



Full Depth Reclamation Reference Guide

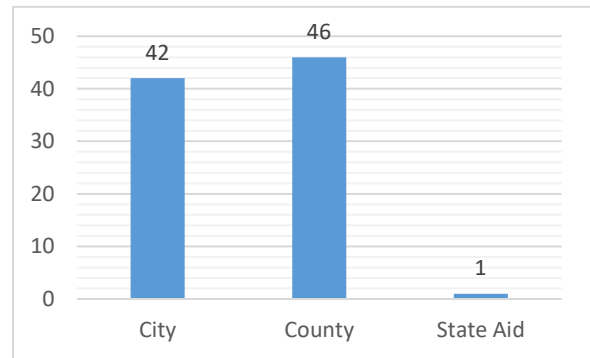
Appendix A – MN Local Agency FDR Survey Results

Survey Results Overview

The survey, which was open from the week of February 20 – March 16, 2020, was distributed via State Aid to MN city/county engineers.

Total Responses Received: 91

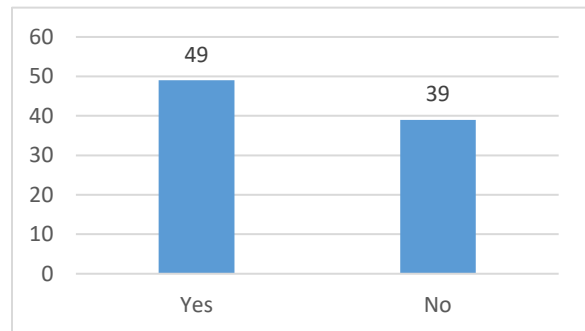
Of the 91 responders, 89 provided their contact information, which showed the following breakdown:



Survey Results

Question 1: We would like to get video of FDR projects; do you have one scheduled for this summer (rural or urban)?

All of those who responded “yes,” identified themselves. They are as follows: *(Note: Some were duplicates)*



Cities

Andover
Baxter
Burnsville
Morris
Northfield
Orono

Chanhassen
City of Anoka
City of Ramsey
Plymouth
Robbinsdale
Rochester

Coon Rapids
Duluth
Shakopee
St. Michael
Stillwater

Lino lakes
Mendota Heights

Counties

Anoka
Becker
Beltrami
Benton
Blue Earth
Brown
Carver

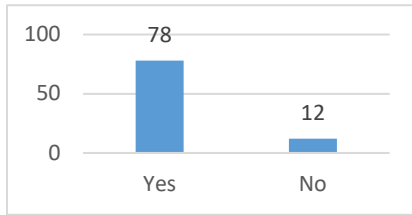
Clay
Clay
Douglas
Faribault
Fillmore
Goodhue
Hubbard

McLeod
Meeker
Olmsted
Otter Tail
Pipestone
Pope
Ramsey

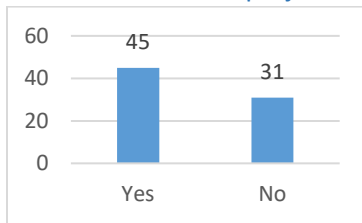
Steele
Traverse
Washington
Wilkin
Wright County

Other: SEH Inc.

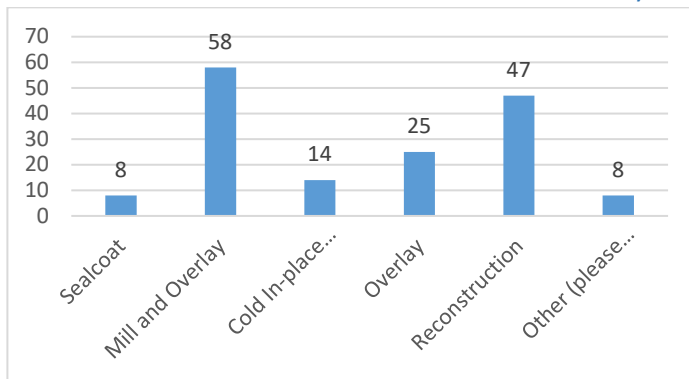
Question 2: Have you ever been involved with an FDR project?



Question 3: Did the project include a pavement with utilities underneath?

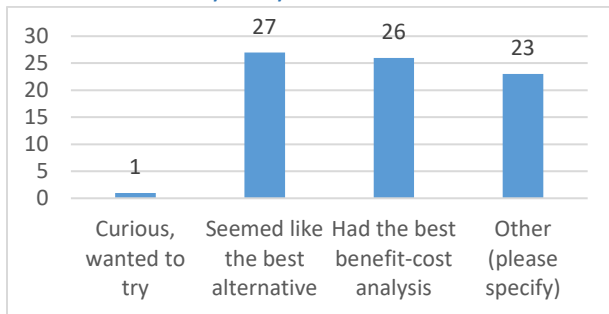


Question 4: What other rehabilitation treatments did you consider (check all that apply):



- No other rehabilitation treatments were considered
- Bituminous Reconstruct where the bituminous was removed and replaced.
- Hot in Place
- SFDR
- Hot-in-place recycle
- FDR is our first choice for rural pavement preservation & if not feasible then we typically go with a mill and overlay
- Have also done HIR projects
- FDR is a standard rehabilitation practice in Mendota Heights. Mill and Overlay does not seem to provide the longevity the city desires.

Question 5A: Why did you choose FDR?



- **All of the above**
- **Cost**
 - Do not have funds to reconstruct. Had to settle for new surface with more strength.
 - Reconstruction was recommended but Residents wanted lower cost and were willing to have a pavement on Poor subgrade.
 - One was best on a rural section road. The second was driven by neighborhood concern for cost and politically driven against recommendations for recon over poor soils
 - Owner desired an increase to the existing street structural capacity of the street (5 ton -> 9 ton). FDR method was both a cost effective and sustainable approach
- **Utilities**
 - The utilities underneath the street were in good condition and did not need to be replaced. If they did, we would have move to a reconstruction type project
- **Agency Experience**
 - Have completed several FDR projects in the past and has become the standard rehabilitation strategy of the city.
 - Experience -have been doing it since it came out. Pavement holds up better with extra support
 - We have had good results in the past.
 - Rural Experience
 - FDR is the Wright County standard for rural highway pavement preservation. Our first FDR test project was in 1998 and we have gradually adopted FDR as our standard treatment for our rural highways unless the granular base isn't thick enough (and then we select "mill & fill" as the Pavement Preservation treatment).
 - It is our standard practice for our rural highway pavement preservation projects. Our first FDR project was in 1998 and it gradually has become our standard design for rural pavement preservation, provided it is feasible based on the existing highway section in place (enough gravel base under the pavement).
- **Pavement Condition / Best Alternative**
 - Elimination of all cracks in pavement and increased pavement section strength.
 - There was not enough existing pavement to complete a mill & overlay and the street needed to be resurfaced.
 - The pavement is too far gone to rehabilitate. Also, an FDR will provide a 10-ton route.



- There was not enough existing pavement to complete a mill & overlay and the street needed to be resurfaced.
- The pavement is too far gone to rehabilitate. Also, an FDR will provide a 10-ton route.
- Best way to eliminate cupping in the sawed/sealed joints and transverse cracking in general. Also adds material to the base of the road rather than continuing to add asphalt through overlays.
- eliminate reflective cracking
- Deterioration was too far advanced for a mill and overlay
- roads typically had 8"+ of Bituminous on them, so we milled off top 4 inches for RAP and shouldering, reclaimed next 8" and stabilized. Then paved 6" new Bit for 10-ton design.
- Vicksburg Lane (Hwy 55 to County Rd 6) summer of 2020. Schmidt Lake Road (Hwy 61 to Hwy 169) summer of 2020. Heavier volume MSA routes with a lot of cracking and some structure concerns with base materials in various locations along each roadway. Wanted a longer-term fix and to eliminate the possibility of reflective cracking that would have been seen with a simple mill and overlay.
- Paving fabric between the layers of bituminous made cold in-place recycling difficult.
- Reconstruction (with special assessments) was not approved so it became the alternative treatment.
- It was past a mill an overlay, and we thought we could get another 10-15 years before we needed to replace the underground utilities.
- Was the best alternative.

Question 5B: Please provide any additional thoughts/notes on why you chose FDR.

- **Cost effective / Strength / Long-lasting / Best Alternative / Etc.**
 - It gives us a new surface that is stronger than the last without having to reconstruct. Although would reconstruct if we could afford it.
 - Life of the pavement has gone beyond a mill and overlay. All the asphalt needed to be removed, in order to provide a long-lasting pavement rehabilitation project.
 - It is the best method to preserve the pavement surface integrity for the longest time and prevents reflective from migrating to the surface as soon as it otherwise would.
 - Stronger pavement design. Pavement was beyond repair for a mill & overlay
 - Longer life span and able to bring the cross section up to a 10-ton design
 - Increases base thickness and strength, especially if stabilized. No reflective cracking like mill and overlay
 - allowed an even base to eliminate reflective cracking that would have been associated with overlay
 - Worthwhile approach with many benefits.
 - To avoid reflective cracking, added pavement life, less maintenance costs.
 - Have used many times and it works to reduce reflective cracking and improving structural strength. Minimal impact to shoulders.
 - An added benefit, the FDR material left behind provides additional base, providing better support of the new pavement, enabling a thinner pavement or higher capacity route.
 - Allows for re-use of existing pavement paid for my taxpayers. Much more cost-effective than a full reconstruction. Less disruptive to property owners than a full reconstruction."



- For rural cross sections, we find FDR useful where resurfacing is no longer a viable alternative, but where reconstruction is not in the budget or needed.
- Since an improved street with curb and gutter, storm sewer and trail were not approved, we wanted to consider an alternative that would provide a long-term solution to a roadway that was well beyond its useful life.
- We do some FDR every year because it is cost effective and sustainable.
- Has proven to be a cost-effective method to reconstruct City streets, utilizing existing underlying gravel and recycling the in place bituminous. We do one every year.
- Seems to be a cost-effective way of addressing pavements that are beyond a mill and overlay but have decent sub-grade conditions.
- Using the recycled material make sense
- Soil borings indicated good aggregate base beneath. FDR is a more sustainable method rather than export all existing material and importing new material. Cheaper price for aggregate base. We had a great stockpile location nearby.
- It does a great job in preventing reflective cracking from coming through as fast as it otherwise would have. We also have used a stabilizing agent in the reclaim material prior to placing the final base and wearing surfaces of bituminous mix for added strength.
- It can be used as a best value contracting method to save on trucking of the millings.
- We are very happy with the end results, giving our farm to market road system the design the locals need.
- Excellent alternative when existing aggregate base is sufficient to combine with existing bituminous.

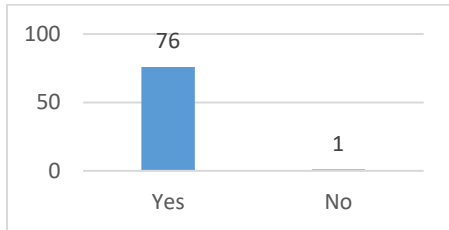
- **Condition of Road**

- The pavement was in poor condition and there was not much base under the pavement.
- A poor road surface lasts longer with FDR and an overlay than just an overlay.
- Depends on existing road condition and striping in the bottom portion of the pavement. If it is severe enough mill and overlay is not a great option.
- FDR seems like the best alternative once the pavement has deteriorated enough that a mill and overlay is not recommended. (If the municipal utilities do not need replacement.)
- Our selection of FDR over other preservation projects is primarily driven by existing road conditions and particularly road cross-section including slopes and shoulder widths.
- When determining which alternative to use, we also look at the cost of different options, constraints (can the elevation of the pavement change?), existing pavement thickness, expected life of improvements, and soil conditions/strength.
- "We are doing extensive Geotech study on 130 miles of roads to identify streets for FDR on adequate subgrades. We want to avoid doing it on poor subgrades.
- The full depth reclamation projects that I have been involved with so far have only been on parking lots - no City streets or rural highways. There were no existing underground utilities to consider and the pavement condition was too poor for overlay/mill & overlay.
- Pavement was thin so recycling existing bituminous into the base seemed like the best choice.



- **Agency Experience**
 - Project experience was gained prior to joining the City. The City has never done one of these projects.
 - Our FDR projects have also included the injection of an emulsion to create a stabilized base. Stabilizing the base has decreased the thickness of the asphalt required, when compared to an un-stabilized base, and significantly reduced reflective cracking.
 - We have been doing FDR's since 2002 with good results. It provides us some added structure with eliminating the perpetual cracking one would get with a mill and overlay
 - We have also done Broad Area Patching to stretch maintenance funding with the intent to build up the pavement section to allow a future project which will mill underlying gravels with old and recent bit surfacing, along with a few more inches of aggregate to result in Milling/reclaiming a new aggregate base that has thickness of 6 to 8 inches before a new pavement is placed ten years from now . This has been done on one neighborhood about 2014 and the bituminous and milled base has performed quite well."
 - Our rural highway project included shoulder widening and re-shaping ditches and backslopes. This leaves an unconfined edge which has been problematic for CIR on past projects. FDR allowed us to reclaim the pavement, base, cap with Class 5 and new bituminous pavement raising the road profile 8".
 - The last two FDR's we have done we stabilized with oil.
 - For urban cross sections, we will do a full depth mill and replace. FDR will not work to meet the existing curb and gutter elevations, unless you remove all the material, at which point it is easier to mill and load straight into haul trucks.
 - Typically choose FDR where both of the following conditions are met: (1) older pavements where the underlying pavement has lost its structural stability to the extent that a mill and overlay would result in excessive reflective cracking and (2) where additional structural strength is needed to support the new bituminous pavement structure. To preserve existing shoulder width and to reduce the amount of bituminous material in the FDR for a better FDR mix, will typically mill off top 2-4" of bituminous pavement prior to performing FDR.
 - Need to resurface and should do a complete reconstruction but did not have the funds. Decided to resurface now and could do a shoulder widening job in future if funds become available.
 - Structural capacity was a concern for 2020 projects. The roads previously were only 9-Ton design and we want to achieve 10-ton design. It was difficult to accomplish with overlay or mill and overlay.
 - Underlying public utilities did not need replacing and curb and gutter was generally good as well. We chose FDR with cement stabilization as it provided the structural benefit to the pavement structure at a noticeably reduced cost compared to a full reconstruction.
- **FDR not a good technique**
 - Frost cracks and heaves projected through immediately, not a permanent solution
 - CIR & HIR leaves a portion of the underlying pavement in place and generally allows reflective cracking within a few years. From what I have seen there is not enough savings to consider those options over FDR. The road in question is too far deteriorated to overlay.
 - FDR usually means a finished surface several inches higher than the existing road, so that affects driveway and other approaches. Also, with the higher elevation, to maintain the existing foreslope, you end up losing some of the shoulder, or the foreslope will get steeper
 - With FDR, you get pavement performance like a reconstruction project without the additional costs. Some pavements are too far deteriorated for the cost/benefit of a mill & overlay. Only disadvantage of an FDR is it raises the road profile so a roadway with narrow shoulders might not be a good candidate of an FDR due to safety.

Question 6A: Would you do it again?



Question 6B: If you answered “yes,” please explain why you would do it again.

- **Same reason as given above**
- **Improves Pavement Quality / Overall Successful**
 - Our FDR projects have also included the injection of an emulsion to create a stabilized base. Stabilizing the base has decreased the thickness of the asphalt required, when compared to an un-stabilized base, and significantly reduced reflective cracking.
 - We are still a growing county with a lot of truck traffic and many of our roadways were not built with adequate aggregate base or pavement thickness. FDR gives us an opportunity to reset everything and have a quality pavement section that can hold up to the current and projected traffic.
 - It is great to be able to eliminate all of the existing pavement cracking with an FDR and place pavement that will do a much better job resisting rutting and low temperature cracking.
 - FDR eliminates the existing cracks and improves the aggregate base. The new surface lasts longer.
 - You have to pick the right roadways to do this on. when you need to add strength to a roadway this is one of many types of projects where you can gain strength in roadways. If you are in an urban area, it is hard to match driveways with this type of project. This would not be a good situation for rural areas.
 - It is the best method to get the longest life out of the pavements on our rural highways.
 - Very happy with the results. Longer pavement life vs a mill & overlay. Public perception to reflective cracking after 1-3 years is not good.
 - Road surface does not have as much reflective cracking like mill and overlays
 - Adds structure with bit properties. No excavation and reduced aggregate
 - Have experienced good results on previous projects.
 - Better quality and longer life span
 - It is a way to replace more pavement and it will perform okay with adequate base.
 - Historically have performed well from past experience
 - Provides good value to municipal clients when a complete street reconstruction is not needed.
 - Good solution in some situations.
 - We've had good results in the past.
 - FDR give you the chance to bring the roadway surface back to an even, well compacted base layer with added roadway structure for newly placed surfacing
 - "It works.
 - The FDR projects we have done have all been successful at achieving desired outcomes.
 - Have used many times and it works to reduce reflective cracking and improving structural strength. Minimal impact to shoulders."



- It has worked very well on the roads where we have adequate width to add strength to the aggregate base and eliminate reflective cracking.
 - For the conditions described in question 7, FDR is the most economical and sustainable option that results in lower project cost and less consumption of limited aggregate resources.
 - The FDR or SFDR projects turned out very well
 - It appears to work. No reflective cracking.
 - Gets rid of reflective joints and results in a thicker base.
 - The repair is holding up very well.
 - On a surface reconditioning project one can use the existing material to strengthen the road section
 - We have had very good results and it provides an easy avenue to get a 10-ton route.
 - The FDR projects we have done have all been successful at achieving desired outcomes.
 - Have used many times and it works to reduce reflective cracking and improving structural strength. Minimal impact to shoulders."
 - You fully rehab the treated aggregate pavement base and bituminous pavement for about twice the money than a mill/overlay.
 - We have had some FDR in place for 10 years and they are performing well.
 - While you do not address in slopes and shoulder width, the improvement is appreciated by the travelling public.
 - Worked well
 - FDR and bituminous overlay have become our standard for rural pavement preservation because it retards the time that the reflective cracking comes to the surface.
 - The construction process is simple, the roadway is kept open, the results gained from it produce a solidly constructed roadway.
 - Eliminates cracks from coming back through unlike mill and overlay or overlay, reuses materials on hand so it is quicker and less expensive than a reconstruction so in the right circumstances it works.
 - It helps buy time and good use of existing materials before the total reconstruction project happens.
 - Pavement performance is better with an FDR.
 - better roadway when completed.
 - Using FDR, city streets are able to have two new lifts of asphalt which seem to provide a longer life.
 - Projects turn out great with FDR
 - Use of existing aggregates and makes use of existing bituminous as well. Highly efficient if can leave mixture in-place, compact and pave new bituminous courses.
 - Good long-term solution to pavement fixes when utilities underneath are still in good shape and don't need much work.
- **Cost-effective**
 - It is a cost-effective full pavement replacement project.
 - It's a lower cost alternative to reconstruction and provides you with much of the same benefits. It can provide you with a stronger road and correct issues with rutting, severe cracking, etc.
 - Cost effective. Longer lasting improvement than overlay.
 - Cost effective alternative for our type of projects
 - Cost-effective pavement improvements while minimizing restoration costs and no reflective cracking issues.



- cost effective way to increase pavement base thickness and minimized need to remove material from the project
- The FDR projects we have done have all been successful at achieving desired outcomes.
- Have used many times and it works to reduce reflective cracking and improving structural strength. Minimal impact to shoulders."
- Reuse of existing materials rather than purchasing new (recycling-green)
- We have a regular program of FDR that provides a cost-effective compromise when resurfacing a road is no longer viable and reconstructing it is not in the budget.
- This works well on rural county roads as a cost-effective way to get a new pavement structure. We have one scheduled as part of a shoulder widening project. The FDR will supply the aggregate base for the roadway and shoulders while keeping a similar roadway profile.
- It is cost effective. It is a fairly simple process. It is environmentally sustainable since new gravel does not have to be hauled in. Our roads only need new curb if the utilities underneath are being replace (e.g. water main).
- Very cost-effective way to reconstruct neighborhood street pavements.
- cost effective fix for certain pavements
- On roads that were reconstructed in the last 20 years or so, the FDR seems to be a cost-effective solution. If the graded width is there, i.e. having existing gravel shoulders, the FDR project seems to make sense.
- Cost effective/sustainable methodology to renewing street infrastructure
- In the correct circumstances it can give you the best results at a cost that is cheaper than reconstruction.
- lower price than importing aggregate base. Quality of material produced met MnDOT spec
- Cost savings and why send good material off of the project site.
- Extremely cost effective to use recycled reclaim.
- Cost effective alternative to reconstructing the roadway.
- Best and most economical way to rebuild the roadway.
- **Good Alternative**
 - I will continue to consider full depth reclamation as an alternative to reconstruction under certain circumstances - underlying utilities are not in need of replacement, existing pavement condition is for mill & overlay, etc.
 - In the right situation where the pavement is in poor condition and there is not much base, we would do a FDR. We would also consider using a base stabilizer and/or adding class 5 and then paving.
 - It is the best option for a lot of our roads in the current condition they are in.
- **Other**
 - It's a tool in the toolbox. There has not been an urban application for it - but if there was one, I would be open to doing it.
 - We have a plan to do this on a series of rural roads. We are reviewing 130 miles of roads with Geotech data. Some urban FDR will be considered if the science supports the technique
 - We have been considering it on a couple roadway segments where there is no existing curb and gutter. We are investigating the appropriate additive (cement, emulsion, Base One, etc.) that will meet our needs and expectations. We have serious concerns with its use in areas where multiple utility infrastructure exists.
 - All our paved roads are 8"+ with bituminous and 8"-10" aggregate base. Doing an overlay wasn't needed.



Milling off the top 4" gave the County material for RAP in new mix, material to shoulder the road with and we get the left-over millings to use as we wish.

Question 6C: If you answered “no,” please explain why you would NOT do it again.

- no, meaning yes if you have the right conditions FDR gets applied when the game is too late

Question 7A: For those that answered “No” on Question 2, why haven’t you used FDR as a rehabilitation technique?

Cost	2
Unfamiliarity with FDR, lack of knowledge/understanding of the benefit	7
Prefer other rehabilitation techniques	2
Other alternatives are easier to implement/contract	3
Lack of contractor	1
Other (please specify)	3

- I have heard they are not appropriate for urban residential projects
- Not sure how it works on suburban streets--excited for the results of this study
- Loss of roadway width

Question 7B: If you answered, “Prefer other rehabilitation techniques,” please list the techniques that you prefer.

- Mill and Overlay
- NA

Question 8: What concerns do you have regarding FDR?

- **None**
- **Narrowing of Road**
 - It narrows the available road so can only be done if you can afford less width.
 - Cost. Losing some shoulder width.
 - The only concerns I have is that you lose shoulder width.
 - Narrow width of roads not allowing an option of an FDR.
 - Limited width resulting from increased profile elevation
 - On many FDR projects, shoulders get too narrow and slopes get too steep if a portion of the bituminous pavement is not milled off prior to FDR
- **Stabilization / Poor Base**
 - In areas with poor soils, what needs to be done to stabilize the soils.
 - On most urban streets, there would be overall loss of aggregate base thickness since the surface elevation is typically controlled by existing curb and gutter and some of the reclaimed bituminous/aggregate surface needs to be removed to make room for the new bituminous surfacing. On an urban street, I would probably investigate stabilizing the reclaimed base to account for this. On the projects I have been involved with, we have been reclaiming slightly into the subgrade level below the aggregate base to include some fines, and this has generally resulted in high quality reclaimed base. The reclaimer needs to move more slowly than when reclaiming bituminous for recycling for achieve the correct gradation/consistency in the reclaimed base.



- If it rains and the grade turns to a technical term "crap". If there are bad soils where it may not perform, or the base may not setup as anticipated. In situations, where a road has already had an FDR it may be high in previously applied oils and could have an issue with smell/high odors in neighborhoods or setting up. If your aggregate base is inconsistent thickness it may cause an issue with consistency and quality of work. In higher volume areas I am concerned about leaving the roadway open without any pavement on it for a long time because it can rut, create potholes and will be hard to grade/pave.
- Premature failure if done on poor base. It is challenging to work around existing utilities in the pavement. We would be uncomfortable doing it with any utility trenching because of potential for settlement and premature failure
- What is the minimum aggregate and bituminous section recommended using FDR?
- Poor soils beneath the road and the variations of pavement thickness and street section
- Some streets do not have enough aggregate material underneath which requires a larger rock to be blended or material flopped to excavate the subgrade can add costs.
- Underlying subjective subgrade soils
- Potential subgrade weakness leading to pumping while trying to get density on the reclaim material.
- Gradation. Contractors complain about the issues with the large chunks, making it difficult to tolerance, etc.
- Deciding whether or not to use stabilization and curing period required...
- Whether or not if the FDR needs to be stabilized.
- how to include utility work and subgrade corrections without turning into a reconstruct
- Deciding whether or not to use stabilization and curing period required...
- If done with cement or some other type of soil stabilization, requires cores/borings of existing roadway and likely the use of geotech consultant to determine soil stabilization "recipe".
- **Vertical Constraint**
 - Streets are constrained vertically by curb and gutter. FDR increases the roadway thickness - so we'd have to rebuild the entire road taller, which means new curb and gutter, and severe impacts to existing building access along the construction route.
 - Constructability sometime. In Ramsey County, we typically have a number of access points and limited ability to raise the road profile. In doing so, we typically with remove excess material after the reclamation to preserve the existing profile.
 - raising the profile and adequate structure and drainage
 - Matching driveway grades in urban setting.
 - Roads typically get higher
- **Excess material**
 - Calculating excess material to be haul off site.
 - If curb is remaining, excess reclamation must be removed. "
- **Pavement Condition**
 - There have been some roads that were FDR and then gravel was added to the top and then paved. These roads developed some ripples in the pavement. It was thought that the asphalt in the FDR was trapping moisture.
 - Soft spots or frost boils creating problems.

- Surfacing to soon without letting the FDR section "set" causes soft spots.
- How to properly inspect it. When is this a viable option if pavement is too far gone will this still work?
- long-term performance
- **Cost**
 - Not sure if the extra costs are worth it. We generally will reclaim the existing pavement and place a new bituminous surface over the top. We will get approx. 15-20 years out of this procedure.
 - Cost. Is it a 20-year solution?
 - Overuse of FDR versus mill and overlay, which results in higher costs and greater use of bituminous and aggregate resources.
 - Costs have risen over the last few years which in turn causes us to pave fewer miles.
- **Drainage / Moisture & Compaction**
 - Raising the grade too high in order to match driveways"
 - If pavement cannot get placed soon after reclamation, the reclamation is susceptible to moisture and contamination.
 - Too many overlays can cause the mixture to become ""oil heavy"" and then typically behaves differently with respect to rainfall and compaction."
 - Attaining adequate compaction on FDR material can be challenging, especially if the FDR is exposed to prolonged periods of wet weather.
 - Sometimes the gravel is very sandy, and it makes it difficult to get good compaction.
- **Expectations**
 - There is sometimes an expectation by elected officials that the FDR will provide the same level of improvement/life that a full reconstruct would.
 - It is not always easy to tell if the contractor is doing the process correctly to generate the best possible reclaim material.
- **Quality / Consistency Mixture**
 - Problems with the mixture consistency. "
 - Consistency with maximum particle size - which is longitudinal speed and RPM related.
 - Quality of the mixture.
 - Durability of the mix.
- **Urban Setting (general)**
 - How would you apply the process "train" to the urban setting? Are the costs and benefits comparable to other techniques?
 - underground utility failures
 - how to include utility work and subgrade corrections without turning into a reconstruct
 - Utility infrastructure within the roadway.
- **Other**
 - In the past, we have opted for removal and replacement of pavement in urban section rehabilitations, rather than FDR. In some situations, this may be a more effective alternative.
 - We time our pavement rehab with utility work. So outside of seal coating, we do not do much, if any full rehab outside of full reconstruction projects.
 - We have a roadway that had an FDR in 2006-2007 with 5.5" of bituminous pavement placed over the top. The roadway has seen very significant rutting and structural failures due to truck traffic. Since this project



we have stabilized our FDR's with good success.

- Meeting gradation, stockpile location when utility work is open trench.
- How best to do the material design. Pre bid by agency or post bid by contractor.
- Obtaining accurate data on existing pavement section. GPR and spot borings appear to help us understand if FDR is a good candidate.

Question 9: What additional information/questions do you have about FDR that you'd like this research project to address?

- **None**
- **Stabilization / Gradation / Aggregate Base**
 - On an urban street, are most agencies stabilizing the reclaimed bituminous/aggregate?
 - What should the aggregate base material consist of, what is the mixture of bituminous and aggregate base be when reclaimed for optimum performance?
 - Stabilization Methods.
 - It might be a good idea to consider additives to the base to firm it up. We also need to make sure the base has adequate drainage. Meeting class 5 spec is important.
 - Limiting amount of recycled concrete should also be studied. No base of 100 % recycled concrete should be allowed because it prevents drainage and tents pavements. We restrict use of recycled concrete to 25 % of the base."
 - What is the GE value per 1" of a FDR?
 - What road or subgrade conditions warrant a FDR versus a reclamation project?
 - Define "full depth". Does it include the aggregate base?
 - -Asphalt Emulsion
 - -Cement
 - -Base One"
 - Whether or not base stabilization additives are beneficial, or if the bituminous left in the reclaimed base material is adequate.
 - Is there a minimum depth of pavement section that you must have in order to use FDR? We've had contractors try other methods to create RAP/reuse existing aggregate and we ended up with too much sand in the aggregate given the thin existing pavement section. Are the gradation standards different for FDR?
 - Recommendation of existing bit to existing aggregate ratios."
 - It would be helpful to have guidelines for evaluating when to specify stabilized full-depth reclamation, and which stabilizing agent to specify.
 - Additives and their appropriate uses.
 - Pavement life span especially when using a stabilizing agent. Long term effect on ride quality. Effects when excess moisture is present during construction.
 - Different options for stabilizers
 - What is the best gradation for FDR
 - How much (if any) rock should be added to the FDR before it's mixed in?
 - we have done a project where we had grading and had to stockpile the milled bit/aggregate material then bring it back onto road top after grading was completed. Worked out just fine.
- **Cost & Contracts**
 - I would like to see cost comparison of FDR to CIR or HIR.
 - Do you need to allow flexibility during construction and how do you manage those costs and contracts?



- What is the cost per SY of a FDR?"
 - Best practices. Mix designs when using SFDR. Is there benefit in hiring a consultant to perform a mix design?
 - Cost info
 - Cost effectiveness to Base One etc.
 - What is the cost vs. benefit of FDR vs. SFDR vs. CSFDR?
 - Are there enough businesses doing it, that we will have access to the equipment if we specify using it.
- **Effects to Curbs/Utilities**
 - What affect do utilities have?
 - best practices for urban curbed sections to minimize potential damage to curb and utilities such as valve boxes and manholes in street along with when to use to minimize need to remove material from project
- **General**
 - Successes, failures. What to look for, what went correctly, what did not go as well.
 - "Best practices
 - Specification templates
 - life cycle comparison to other methods reconstruct or deep mill/overlays
 - When to stabilize or not stabilize.
 - I would be interested to see a summary of the information requested herein attained from the counties.
 - best cases to use FDR vs. HIR and CIR
 - would be nice to have a specification more geared toward local agencies rather than having to rely on MnDOT specs, which tend to be more directed towards larger highway projects.
 - We have not done FDR in urban settings, so all of the various challenges should be addressed (manhole castings, gate valves, matching into curb & gutter, etc.).
 - Dust control. Cement blows when spread on the road. Tilled soil is dusty too.
 - Speed & RPM.

Question 10: What specific questions do you have regarding using FDR in urban settings?

- **None**
- **See previous questions**
- **Cost-effectiveness**
 - "Cost effectiveness vs. other alternatives
 - Life Cycle Cost Evaluations
 -
- **Traffic**
 - Traffic control. Much longer impacts to residential access.
 - How long is a street closed for this type of work?
 -
- **Constraints to Accesses, Sidewalk, Curb and Gutter, etc.**
 - how to address the additional thickness from the FDR and the new surfacing."
 - Increased pavement section - how to match into driveways, curb and gutter, adjacent streets, etc. "
 - This would only work where there is no Curb and Gutter, ADA sidewalk, or the Curb and Gutter and sidewalk is planned to be redone?

- with a curb and gutter section, you might have to mill material and haul to a site to crush and bring back depending on the strength requirement of the road you are redoing. You will have material left over though in the end for other uses.
- If curb is remaining, what advantages does FDR have compared to remove and replace bituminous.
- If curb and gutter is left in place, do they first remove some material in order to lower the finished surface elevations and better match gutter heights?
- When does necessary concrete curb replacements become prohibitive (25% is our "rule of thumb")?
- How does it impact curb and gutter?
- We have not used it in urban settings. If we did consider it, we would have several concerns including, but not limited to: How it would match into existing curb & gutter; how it would work with manhole castings, gate valves; and storm sewer structures?
- Matching into existing curb & gutter because and FDR with pavement raises the profile.
- "How does this work with urban design when curb and gutter controlling the road grade? Assume material needs to be ground up, some hauled out and pavement replaced to match gutter line?
- How do you prepare manholes and gate valves for the FDR or do you go around them?
- What are common methods for matching existing curb and gutter?
- How close can the mill get to a B6 curb (no gutter pan)?
- How can the process be utilized with utility castings and valve boxes within the pavement?
- How would you do it, without replacing the curb and gutter at a higher elevation?
- We've only used FDR in rural areas due to the need for removing material in a curb and gutter section. In urban areas, we have strictly used milling.
- **Process Train**
 - "How can the process train be utilized in residential neighborhood settings?
 - How do you fit the train on short residential segments or cul de sacs? How do you work around manholes and catch basin? How long do you impact traffic when going through an intersection? Is there a minimum size of the project/road length in order to get decent bids?
 - The equipment train appears to be quite long and un-maneuverable in a curvilinear residential neighborhood with cul-de-sacs
- **Reclaim and Excess Material**
 - Where does the excess go? How do you work around structures? Seems like there would be double handling of material which would increase costs. Would it be worthwhile to use if you had thin pavement thickness? What about stabilizing in urban settings?
 - Best practices - reclaim and remove excess material? pre-mill? Remove and replace curb & gutter to change elevation of roadway? etc."
 - Isn't this about the same as removing the material and recycling it at a plant site?"
 - Calculating excess material to be haul off site.
- **General**
 - What are some of the benefits/problems conducting this work in an urban setting?
 - How it can be done effectively with all of the challenges in an urban setting?
 - "best practices
 - What benefits or advantages would this pavement rehabilitation method have over other methods