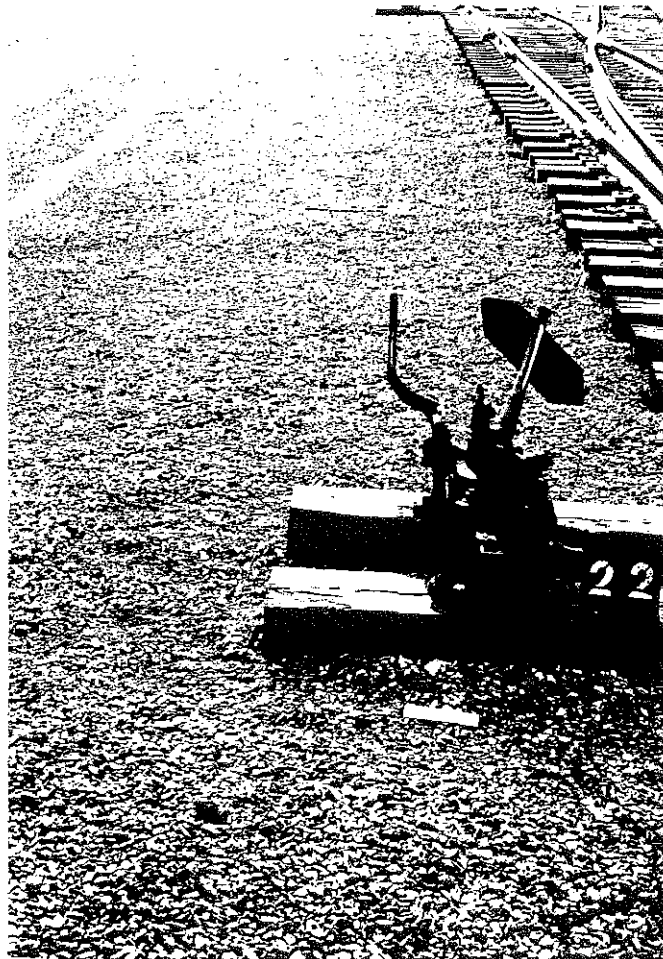
Sand Track for Locomotive, Baker Stone



No. 2 Lead, Eastbound Yard, Baker Stone High-Use Area



No. 2 Lead, West End of East Bound Yard



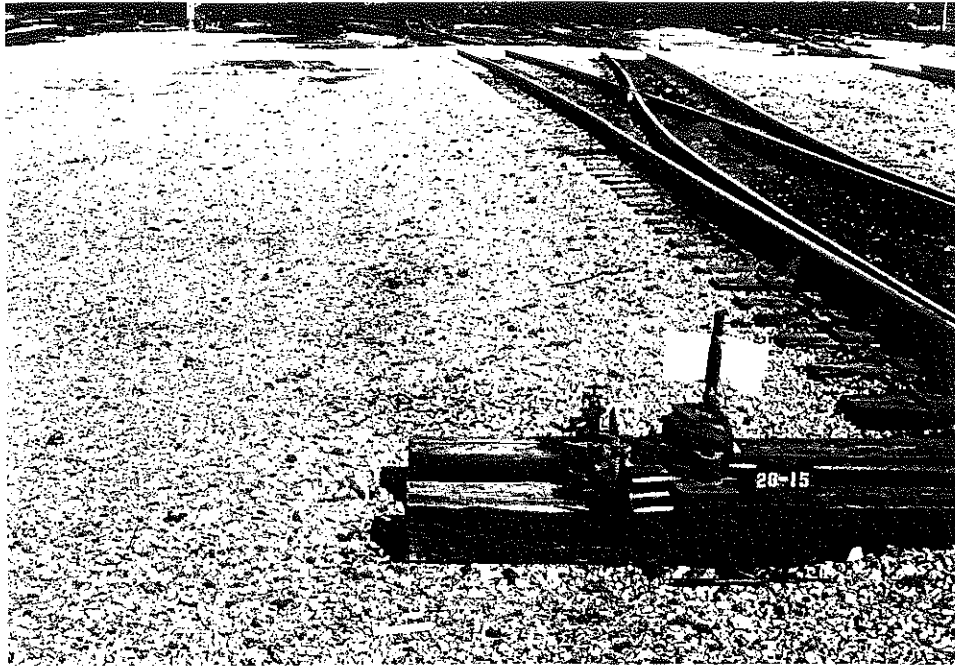
No. 3 Lead, West End of Manifest Yard



Car Shop, Throughfare Track



No. 3 Lead, West End of Coal Classification Yard



No. 2 Group Track, East End of Coal Classification Yard

Railroad Company: CSX

Yard Destination: Shelby

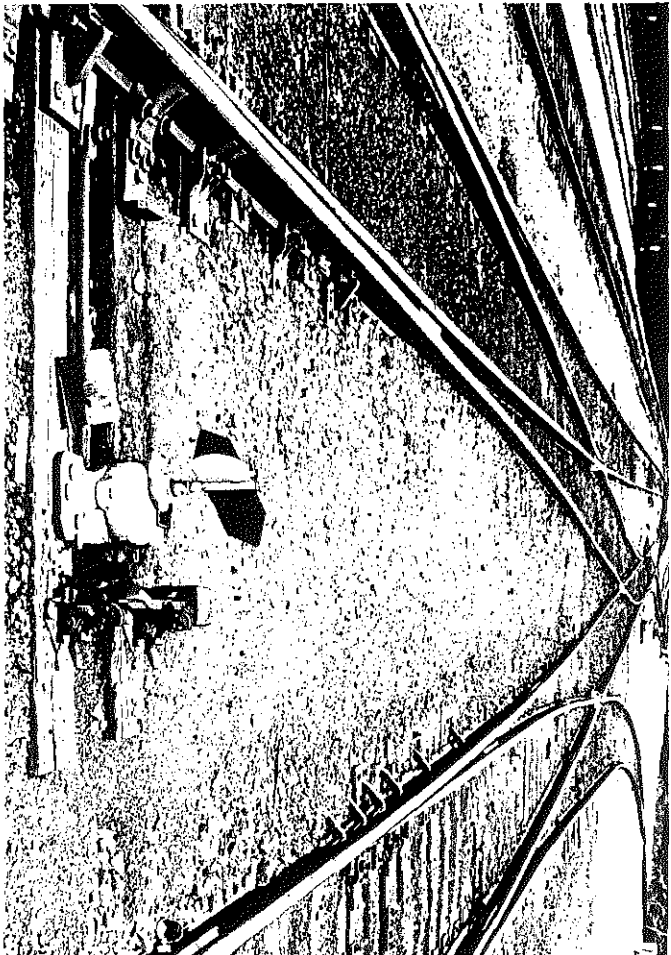
Date Visited: 5/23/95

Yard Location: Shelby

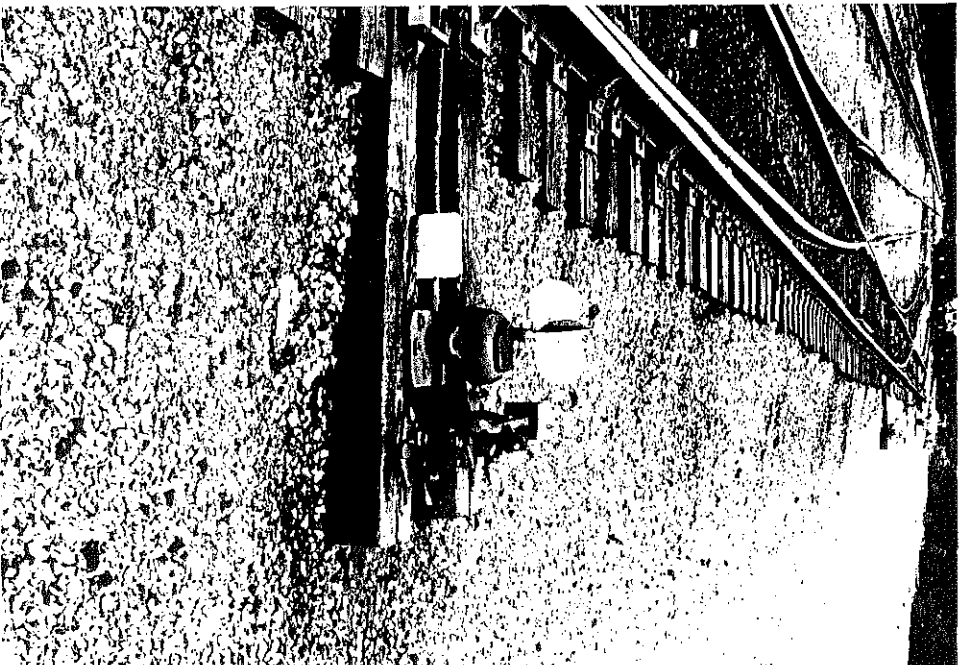
Accompanying Officials: S.W. Petree, Asst. Division Engineer

Type of Facility: Flat Switching Yard

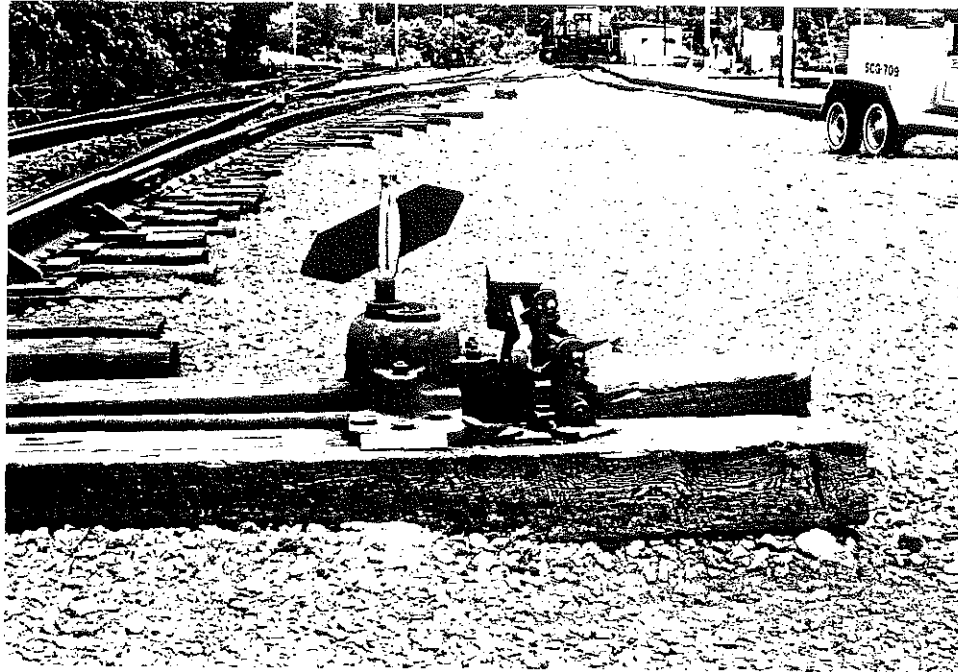
Basic Description: This facility mainly serves as a marshaling yard for coal mine runs in the area and a crew change terminal. It is a small yard. Most of the switching is on the west (or north) end of the yard. The ballast is a mixture of sizes and acceptable for foot traffic in the high use areas.



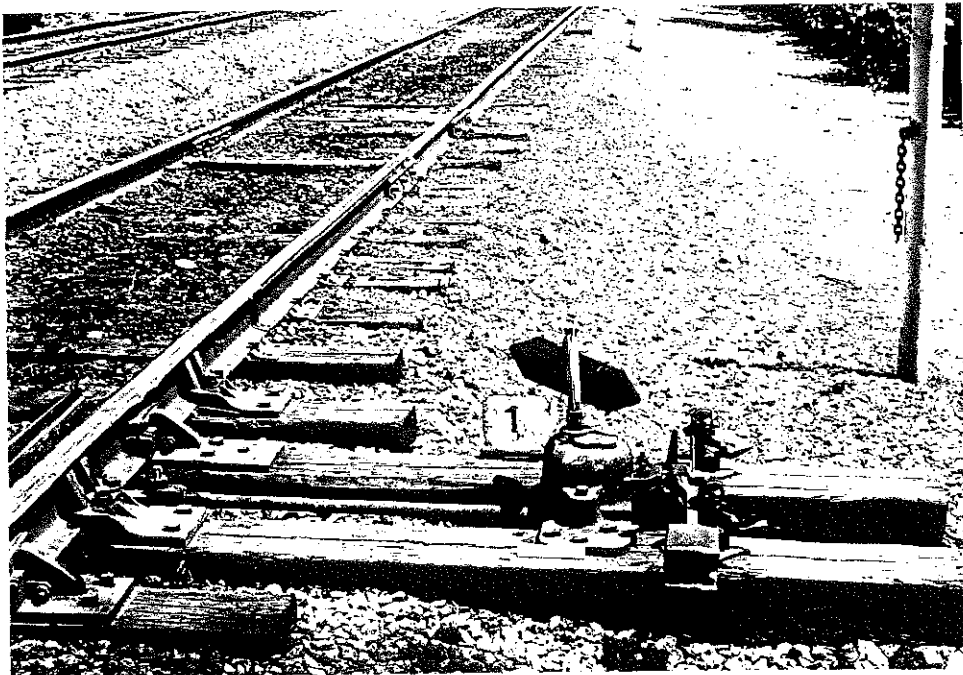
Cross Over From No. 6 to No. 7 Track, West End of Yard



No. 8 Track, West End of Yard



Locomotive Servicing Facility, Near West End of Yard



East End of No. 1 Connection to Throughfare

Railroad Company: CSX

Yard Destination: Hazard

Date Visited: 5/24/95

Yard Location: Hazard

Accompanying Officials: Carl Gross, Curve Oiler

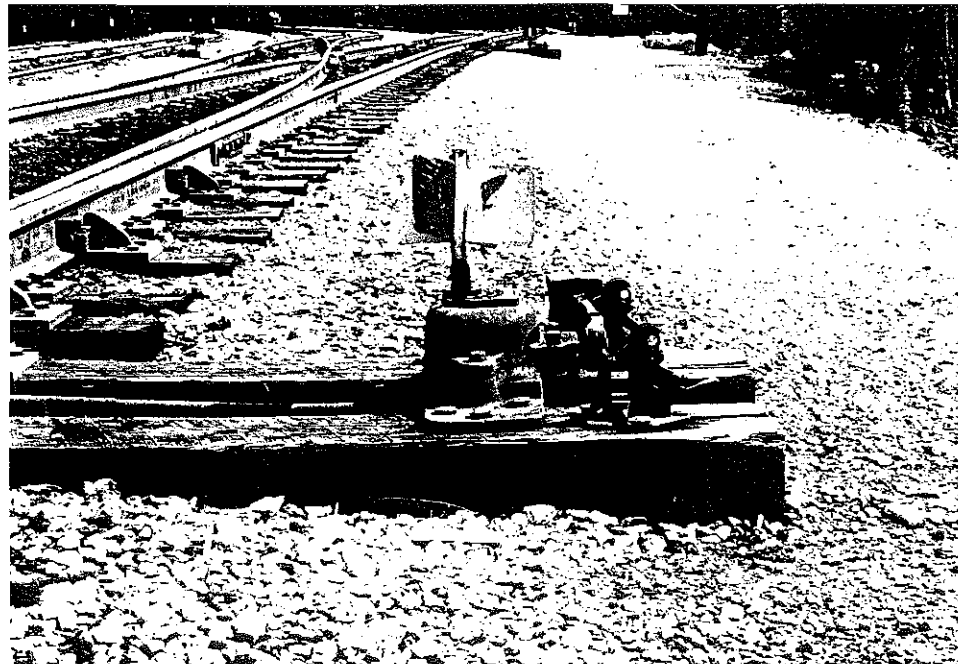
Type of Facility: Flat Switching Yard

Basic Description: This reasonably small facility mainly serves as a marshaling yard for coal mine runs in the area and a crew change terminal.

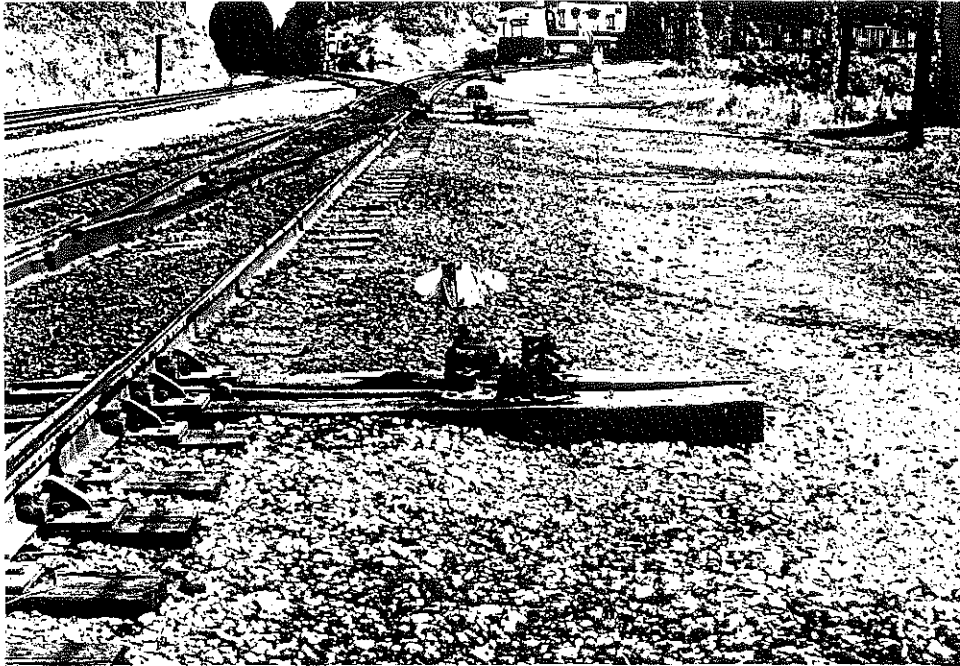
A variety of ballast types and sizes exist. The size is acceptable.



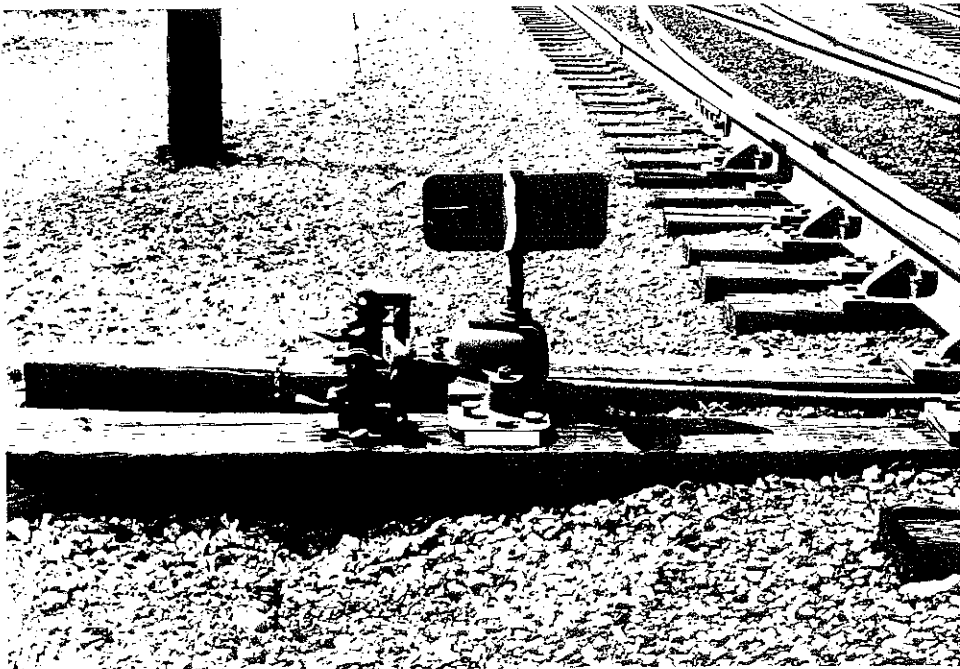
No. 2 Switch on South Ladder Track



No. 5 Switch on South Ladder Track



No. 3 Track to Ladder Track North End of Yard



No. 5 Track to Ladder Track North End of Yard



Overview of Hazard Yard

Railroad Company: CSX

Yard Destination: Atkinson

Date Visited: 5/30/95

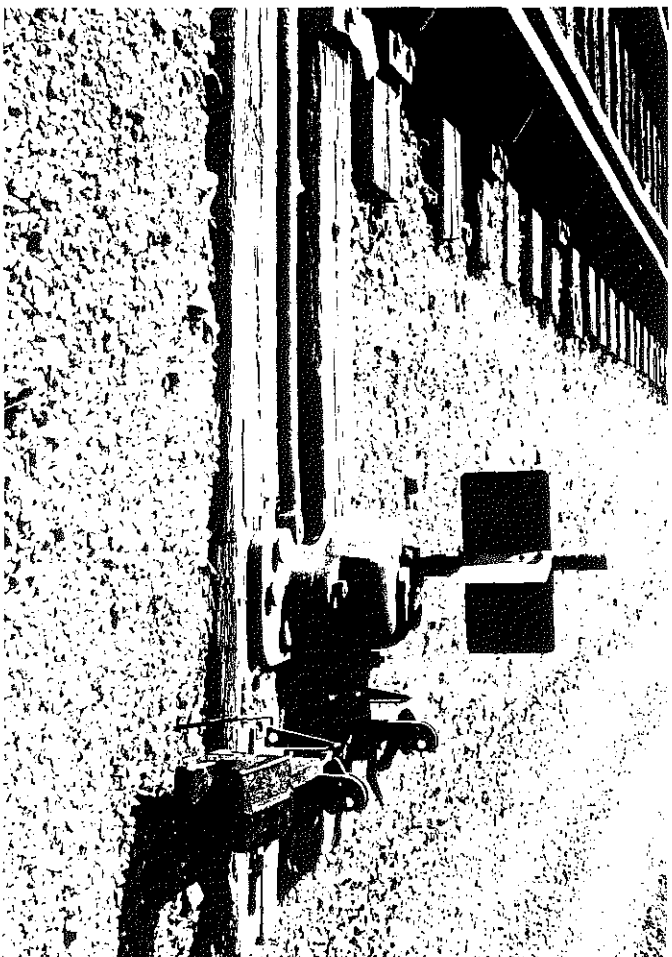
Yard Location: Madisonville

Accompanying Officials: R.P. Johnson, Roadmaster

Type of Facility: Flat Switching Yard

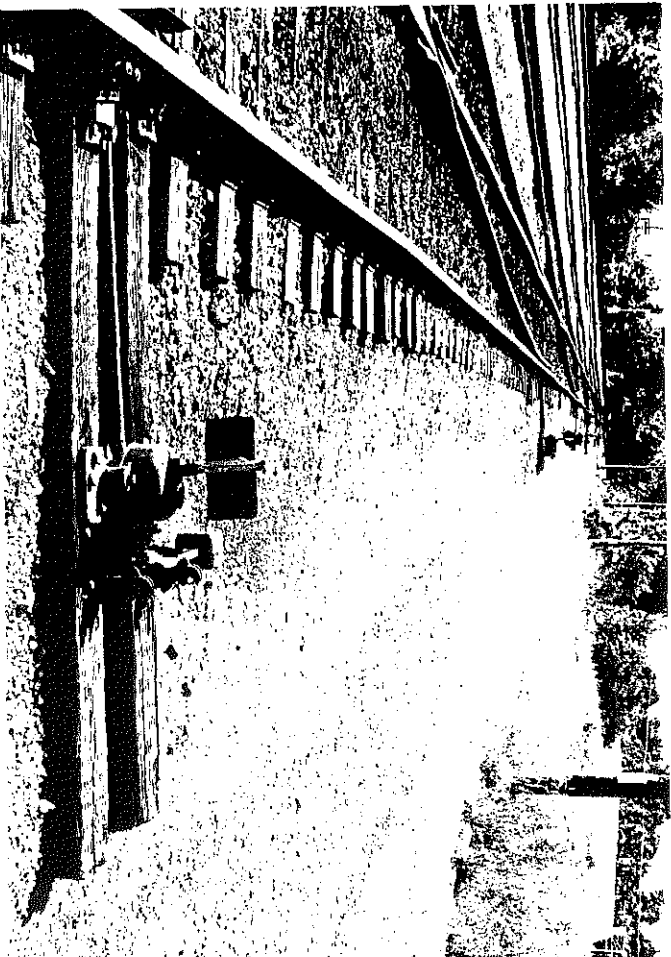
Basic Description: This medium size facility mainly serves as a marshaling yard for the west Kentucky coal fields. It provides interchange with the P&L Railway and is a crew change point. Most switching occurs in the north yard.

Limestone is the predominant yard ballast. No. 57 size is common, also No. 8 is used as a choke for mainline ballast.



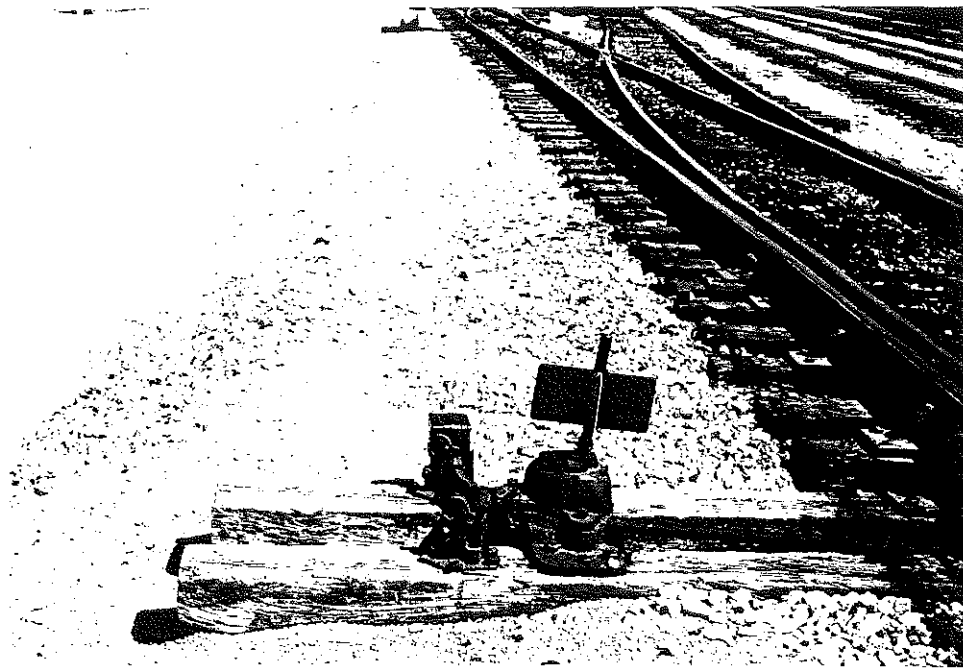
North End of Yard

No. 10 Track at West Side of Ladder Track



South End of South Yard

No. 8 Track at West Side Ladder



North Yard at South End
No. 5 Track at West Side Ladder



North Yard at South End Looking North

Railroad Company: P&L

Yard Destination: Princeton

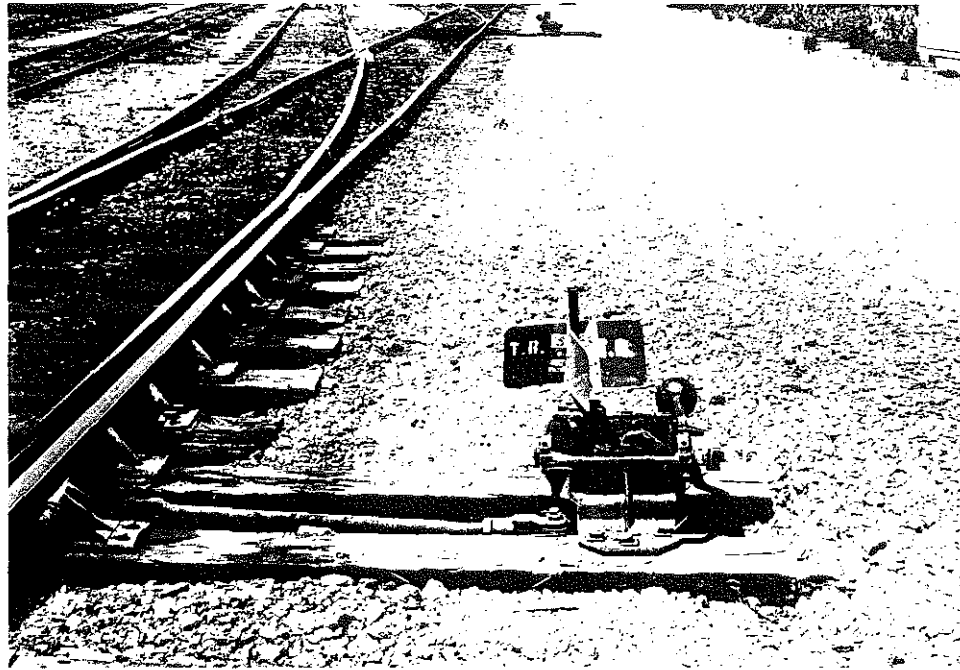
Date Visited: 5/30/95

Yard Location: Princeton

Accompanying Officials: None

Type of Facility: Flat Switching Yard

Basic Description: This small facility is a marshaling yard for the west Kentucky coal area. No. 57 limestone is the predominant ballast in the yard.



Ladder Track at North End of Yard, Looking Compass West



Ladder Track at North End of Yard, Looking Compass West



South End of Yard, Looking Compass East



Mainline Adjacent to Yard

Railroad Company: P&L

Yard Destination: Paducah

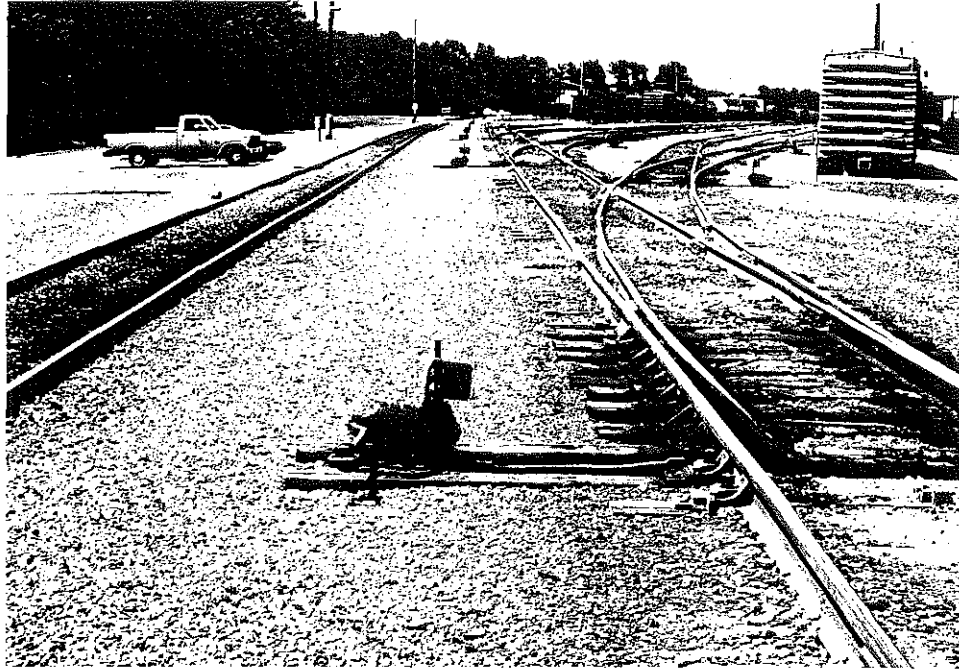
Date Visited: 5/30/95

Yard Location: Paducah

Accompanying Officials: Witt Sandefur, Engineering Supt.

Type of Facility: Flat Switching Yard

Basic Description: This is the primary yard for the P&L Railway. It is a former IC facility. Most all switching and car inspection is in the North Yard and is concentrated on the South Ladder track. Most ballast is No. 57 size limestone. Some mud is present, particularly on the heavily used switching leads.



North Yard, No. 10 Track at South Ladder Track



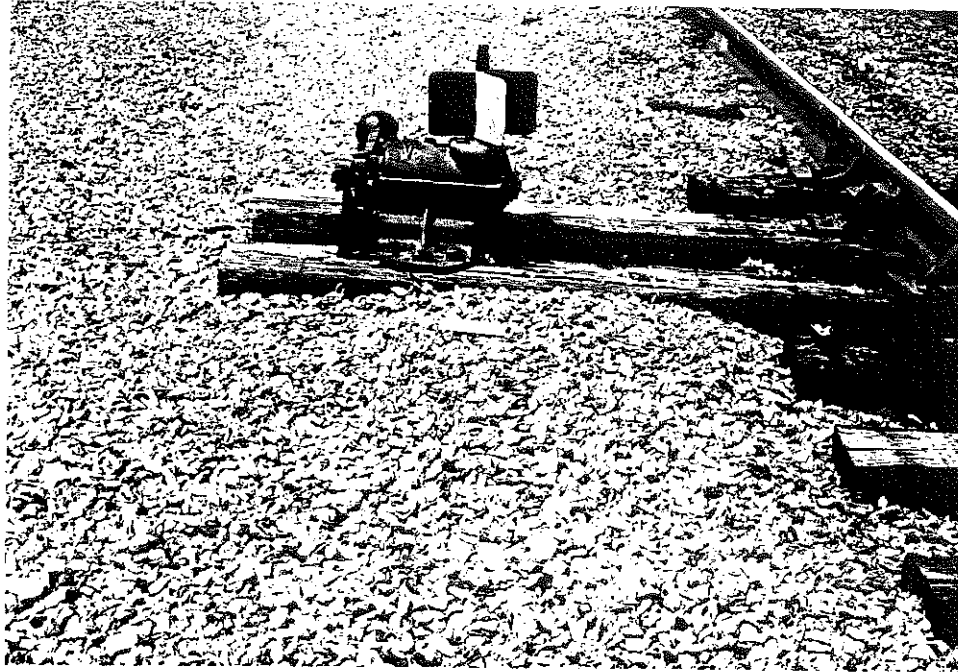
North Yard, No. 13 Track at South Ladder Track



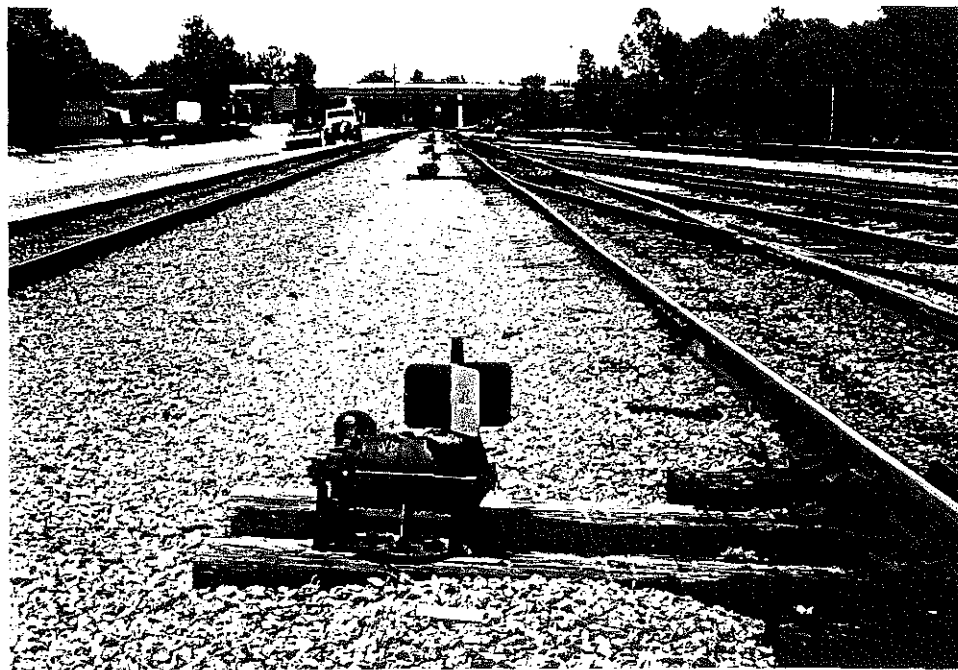
North Yard, No. 6 Track at South Ladder Track



South Yard, Looking South



North Yard, No. 13 Track and North End Ladder Track



North Yard, No. 13 Track and North End Ladder Track

Railroad Company: IC

Yard Destination: Fulton

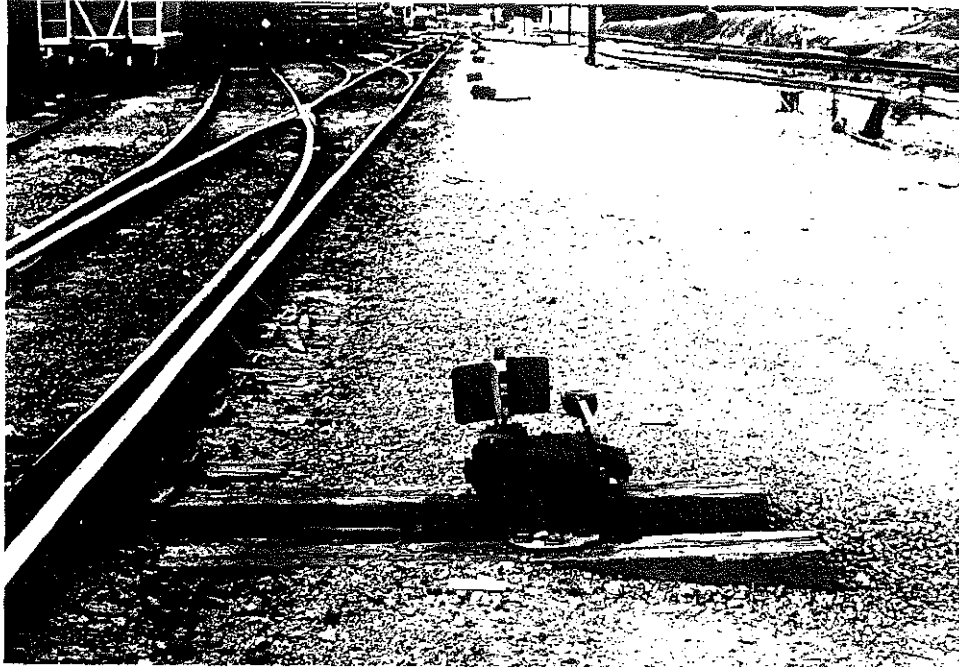
Date Visited: 5/31/95

Yard Location: Fulton

Accompanying Officials: Bobby Bowden, Maint. Of Way Foreman

Type of Facility: Flat Switching Yard

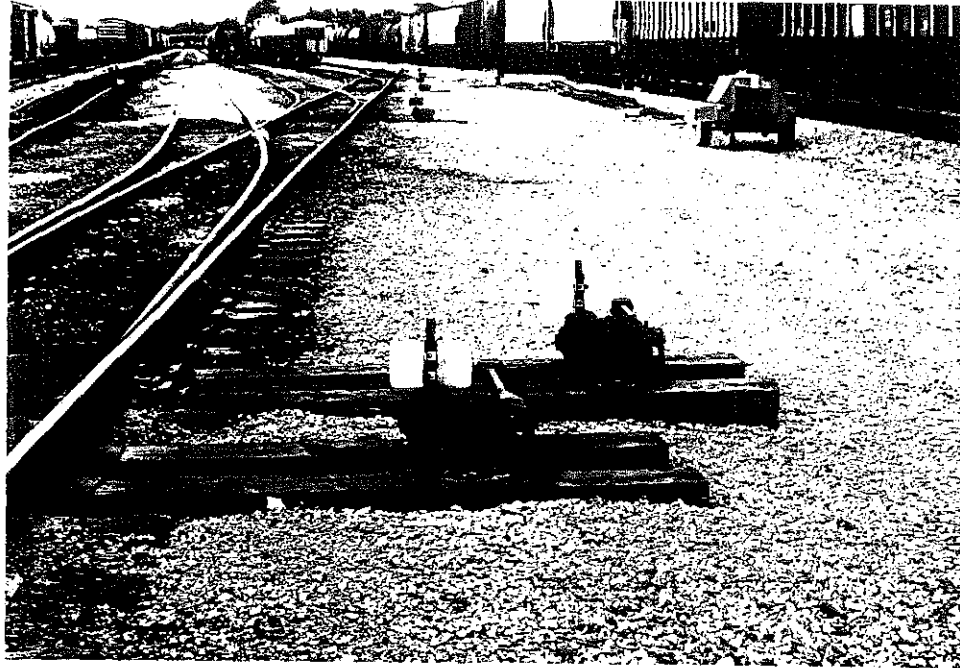
Basic Description: This is a fairly large yard and is located on the north-south mainline. Most all switching is on the north end of the yard. The ballast is mainly No. 57 limestone.



North End, No. 11 Track at Ladder Track



North End, No. 11 Track at Ladder Track



North End, No. 4 Track at Ladder Track



South End, No. 8 Track at Ladder Track

Railroad Company: CSX

Yard Destination: Corbin

Date Visited: 6/5/95

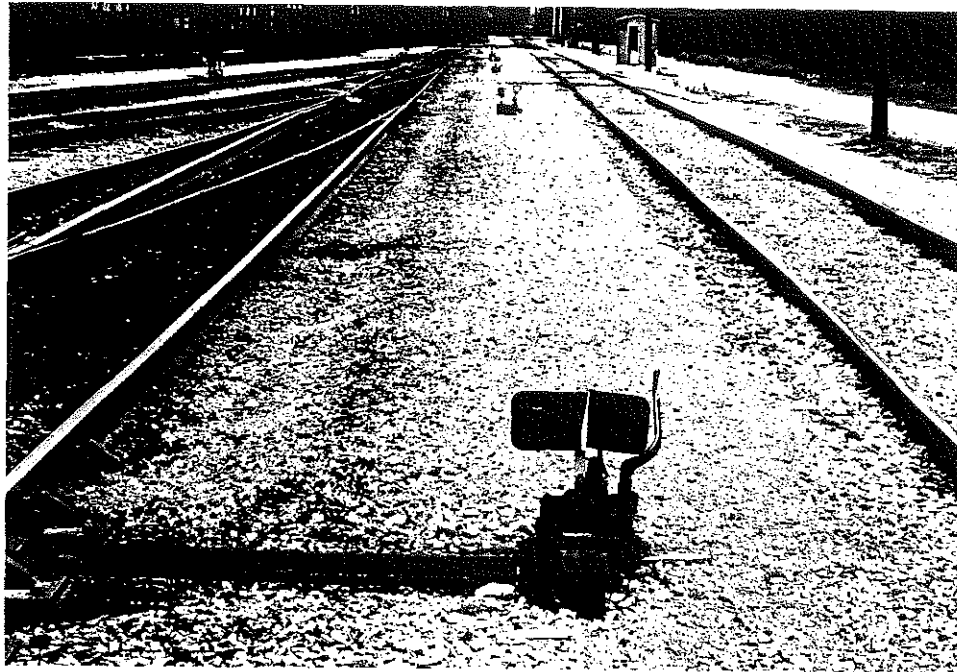
Yard Location: Corbin

Accompanying Officials: L. Don Reed, Roadmaster

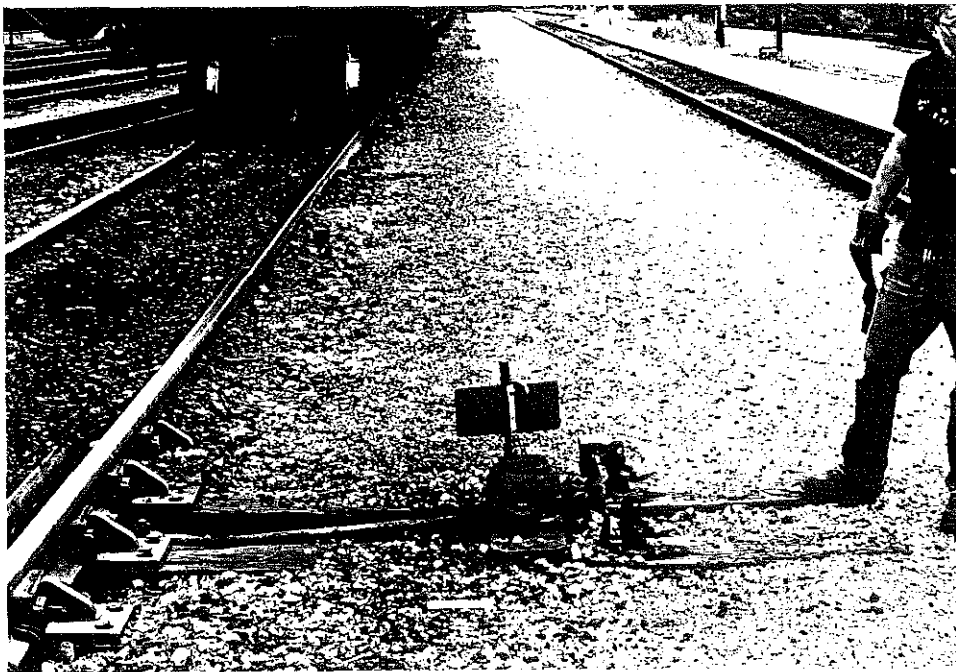
Type of Facility: Flat Switching Yard

Basic Description: This is a large yard at the junction of two mainlines. Considerable coal traffic is switched here. Most switching is conducted in the east yard where most of the ballast is a mixture of No. 57 limestone and smaller size choke rock. South end of east yard contains considerable coal, but is scheduled for cleaning very soon.

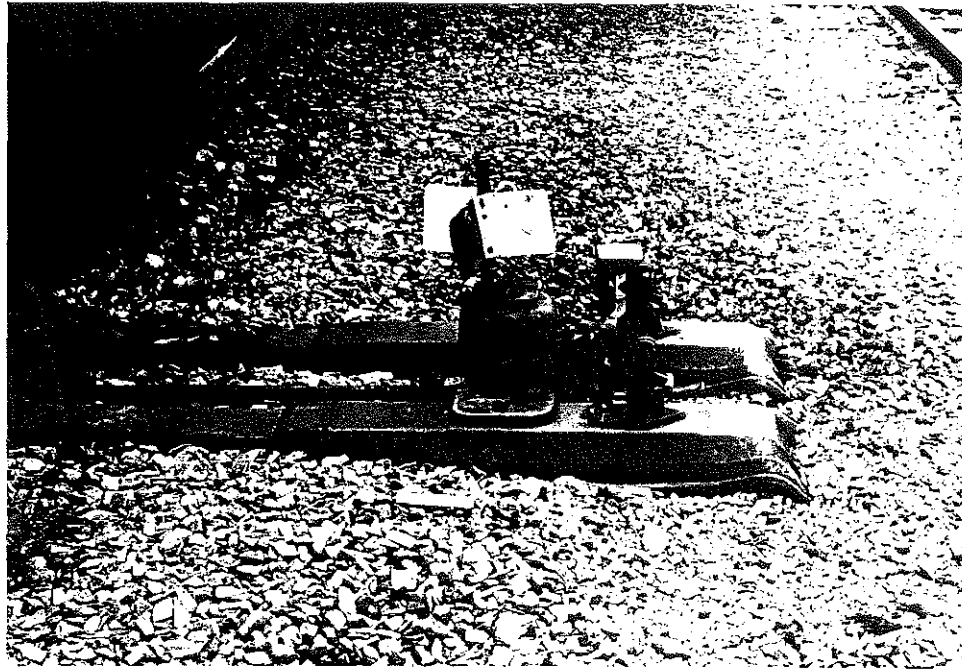
The west yard has several paved drive/walkways for mechanical department employees.



East Yard, No. 14 Track at North End Ladder Track



East Yard, No. 9 Track at North End of Ladder Track



East Yard, No. 3 Track Switch on Lead



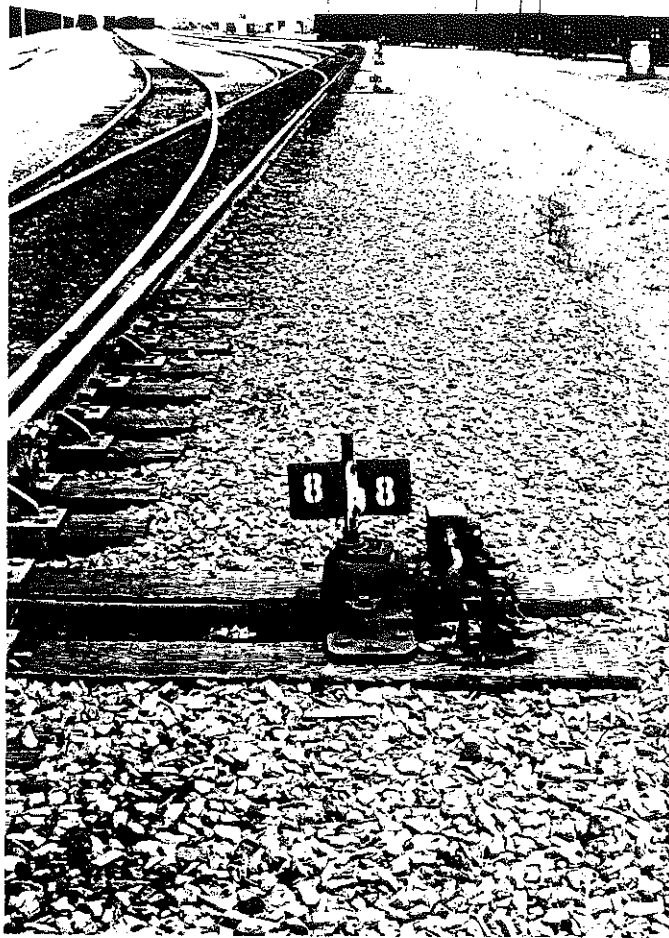
East Yard, South End of Front Lead Switches 1-7 Tracks



East Yard, Between No. 6 and No. 7 Tracks



East Yard, South End Between No. 11 & No. 12 Tracks



West Yard, No. 8 Track on Lead



West Yard, Between No. 4 and No. 5 Tracks Paved Walk/Driveways



West Yard, North End No. 3 Track at Lead

Railroad Company: CSX

Yard Destination: Loyall

Date Visited: 6/6/95

Yard Location: Loyall

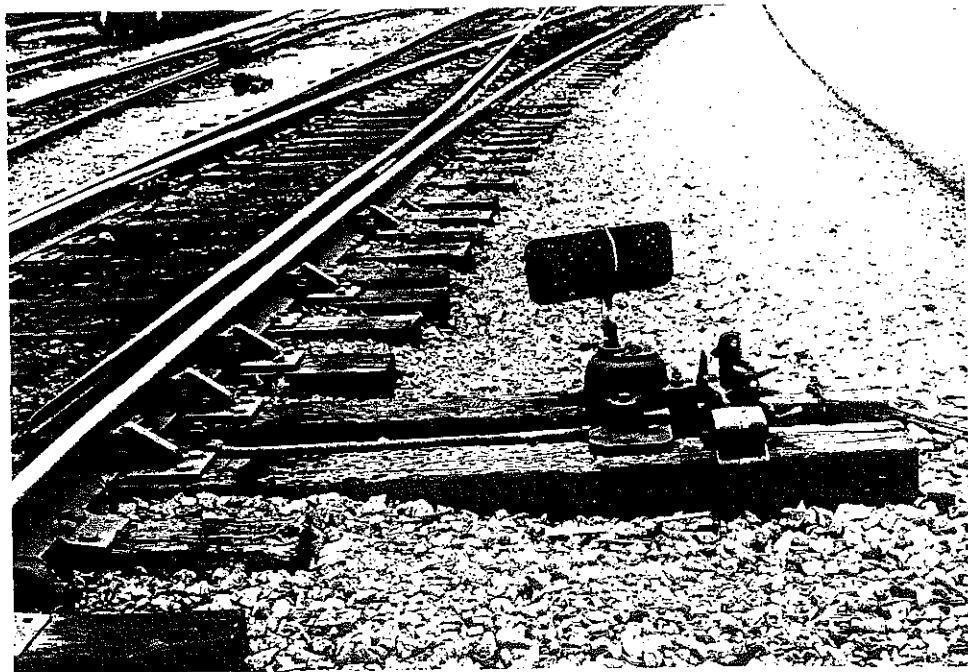
Accompanying Officials: J. David Stephens, Roadmaster

Type of Facility: Flat Switching Yard

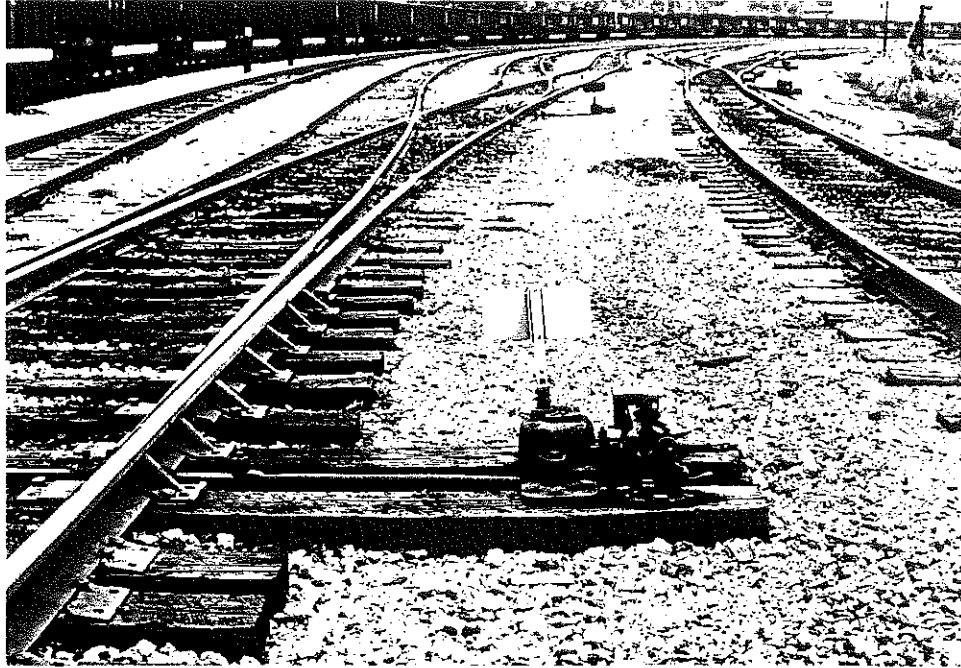
Basic Description: This small facility is a marshaling yard and junction point for several coal lines in the area. The ballast is mainly No. 57 limestone.



South End of Yard Looking North



South End of Yard Looking North



North End, No. 9 Track

Railroad Company: CSX

Yard Destination: Ravenna

Date Visited: 6/23/95

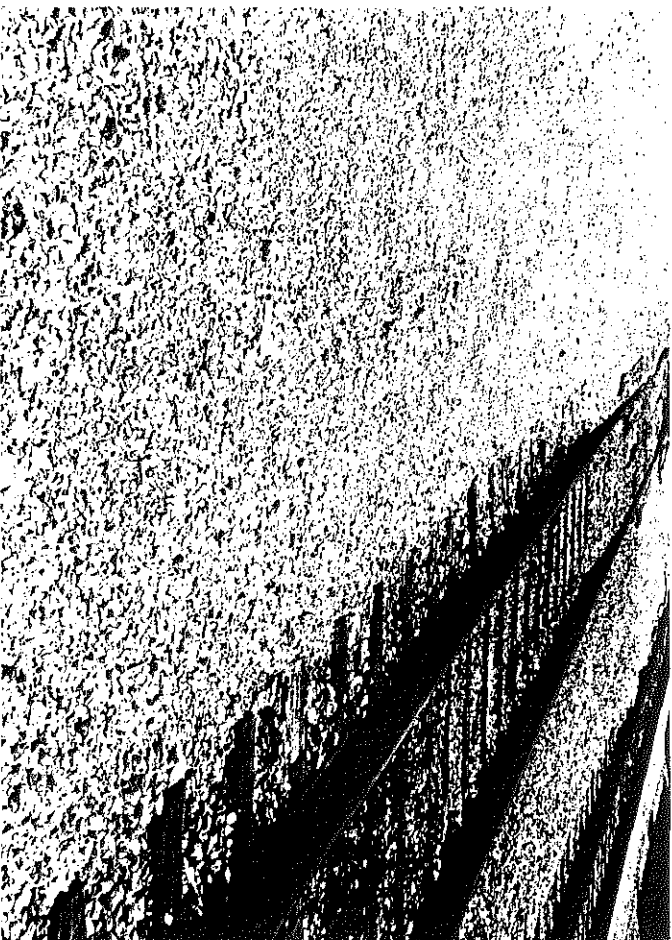
Yard Location: Ravenna

Accompanying Officials: Gary W. Chandler, Roadmaster

Roger McIntosh, Switchman

Type of Facility: Flat Switching Yard

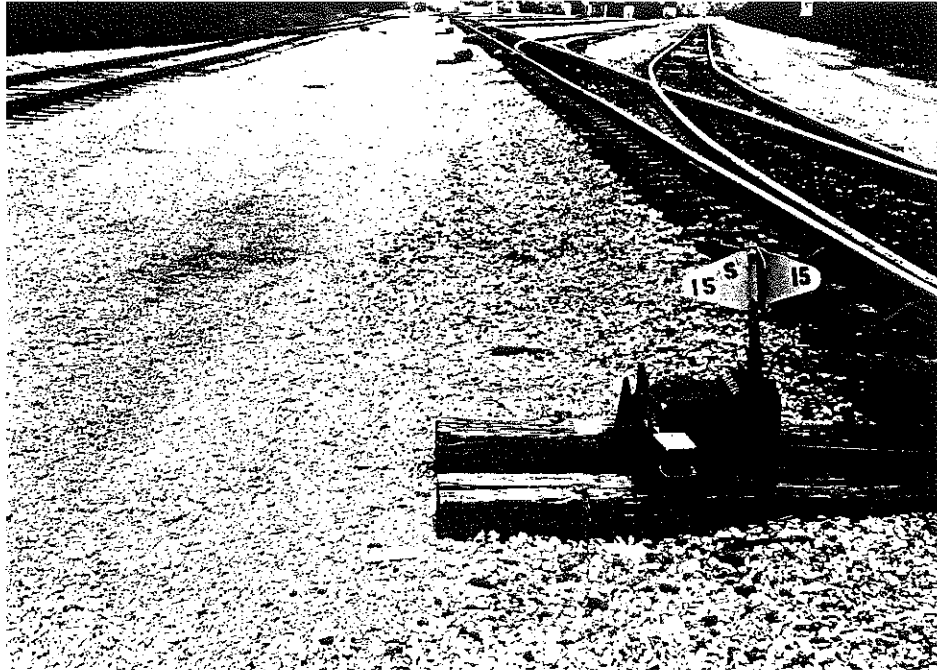
Basic Description: This medium size facility is a major crew change point and classification yard for east Kentucky coal. The ballast is mainly No. 57 limestone and No. 610 limestone used for choke for mainline granite ballast.



North End, No. 3 and No. 4 Tracks where Crews Detrain



South Ladder Track at No. 12 Track



South Ladder Track at No. 15 Track



South End, No. 1 and No. 2 Tracks Where Crews Detrain