1ST AVENUE DRAINAGE IMPROVEMENTS

CONCEPT REPORT

STURGIS, SOUTH DAKOTA

September 17, 2015

PREPARED BY:

ACES

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PREFACE

The purpose of this report is to identify problems, causes, effects and conceptual solutions to the drainage issues impacting the City infrastructure and private property owners along 1st Avenue in Sturgis, South Dakota. 1st Avenue is located south of Interstate 90 and west of Vanocker Road in the southern portion of the City of Sturgis. (See Figure 1, 1st Avenue Location Map.)

The responsibility to regulate and manage stormwater drainage falls under the jurisdiction of the community. State and Federal guidelines are generally used by communities to meet their obligations.

Based on citizen input, staff observation, maintenance records, and personal knowledge the City of Sturgis has identified 1st Avenue as an area that is a candidate for drainage improvements. The threat or occurrence of damage to private property has been reported by property owners to the City. Damage due to improper drainage to street pavement, ditches, swales, inlets, and pipe within the public right-of-way is apparent.

Property owners have attempted to deal with the potential of inconvenience or damage due to inadequate drainage by installing a variety of drainage control features in the public right-of-way and on their own property to control the impact to their property. Unfortunately, some of that effort, though beneficial to the immediate property, may in fact, be exacerbating the problem for the down gradient owners. In certain instances the problem has not been solved, it has only been moved.

This report will note existing conditions, the causes for the conditions, and will offer several options for minimizing the impact of stormwater drainage on private property and on public infrastructure. This report is not intended to be a Preliminary Design Report nor is it a Drainage Basin Design Report. The effort and detail required in those types of reports is beyond the scope of this initiative. This Concept Report will provide City officials with a perspective of the issues, options for addressing those issues, and relative costs for implementing each of the options. The Probable Costs are not meant to be Construction Cost Estimates or Engineering Estimates. Those can only be determined as a part of engineering design. However, this report is of sufficient detail for use in setting policy, scheduling capital improvements, and for budgetary purposes.

The Summary and Recommendation section will provide a brief overview of each option and a recommendation. The recommendation will be based on what is shown to provide the highest benefit for the cost.

FIGURE 1

1ST AVENUE LOCATION MAP

STURGIS, SD

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100 50 0 100

1"=200'

EXISTING CONDITIONS

The 1st Avenue corridor has exhibited a variety of issues that have apparently been a result of inadequate stormwater drainage. Photo's 1 – 12 provide images of the existing conditions contributing to and results of improper drainage control.

Sedimentation is blocking pipes and is filling ditches and swales. The majority of the sedimentation is a result of homeowners' attempts to control erosion and make repairs; primarily to driveways. Many of the driveways are gravel surfaced. During significant rainfall events the gravel erodes from the driveways filling ditches, pipes, inlets, and settling in grassed areas.

Property owners have apparently filled some roadside ditches. In one case a ditch has been filled blocking the culvert outlet under the owner's driveway while the inlet side remains open to flow. Landscaping, walls, and sandbags have been placed and channels cut to divert the water away from one property to another. A variety of culvert pipes made up of different sizes, materials and alignments have been installed. In many cases larger pipes are discharging into smaller pipes. There has been little or no consideration given to the impact on hydraulics created by the potpourri of homemade drainage control features.

Several culverts at intersections are overgrown with brush and at least partially filled with gravel. These are difficult to maintain properly because of their close proximity to the edge of the pavement. They also represent a hazard to traffic should a vehicle leave the edge of pavement and drop into the ditch.

On the north side of 1st Avenue, at approximately mid-corridor, there are several homes that are lower than street elevation. Obviously, without some control, stormwater naturally would flow from the street toward the homes.

The FEMA Flood Map, shown in Figure 2, illustrates the natural drainage pattern for the area. This pattern has been significantly altered by the multitude of individual diversions installed by property owners and due to development of the area. Stormwater is now being forced to flow in an unnatural direction without the benefit and control provided by a properly designed and constructed stormwater system. Most of the flow from the drainage basin now enters and crosses a City owned lot east of the intersection of 1st Avenue and Vanocker Road.

Improvements to the west end of 1st Avenue have been installed. Curb, gutter and drain pans control the flows in that area. However, the control and containment of these upstream flows has amplified the impact on down-gradient property. The installed improvements increase the flow volume and velocity so that they are difficult to control

once the flows pass beyond the improvements. Typically, stormwater control improvements are made from the down gradient end first to avoid this type of condition.

To start near the top, flooding is reported to occur at the end of the Maple Drive cul-de-sac. Verification of that is the evidence of sedimentation in the cul-de-sac. A 10" diameter open pipe is acting as the inlet on Maple Drive. Debris may easily enter the pipe limiting or blocking flow. The pipe itself may be too small to carry the flow demand during a significant rainfall event.

Flooding of the Cedar Drive cul-de-sac has also been reported by affected property owners. As seen on Maple Drive, there is sedimentation on the street that is a result of the flooding. A grated curb inlet is collecting water on Cedar Drive into a box culvert with a 30" diameter discharge pipe. The grate seems too small to take full advantage of the pipe capacity. Flow from S. 1st Avenue also enters the Cedar Drive cul-de-sac adding to the flow required to be handled by the inlet.

The 10" diameter inlet pipe on Maple Drive is reported to connect to the 30" pipe serving Cedar Drive. This has not been verified but appears logical. The 30" pipe carries the combined flows from Cedar Drive and Maple Drive northward towards 1st Avenue through two manholes before connecting in some unknown manner to a 24" plastic pipe on 1st Avenue. (See Photos 7 & 8.) There is no proper means of carrying that flow beyond the point of discharge. There is a small pipe in the washout that has been created by discharge from the 24" pipe that carries very little water. Overflow water is forced onto and along the edge of the street pavement and the downstream gravel surfaced driveway. The result is significant erosion.

Flows on the south side of the 1st Avenue Sub-Basin (See Figure 3) ultimately discharge to a cross road pipe which carries the flow across Vanocker Road. Although the discharge opening is routinely maintained by the City, it is apparent that the opening has a tendency to fill with sediment, mostly gravel, carried from 1st Avenue. After crossing Vanocker Road the water tends to fill the vacant City owned lot east of Vanocker Road. Surface water eventually meanders to the floodway located immediately east of the lot. (See Figure 2.) Flows on the north side of the intersection appear to pond on private property and in the public right-of-way. They apparently subside through percolation and evaporation.

EXISTING CONDITION PHOTOS

Photo 1.
Area Discharge Outlet
East Side of Vanocker Road
and 1St Avenue

Photo 2.
Road Crossing Culvert
SW Corner of Vanocker Road and 1st Avenue

Photo 3.
Edge Erosion at Filled Ditch

Photo 4.
Sandbagged Drainage Erosion at Driveway
Caused by Diverted Flow

Photo 5.
Edge Rut Erosion Due to
Landscape Feature

Photo 6.
Erosion at End of Gutter Pan

Photo 7.
24” Elevated Discharge Pipe

Photo 8.
Erosion at 24” Pipe Discharge

Photo 9.
Driveway Culvert

Photo 10.
10 “ Diameter Storm Inlet on Maple Drive

Photo 11.
Storm Inlet on Cedar Drive

Photo 12.
Storm Manhole North of Cedar Drive

GREENWOOD TRAIL

1ST AVENUE

1ST AVENUE SOUTH

MAPLE DR.

CEDAR DR.

VANOCKER DR.

VANOCKER RD.

FIGURE 2

FEMA FLOOD MAP

LEGEND

FLOODWAY

FLOODPLAIN

N

100 50 0 100

1"=200'

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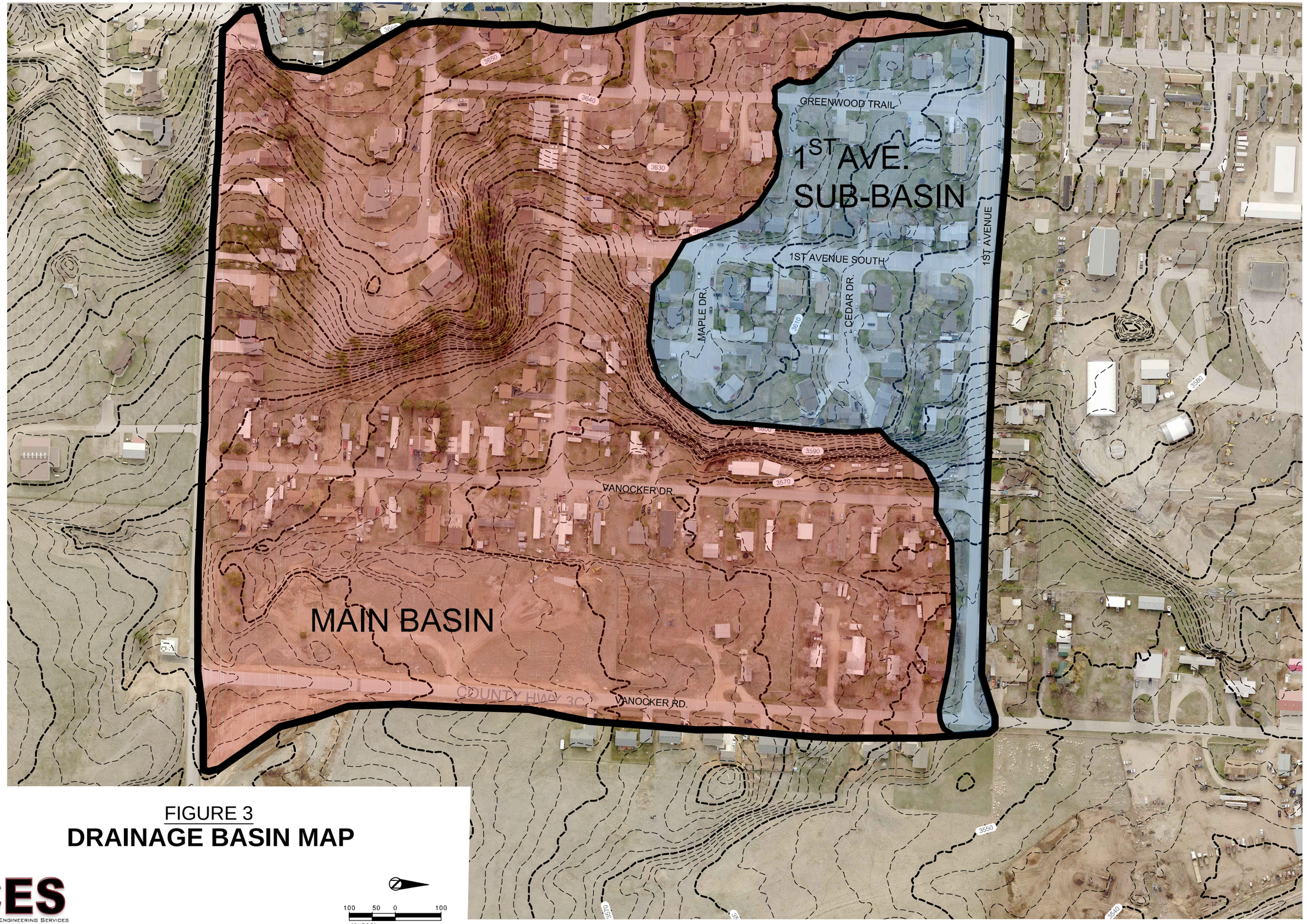

FIGURE 3

DRAINAGE BASIN MAP

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100 50 0 100

1"=200'

CAUSE AND EFFECT

Precipitation: It is important to note that multiple episodes of heavy precipitation inundated the central U.S. from Wyoming and South Dakota south to Oklahoma and Texas during May, 2015. The 25 U.S. Climate Reference Network (USCRN) stations shown in Figure 4 received enough precipitation in May, 2015 to qualify it as one of the five wettest months, regardless of time of year.

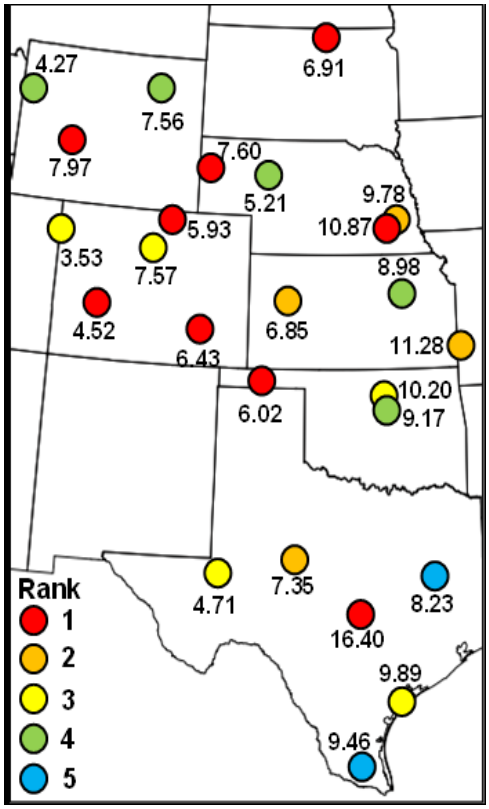


Figure 4.
The dot color indicates the overall rank of May 2015 precipitation compared to all months. Numbers are precipitation in inches.

The National Weather Service National Climate Data Center recorded 8 days from May through August, 2015, that were record precipitation days as recorded at the Rapid City, South Dakota, Airport. Of particular note was May 6, 2015. The record that day, established in 1995, was 0.66 inches. On May 6, 2015, precipitation was measured at 1.61 inches; roughly 2.5 times greater. That is significant. Although the amounts were recorded at the Rapid City Airport it does represent what occurred in the Sturgis area during the same time.

The monthly averages were also greater in 2017, as shown in Table 1. These are a further representation of the abnormal amount of rainfall and rainfall events that occurred this year.

Month	2015 Total (in.)	Normal Total (in.)	Difference (in.)
May	7.76	4.19	3.57
June	6.87	3.16	3.71
July	3.62	2.50	1.12
August	2.25	1.97	0.28

Table 1
Monthly Precipitation as Recorded at the Rapid City National Weather Service

Effect: If the stormwater collection system along the 1st Avenue corridor was built or was functioning according to or near acceptable standards, it could be argued that 2015 was an abnormal year and it is not feasible for the City to protect property under these conditions. However, that is not the case. The existing stormwater collection system consists of a conglomeration of makeshift approaches that appear to have been installed by the property owners to address their individual issues. As a whole, in some cases, this approach has aggravated the negative impact on both public and private property.

These private measures have in most cases contributed to the overall drainage problem. Filling ditches pushes flows into the street where it normally travels to downstream properties in either a controlled or uncontrolled manner. Erosion is evident at the edge of pavement and at driveways. Blocked culverts eventually back up and force water onto streets or neighboring property.

Little thought has been given to the sizing of culvert pipes to carry the flows. In multiple instances along 1st Avenue pipes smaller than the upstream pipe have been installed. Obviously, the smaller pipe cannot carry the same amount of flow as the larger pipe. Water back-up is forced elsewhere and the water that does flow through the smaller pipe can discharge at higher velocity. Each condition adds to the potential of erosion or flooding.

Improvements to the west end of 1st Avenue (up-gradient) appear to control stormwater there. A gutter section installed about mid-corridor on the north side appears to do the same for the adjacent property. It is important to note that these improvements exacerbate the negative impacts on the remaining properties; particularly those down gradient. The amount of flow, the velocity of the flow, and the alignment of the flow path

adversely impacts the areas outside of the locally improved areas. Managed stormwater typically begins at the downstream end and progresses upstream. The opposite has been occurring on 1st Avenue. Addressing upstream issues has not solved the problem. It simply moved it downstream.

The 10” diameter open pipe inlet on Maple Drive is unprotected and subject to plugging. It may also be undersized. Flooding has occurred as a result.

The inlet grate on Cedar Drive appears to be undersized for the amount of water that is directed to it. The adjacent property owner has noted that flooding occurs at the inlet and surface water enters their garage. Surface water from 1st Avenue South turns onto Cedar Drive and is collected at this inlet. Flooding of the street and adjoining property has resulted.

REMEDIATION OPTIONS

The first step in considering any remedial action is to define the base factors impacting the drainage in the 1st Avenue corridor. These include the following:

- Hydraulics/Hydrology
- Existing/Potential Development
- Topography
- Impact

Hydraulics/Hydrology

Determining the flow volume and flow rate resulting from a significant rainfall event is essential in considering the degree of any remedial options. Although this report is not a Drainage Basin Design Report, it was necessary to estimate the flows so an order of magnitude could be applied to the options.

The Rational Method was used to estimate the flows. Appendix A provides the calculation results with assumptions. Flows were calculated for the entire Main Basin discharging at the intersection of 1st Avenue and Vanocker Road and for the 1st Avenue Sub-Basin. (See Figure 3, Drainage Basin Map.)

For purposes of design, flows are calculated based on a statistical storm event. For example: a 100 year storm occurs statistically every 100 years, or has a 1% chance of occurring at any time; or a 10 year storm occurs statistically every 10 years; or has a 10% chance of occurring at any time. A storm that has a 1% chance of occurrence is a much larger event than one that has a 10% chance of occurrence. For estimation of remediation options a 10 year storm event was selected. This is normal for sizing storm drainage infrastructure in the Black Hills region.

The total flow from the Main Basin contributing to the discharge point at 1st Avenue and Vanocker Road is important because it is needed to size infrastructure serving the basin. The flow volume from the Main Basin for a 10 year storm event was calculated to be 34,546 cubic feet (259,095 gallons) at a rate of 115.2 cubic feet per second (51,725 gallons per minute).

The flow volume from the 1st Avenue Sub-basin was calculated to be 7,650 cubic feet (57,375 gallons). The flow rate is 25.5 cubic feet per second (11,450 gallons per minute). These values were used to estimate sizes of features within the Sub-Basin.

Existing/Potential Development

When determining flows and flow rates within a drainage basin it is important to account for the type of surface within the area. For example: Lawns will absorb some water and the speed of surface water movement over the lawns is relatively slow. Whereas, paved streets and roofs do not absorb any water and the movement of the water across either is relatively fast.

The area under review in this report is predominately developed with little room for additions. This is the characteristic of the basin used in determining flow volumes and rates. Pre-development rates and volumes were also calculated and used to size required flow control features.

Topography

The flow rate is affected by the contours within the basin. 1st Avenue lies on a hill which will increase flow rate. This should be considered during design of future improvements.

Impact

In order for any drainage channel to function efficiently it is best to minimize the flow rate from upstream sources. The flow from the Main Basin and the1st Avenue Sub-Basin ultimately reaches the Anna Street Drainage channel.

It is also necessary to regulate the flow onto downstream properties at the pre-development flow rate. Downstream properties cannot be adversely impacted by an increase in flow rate or volumes due to upstream development.

Detention ponds are installed to regulate and meter the flows onto downstream property. Therefore, this report is recommending that a detention pond be installed as part of any option for drainage improvements selected.

THE FOLLOWING REMEDIATION OPTIONS ARE PROVIDED:

Detention Pond

As previously noted, the natural flow path, as shown on FEMA Flood Map (See Figure 2) has been obliterated over time and no longer carries a majority of the flow. A portion

of stormwater does follow this path, however, the majority of the surface flow from 1st Avenue enters and crosses the City owned lot shown on Figure 5.

This lot is approximately 0.75 acres in area. The volume required for the pond is 0.79 acre-feet. (As a matter of definition an acre-foot is area of one acre one foot deep.) The lot could be re-graded so that is would adequately detain the flows from the 10 year storm. The pond would be approximately 2.5 feet deep from top of berm to the bottom of the pond and would encompass virtually the entire lot. The depth would include one foot of freeboard.

The pond would be seeded and would have shallow side slopes to allow for easy mowing. A discharge pipe or structure would have to be constructed to allow the water to flow out of the pond at the Pre-Development rate.

A secondary benefit of the detention pond is an improvement in water quality. The pond allows suspended solids carried with the stormwater to settle out by slowing the rate of flow. This will also promote percolation into the ground.

A detention pond should be constructed as part of any remedial action taken. An example of a typical residential detention pond can be seen in Photo 13.

Photo 13.

0 165 330 660 ft

FIGURE 5

PARCEL MAP

September 03, 2015

Option A: Total Reconstruction - 1st Avenue (Greenwood Trail to Vanocker Road)

This option would meet urban street standards. The existing pavement, gutters and sidewalk would be removed along with the variety of drainage features. In their place a new properly sized storm sewer with inlets would be installed. Inlets would be placed at each intersection, mid-block at long and steep blocks, and in each of the two cul-de-sacs within the Sub-basin. New asphalt pavement with correct crown to direct flow from the pavement to new curb and gutter would also be installed. New sidewalks and ADA ramps would be included in the reconstruction. Driveway approaches would be paved. The detention pond would also be constructed on the vacant City lot, east of Vanocker Road. A detail summary of Option A can be seen in Figure 6.

Option B: New Storm Sewer - 1st Avenue

This option would retain the existing pavement, sidewalk, and curb and gutter as much as possible. New storm sewer would be installed on the north side of 1st Avenue. Flows from the south side of the street would be collected by new inlets and carried to the north with new inlet cross pipes. New inlets would be constructed at each 1st Avenue intersection and in the Cedar Drive and Maple Drive cul-de-sacs. Driveway approaches would be paved and appropriate driveway culverts installed. The detention pond would be constructed on the vacant City lot, east of Vanocker Road. A detail summary of Option B can be seen in Figure 7.

Option C: Inverted Crown Pavement - 1st Avenue

Conventional urban street design calls for the center of the street pavement (the crown) to be higher than the edge of the street pavement so that surface water drains off the travelled portion of the street. In certain instances where drainage along the side of the street is not feasible or practical, the center of the pavement is constructed lower than the sides so the surface water can be collected there. This is referred to as an inverted crown. An inverted crown is one option for managing stormwater on 1st Avenue.

The asphalt pavement would be removed and the street surface regraded so that an inverted crowned pavement could be installed. Existing sidewalks, curb and gutter, and drainage ditches would be retained to the highest degree possible. It is likely that some of the ditches would have to be reshaped. A new storm sewer would be installed in the middle of the street. Inlets would be installed at each intersection at the corners and at selected points in the middle of the pavement. New inlets would also be installed in the Cedar Drive and Maple Drive cul-de-sacs. Driveway approaches along 1st Avenue

would be paved and appropriate driveway culverts installed. The detention pond would be constructed on the vacant City lot, east of Vanocker Road. A detail summary of Option C can be seen in Figure 8.

Option D: Reconstruct Rural Section Type Road – 1st Avenue

Rural section roads typically consist of a driving surface, shoulders, and drainage ditches. The driving surface can be dirt, gravel or pavement. The portion of 1st Avenue south of Greenwood Trail is currently a rural section type road. Option D would reconstruct the road to maximize drainage characteristics within the existing configuration of the street.

Under this option the existing asphalt pavement, sidewalks, and curb and gutter would be retained**.** Inlets with new cross pipes would be installed, as necessary, at each intersection. Ditches would be reshaped and restored. Obstructions in the ditches would be removed. Walls, pipes or channels may be required for those properties below ditch elevation. Driveway approaches would be paved and appropriate driveway culverts installed to minimize erosion and to assist in flow control. New inlets will be installed at the Cedar Drive and Maple Drive cul-de-sacs. The drain pan across 1st Avenue South may be reconstructed with the intent of directing more flow to the south side of 1st Avenue. The detention pond would be constructed on the vacant City lot, east of Vanocker Road. A detail summary of Option D can be seen in Figure 9.

Table 1. summarizes each of Options A – D. Table 2. lists the probable costs for each option.

TABLE 1 - REMEDIATION OPTIONS SUMMARY

OPTION A: TOTAL RECONSTRUCTION – 1ST AVENUE (GREENWOOD TRAIL TO VANOCKER ROAD)

- New Asphalt Pavement with Center Crown
- Underground Storm Sewer System
  - New Storm Sewer Main
  - Inlets at Intersections and Mid-Blocks
  - Eliminate Steep Intersection Ditches
  - New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- New Sidewalks
- Standard Curb and Gutter
- Pave Driveway Approaches
- Detention Pond on City Lot

OPTION B: STORM SEWER - 1ST AVENUE

- Retain Existing Asphalt Pavement, Sidewalks and Curb and Gutter
- Underground Storm Sewer Main on the North Side of 1st Avenue
  - Inlets in Ditch Locations Along 1st Avenue
  - Eliminate Steep Intersection Ditches
  - New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Reconstruct Existing Ditches
- Detention Pond on City Lot
- Pave Driveway Approaches
- New Driveway Culverts

OPTION C: INVERTED CROWN PAVEMENT - 1ST AVENUE

- New Asphalt Pavement with Inverted Crown
- Retain Existing Sidewalks, Curb and Gutter, and Ditches
- Underground Storm Sewer System in the Center of 1st Avenue
  - Inlets in Ditch Locations Along 1st Avenue and in the center of pavement
  - Eliminate Steep Intersection Ditches
  - New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Detention Pond on City Lot
- Pave Driveway Approaches
- New Driveway Culverts

OPTION D: RECONSTRUCT RURAL SECTION STYLE ROAD - 1ST AVENUE

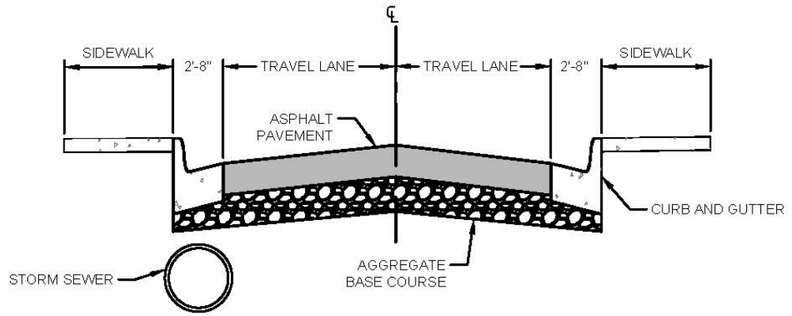
- Retain Existing Asphalt Pavement
- Retain Existing Sidewalks and Curb and Gutter
- New Inlets and Cross Pipe at the Intersection of 1st Avenue and Vanocker Road
- Eliminate Steep Intersection Ditches
- New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Detention Pond on City Lot
- Pave Driveway Approaches
- New Driveway Culverts
- Reconstruct Drainage Pan at 1st Avenue South Intersection

TABLE 2 - REMEDIATION OPTIONS COST SUMMARY

OPTION A:	**TOTAL RECONSTRUCTION - 1ST AVENUE (GREENWOOD TRAIL TO VANOCKER ROAD)**	**$ 1,611,387.80**
OPTION B:	**STORM SEWER - 1ST AVENUE**	**$ 642,975.30**
OPTION C:	**INVERTED CROWN PAVEMENT - 1ST AVENUE**	**$ 1,187,406.00**
OPTION D:	**RECONSTRUCT RURAL SECTION STYLE ROAD - 1ST AVENUE**	**$ 339,787.80**

FIGURE 6 - OPTION A: TOTAL RECONSTRUCTION - 1ST AVENUE (GREENWOOD TRAIL TO VANOCKER ROAD)

- New Asphalt Pavement with Center Crown
- Underground Storm Sewer System
  - o New Storm Sewer Main
  - o Inlets at Intersections and Mid-Blocks
  - o Eliminate Steep Intersection Ditches
  - o New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- New Sidewalks
- Standard Curb and Gutter
- Pave Driveway Approaches
- Detention Pond on City Lot



TYPICAL SECTION

Opinion of Probable Cost

Item No.	Description of Item	Estimated Quantity	Unit	Unit Cost	Extended Cost
1	Mobilization	1.0	LS	$ 55,000.00	$ 55,000.00
2	Miscellaneous and Incidentals	1.0	LS	$ 44,000.00	$ 44,000.00
3	Erosion and Sediment Control	1.0	LS	$ 16,400.00	$ 16,400.00
4	Construction Staking	1.0	LS	$ 11,000.00	$ 11,000.00
5	Traffic Control	1.0	LS	$ 8,200.00	$ 8,200.00
6	Remove and Salvage Street Pavement	5,700.0	SY	$ 8.50	$ 48,450.00
7	Scarify and Recompact Subgrade - 8" Depth	5,985.0	SY	$ 3.50	$ 20,947.50
8	Remove Curb and Gutter	635.0	LF	$ 9.00	$ 5,715.00
9	Remove PCC Sidewalk	2,540.0	SF	$ 9.00	$ 22,860.00
10	Unclassified Excavation	50.0	CY	$ 38.00	$ 1,900.00
11	Drop-Inlet with Grate	10.0	EA	$ 6,000.00	$ 60,000.00
12	18" RCP O-Ring Gasket Pipe	1,200.0	LF	$ 84.00	$ 100,800.00
13	48" RCP O-Ring Gasket Pipe	800.0	LF	$ 225.00	$ 180,000.00
14	Storm Sewer Manhole	6.0	EA	$ 4,500.00	$ 27,000.00
15	Rip-Rap, Class I	50.0	TON	$ 110.00	$ 5,500.00
16	Sidewalk	9,600.0	SF	$ 12.00	$ 115,200.00
17	Detectable Warning Panel	6.0	EA	$ 280.00	$ 1,680.00
18	PCC Driveway Pavement	150.0	SY	$ 100.00	$ 15,000.00
19	Aggregate Base Course - 8" Thick	2,565.0	TON	$ 35.00	$ 89,775.00
20	Asphalt Pavement - 5" Thick	1,603.1	TON	$ 125.00	$ 200,387.50
21	Concrete Curb and Gutter, Type "B"	2,400.0	LF	$ 40.00	$ 96,000.00
22	Material Testing	1.0	LS	$ 9,500.00	$ 9,500.00
23	Construction Entrance	2.0	EA	$ 800.00	$ 1,600.00
24	Utility Adjustments	1.0	LS	$ 15,000.00	$ 15,000.00
25	Topsoil	50.0	CY	$ 135.00	$ 6,750.00
26	Seed, Fertilize and Cover	500.0	SY	$ 2.50	$ 1,250.00
27	Detention Pond	1.0	LS	$ 65,000.00	$ 65,000.00
				Contingency, 20%	$ 244,983.00
				Engineering, Survey and Legal	$ 141,489.80
				Total:	**$ 1,611,387.80**

PRO'S

1. Eliminates a Majority of the Drainage Issues
2. Meets Standards for Urban Street Design
3. Minimize Maintenance
4. Aesthetics
5. Meet ADA Requirements
6. Eliminate Drop-Offs at Pavement Edge

CON'S

1. Cost
2. Disruptive to Property Owners
3. Duration of Construction
4. Mismatch to Surrounding Development

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FIGURE 7 - OPTION B: STORM SEWER - 1ST AVENUE

- Retain Existing Asphalt Pavement
- Retain Existing Sidewalks and Curb and Gutter
- Underground Storm Sewer Main on the North Side of 1st Avenue
  - Inlets in Ditch Locations Along 1st Avenue
  - Eliminate Steep Intersection Ditches
  - New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Reconstruct Existing Ditches
- New Driveway Culverts
- Detention Pond on City Lot
- Pave Driveway Approaches

Opinion of Probable Cost

Item No.	Description of Item	Estimated Quantity	Unit	Unit Cost	Extended Cost
1	Mobilization	1.0	LS	$21,600.00	$ 21,600.00
2	Miscellaneous and Incidentals	1.0	LS	$17,400.00	$ 17,400.00
3	Erosion and Sediment Control	1.0	LS	$ 6,500.00	$ 6,500.00
4	Construction Staking	1.0	LS	$ 4,400.00	$ 4,400.00
5	Traffic Control	1.0	LS	$ 3,250.00	$ 3,250.00
6	Unclassified Excavation	30.0	CY	$ 38.00	$ 1,140.00
7	18" RCP O-Ring Gasket Pipe	1,000.0	LF	$ 84.00	$ 84,000.00
8	36" RCP O-Ring Gasket Pipe	625.0	LF	$ 125.00	$ 78,125.00
9	Storm Sewer Manhole / Junction Box	12.0	EA	$ 4,500.00	$ 54,000.00
10	Rip-Rap, Class I	120.0	TON	$ 110.00	$ 13,200.00
11	Aggregate Base Course	762.5	TON	$ 35.00	$ 26,687.50
12	Drop-Inlet with Grate	10.0	EA	$ 6,000.00	$ 60,000.00
13	PCC Driveway Pavement	150.0	SY	$ 100.00	$ 15,000.00
14	Driveway Culverts, 18" CMP	450.0	LF	$ 64.00	$ 28,800.00
15	Topsoil	50.0	CY	$ 135.00	$ 6,750.00
16	Seed, Fertilize and Cover	500.0	SY	$ 2.50	$ 1,250.00
17	Detention Pond	1.0	LS	$65,000.00	$ 65,000.00
				Contingency, 20%	$ 97,420.50
				Engineering, Survey and Legal	$ 58,452.30
				Total:	**$ 642,975.30**

PRO'S

1. Sub-Surface Collection of Storm Water
2. Minimal Disruption to Private Property
3. Cost Effective
4. Minimal Maintenance
5. Eliminate Drop-Offs at Pavement Edge

CON'S

1. Less Effective than Option A
2. No Aesthetic Improvement
3. Retain Old Pavement
4. Damage to Existing Pavement from Cross Pipe Installation and Patching

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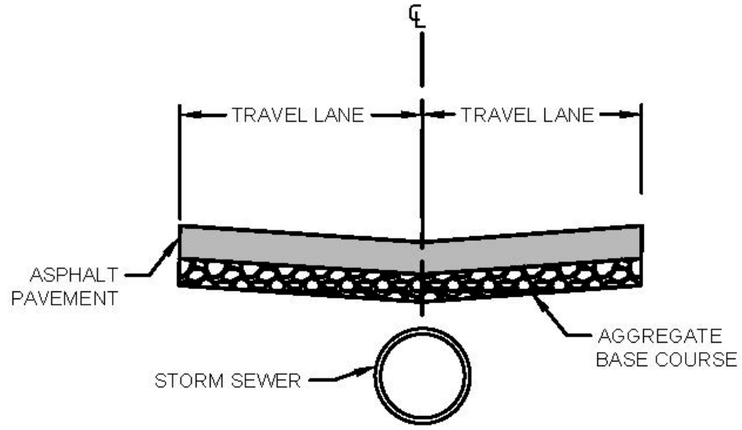
FIGURE 8 - OPTION C: INVERTED CROWN PAVEMENT - 1ST AVENUE

- New Asphalt Pavement with Inverted Crown
- Retain Existing Sidewalks, Curb and Gutter, and Ditches
- Underground Storm Sewer System in the Center of 1st Avenue
  - o Inlets in Ditch Locations Along 1st Avenue and in the center of pavement
  - o Eliminate Steep Intersection Ditches
  - o New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Detention Pond on City Lot
- New Driveway Culverts
- Pave Driveway Approaches



TYPICAL SECTION

Opinion of Probable Cost

Item No.	Description of Item	Estimated Quantity	Unit	Unit Cost	Extended Cost
1	Mobilization	1.0	LS	$40,000.00	$ 40,000.00
2	Miscellaneous and Incidentals	1.0	LS	$32,000.00	$ 32,000.00
3	Erosion and Sediment Control	1.0	LS	$12,000.00	$ 12,000.00
4	Construction Staking	1.0	LS	$ 8,000.00	$ 8,000.00
5	Traffic Control	1.0	LS	$ 6,000.00	$ 6,000.00
6	Remove and Salvage Street Pavement	5,700.0	SY	$ 8.50	$ 48,450.00
7	Scarify and Recompact Subgrade - 8" Depth	5,985.0	SY	$ 3.50	$ 20,947.50
8	Unclassified Excavation	50.0	CY	$ 38.00	$ 1,900.00
9	Drop-Inlet with Grate	8.0	EA	$ 6,000.00	$ 48,000.00
10	18" RCP O-Ring Gasket Pipe	1,000.0	LF	$ 84.00	$ 84,000.00
11	36" RCP O-Ring Gasket Pipe	600.0	LF	$ 125.00	$ 75,000.00
12	Storm Sewer Manhole / Junction Box	6.0	EA	$ 4,500.00	$ 27,000.00
13	Rip-Rap, Class I	75.0	TON	$ 110.00	$ 8,250.00
14	Sidewalk	480.0	SF	$ 12.00	$ 5,760.00
15	Detectable Warning Panel	6.0	EA	$ 280.00	$ 1,680.00
16	Aggregate Base Course - 8" Thick	2,565.0	TON	$ 35.00	$ 89,775.00
17	Asphalt Pavement - 5" Thick	1,603.1	TON	$ 125.00	$ 200,387.50
18	Material Testing	1.0	LS	$ 8,000.00	$ 8,000.00
19	Construction Entrance	2.0	EA	$ 800.00	$ 1,600.00
20	Utility Adjustments	1.0	LS	$15,000.00	$ 15,000.00
21	Concrete Drainage Pan	633.3	SY	$ 90.00	$ 57,000.00
22	PCC Driveway Pavement	150.0	SY	$ 100.00	$ 15,000.00
23	Driveway Culverts, 18" CMP	450.0	LF	$ 64.00	$ 28,800.00
24	Detention Pond	1.0	LS	$65,000.00	$ 65,000.00
				Contingency, 20%	$ 179,910.00
				Engineering, Survey and Legal	$ 107,946.00
				Total:	**$ 1,187,406.00**

PRO'S

1. ADA Compliant
2. Effective Street Drainage System
3. New Pavement
4. Eliminate Drop-Offs at Pavement Edge
5. Minimize Ditch Flow

CON'S

1. No Connecting Sidewalks to ADA Compliant Ramps
2. Collects Surface Water on Traveled Portion of Street
3. Cost
4. Ditch Flow Not Eliminated
5. No Curb and Gutter
6. No New Sidewalk
7. Minimal Aesthetic Improvement

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FIGURE 9 - OPTION D: RECONSTRUCT RURAL SECTION STYLE ROAD - 1ST AVENUE

- Retain Existing Asphalt Pavement
- Retain Existing Sidewalks and Curb and Gutter
- New Inlets and Cross Pipe at the Intersection of 1st Avenue and Vanocker Road
- Eliminate Steep Intersection Ditches
- New Inlets on Maple Drive and Cedar Drive Cul-de-sacs
- Detention Pond on City Lot
- Pave Driveway Approaches
- New Driveway Culverts
- Reconstruct Drainage Pan at 1st Avenue South Intersection

Opinion of Probable Cost

Item No.	Description of Item	Estimated Quantity	Unit	Unit Cost	Extended Cost
1	Mobilization	1.0	LS	$12,000.00	$ 12,000.00
2	Miscellaneous and Incidentals	1.0	LS	$ 9,200.00	$ 9,200.00
3	Erosion and Sediment Control	1.0	LS	$ 3,400.00	$ 3,400.00
4	Construction Staking	1.0	LS	$ 2,300.00	$ 2,300.00
5	Traffic Control	1.0	LS	$ 1,800.00	$ 1,800.00
6	Unclassified Excavation	80.0	CY	$ 38.00	$ 3,040.00
7	Drop-Inlet with Grate	3.0	EA	$ 6,000.00	$ 18,000.00
8	36" RCP O-Ring Gasket Pipe	150.0	LF	$ 125.00	$ 18,750.00
9	Storm Sewer Manhole	4.0	EA	$ 4,500.00	$ 18,000.00
10	PCC Driveway Pavement	150.0	SY	$ 100.00	$ 15,000.00
11	Driveway Culverts, 18" CMP	450.0	LF	$ 64.00	$ 28,800.00
12	Rip-Rap, Class I	120.0	TON	$ 110.00	$ 13,200.00
13	Topsoil	75.0	CY	$ 135.00	$ 10,125.00
14	Seed, Fertilize and Cover	4,000.0	SY	$ 2.50	$ 10,000.00
15	Concrete Drainage Pan	320.0	SY	$ 90.00	$ 28,800.00
16	Detention Pond	1.0	LS	$65,000.00	$ 65,000.00
				Contingency, 20%	$ 51,483.00
				Engineering, Survey and Legal	$ 30,889.80
				Total:	**$ 339,787.80**

PRO'S

1. Least Costly Option
2. Least Disruptive Option
3. Match Area Improvement Style

CON'S

1. Least Effective
2. No Aesthetic Improvement
3. Requires Highest Level of Private and Public Maintenance

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SUMMARY AND RECOMMENDATION

SUMMARY:

The purpose of this Concept Report was to provide adequate information for the City of Sturgis to use in determining what course of action might be adopted in addressing drainage issues on 1st Avenue. Four options have been provided. It should be noted that these options are provided as general solutions. Actual design of a selected option may incorporate components of the other options for the best results.

A *detention pond* is included in the probable cost of each option. A detention pond should be constructed to control flows leaving the area so as not to adversely impact downstream properties and improvements.

Option A, Total Reconstruction – 1st Avenue is the most effective drainage control option. It would provide the best control of drainage, improve the overall appearance of 1st Avenue, and would require the least amount of both routine and long term maintenance. It is also the costliest option at a probable cost of $1,611,387.80. The overall character of these improvements would differ from those typical to the area. It could be anticipated that if these improvements were made to 1st Avenue that demand for like improvements would come from adjoining areas.

Option B, Storm Sewer – 1st Avenue in simple terms installs a storm sewer within the existing public and private features of 1st Avenue. The character and appearance of the street would remain relatively unchanged. The cost is about a third of Option A at $642,975.30. Most of the surface water would be carried underground, however, open ditches would remain in place and have to be reconstructed to collect the water and deliver to the sewer. This option is not as effective as Option A and would require routine maintenance to insure the ditches and inlets function properly.

Option C, Inverted Crown Pavement – 1st Avenue is offered as an option which will collect water entering the street and carry it underground while causing little disruption to private property owners. The result is improved drainage management and new pavement. Driveway improvements would enhance flow characteristics and minimize sedimentation. The probable cost is approximately double of Option B at $1,187,406.00.

Option D, Reconstruct Rural Section Style Road is basically restoring the drainage ditches along 1st Avenue, and installing new inlets on 1st Avenue, Cedar Drive and Maple Drive. Pipes would be replaced to match actual flow demands. Driveway approaches would be paved to minimize erosion and sedimentation. This option would

provide the least benefit in mitigation of drainage issues. The probable cost is $339,787.80.

RECOMMENDATION:

Source and availability of funding is determined by the City. If funding were not an issue, the best option for mitigating the drainage issues is Option A. New sidewalk, curb and gutter, storm inlets, and pavement all impact drainage improvements. Routine maintenance would be minimized. This recommendation is offered with the caveat that if this option is selected it is likely that funding will be required for similar projects for which public demand is anticipated. The Probable Cost is $1,611,387.80

Option B, Storm Sewer – 1st Avenue provides the most benefit, when strictly considering drainage, for the funds required. Although drainage ditches would remain, surface flows would be collected along the street and carried underground to the point of discharge at Vanocker Road. The impact from storm events on the ditches, culverts and the street would be minimal in comparison to existing conditions. The Probable Cost is $642,975.30.

APPENDIX A

Drainage Calculation Results and Assumptions

DRAINAGE BASIN	UNITS	PRE-DEVELOPMENT	POST DEVELOPMENT
BASIN AREA	(AC)	59.96	59.96
PERVIOUS AREA	(AC)	58.00	29.98
IMPERVIOUS AREA	(AC)	1.96	29.98
IMPERVIOUS AREA	(%)	3.27	50
TIME OF CONCENTRATION (t_c)	(MIN)	5.0	5.0
C_2		0.10	0.25
C_{10}		0.20	0.30
C_{100}		0.30	0.40
i_2	(IN/HR)	4.20	4.20
i_{10}	(IN/HR)	6.4	6.4
i_{100}	(IN/HR)	9.6	9.6
Q_2	(CFS)	25.18	62.96
Q_{10}	(CFS)	76.75	115.12
Q_{100}	(CFS)	172.68	230.24
RUNOFF VOLUME$_2$	(CF)	7,555	18,887
RUNOFF VOLUME$_{10}$	(CF)	23,024	34,536
RUNOFF VOLUME$_{100}$	(CF)	51,804	69,071
RUNOFF VOLUME$_2$	**(ACFT)**	**0.17**	**0.43**
RUNOFF VOLUME$_{10}$	**(ACFT)**	**0.53**	**0.79**
RUNOFF VOLUME$_{100}$	**(ACFT)**	**1.19**	**1.59**

1ST AVE. SUB-BASIN	UNITS	PRE-DEVELOPMENT	POST DEVELOPMENT
BASIN AREA	(AC)	13.28	13.28
PERVIOUS AREA	(AC)	12.84	5.31
IMPERVIOUS AREA	(AC)	0.44	7.97
IMPERVIOUS AREA	(%)	3.33	60
TIME OF CONCENTRATION (t_c)	(MIN)	5.0	5.0
C_2		0.10	0.25
C_{10}		0.20	0.30
C_{100}		0.30	0.40
i_2	(IN/HR)	4.20	4.20
i_{10}	(IN/HR)	6.4	6.4
i_{100}	(IN/HR)	9.6	9.6
Q_2	(CFS)	5.58	13.95
Q_{10}	(CFS)	17.00	25.50
Q_{100}	(CFS)	38.25	51.00
RUNOFF VOLUME$_2$	(CF)	1,674	4,184
RUNOFF VOLUME$_{10}$	(CF)	5,100	7,650
RUNOFF VOLUME$_{100}$	(CF)	11,475	15,301
RUNOFF VOLUME$_2$	**(ACFT)**	**0.04**	**0.10**
RUNOFF VOLUME$_{10}$	**(ACFT)**	**0.12**	**0.18**
RUNOFF VOLUME$_{100}$	**(ACFT)**	**0.26**	**0.35**

Assumptions and Perceptions for the Drainage Calculations included in the Concept Report

- Drainage Basins were created by using GIS data and contours

- Area was calculated from GIS data and mapping

- Impervious Area was calculated based on mapping of Pre-Development vs. Post Development. The Drainage Basin was assumed to have a Post Development Impervious Area of 50%. The 1st Ave. Sub-Basin has an assumed Impervious Area of 60% due to the smaller area inside the Sub-Basin and the location of roadways.

- The Flow, Q was calculated using the Rational Method:

  $$Q = CiA$$

  where:

  Q = maximum rate of runoff, cfs
  C = runoff coefficient representing a ratio of runoff to rainfall
  i = average rainfall intensity for a duration equal to the time concentration for a selected return period, in/hour
  A = drainage area tributary to the design location, acres

- Runoff Coefficients (C) were taken from the South Dakota Drainage Manual Figure 7.13-A. Pre-Development was assumed to have the drainage area type of “Unimproved Areas” and the Post Development was assumed to be a “Suburban” drainage area type.

- The Rainfall Intensity values, i, were taken from the South Dakota Drainage Manual, IDF curve. Sturgis was not included in the manual but it was assumed that the rainfall would be similar to the Belle Fourche area, Figure 7.13-H. A conservative time of concentration of 5 minutes was used to determine the rainfall intensity.

- The Flow for the 2, 10 and 100 year storms were calculated. When sizing any storm water features in this residential area the 10 year storm would be used as a minimum.