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September 13, 2013

Ms. Robin Barton
Big Country Acres
Foristell, MO 63348

RE: Big Country Acres Improvement Plans

Dear Robin,

Thanks again for having me out to meet with you regarding some of your questions about facility improvements. Here is a rundown of some of the items that we discussed, and if you ever have questions, feel free to give me a call.

Roadway Improvements

After a brief inspection of the roadways within Big Country Acres, it looks like the bituminous pavement currently in place is structurally sound. I noticed some surface cracking as well as a few areas where the edges of the roadway have become damaged. Before doing any work to the surface of your roadways, you will want to make sure that you patch any areas where potholes, breakoff at the roadway edges, or deteriorated patches exist. Here are a few options to maintain your roadway surface as we discussed.

- *Asphalt overlay*: Typically a full surface course asphalt overlay would be around 1.5" – 2". You can either mill off the existing surface and have the new asphalt surfaced placed, or you can just place the new asphalt on top of the existing surface. The cost to place an asphalt overlay would be near the range of $8.00 - $11.00 per square yard. The expected life-span of an asphalt overlay could be in the 10 – 20 year range depending on conditions.

- *Micro-surface*: A micro surface application consists of the placement of a thin layer of asphalt mixture, typically around 3/8" over the existing pavement. Micro-surfacing can increase skid resistance, cover surface cracks, and fill any areas of rutting. The cost of micro-surfacing is estimated around $3.00 per square yard. The expected durability of a micro-surface application is 5 – 7 years. However with the low volume traffic on sub division streets, it is possible that this life span is increased.

  Contact for any specific questions on cost or application of micro-surfacing:
  Missouri Petroleum
  1620 Woodson Road
  St. Louis, MO 63114
  (314) 991-2180

- *Ultra-Thin Asphalt Overlay*: The ultra-thin asphalt overlay is a relatively new application, and is being used by subdivisions, municipalities and DOT's. The ultra-thin overlay is the application of asphalt at a thickness of 1/2" – 7/8". The ultra-thin asphalt overlay has a similar cost to micro-surfacing near $3.00 - $4.00 per square yard. The life expectancy of this application would generally be longer than a micro-surface treatment, typically in the 7-10 year range.

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Contact for any specific questions on cost or application of Ultra-Thin Asphalt Overlay

West Contracting
2780 Mary Avenue
Brentwood, MO 63144
(314) 962-3145

Drainage Improvements

- *Slope Stabilization:* There were a couple of areas near the large cross culvert at the pond where you mentioned having some erosion problems. If these are areas where a large amount of stormwater runs off of the roadway, one solution would be to cover these banks with riprap (large rock). This will help to protect the surface from eroding, and also slow down the runoff to prevent further erosion downstream.

- *Culvert Crossings:* You had asked about maintenance for the culvert crossings that are in place. The costliest method to repair any damaged pipes would be to remove the pipe and replace it. Along with the cost of the new pipe, you will incur cost for removal of the old pipe, backfill, and removal/replacement of a portion of the street. An alternative to replacing an existing pipe would be to slipline the existing pipe with a plastic, HDPE pipe. This will involve inserting a new HDPE pipe into the existing culvert. Attached is a document from ADS, a plastic pipe manufacturer and dealer, which details the installation techniques for sliplining an existing culvert.

- *Existing 72" CMP Culvert:* As was discussed in our meeting, currently the existing 72" CMP culvert has had a new CMP installed in roughly half of the pipe. Regarding the question asked as to whether or not a plastic pipe could be installed in the remaining half, I would not recommend using two different materials to slipline the pipe. Most likely the flowlines of each pipe would not meet, which could cause further leaks. If in the future you experience any erosion problems at the spot where the two new pipes meet, you can excavate around this joint and place a concrete collar or CMP band around this joint, in order to from a seal around the joint and prevent any further infiltration. This is assuming the integrity of the pipe still exists.

  Also, regarding erosion around the ends of the 72" CMP Culvert, stone riprap could be placed around the exposed ends of the pipe, to prevent any further erosion around the pipe.

This is a synopsis of what we discussed, with some recommendations based on a brief site visit. If you would like more information such as specific price or application on some of the roadway improvements that I discussed, I would recommend contacting the companies that I mentioned, as they could explain their products in greater detail.

Respectfully,

THOUVENOT, WADE & MOERCHEN, INC.
EDWARDSVILLE REGIONAL OFFICE

Matt J. Kitzmiller, P.E.

ENCL: Culvert Sliplining with HDPE Pipe

Repair Techniques

Crack Sealing with a polymer modified asphalt material provides flexibility so that the material can flex when the pavement moves under traffic loading. The material is applied to pavement cracks after the cracks are cleaned. Crack sealing is a preventive maintenance technique that prevents water intrusion into the base material thus preventing base failure. Crack sealing done by in-house forces is $0.48 per linear foot and through contract is $0.55 per linear foot.

Skin Patching/Paving is the placement of asphalt concrete in thin layers up to 1½ inch, either manually (skin patching) or using paving machinery (skin paving). Patching is done in small areas or quantities where using the paving machine is not feasible or economical. This type of treatment is often done to provide a wearing surface over badly cracked and deteriorated pavement or to level pavement surfaces to provide better drainage. Skin Patching and Paving is $1.71 and $0.66 per square foot, respectively using in-house forces and is $4.11 and $1.86 per square foot using contract forces.

Base Failure Repair (Dig-Out) is the removal of existing pavement and underlying base and sub base material as necessary, to a depth where stable material exists. This void is then replaced with either full-depth asphalt concrete or a combination of asphalt concrete and aggregate base materials. The cost of base failure is $4.33 per square foot performed by in-house forces and $9.43 per square foot by contract.

Figure 9: Base failure repair.

Pothole Patching in good weather is similar in process to base failure repair with complete removal and replacement of affected material. Potholes often appear in inclement weather which does not permit full repair. In this situation, temporary repair involves cleaning out the hole and filling it with a premixed asphalt patching material. The cost of pothole repairs varies by the size of the damage and the type of repair. The average cost for in-house repair is $12 per pothole.

Maintenance Techniques

Slurry Sealing is the process of applying a mixture of asphalt, rock, additives such as lime or Portland cement and water to an existing road surface forming a thin impervious surface layer. Slurry seals need approximately six hours to fully cure depending on weather conditions. Parking and access to the street is limited on the day of application but streets are rarely closed overnight for slurry seal work.

Figure 5: Slurry Seal Application

Modified slurry seals include a latex polymer that allows the surfacing to remain more flexible through the material life rather than becoming brittle. These seals are very susceptible to damage from power steering tire scuffs but they tend to heal and smooth out with traffic depending on the severity of the damage.

The average thickness of a slurry seal is 3/8 inch. Slurry seals are used throughout the city for streets in good condition that are starting to show the early signs of deterioration. Slurry seals provide a water barrier by covering existing cracks and create a thin wearing surface over the existing pavement. Slurry seal treatments are expected to last approximately 7 years and have an average cost of $1.05 per square yard.

Chip Seals spread a layer of hot asphalt oil on the pavement surface and cover it with rock "chips" which are compressed with a rubber tired roller. The oil holds the chips in place and also seals the surface of the existing pavement to prevent water intrusion. Chip seals can be driven on at slow speeds immediately after the roller is finished but roads are typically kept closed for approximately six hours to allow further curing before reopening to traffic.

Figure 6: Chip seal oil application is immediately followed by placement of the chip.

Chip seals are seldom used in residential areas of the City due to their unpopularity due to loose rock and the need for excessive, slow speeds when driving over them in the first few weeks after placement.

The average thickness of a chip seal is 3/8 inch. Chip seals are used for streets that are beginning to show more advanced signs of aging and more severe distresses that Slurry can not repair. Chip seals provide a water barrier by penetrating and sealing existing cracks and create a thin wearing surface over the existing pavement. Chip seals are expected to last approximately 5 years and have an average cost of $2.50 per square yard.

Scrub Cape Sealing is a two-day, combination surface treatment that includes the chip and slurry seals and the application of a rejuvenating emulsion – a polymer modified asphalt-rejuvenating agent, mixed with water. Scrub cape seals are used as an alternative to chip seals.

The emulsified oil is sprayed on the surface of the pavement and then a specially designed drag broom scrubs the oil into the pavement, which fills the voids and cracks in the pavement. This is followed by a layer of rock chips as is done in the chip seal application. On the second day of application – often separated from the initial application by a few days to a few weeks - a slurry seal is applied over the rock chips creating a smoother surface. Both days of treatment will have the road closed during the work day.

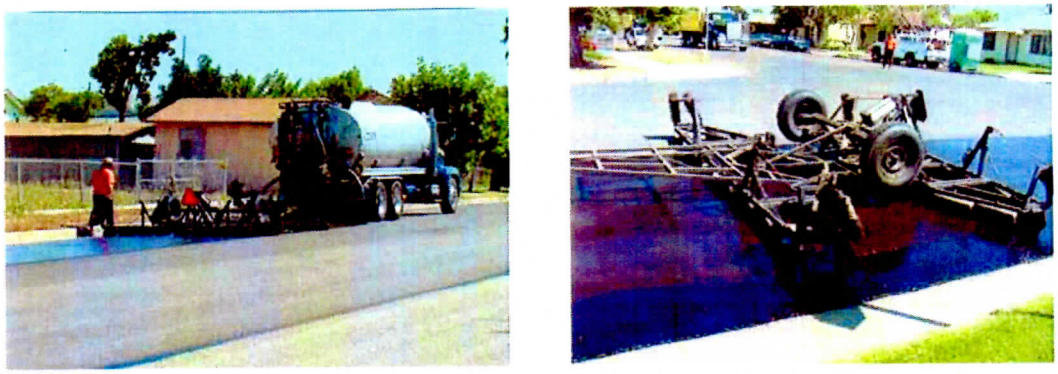


Figure 7: The drag broom is attached to the oil spray truck and the brooms force the oil into the pavement.

The average thickness of a scrub cape seals is 3/4 inch. The treatment is more advanced than a chip seal and is sufficient even for roads with mild to severe distresses. The scrub cape seal treatment rejuvenates the existing pavement surface by adding fresh asphalt oil. It also provides a water barrier by penetrating and covering existing cracks and creates a double layer wearing surface on the existing pavement. Scrub cape seals have an expected life of 7-9 years and an average cost of $3.23 per square yard.

Fabric Cape Sealing is a two-day combination treatment similar to the scrub cape seal. On the first day, before the first layer of oil is placed, hot asphalt oil is sprayed on the pavement immediately followed by the placement of paving fabric which becomes fully embedded in the oil. This is followed by a standard chip seal process. The chip rolling ends day one and the roads can be opened. On the second day of application – often separated by a few days to a few weeks - a slurry seal is applied over the rock chips. Both days of treatment will have road closures during the work day.

Figure 8: Fabric rolls are mounted on oil trucks; the fabric is applied immediately to the hot oil.

The fabric cape seal has been used recently as a way to save failed pavements that have sound base material. In extreme cases where the pavement is severely broken, a thin overlay will be placed before the treatment to provide a smooth surface for the fabric to adhere to. The fabric helps prevent reflective cracking – when cracks from the original surface propagate up through to the new surface. The fabric also stabilizes distressed pavement that is beyond typical repair methods until such time that reconstruction is possible.

The composite thickness of the fabric cape seal is approximately 3/4 inch. Fabric cape seals provide a water barrier by penetrating and covering existing cracks, prevent reflective cracking and create a double layer wearing surface over the existing pavement. The expected life of the treatment is 10-12 years at a cost of $5.40 per square yard.

Micro Surfacing is a polymer modified paving system developed in the 1970's in Europe. The product was developed as a very thin paving surface that could be applied in multiple layers to fill ruts. The material remains hard enough to fill the ruts and the polymer modification allows it to stay flexible and not get brittle.

Micro surfacing is a a one day treatment unless rut filling is required. It is similar in application and cure-time to a slurry seal and will also require road closures and parking restrictions. Micro surfacing cures into a harder surface and as a result is less susceptible to power steering tire scuffs. It is also good for use in areas with higher traffic volumes.

The average thickness of micro surfacing is 3/8 to 5/8 inch. Micro surfacing creates a water barrier by covering existing cracks and creates a thin wearing surface over the existing pavement. The treatment is expected to last 7-9 years at a cost of $2.31 per square yard.

$3.22 SY

salt?

Rehabilitation Techniques

Thin Asphalt Overlay is a type of pavement rehabilitation that improves the driving surface and extends the life of the pavement. This treatment may include grinding off the surface layer of pavement and replacing it with a new layer of hot-mixed asphalt. The grinding is often used to prevent excessive crown on the road, to ensure drainage in the case of edge only grinding or to provide a rough surface for better adhesion between asphalt layers. The street is typically closed to traffic and parking for all or part of the work for most roadways. Thin asphalt overlays up to 2" thick cost on average ~~$20~~ $10/square yard.

Thick Asphalt Overlay is similar in placement to a thin overlay. Thick overlays in contrast are intended to increase the structural section of the roadway. The grind does not remove a significant amount of the existing pavement if it is in good condition. The intent is to add asphalt concrete to the pavement section. Access is typically limited or completely restricted for all or part of the project. The cost of an overlay between 2-4 inches is ~~$35~~ $20/square yard.

Reconstruction is the complete removal and replacement of an existing pavement, base and sub-base. The work associated with road reconstruction usually will typically incorporate any underlying utility repair or upgrade requirements to avoid unnecessary trench cuts through the new pavement for this work. The road is typically closed for the duration of the project with limited, non-work hour, access for local traffic. The average cost of road reconstruction is $90/square yard.

TECHNICAL NOTE

Culvert Sliplining with HDPE Pipe

TN 5.06
January 2010

Introduction

An abrasive or corrosive environment can cause premature deterioration of some types of pipe. In lieu of a total replacement, sliplining the existing pipe with a durable material may be an economical method to significantly extend the service life. Polyethylene pipe, because of its resistance to aggressive environments, is often the product of choice to slipline deteriorated pipes. This technical bulletin describes the site and installation considerations that must be evaluated before using HDPE pipe in these applications.

Access to the Host Pipe

The "host" pipe may be open on both ends, as in a culvert application, or it may be accessible only through a manhole opening, as in a storm sewer application. Open-ended applications are more appropriate for HDPE pipe products, provided they do not require the pipe to be bent in order to enter the host pipe. If access can only be made through a manhole, HDPE pipe products may not be acceptable because they cannot be bent sufficiently.

Diameter of the Host Pipe

The greater of either the outside diameter of the HDPE pipe or coupler should be compared to the inside diameter of the host pipe. This may be accomplished by attempting to pull a short section (~2 feet in length) through the host pipe as a trial run. The host pipe should be clean; free from sediment and debris so as to not interfere with the installation of the liner pipe. Sliplining installations may be subject to thermal length changes of 0.07-inches per 100 feet of pipe per change in degree F. One should design to allow for these changes during installation. To allow for proper grout placement and clearance, the reline pipe should have a maximum outside diameter no greater than 90% of the inside diameter of the host pipe. The maximum outside diameters of ADS products are shown in Table 1.

Table 1
HDPE Pipe Dimensions

Nominal Inside Diam. in (mm)	Max Outside Diam. in (mm)
4 (100)	4.8 (122)
6 (150)	7.0 (178)
8 (200)	9.5 (241)
10 (250)	12.0 (305)
12 (300)	14.5 (367)
15 (375)	17.8 (452)
18 (450)	21.5 (546)

Nominal Inside Diam. in (mm)	Max Outside Diam. in (mm)
24 (600)	28.4 (721)
30 (750)	35.6 (904)
36 (900)	41.4 (1052)
42 (1050)	48.0 (1219)
48 (1200)	55.0 (1397)
54 (1350)	61.0 (1549)
60 (1500)	67.3 (1709)

Length of Installation

HDPE pipe joints are not designed to withstand large pulling forces. Furthermore, pushing the liner pipe in through the host pipe may damage the corrugations at the pipe ends as they butt up against each other. The method of installation will affect, in large part, the maximum length that can be slip lined without damaging the pipe. Using skids, especially in a corrugated host pipe, will help minimize resistance between the two surfaces. Skids could be as simple as a pair of 2X4's placed near the invert. A push-and-pull technique keeps stress on the joints to a minimum. Projects in excess of 100 ft (30 m) between access points are addressed in Technical Note 5.11: *Sliplining Extended Lengths with HDPE Pipe*.

Hydraulic Considerations

Original design calculations may be referenced, however careful attention should be given to changes in land use which would change the calculated runoff tributary to the culvert. Once a discharge has been determined, the required size of the HDPE pipe may be established. If original design calculations are not available, the project engineer should complete a thorough drainage study. A culvert size can be selected based on watershed attributes, design storm, allowable headwater, culvert entrance conditions and any other related design factors.

In many cases, where culverts are too deep to make replacement practical, slightly reduced hydraulics may be an acceptable tradeoff to an expensive replacement. Typically, gravity flow systems are designed using Manning's Equation with a conservative 'n' value of 0.012 for HDPE. It should be noted that culverts in need of relining do not have Manning's 'n' values typical of original design values. Relining with smooth interior HDPE pipe may actually increase the capacity of the deteriorated culvert.

Structural Requirements

Failing culverts in need of relining may eventually deteriorate into a conduit with no structural integrity at all. For this reason, it is important to reline with a culvert capable of handling the loads based on its installation assuming no load reduction from the host pipe. Loading for Highway and pavement tunnels shall be based upon a continuous load carrying structure for the height of cover under HS-25 loading. Voids between the surrounding soil and the host pipe shall be pressure grouted to ensure structural integrity and resistance to thermal effects. For more information for determining the structural capacity of HDPE, refer to the Structures section of the *Drainage Handbook*.

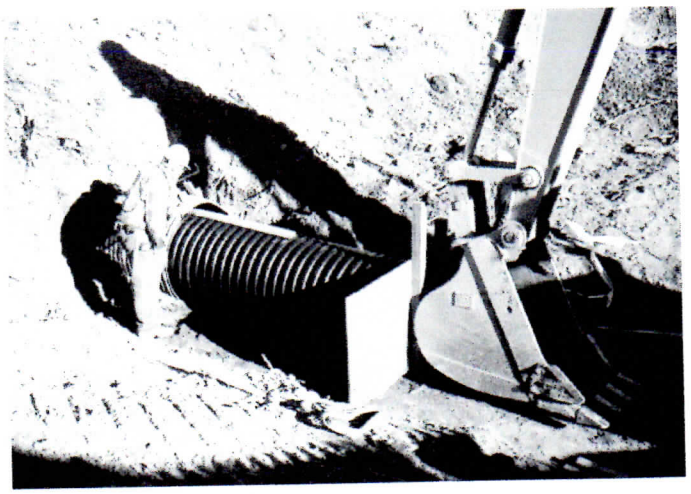
Installation of HDPE in Host Pipe

Before the HDPE pipe is inserted into an existing culvert for relining, it is critical to inspect the existing culvert for any objects or obstructions, which may be extending into the barrel of the existing culvert to be relined. Failure to do this may result in a damaged reline.

Insertion Forces

Once the culvert is clear, the new material may be pushed through. It is important to determine the maximum insertion force that can be applied to the culvert. This will prevent the pipe wall profile from buckling in the axial direction under excessive insertion loading.

In cases where the new culvert will be two or more sizes smaller than the existing culvert, it is possible to construct mechanisms to transport the new material along the existing culvert without sliding across the invert. Although ideal for construction,

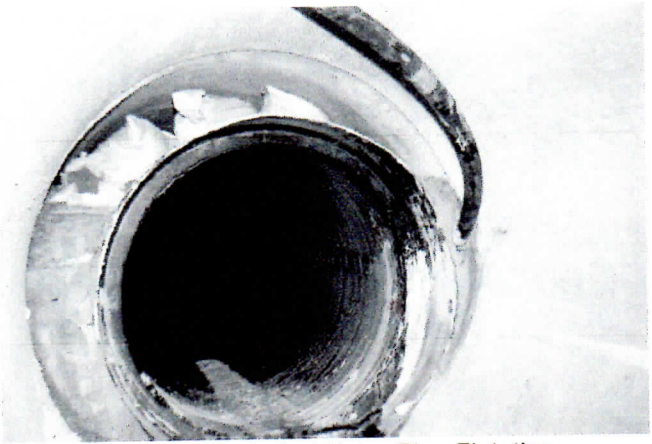


many times there is insufficient room to allow this technique.

Grouting Procedures

When relining a culvert with HDPE pipe, it is recommended to fill the void space between the existing culvert and the new material with a grout material. The grout material is often a controlled low strength material – controlled density fill (CLSM-CDF). A CLSM or flowable fill material will help provide uniform support on the sides of the pipe, maintain a consistent soil density, provide lateral support for the pipe, and eliminate point loads. For more information on flowable fill mix, refer to Technical Note: *Flowable Fill Backfill for Thermoplastic Pipe*.

It is common for aging metal culverts to have deteriorated or completely destroyed inverts. This allows the fluid carried through the culvert to create void space under the pipe, creating an undesired design consideration. The grout material will help plug and fill any fractures or holes in the existing culvert along with structurally stabilizing the system from thermal, hydrostatic pressure, point loads, and function as a water barrier.



To ensure proper alignment and prevent joint separation, the pipe should be anchored against flotation when placing the grout material. Grouting in layers thin enough such that they don't float the pipe helps tremendously. Each layer should be allowed to set up between pours. Contractors may have other techniques that will also prevent flotation such as the use of deadweight inside the pipe. Regardless of the method used, it is also important to avoid applying point loads to the pipe. For more information on flotation and anchoring methods, refer to Technical Note: *Pipe Flotation*.

When HDPE pipe, or any flexible pipe, is used as a liner, it is very important not to use excessive grout pressure. In most circumstances, the joint, not the wall strength, will be the limiting factor for maximum allowable grouting pressure. Including a factor of safety, the recommended maximum grouting pressure for water tight pipe products is 5 psi; this value may vary based on specific site conditions and specific products used. Due to the application method of grout, water tight pipe is recommended for sliplining applications. During the grouting operation, gauges should be used to monitor the grout pressure exerted on the pipe system. For some applications, hydrostatic head pressure may increase the expected pressure on the pipe from the grouting. Additional pressure may be a result of the slope and/or diameter of the pipe, elevation changes between the pipe and the gauge, and other conditions that should be considered during the design. The sum of all pressures that will be exerted on the pipe should not exceed the recommended maximum pressure for the application.