

30 minute overview

of

HydInfra and Culvert Cost

MnDOT's version of
drainage asset management

29JUL16





HydInfra = Hydraulic Infrastructure

MnDOT's

Culvert and Storm Drainage System
Inventory and Inspection Program

(Culverts less than 10 foot span)

Big storm + bad pipe = wrecked road



We could have fixed it cheaper, sooner



Pipe with Holes causes Piping and Road Void

Road fill washes out at each
burst of rain

CMP Storm Drain at MnDOT Oakdale Office
in 2015



While some steep slopes are prone to failure
leaking pipes lubricate the slide



Photo by
MnDOT Oakdale
Surveys

Soil crack to left of pipe end indicates slope failure.
US Highway 8, April 2016

Void in Road – Evidence of a loss of soil from the road around or near the pipe or other feature.



D6 Jacked Pipe creates road void 27SEP2011 – Rob Coughlin

Typical Culvert Failure has a pavement patch

MN 95 2015 Eric Brenna



Water flows along the outside of pipe carrying road fill away.

Culvert Cost WIG on the Road to Drainage Asset Management

HydInfra Inspection Manual

Condition Rating Codes

- 1 - Excellent
- 2 - Good
- 3 - Fair
- 4 - Poor
- 5 - Very Poor
- 6 - Failed

Similar rating codes suggest repair costs.

HydInfra - MinDOT's Call Center Storm Drain Inventory System

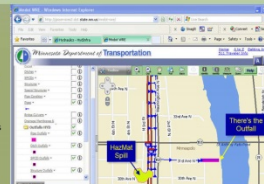
It all began with a need to improve the way MinDOT's Call Center Storm Drain Inventory System was used. HydInfra was built with GIS tools designed to help the Call Center staff query for drainage features, make a map, and export the map to a spreadsheet. HydInfra's simple condition rating code system, with an explicit criteria for different materials, and flags to record defects make it a versatile framework to build asset management on.

HazMat Spills Response Utility Locations and MS4 Water Quality

Metro WRE and Maintenance partner on MS4 water quality requirements.

Storm drain networking and "Geonilla" map service. Improve response times for hazardous spill capture.

Storm drain networks are also used for Gopher State One Call utility locations.



Recommended Inspection Frequency for Highway Pipes

Pipe Condition	Inspection Frequency	Notes
Class 1	1	Class 1 pipes require no inspection.
Class 2	2	Class 2 pipes require inspection under the road.
Class 3	3	Class 3 pipes require inspection.
Class 4	4	Class 4 pipes require inspection.
Class 5	5	Class 5 pipes require inspection.
Class 6	6	Class 6 pipes require inspection.

Goal is to inspect all Class 3 pipes in 2015. Many of these are storm drain pipes and require inspection under the road. There should be an effort to inspect each culvert in 2015.

Source: Target 30% of Highway Pipes need Recommended Inspection Frequency.

Drainage Performance Measure

In 2008, Maintenance Operations chose HydInfra to track their Drainage Performance Measure for Highway Culverts. The measure tracks the condition of all highway culverts and manholes. Since then, the inventory work has been completed and the data is now being used to track the performance of each culvert in the system.



Big Storm + bad pipes = wrecked road

Culvert inspectors record defects that may cause road failure during extreme rainfall events. Pipe defects include road void, piping, and holes.

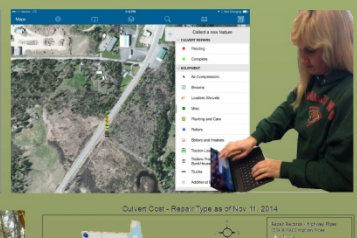
Project Scoping and Pre-design

GIS layers from many sources give context to drainage design work. DNR layers for Public Waters illustrate areas that need environmental permits. HydInfra layers with drainage feature data help speed scoping and pre-design tasks, especially in winter.

Culvert Cost

Culvert Repair Cost

Repair data is available immediately in web-based reports that repair crews can access from the repair site. Others in MinDOT can find Culvert Cost Reports by searching GHUB for "Culvert Cost".

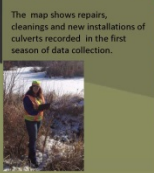
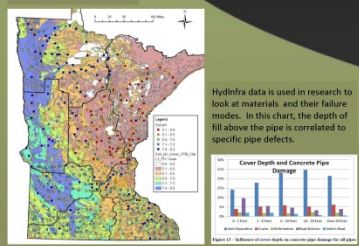


The Road Ahead to Drainage Lifecycle Cost Analysis

- Capture construction costs for drainage features from projects by contractors, along with as-built details about the drainage features.
- Get an Enterprise Asset Management software solution that includes GIS, to merge HydInfra and Culvert Cost databases and to integrate data from MinDOT's many other parts, like Pavement, Traffic and Maintenance Operations' many responsibilities.
- Inventory and inspect storm drain networks, ponds and other water quality devices and all those other features that are part of the drainage system.
- Research pipe materials to improve service life predictions.
- Project Lifecycle Performance to get the most bang for the buck.

Research on Pipes and Materials

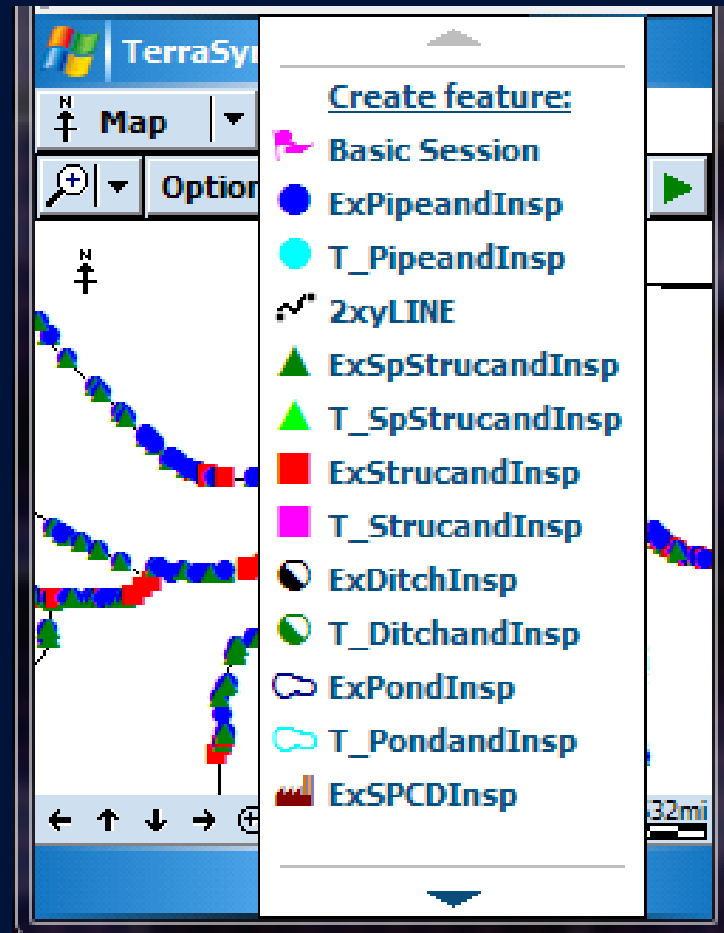
Research focusing on the projected lifespan of steel pipe is underway. The map below shows roadside pH overlaid on NRCS pH data. Acidity, or low pH, is a factor in steel pipe deterioration rates. The research is being done by Barbara Burkholder Heitkamp, U of M.



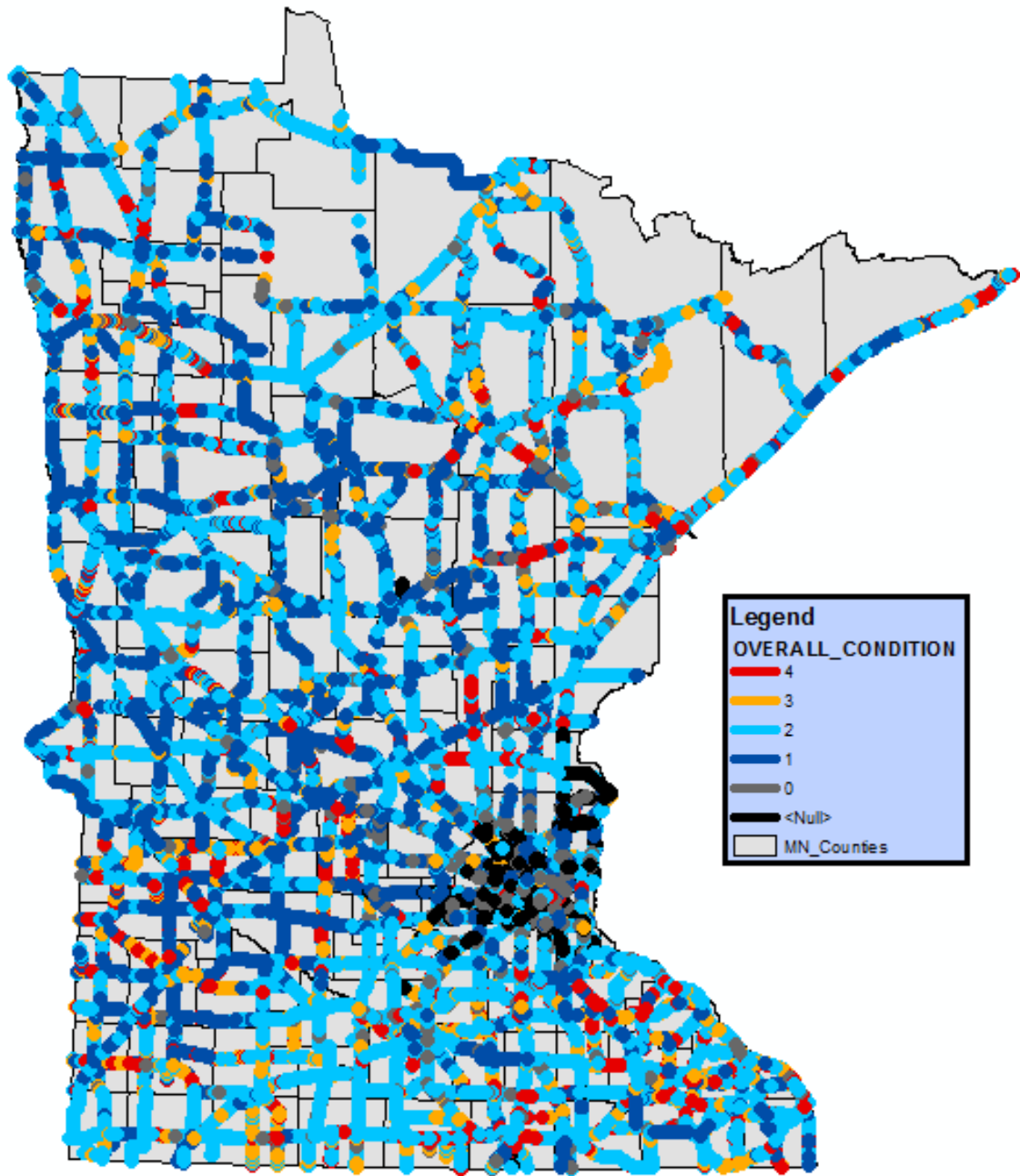
End Goal: Lifecycle Cost Analysis in Asset Management

HydInfra Inspectors inspect drainage features with Trimble GPS devices

(Terrasync or ArcPad software)



Key Experts in each District process the data with Pathfinder Office software and upload the data files through a web portal.

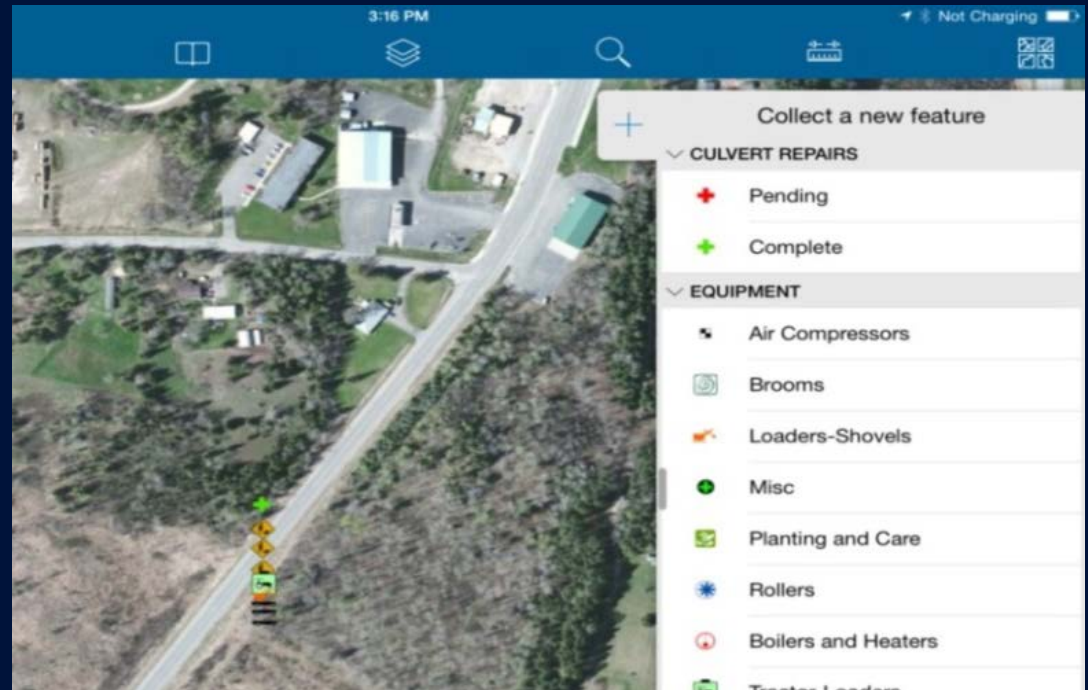


HydInfra Culvert and Storm Drain

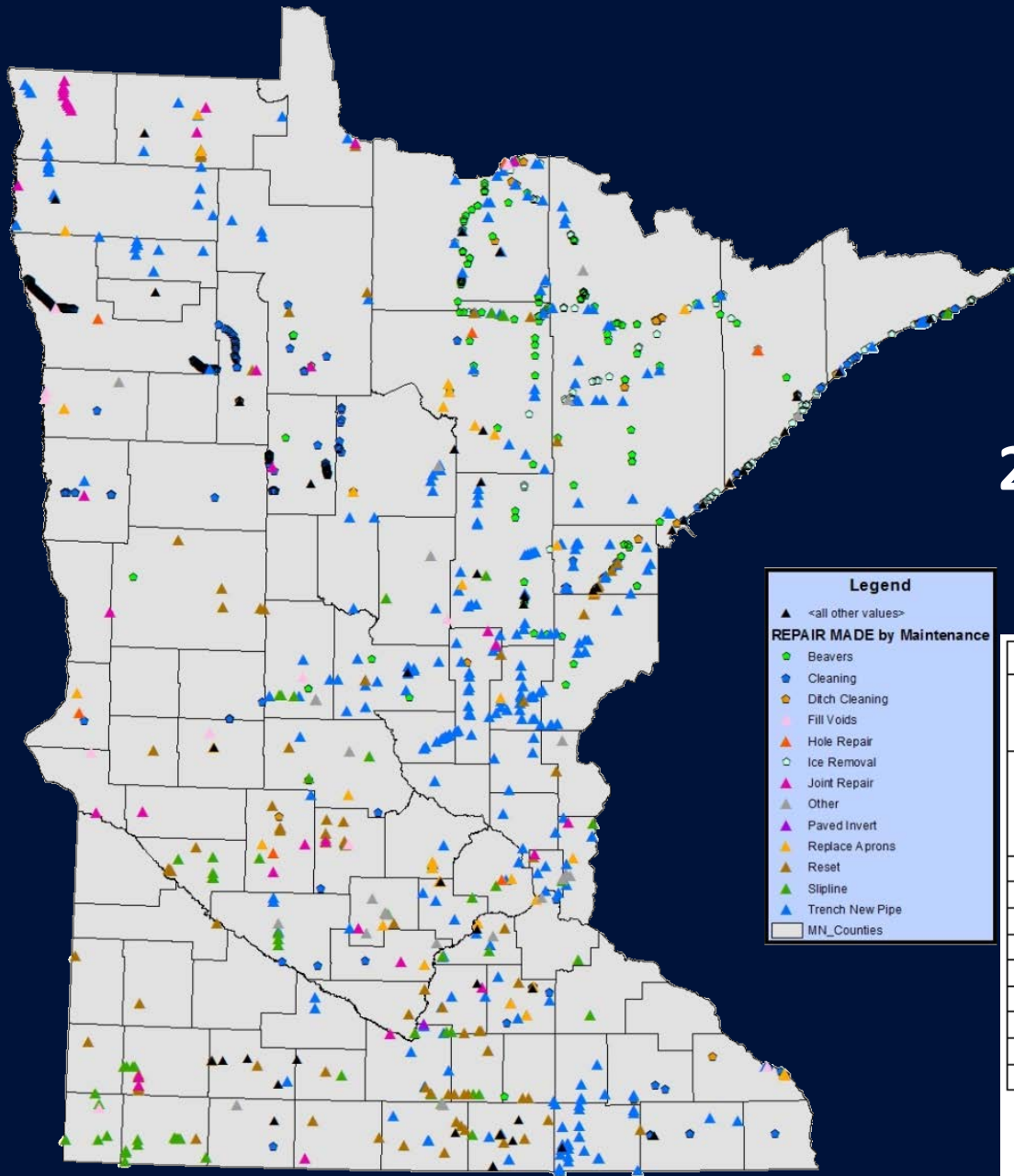
Pipes by Condition

July 2016

Maintenance records Culvert Repair Cost with ArcGIS Online Application for iPad or PC



Map of 1465 Culvert Cost Repairs by MnDOT Maintenance 2014-2015 Cost Summary



Legend	
▲	<all other values>
REPAIR MADE by Maintenance	
●	Beavers
●	Cleaning
●	Ditch Cleaning
●	Fill Voids
●	Hole Repair
○	Ice Removal
▲	Joint Repair
▲	Other
▲	Paved Invert
▲	Replace Aprons
▲	Reset
▲	Slipline
▲	Trench New Pipe
■	MN_Counties

Average Estimated Maintenance Cost of Culvert Repair			
Repair Category	Culvert Categories	Number of Repairs	Average Repair Cost
Trench New Pipe	All	314	\$ 8,430
	Highway ¹		\$32,170
	Side ²		\$ 9,610
	Entrance ³		\$ 5,160
Slipline		47	\$12,570
Reset Apron and Pipe		66	\$ 3,000
Replace Apron and Pipe		52	\$ 3,000
Joint Repair		33	\$ 2,710
Pipe Extension		15	\$ 4,060
Hole Repair		4	\$ 2,000
Fill Void		6	\$ 1,020
Other		13	\$11,270
All Culvert Repairs		550	

¹ Highway culverts include: centerline, mainline, median, CD and ramp-loop

² Side culverts include: city, county, township, frontage, cross-over

³ Entrances culverts include: entrance, farm entrance and field entrance

Bridge Hydraulics is the **Hub**

for Drainage Asset Management

Feedback gets incorporated from all around and back:



TAM software transition from HydInfra and Culvert Repair Cost to Agile Assets begins September 2016

1. District Hydraulics\WRE Engineers & Designers
2. District Maint. Supervisors and Engineers
3. District HydInfra Inspectors
4. District Maint. Drainage Repairers
5. Asset Management group – Agile Assets leaders
6. MnDOT Planning and Management
7. Federal guidance and best practices
8. Ideas from other States and entities

HydInfra sprang from the 1986 Culvert Inspection Manual

with some
important
differences . . .



MnDOT Hydraulic Engineers designed HydInfra in 1996

- Condition Ratings **1 – 4**
- **Flags and Measures** record defects
- Criteria for each **Material type**
- Culverts **less than 10 foot** span
- **Automated** from the get-go
 - Centralized database
 - GPS
 - GIS
 - Hired a specialist for database development – Thomas Martin

HydInfra spawned the FLH Culvert Manual (2010) codes and later NCHRP 14-26 Culvert and Storm Drain Inspection Manual (2016)

2005 HydInfra RA Ratings Guide

Condition Codes:

- 1 Good as new condition
- 2 Some wear, but structurally sound
- 3 Schedule for repair or replacement
- 4 May require immediate fix – Inform Maintenance people
- 0 Not rate-able

Notes:

- 1) The worst condition found in a feature determines its condition rating (see lists).
- 2) The general conditions of the roadway and adjacent area should be used as clues to help determine the condition rating for each hydraulic feature that is inspected. These general conditions can be indicators of concealed structural problems.
- 3) Broken grates or plugged pipes should be reported to Maintenance within 24 hours.

2010 FLH

CHAPTER 2 – CULVERT ASSESSMENT TOOL

FHWA FLH CULVERT ASSESSMENT GUIDE

CONDITION ASSESSMENT RATING CODES

Good	Like new, with little or no deterioration, structurally sound and functionally adequate.
Fair	Some deterioration, but structurally sound and functionally adequate.
Poor	Significant deterioration and/or functional inadequacy, requiring repair action that should, if possible, be incorporated into the planned roadway project.
Critical	Very poor conditions that indicate possible imminent failure that could threaten public safety, requiring immediate repair action.
Unknown	All or part of the culvert is inaccessible for assessment or a rating cannot be assigned.

Notes:

- In general, the lowest elemental rating for the culvert determines the overall rating.
- Culvert conditions are assigned the above ratings, while failing culvert performance parameters are indicated by a check box if present.
- This guide is used for the rating of culverts with spans less than 20 feet as measured along the centerline of the roadway, as defined by NCHRP 14-26.
- Due to the varied background and experience of the assessors, and variety of structures and deterioration causes, there is subjectivity to assigning the ratings in this guide.

2012 HydInfra Inspection Manual

Culvert and Storm Drainage Systems

Condition Rating Codes:

- 1 Excellent – like new condition
- 2 Fair – some wear, but structurally sound
- 3 Poor – deteriorated, consider for repair or replacement
- 4 Severe – serious deterioration
- 0 Not able to rate, not visible

Notes:

- This guide is used to rate the condition of storm drainage system features or culverts where the pipe (or installations of more than one pipe) is less than 10 feet wide, as measured along the centerline of roadway.
- The worst defect found in a feature determines its condition rating. (Refer to condition rating criteria on pages 13 to 20).
- Components are rated on structural integrity and ability to perform their functions. Need for cleaning is NOT part of the Overall Condition rating but is noted with a separate 'Clean?' flag (Clean? = Y) and a 'Sediment % Full' value.
- Broken grates or plugged pipes or structures should be reported to Maintenance Area Supervisor within 24 hours of inspection.

HydInfra 2005 manual equated need for repair with condition rating and FHWA FLH 2010 manual paraphrased the ideas. NCHRP 14-26 manual used HydInfra's **Other Materials Criteria for Action Indicated**. Compare the **Notes** sections too.

2016 NCHRP 14-26

RATING SCALE AND ASSOCIATED ACTION

	1	2	3	4	5
	GOOD	FAIR	POOR	CRITICAL	FAILED
CONDITION	Like new, with little or no deterioration, structurally sound and functionally adequate.	Some deterioration, but structurally sound and functionally adequate.	Significant deterioration and/or functional inadequacy, requiring maintenance or repair.	Very poor conditions that indicate possible imminent failure which could threaten public safety.	Failed or non-functional condition.
ACTION INDICATED	No action is recommended. Note in inspection report only.	No immediate action is recommended, but more frequent inspection may be warranted. Maintenance should be performed.	Team Leader (Inspector) evaluates need for corrective action and makes recommendation in inspection report.	Corrective action is required and urgent. Engineering evaluation is recommended to specify appropriate repair.	Emergency action is required to address public safety hazard. Roadway closure is typical.

HydInfra described as “*The Best*” among DOT’s Culvert Management Systems*



**HydInfra is
Nationally
Known!**

- 2012 TAMP – Transportation Asset Management Plan – Pilot project will include HydInfra
- 2011 NCHRP 14-26 project to create “Culvert Inspection Manual” includes us
- 2007 -- Featured in FHWA Culvert Management Systems booklet



[Put Your Drainage Asset Management System to Work](#)

presented at the National Hydraulic Engineers Conference in Iowa City, August 2014.

(Concrete Pipe Association requested we present at their conference in Texas 2015 but we had to refuse.)

2016 American Public Works Conference in Mpls -- *Culvert Inspection and Repair* -- *We could have fixed it cheaper, sooner!*

* Feb 2015, Marie Venner, consultant who has researched and written 2 FHWA guides to Culvert Management Systems

HydInfra can capture all kinds of Drainage Feature Types


- ★ Pipes – Culvert, Storm Drain, Drain Tile, Tunnels, etc.
- Structures – MH, CB, DI
- Special Structures – Aprons, Weirs, (catch all)
- Ponds – Infiltration, Wet, Dry, etc
- WQ devices– swirling separators, skimmers etc.
- Ditches
- Discharge Points – Outfalls (MS4) Infalls , etc.
- Illicit Discharges
- Environmental – pH, resistivity locations

Highway Culvert Inspections are scheduled according to Performance Measures

Inspection Cycle for Drainage Performance Measure		
Recommended Inspection Frequency for Highway Culverts		
Overall Condition	Recommended Inspection Frequency Years	Comments
4 Very Poor	2	Pipes where problem is not under the road
	1	Pipes where problem requires a repair under
3 Poor	4	Most condition 3 pipes
	2	Pipes with Piping or Road Void (these show
1 & 2 Like New and Fair	6	
0 Can't be Rated	2	
Pipes with no inspections		Goal to inspect within 6 years - 2019, man pipe, so as districts identify pipes as storm reduced
Overall Target: 80% of Highway Pipes meet Recommended Inspection Frequency		

Inspection Cycle:
 Condition 4: 1 or 2 years
 Condition 3: 4 years
 Condition 2: 6 years
 Condition 1: 6 years
 Condition 0: 2 years

- Start with inventory and inspection cycle
- Later target to reduce numbers of bad pipes



HydInfra Condition Rating Criteria
aim to
protect the roadway

Holes or Joint Separations
in pipes create
Piping and Road Voids



HydInfra Inspection Manual

Culvert and Storm Drainage Systems

Condition Rating Codes:

Like new

1

Excellent – like new condition

Still okay

2

Fair – some wear, but structurally sound

Fix in project

3

Poor – deteriorated, consider for repair or replacement

Fix it sooner

4

Very Poor – serious deterioration

Unknown

0

Not able to rate, not visible

Condition Rating Codes suggest the need for repair

Pipe Materials &

MATERIAL TYPE

to track performance

- Concrete

CONCRETE

- Corg. Steel (CSP)

- Structural Plate

- Polymeric-Coated

- Bituminous-Coated

- Aluminized Steel

STEEL

- Corg. Aluminum (CAP)

ALUMINUM

- Timber

- Vitrified Clay

- Other

OTHER

- Corg. Plastic (HDPE)

- PVC

- Perforated Plastic

- Polypropylene

- SRPE (Steel Reinforced PolyEthylene)

PLASTIC

“Liner” materials describe a lined pipe:

- Liner HDPE

- Liner PVC

- Liner Cured in Place

- Liner Metal

- Liner Other

LINER

Each
Material Type
has **explicit**
rating criteria

HydInfra Ratings Guide

Concrete Pipe & Special Structure

Factors: Structural integrity, Integrity of surrounding material

1 Excellent Condition

- Minor chipping at joints/openings
- Hairline cracks
- Insignificant spalling or scaling

2 Fair Condition

- Joints broken or pulled apart up to 1" (anywhere along joint)
- Aggregate exposed
- Cracks evident with widths up to 1/8 inch
- Spalling or scaling to 1/4 inch depth

3 Poor Condition

- Joints broken or pulled apart 1" - 2" (anywhere along the joint)

4 Very Poor Condition

- Joints pulled apart or broken (more than 3" at any point along joint)
- Cracking evident with widths > 1/4 inch
- Reinforcement fully exposed in places
- Eroded holes through concrete or bottom gone
- Deformation
- Cracks showing movement – pipe pieces have shifted
- Pipe condition is causing soil loss beneath road surface

- Pipe condition is causing soil loss beneath road surface

Notes:

Special Structures include Aprons, Slotted Drain, Headwalls, Wingwalls, open Flumes, Weirs, Expander/Reducers, Floodgates, Energy Dissipaters and other items that are not Pipes, Structures, SPCDs (Structural Pollution Control Devices), Ponds or Ditches.

Attributes such as crack width and spalling depth won't be measured in most cases – inspectors must estimate sizes based on what they see.

“Flags” and “Measures”

describe the defects

Condition Indicators

- Needs Repair?
- Piping
- Cracks
- Holes
- Deformation
- Misalignment
- Max Joint Separation
- # Separated Joints
- Separated Apron
- Spalling/Flaking
- Pitting/Rusting
- Infiltration

Roadway Indicators

- Void in Road
- Road Distress
- Inslope Cavity
- Erosion/Scour

Not in Condition Rating

- Needs Clean?
- Plugged
- Silt
- Sediment % Full
- Standing Water

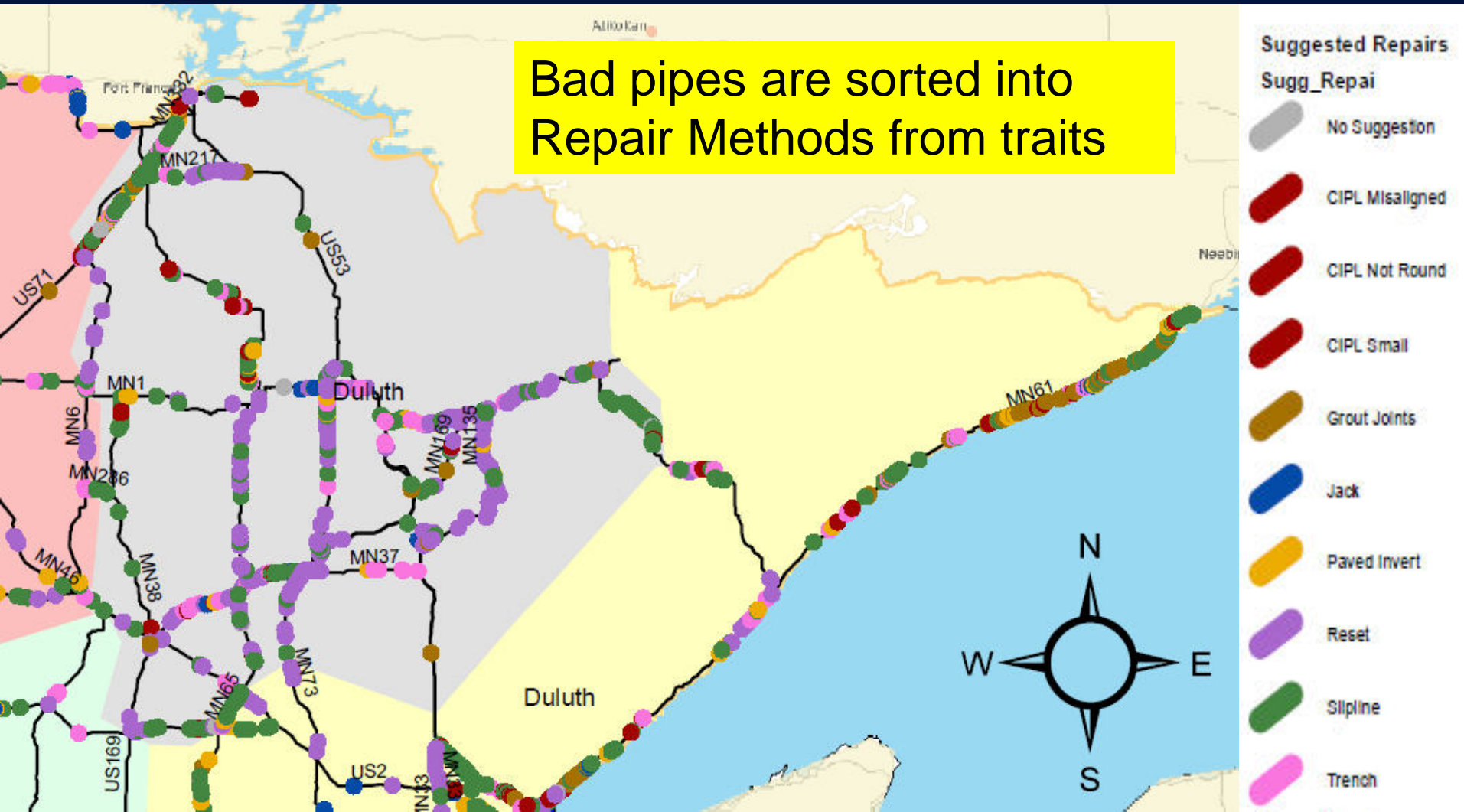
Together

Materials, explicit criteria
and defect flags

create solutions

Flowchart Suggested Repair Report for **estimating repair costs**

Example shows northeast MN potential pipe repairs on the map



Statewide Pipe Repairs Cost Estimate from Suggested Repair Report

	A	B	C			H	I	L	R		
1			Repair me			Contract average bid			Contract		
2						Unit P			Contract		
3	District	1		District	1		Cost		Total Cost		
4			CIPL				\$183,973	973			
5			Grout				\$77,387	387			
6			Jack				\$968,165	165			
7			Paved Invert				\$40,212	212			
8			Reset			\$2,4	\$323,374	374			
9			Slipline				\$1,552,383	383			
10			Trench			\$26,3	\$2,260,010	010	\$5,405,504		
11	District	2									
12			CIPL				\$518,691	691			
13			Grout				\$23,009	009			
14			Jack				\$1,025,585	585			
15			Paved Invert				\$2,715	715			
16			Reset			\$2,4	\$29,643	643			
17			Slipline	45	3562	\$93.22	foot	\$365,255			
18			Trench	21	1633	\$65.37	foot	\$26,362.84	each	\$726,406	\$1,893,341
19	District	3									
20			CIPL	23	3637	\$129.65	foot	\$518,691			
21			Grout	5	644	\$32.48	foot	\$23,009			
22			Jack	8	1286	\$725.00	foot	\$1,025,585			
23			Paved Invert	2	152	\$16.24		\$2,715			
24			Reset	11	1029			\$2,449.80	each	\$29,643	
25			Slipline	44	3833	\$93.22	foot	\$393,043			
26			Trench	27	1848	\$65.37	foot	\$26,362.84	each	\$915,860	\$2,908,546

2010

The **sorting** process for repair suggestion is described in a 3-page flowchart on the web

Flowchart of HydInfra Report: Pipe Suggested Repair Method

Consider many additional factors before repairing a pipe:

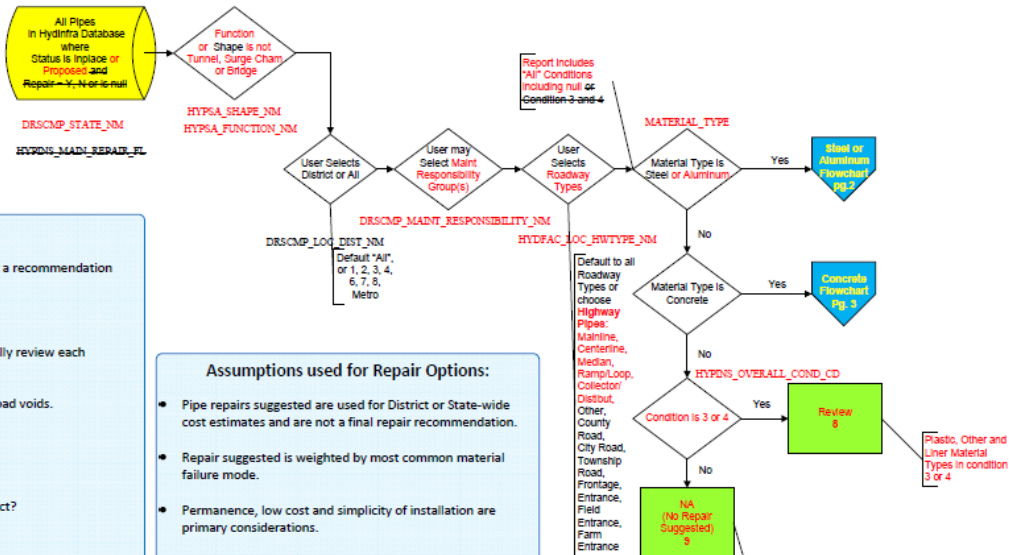
- 1) If you reduce the hydraulic capacity of the repaired pipe you may cause problems – get a recommendation from Hydraulics/WRE before you line or replace a pipe.
- 2) Verify Pipe's size, shape, material, length before a doing a major repair.
- 3) Compare the Field Recommended Repair to the Flowchart Suggested Repair and critically review each suggestion against the condition problems (inspection flags and measures).
- 3) Additional work may be required with any repair method, especially mud-jacking the road voids.
- 4) Soundness of road – can voids outside of the repaired pipe be adequately filled?
- 5) Structural integrity – will the pipe be structurally sound after repair?
- 6) Cost reduction by combining repairs – can several pipes be repaired together in a project?
- 7) Local costs of repair methods may suggest a different repair method.
- 8) Open trenching costs must include pavement cost except when part of a paving project.
- 9) The scope of the construction project (re-construction, overlay, maintenance) may suggest choosing replacement over repair, or vice versa
- 10) Traffic requirements – are lane closures required, or are they feasible?
- 11) Right-of-Way – is the highway-owned work area sufficient for the repair method?
- 12) Accessibility – Can equipment or materials needed for the repair method reach the pipe?
- 13) Presence of large rocks prevents jacking – consult Materials Office for soils information.
- 14) Other repair methods may be appropriate for any pipe, for example, "Joint Repair " may include internal bands, grouting, or other method.
- 15) Pipes with Roadway Types "Entrance", "Township Road" or "City Road" might be open trenched, whereas Mainline, Centerline, Ramp/Loop, Collector/Distribut and County Roadway Types often may not be, due to traffic.
- 16) Permit requirements – work with hydraulics to determine if any permits are required or conditions that need to be met.
- 17) CIPP Liners cured with hot water may contain Styrene that has caused fish kills in streams. Capture all heated water used in resin-curing process and truck to a proper disposal site.

Assumptions used for Repair Options:

- Pipe repairs suggested are used for District or State-wide cost estimates and are not a final repair recommendation.
- Repair suggested is weighted by most common material failure mode.
- Permanence, low cost and simplicity of installation are primary considerations.
- Fixes done by MnDOT Maintenance are preferred to letting a contract.
- Maintenance is equipped to do some repairs (like joint repair, paved invert, slipline, and reset end sections) but not others (like CIPP or Jack).
- Contracts are required for Cured in Place Pipe Liner , open Trench replacement, or Jacking.
- Reduction in diameter reduces hydraulic capacity. Sliplining reduces internal diameter more than cured in place liner or other methods, and limits its use.
- In pipes less than 36" diameter (2.90 meters) difficulty of human access will favor sliplining or cured-in-place pipe liner over other methods.
- Open trench replacement is least preferred for highways if traffic is disrupted and likely more expensive when repaving costs are included.
- Pipes under deep cover are more difficult and expensive to open trench.

Repair Methods:

- 1 = Reset (reset or replace end sections or apron)
- 2 = ~~Grout~~ Joint Repair
- 3 = Paved Invert
- 4 = Slipline
- 5 = CIPP (Cured In Place Pipe Liner)
- 6 = Trench
- 7 = Jack (or auger, ramming, drilling, bursting etc.)
- 8 = Review (needs repair, no suggestion given)
- 9 = NA (not applicable)



May 13, 2013
<http://bridge.hydraulics/HydInfraforBNT.html>
 Page 1

Correlate sets of defects – “flags” with Material Type

Material/Flag combinations that we see in MnDOT photos:				
Concrete	Deformation	Cracks	Spalling	
Concrete	Joint Separation	Road Void		
Concrete	Inslope Cavity	Joint Separation		
Concrete	Joint Separation	Infiltration		
Steel	Holes	Road Distress		
Steel	Holes	Deformation		
Steel	Holes	Piping		
Steel	Holes	Road Void		
HDPE	Cracks			
HDPE	Misalignment (floating)			
Liner HDPE	Deformation			

2. **Prioritize** based on today's requirement

Choose your
biggest, worst culverts
that have piping and road voids
with shallow cover,
and highest ADT
(and **highest price tag**)

Or Prioritize based on today's funds

Choose the pipes that

Maintenance can repair now

with little cash:

Resets, Paved Inverts, Joint Repair

Know which pipes to fix before the paving project (not after)



Use Project Design Report to sort out drainage features that need repair

MnDOT HydInfra Project Design Recommendation Report																		
Data Date 7/14/2016																		
Hwy 22 Ref. Pt. 145.00 to 157.00																		
INSPECTION SUMMARY																		
SHEET NO.	R.P.	STA.	DIR	ID	SIZE (INCHES)	LENGTH (FEET)	MATERIAL	STRUCT TYPE	HEIGHT (FEET)	CONN PIPE	CONDITION RATING	CORRECTIVE ACTION	Work Code	D.C.	MISC. NOTES	UTM_X		
											1	2	3	4	0			
SHEET NO.	RP	STATIC	ROAD TYP	R	HYD I	SPA	RIS	LENGTH (F)	MATERIAL	STRUCT TYP	STRUCTURE H	CONN. PIPE	CONDITION	CORRECTIVE ACTION	WORK CODE	COVER (FT)	MISC NOTES	UTM_X
12	145.786	Centerline			597346	24	24	72	Concrete	Round			4			2 - 6 Feet		378,727.4
13	146.338	Centerline			597347	36	36	72	Concrete	Round			4			2 - 6 Feet		378,754.8
14	146.906	Centerline			597348	24	24	90	Concrete	Round			3			2 - 6 Feet		378,776.8
15	147.101	Centerline			597349	24	24	66	Concrete	Round			3			6 - 10 Feet		378,783.9
16	147.267	Centerline			597350	36	36	70	Concrete	Round			4			2 - 6 Feet		378,791.0
17	148.070	Centerline			597351	24	24	66	Concrete	Round			3			2 - 6 Feet		378,845.0
18	148.842	Centerline			597352	24	24	48	Concrete	Round			4			2 - 6 Feet		378,882.1
19	149.795	Centerline			597353	36	36	50	Concrete	Round			4			2 - 6 Feet		378,914.4
23	150.770	Centerline			597357	24	24	88	Concrete	Round			4			2 - 6 Feet		378,533.0
24	150.924	Centerline			597358	24	24	88	Concrete	Round			4			2 - 6 Feet		378,540.6
25	151.239	Centerline			597359	24	24	88	Concrete	Round			3			2 - 6 Feet		378,574.7
26	151.474	Centerline			597360	24	24	88	Concrete	Round			4			2 - 6 Feet		378,599.8
28	152.653	Centerline			597362	36	36	120	Concrete	Round			3			2 - 6 Feet		378,668.5
29	153.194	Centerline			597363	24	24	75	Concrete	Round			4			2 - 6 Feet		378,682.1
32	153.916	Centerline			597366	36	60	75	Concrete	CattlePass			3			2 - 6 Feet		378,700.9
33	154.246	Centerline			597367	24	24	110	Concrete	Round			3			Over 20 Feet		378,710.1
34	154.552	Centerline			597368	24	24	100	Concrete	Round			3			2 - 6 Feet		378,718.0
35	154.829	Centerline			597369	24	24	84	Concrete	Round			4			2 - 6 Feet		378,725.7
36	155.008	Centerline			597370	24	24	100	Concrete	Round			3			Over 20 Feet		378,730.6
37	155.329	Centerline			597371	36	36	120	Concrete	Round			4			2 - 6 Feet		378,740.6
38	155.592	Centerline			597372	36	36	120	Concrete	Round			4			10 - 20 Feet		378,749.8
39	156.057	Centerline			597373	72	72	75	Concrete	Round			4			2 - 6 Feet		378,766.2
40	156.139	Centerline			597374	48	48	100	Concrete	Round			4			2 - 6 Feet		378,769.8
41	156.393	Centerline			597375	24	24	72	Concrete	Round			4			2 - 6 Feet		378,780.1

This report is used for project scoping or construction project hydraulic design recommendations. It draws from HydInfra inventory and inspection data for culvert and storm drain pipes, hydraulic structures (catchbasins, manholes, drop inlets) and special structures (pipe aprons or other items). This spreadsheet has only pipe data. Designers review inspection data and determine repair or replacement needs. Flowchart

Culvert Repair Cost

The purpose of the Culvert Cost app is to estimate the costs of future repairs by capturing Labor, Equipment and Materials costs of current repairs done by Maintenance



Culvert Repair Cost - Individual Repair Details Report

Repair ID: 16529 Repair Status: Final Hydinfra ID:
 Culvert Type: County Road RCA Work Order #:
 Repair Made: Reset Date Completed: 06/11/2015
 Date Started: 06/10/2015

Repaired Length (ft): 24.00 Repaired Material: Concrete Full Name: Steve Aldrin
 Total Length (ft): 100.00 Repaired Shape: Round District: 1
 Clean Done: Major Inside Height (Inches): 24.00 Route System: IS
 Pre-repair Condition: 4 - Very Poor Inside Width (Inches): 24.00 Route Number: 35
 Repaired Condition: 2 - Fair Fill Over Pipe (ft): 10.00 Route Reference: 213.30
 Comment: reset both aprons and first pipe section. Left or Right: I

Cost Summary	Labor Costs	Equipment Costs	Material Costs	TOTAL COST
	\$ 1,405.88	\$ 1,142.20	\$ 1,187.67	\$ 3,735.75

Labor Classification	Charge Rate		Hours	Labor Cost
	Base Rate	Including Additive		
TA	\$ 25.79	\$ 36.96	12.0	\$443.58
TG	\$ 31.65	\$ 45.36	8.0	\$362.91
TGS	\$ 34.19	\$ 49.00	12.0	\$588.05
Traffic Control TG	\$ 31.65	\$ 45.36	0.3	\$11.34
Total Labor Costs:				\$1,405.88

Equipment Charge Class Description - Units	Charge Rate		Quantity	Equipment Cost
	Base Rate	Including Overhead		
190 Pickup 3/4 Ton - MILE	\$ 0.71	\$ 0.82	50.0	\$40.97
350 57M LB Chassis Cab Tandem Axle Truck - MILE	\$ 2.85	\$ 3.29	80.0	\$263.11
352 Tandem Axle Truck T - MILE	\$ 2.55	\$ 2.94		
480 Semi Type TRLR 20-50T LowBoy ET - HR	\$ 19.79	\$ 22.84	1.0	\$22.84
482 Pull type Trailer 10-25 ton - HR	\$ 35.23	\$ 40.66	1.0	\$40.66
727 Skid Steer Loader 30HP - HR	\$ 38.45	\$ 44.37	3.0	\$133.11
770 Shovels 1/2 C.Y.. or 3/4 C.Y. - HR	\$ 55.59	\$ 64.15	10.0	\$641.51
Total Equipment Costs:				\$1,142.20

Materials Material Description	Charge Rate		Quantity	Materials Cost
	Base Rate	Including Overhead		
Fiber Blanket, Erosion Control - SY	\$ 1.23	\$ 1.52	200.0	\$303.39
Geotextile Fabric - SF	\$ 1.40	\$ 1.73	320.0	\$552.52
Pipe Ties - EA	\$ 30.00	\$ 37.00	8.0	\$295.99
Seed Mix - LB	\$ 2.90	\$ 3.58	10.0	\$35.77
Total Materials Costs:				\$1,187.67

Paved Invert

- Trench New Pipe
- Slipline
- Replace Aprons
- Reset
- Extension
- Joint Repair
- Hole Repair
- Paved Invert
- Fill Voids
- Remove Only
- Abandon Only
- Other

Fix the invert of the pipe by pouring, troweling or covering the invert with concrete or other material, usually in a larger metal pipe (accessible for interior repair). May also include filling voids in road bed. Repaired Length = length of paved invert.



Paved Invert repair, done in 1971, on steel plate culvert still looks good in 2015. Has a channel that keeps most flows away from galvanized steel sides. 2005 Photo from Bergstrand, D1

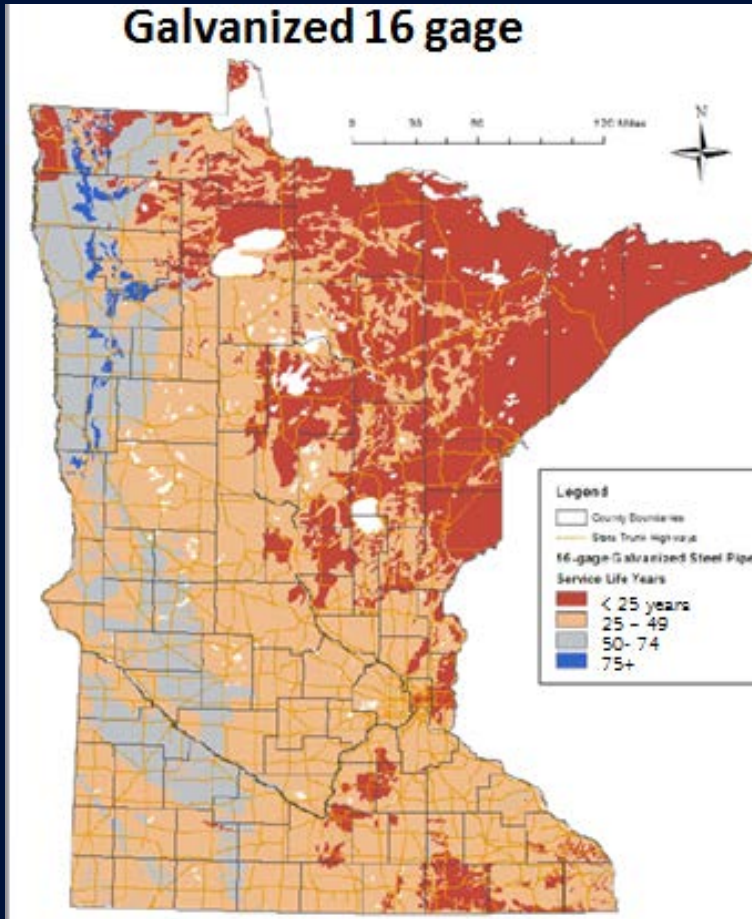


Fresh
Paved Invert

Pipe is
condition 2
if repair is
successful

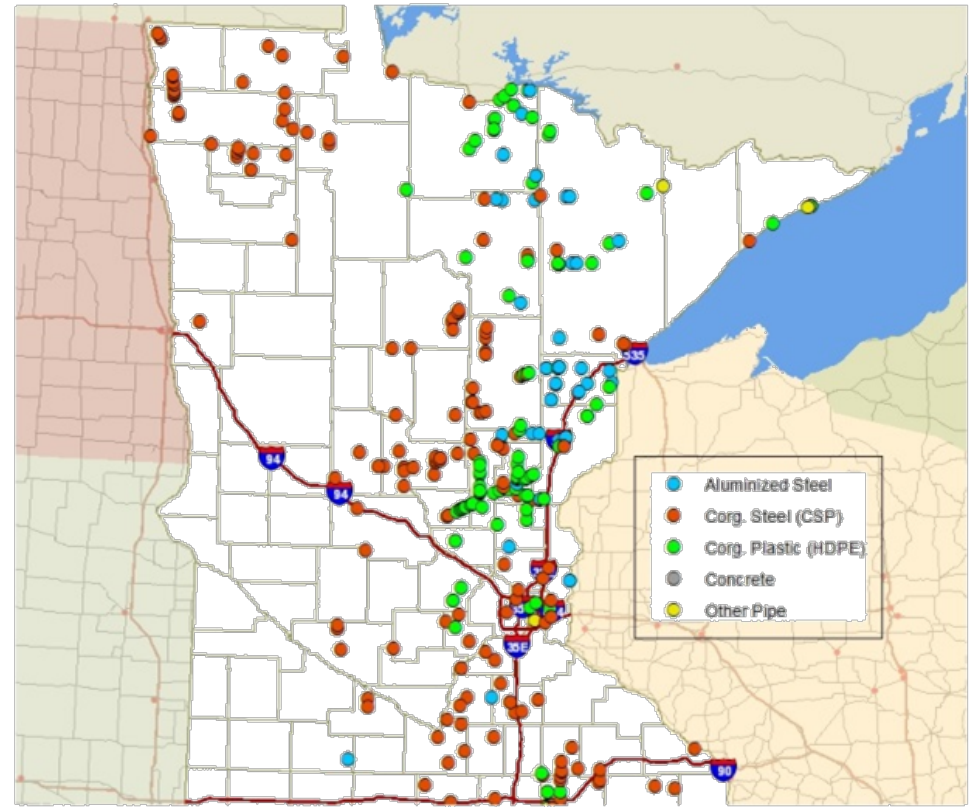
D6 Rob Coughlin, 2013

Maintenance is switching culvert materials for longer lifespan



MnDOT Research shows projected lifespan for Galvanized Steel (red northeast MN is bad for galvanized)

Culvert Cost - Maintenance Installed New Pipes 2014-2015



Culvert Cost app shows Plastic and Aluminized pipe installed by Maintenance (green and blue dots, galvanized are red dots)

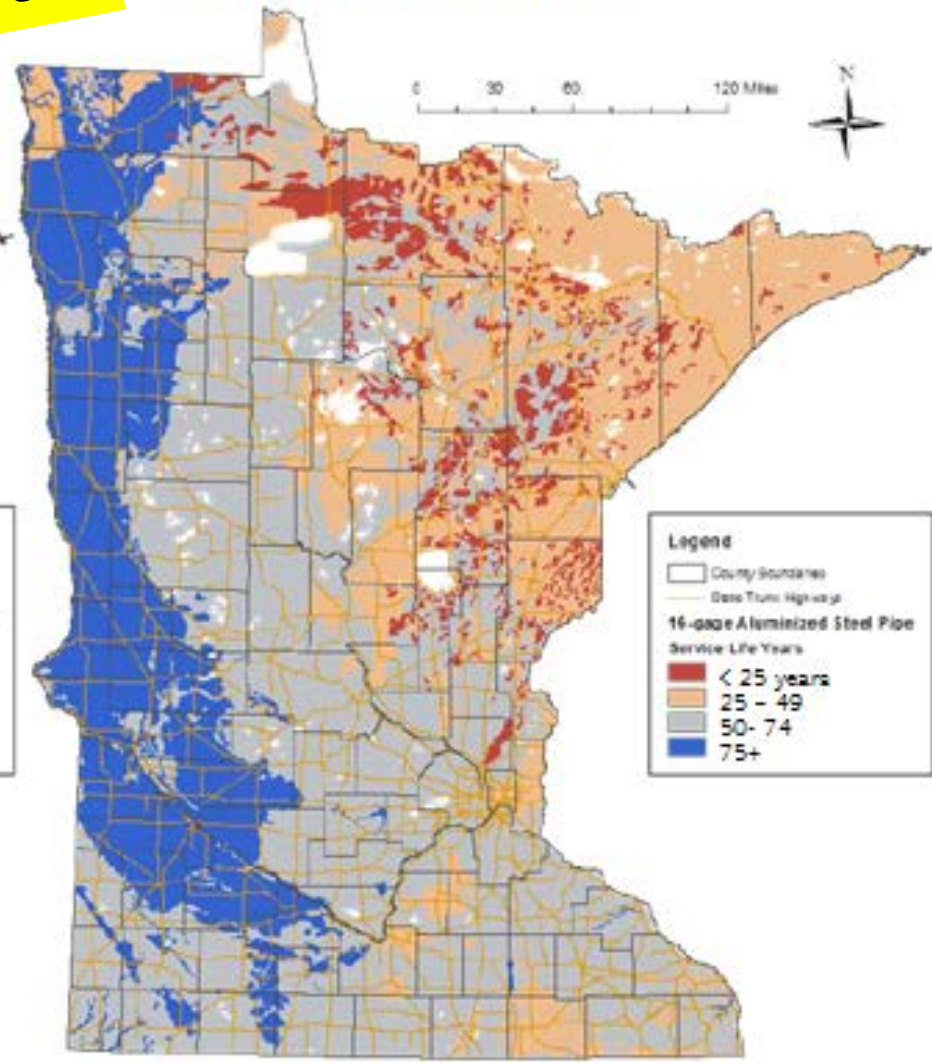
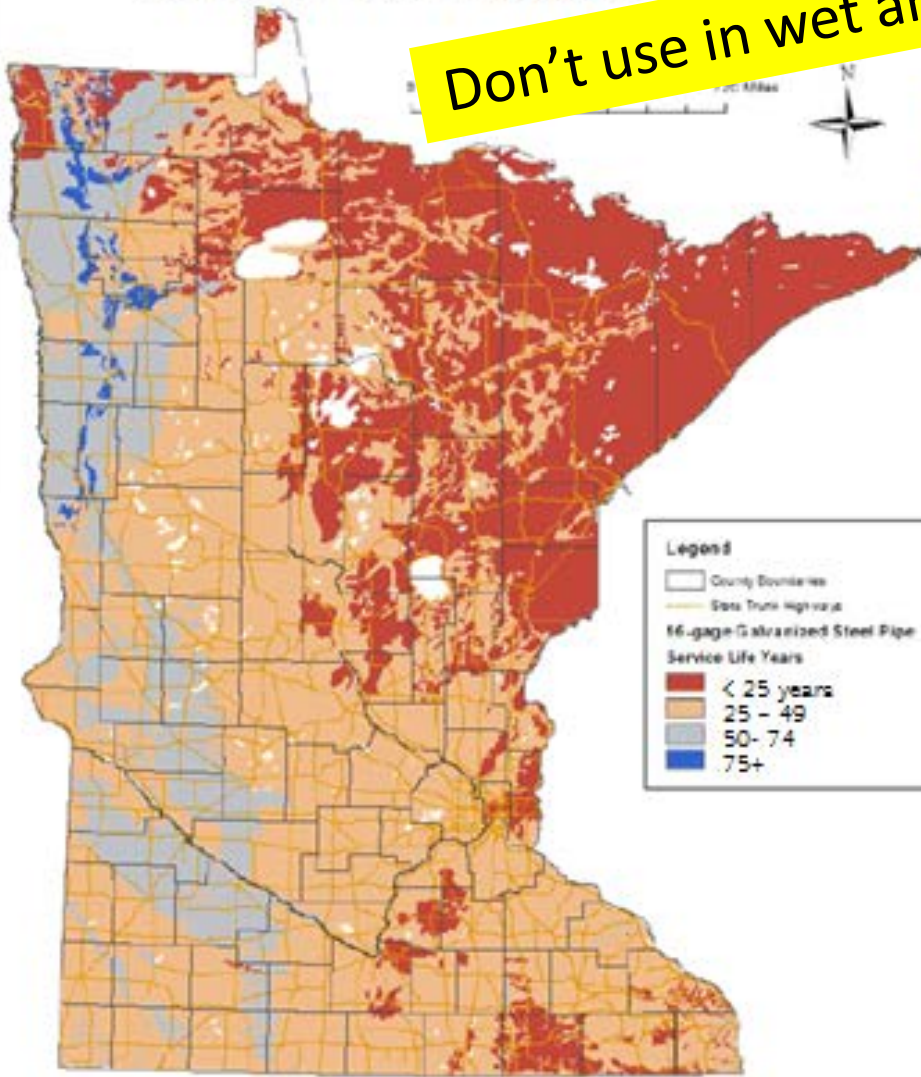
Service Life Comparison

[Minnesota Steel Culvert Pipe Service-Life Map Research](#)

Galvanized 16 gage

Aluminized 16 gage

Don't use in wet areas



HydInfra-Culvert Cost

Capabilities:

1. Performance Measures
2. Prioritize Repairs
3. Estimate Costs – “Suggested Repair Method”
4. Maintenance Planning
5. Project Pre-design
6. Respond to flood damage
7. MS4 Water Quality record keeping
8. Utilities locations – “Call before you dig”
9. Research pipe materials
10. Lifecycle cost analysis