CLARK ENGINEERING

1410 WEST RUSSELL STREET • SIOUX FALLS, SD 57104 • MAIN: 605.331.2505 • FAX: 605.331.2602

November 29, 2019

Pickerel Lake Conservancy
Board of Directors
Grenville, SD 57230

Re: 2019 South End Study

Dear Gentlemen,

Clark Engineering would like to thank the Pickerel Lake Conservancy and the South End Association for this opportunity to provide you with this study. This study is recommending a multi-level approach with practical options in the areas of road maintenance, intermediate projects, comprehensive planning, and zoning/building regulations.

As residents of Pickerel Lake, you have observed the effects of stormwater runoff entering the lake after a storm event. Seasonal stormwater runoff is classified as nonpoint source pollution. Typical nonpoint pollution sources include overland runoff, precipitation events, drainage seepage, and hydrological modifications. The South End neighborhood of Pickerel Lake receives storm water from all nonpoint sources.

There are existing physical constraints from cabins, infrastructure, and lay of the land. These constraints present challenges in retrofitting the existing system to protect the lake. The current water management system was designed many years ago with the purpose of simply convey water through the South End neighborhood to the lake. We now know the old way of water conveyance has had a negative impact on Pickerel Lake. Improvements to water management system can be done by changing maintenance techniques, increasing permeable surfaces, implementation of upstream water management, changes in zoning, and building regulations.

This report identifies short-term, intermediate, and long-term projects designed to improve the overall watershed management. Short-term projects center on the maintenance of roads, culverts, and ditches. Short-term maintenance projects can be implemented immediately without dramatic increases in funding. The intermediate level projects focus on creating stable permeable surfaces, replacement of existing drainage systems, and creating raingardens. Most of the short term and intermediate project recommendations are located within the right-of-way of the local roads. Long-term projects include a comprehensive drainage plan, changes in zoning, and building regulation. The long-term plans include significant construction projects and require changes in existing regulations.

Thank you,

Paul Clinton, PLA

1. Background and Purpose

The Pickerel Lake Conservancy and South End Association hired Clark Engineering to evaluate and provide possible solutions to improve water qualified in the south end of Pickerel Lake in the area of Webster Boulevard.

The focus areas of this study are the local roads along Webster Boulevard and the area upstream of the CR6 culvert. An on-site review of the roads was performed in August of 2019. The study included a review of USGS Streamstats to determine the size of the watershed upstream of CR6 culvert. A literature review of gravel road maintenance techniques and ice block drainages was also performed.

This study presents the preliminary findings and conceptual plans to moderate nonpoint stormwater associated with the South End neighborhood, road system, and upstream runoff. The methods and estimated costs presented are preliminary. The presented costs may not represent the final system that will be developed as the evaluation and design of the site progresses. This plan has been prepared in accordance with generally accepted practices consistent with this geographic setting. No warranty, expressed or implied, is made.

2. Site Development History

Pickerel Lake has a long history of being a recreational lake in northeast South Dakota. The South End neighborhood has transformed from a group of rustic cabins to a mix of modern summer and year-round cabins. All cabins have electric, communication, water, and sanitary sewer. The improvements to sanitary sewers were completed to improve the water quality of the lake. The component of the infrastructure that has not seen the same level of improvement is the drainage and roads that support the cabins. Awareness of nonpoint pollution sources has increased over the years. When people see murky water in the lake after a storm event, they now understand there is an issue.

3. CR6 Culvert

The issue with the ice block of the culvert under CR6 revolves around the annual freezing of the culvert. The culvert fills with ice and snow and freezes causing the ice blockage. This ice blockage prevents the downstream flow of water in the winter and into the spring. The water flows from the south to the north. The orientation, height of CR6, and vegetation are factors that prevent water from flowing through the system in freezing weather. The north side of the culvert is well shaded from the road and vegetation. There is little solar energy available to thaw the north side of the culvert in the spring. The ice and snow melt at a slower rate on the north side than on the southside of CR6. The ice blockage in the culvert backs up and pools water on the south side of the road. The melting of the ice blockage on downstream (north) side of the culvert occurs there is an uncontrolled flow of water. This flow of water may cause minor flooding depending on the weather conditions and sediments being flushed downstream into Pickerel Lake.

The watershed upstream of CR6 consists is approximately 75-acres of pastureland. The unnamed tributary to the culvert is in a small ravine. A wetland is upstream of the culvert in the channel. The channel and wetland are likely to be classified as Waters of the United States and will be regulated by the Corps of Engineers. The south ditch of CR6 also drains into the culvert.

The US Army Cold Region Research & Engineering Laboratory identifies steam as a method to melt ice in culverts. The recommendation is to use a steamer to thaw out the culvert every spring. Day County Highway Department has a steamer available. The South End Association has been in contact with the County to use the steamer to clean out the CR6 culvert. Removing ice from CR6 culvert is part of the solution for managing spring runoff. Keeping the smaller downstream culverts open will also play an important role in managing water flow.

To improve the efficiency of steaming CR6 culvert, selective removal of vegetation downstream will provide the steamer operator easier access to the culvert. Removing the vegetation will allow sunlight to passively thaw the culvert. Photograph 1 illustrates how the outlet is shaded by vegetation, accumulated debris, and the undefined channel. The caution with vegetation management is to avoid clear cutting. The vegetation on the slope stabilizes the hillside. Vegetation management should focus on the area downstream of the culvert. The first stage of vegetation management is to remove the dead and dying trees. The small trees without bark in Photograph 1 should be removed immediately.

Photograph 1 is facing south looking at the outlet culver.

In addition to the annual maintenance of the culvert system the US Army Cold Region Research & Engineering Laboratory, Cold Regions Technical Digest No. 84-2 September 1984, Solving Problems of Ice Blocked Drainage (USACRREL) identifies the construction of a control structure upstream of culverts. The USACRREL Technical Digest lists simply ways to block the

upstream inlet with sandbags, plastic or plywood to prevent water from entering small culverts. Theses techniques are not practical for the South End. The Technical Digest also suggests a bypass pipe above the elevation of the current pipe. This technique is not practical because of the condition of the downstream conveyance system. The advanced recommendation is to construct a structure upstream of the culvert. The concept behind the upstream structure is to hold water behind a structure that would freeze up at a similar rate as the culvert.

An upstream structure was selected for CR6. The rational is for selecting a structure is that it would freeze up and secondly is it would provide some level of water quality. The concept design is to construct a passive structure. The system would consist of a small internal earthen berm, drain tile, capped with riprap, and overflow pipe. The concept is water behind the structure would freeze creating an ice dam before it would reach the culvert. As the spring thaw would occur the riprap would regulate the higher flow of water through the system. The internal earth berm would detain water, the drain tile system would freeze in the winter and allow base flows during the summer. This structure will provide a secondary function of treating the first flush of water during a storm event. Details of the proposed location and concept design are on plan sheet 3.

The goal of this project is to provide flow control during the spring thaw. This solution involves multiple landowners. The proposed concepts may not be acceptable to individual landowner(s) who could prevent the project from moving forward. Once the landowner(s) agree(s) to the proposed conceptual solution, the project can move forward. For project completion further engineering analysis and design are required. The additional detailed engineering analysis and design could include a hydrology study, topographic survey, and wetland determination.

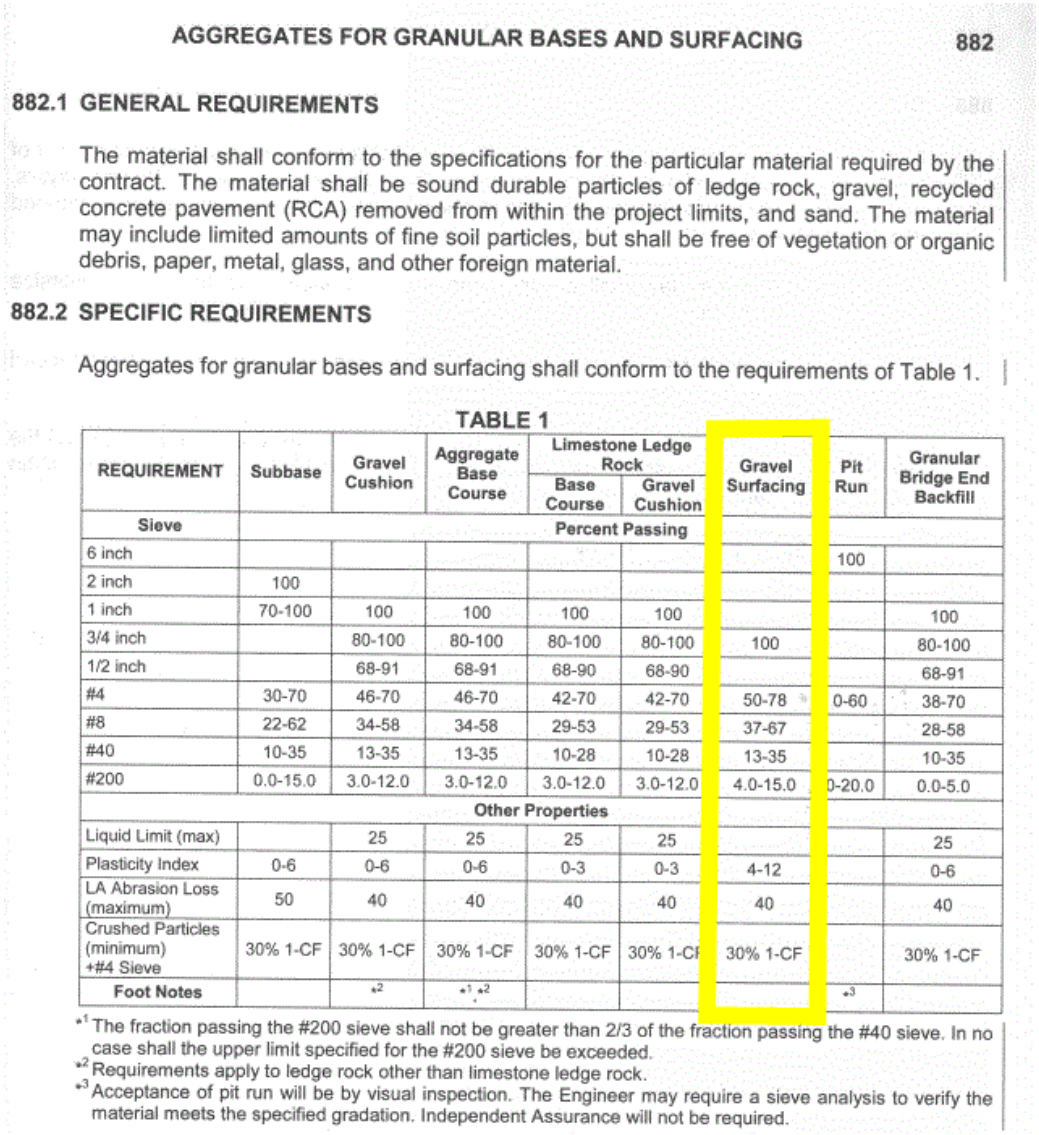
4. South End Road System Maintenance

All the gravel road surfaces in the south end of Pickerel Lake have low quality pit-run material. The current surface of the roads consists of fine sands and clay with minimal stones. The lack of adequately sized aggregate (stones) in the road surface mix increases the number of fine sands and clay that are washed out of the road surface. These “fines” flow into ditches and culverts and settle out and clog the system. The crowns of the roads are in poor to fair condition. Deficient road crowns lead to poor drainage and the creation of unintentional secondary ditches. These secondary ditches are developing along the road shoulder and on the roads. These deficiencies are repairable by improving maintenance techniques

Road improvements are necessary to resolve sedimentation issues in the ditches and culverts. Improving maintenance techniques range from blading techniques to reconstructing portions of the roads. The following sections will discuss the different options that are available for short-term maintenance improvements.

One of the first improvements that can be implemented is to improve the road surface by using the South Dakota Department of Transportation gravel specification. This gravel specification has a well-graded blend of material that will bind larger stone with finer sands and clays. This type of

material is less erosive than the existing material consisting of mostly sand and clay. Figure 1 is a copy of the South Dakota Department of Transportation gravel surface specification.



AGGREGATES FOR GRANULAR BASES AND SURFACING 882

882.1 GENERAL REQUIREMENTS

The material shall conform to the specifications for the particular material required by the contract. The material shall be sound durable particles of ledge rock, gravel, recycled concrete pavement (RCA) removed from within the project limits, and sand. The material may include limited amounts of fine soil particles, but shall be free of vegetation or organic debris, paper, metal, glass, and other foreign material.

882.2 SPECIFIC REQUIREMENTS

Aggregates for granular bases and surfacing shall conform to the requirements of Table 1.

TABLE 1

REQUIREMENT	Subbase	Gravel Cushion	Aggregate Base Course	Limestone Ledge Rock		Gravel Surfacing	Pit Run	Granular Bridge End Backfill
				Base Course	Gravel Cushion			
Sieve	Percent Passing							
6 inch							100	
2 inch	100							
1 inch	70-100	100	100	100	100			100
3/4 inch		80-100	80-100	80-100	80-100	100		80-100
1/2 inch		68-91	68-91	68-90	68-90			68-91
#4	30-70	46-70	46-70	42-70	42-70	50-78	0-60	38-70
#8	22-62	34-58	34-58	29-53	29-53	37-67		28-58
#40	10-35	13-35	13-35	10-28	10-28	13-35		10-35
#200	0.0-15.0	3.0-12.0	3.0-12.0	3.0-12.0	3.0-12.0	4.0-15.0	0-20.0	0.0-5.0
Other Properties								
Liquid Limit (max)		25	25	25	25			25
Plasticity Index	0-6	0-6	0-6	0-3	0-3	4-12		0-6
LA Abrasion Loss (maximum)	50	40	40	40	40	40		40
Crushed Particles (minimum) +#4 Sieve	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF		30% 1-CF
Foot Notes		*2	*1 *2				*3	

*1 The fraction passing the #200 sieve shall not be greater than 2/3 of the fraction passing the #40 sieve. In no case shall the upper limit specified for the #200 sieve be exceeded.
*2 Requirements apply to ledge rock other than limestone ledge rock.
*3 Acceptance of pit run will be by visual inspection. The Engineer may require a sieve analysis to verify the material meets the specified gradation. Independent Assurance will not be required.

Figure 1 Is the gravel specification for gravel roads from the South Dakota Department of Transportation, Standard Specification for Roads and Bridges, 2015. The highlighted column is the gravel surface technical specifications.

All the roads within the study area need some form of rehabilitation. This work would include reshaping to reestablish road crown, remove secondary ditches on the shoulder, and reestablish ditch flow lines to improve drainage. A new gravel surface layer would be incorporated into the existing road surface. Incorporating a new surface would be done by ripping or disking the top 4 to 6 inches of the existing road surface. In several locations, existing material may need to be

removed to re-establish the grade of the road. The new gravel would be placed, graded, and compacted. Figure 2 illustrates typical methods in which roads can be graded.

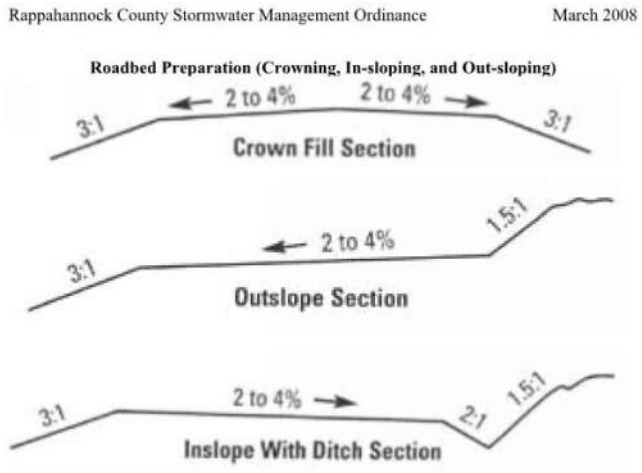


Figure 2 illustrates a typical cross section of roadbed crowing, in-sloping and out-sloping.

Changing the routine blading techniques of the road to increase the crown of the road and define the existing ditches where possible will improve drainage and reduce soft spots. Portions of the south end roads will require heavy maintenance for the removal of secondary ditches. Heavy maintenance will include reshaping selected ditches, installing wing ditches, cleaning, and repairing culverts.

Ditches are one of the most important elements of a road providing drainage for the road system. However, in the case of the south end road system, ditches cannot be reestablished in all locations due to underground utilities and surface obstructions. The underground utilities and surface obstructions create narrow work areas or issues with cabin access points. Alternatives to typical ditches with culverts may include underdrains, low water crossing, concrete valley gutters, or traditional curb and gutter systems.

Heavy road maintenance is needed to prevent the creation of secondary ditches, erosion, sedimentation, and culvert plugging that will need to occur several times per year depending on the activity.

Rain gardens could be placed on private property adjacent to the right-of-way to retain water in poorly drained areas. Rain gardens are landscaped depressional areas that are planted with perennial flowers and native vegetation that soak up or retain water. They are strategically located to capture run-off from impervious surfaces, such as roofs and streets. Rain gardens fill with a few inches of water after a storm. The water filters into the ground rather than running off

to a storm drain. Infiltration of water into the ground helps to protect water quality and reduces stormwater runoff.

5. Major Reconstruction Projects by Road Segment

This section identifies maintenance work and proposed intermediate work by road segment.

A. Webster Boulevard

Webster Boulevard is the central road of the South End Study area. The proposed improvements will be from the west to east. Webster Boulevard has been divided into three segments using the cross streets. The work areas are shown on sheets 4 and 5.

Segment one is from the intersection of Peabody Avenue and Webster Boulevard. Some coarse aggregate has been added to the road surface. Secondary ditches are developing on both the north and south shoulders of the road.

- **Proposed Improvement**
  - Maintenance:
    - Install SD DOT specified gravel surface.
    - Shape road – ditch cleaning to maintain drainage.
    - Remove secondary ditches/ditch construction.
  - Intermediate Work:
    - Install off-line raingarden on private land.

Segment two is from Scenic Avenue to Cottage Street. The intersection of Scenic Avenue is a flat area. East of the Scenic Avenue intersection there are two retaining walls on both the north and south side of the road. The purpose of these retaining walls is to prevent water from entering the private property. East of the intersection is a downhill slope that flattens out at Cottage Drive. There are underground utility conflicts on both sides of the road. Photograph 2 illustrates water in the secondary ditch in the road and the existing inlet to the culvert at Cottage Drive. Photograph 3 demonstrates where the secondary ditch is improperly conveying water to the culvert. Photograph 4 is upstream of the culvert at Cottage Drive. From this angle, the lack of a ditch is forcing water on to the road.

Photograph 2 is facing west at the intersection of Webster Boulevard and Cottage Drive. This is an example where a secondary ditch needs modification. (Dan Pearson - 2019)

Photograph 3 is looking at the culvert in the southwest corner of the intersection of Webster Boulevard and Cottage Drive. The water from the west is not correctly entering the culvert. Work at this location consists of re-establishing the ditch from the west. (Dan Pearson -2019).

Photograph 4 is facing east at the intersection of Cottage Drive and Webster Boulevard. This is where the ditches are not functioning correctly (Dan Pearson -2019).

- **Proposed Improvements**
  - Maintenance work:
    - Install SD DOT specified gravel surface.
    - Shape road – ditch cleaning to maintain drainage.
    - Remove secondary ditches/ditch construction.
    - Clean out the culvert at Webster Boulevard.

  - Intermediate work:
    - Replace existing culvert.
    - Install manholes with inlet grates on the south and north side of Webster Boulevard (see plan sheet 3). A second option is to install a manhole system that collects sediment. The figure below is an example of a commercial system that is available.
    - Install valley gutter on the south side of Webster Boulevard at Scenic Avenue.

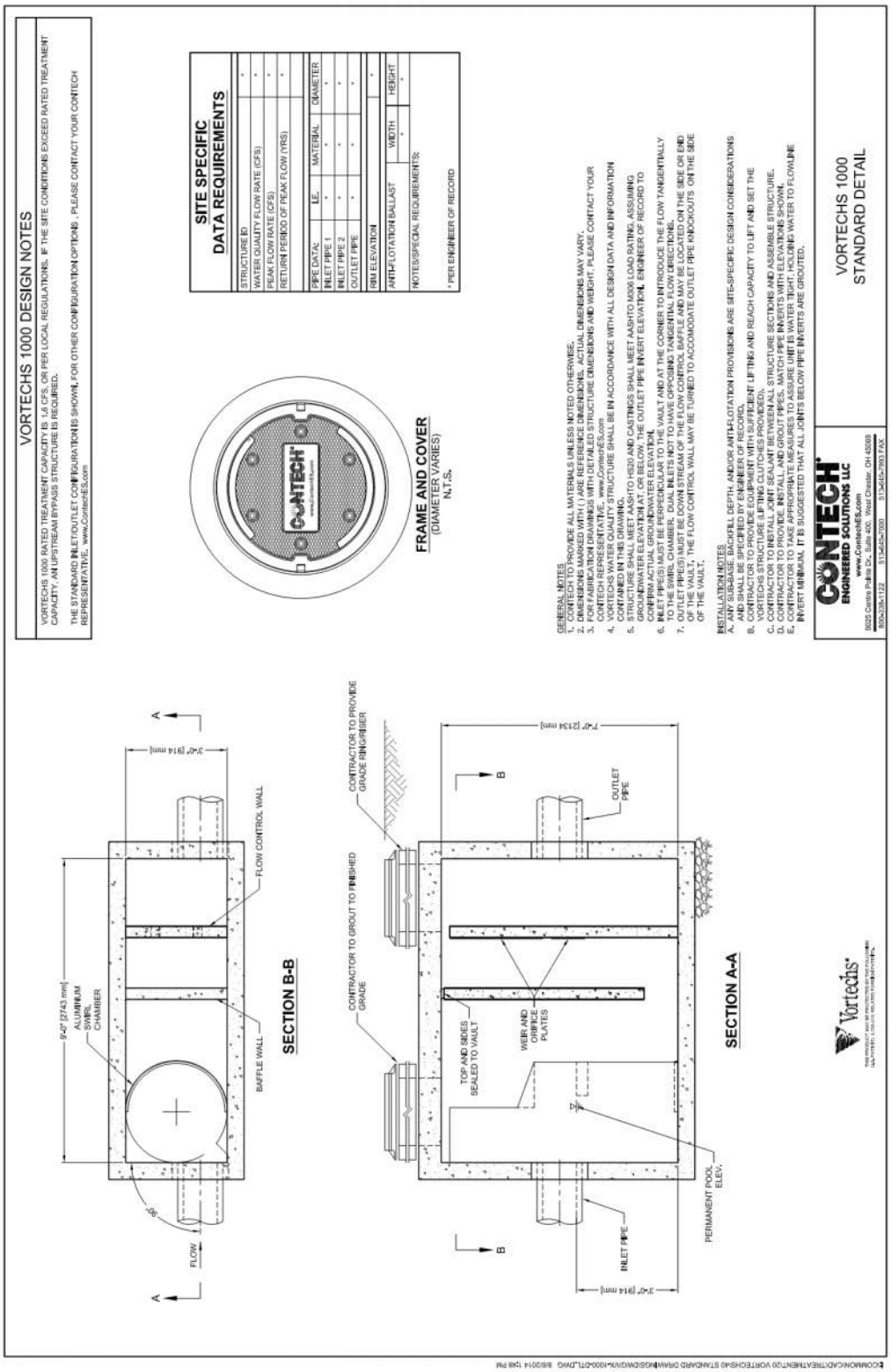


Figure 3 is an example of a commercially available sediment collection system.

Segment three is from Cottage Drive to Huggett Lane. This segment is the flattest and lowest portion of Webster Boulevard. The water flows east to west into the culverts under Webster Boulevard at the intersection of Cottage Drive. Underground utility conflicts are high in this area primarily along the north side of Webster Boulevard. There is a high density of cabins on the north side of the road with access points/driveways. On the south side of Webster Boulevard, the ditch should be reestablished. Photograph 5 shows the standing water in the secondary ditch along the road and water in the ditch location.

Photograph 5 is facing west on Webster Boulevard from near the intersection of Huggett Lane. Water can be seen in the secondary ditch. This is the area where the maintenance needs to be complete to remove the secondary ditch and re-establish the ditch. (Dan Pearson -2019).

- **Proposed Improvements**
  - Maintenance:
    - Install SD DOT specified gravel surface
    - Shape road – ditch cleaning to maintain drainage.
    - Remove secondary ditches/ditch construction.
    - Clean culvert.
    - Re-establish south ditch.
  - Intermediate work:
    - Replace existing culvert under Webster Boulevard.
    - Install manhole with inlet grate in the northwest corner of Webster Boulevard and Cottage Drive.
    - Expand the width of the south ditch to increase capacity.

- Install rain gardens outside of the right of way at selected loacations.

B. Peabody Avenue

Peabody Avenue from CR6 to Webster Boulevard is a 460-foot segment of road. CR6 is the high point of this segment. The segment of road between CR6 and the Sanitary District Building has a slope of 1 percent. There is little evidence of erosion creating a secondary ditch from the Sanitary District Building down to Webster Boulevard intersection where the slope of the road increases. Erosive actions are creating secondary ditches on both the west and east side of the road. Work areas are shown on sheet 6.

- **Proposed Improvements**
  - Maintenance:
    - Install SD DOT specified gravel surface.
    - Remove secondary ditches from the Sanitary District Building to Webster Boulevard.
    - Focus on the east ditch and create a cut-off or wing ditch to move the water downslope into the open grass area.
  - Intermediate work:
    - Install culvert at driveways.
    - Install Raingarden

C. Scenic Avenue

Scenic Avenue has two distinct segments. The segment from CR6 to Webster Boulevard is a township road with the full right-of-way. The segment from Webster Boulevard is an access easement to the lake.

The township road segment's high point is at CR6. The road right of way is the standard township road width of 66 feet. The road is in the west half of the right of way. Photograph 6 illustrates the poor condition of the road surface. The retaining wall that directs flow to Webster Boulevard can be seen in photograph 7. Photograph 8 identifies a potential location of a raingarden that could provide stormwater manage along Scenic Avenue. The work areas are shown on sheets 7 and 8.

Photograph 6 is facing north on Scenic Avenue. (P. Clinton - 2019)

Photograph 7 is facing north on Scenic Avenue. (P. Clinton - 2019)

Photograph 8 is facing south from the intersection of Scenic Avenue and Webster Boulevard.

The second segment of Scenic Avenue is from Webster Boulevard to the lake. The alignment of the existing roadway north of Webster Boulevard is off-center to the west. The east side of the existing road is approximately 4 to 6 feet above the adjacent property. Photograph 9 illustrates the sediment deposits from rain events. Photograph 10 demonstrations the flow of water in a secondary ditch. In the background, of the photograph overland flows of water can be seen going to the lake. This is a good location for a grass pavement system that will provide a stable surface for vehicles and infiltrate water into the subgrade. Plan sheet 7 identifies the location and has a cross section of the system.

Photograph 9 is looking south at Scenic Avenue from the lake shore.

Photograph 10 is looking north down Scenic Avenue and Webster Boulevard. This is a proposed location for a permeable grass pavement system (Dan Person 2019).

- **Proposed improvements**
  - Maintenance:
    - Install SD DOT specified gravel surface.
    - Reshape the road includes blade maintenance and ditch cleaning.
    - Remove secondary ditch.
  - Intermediate work:
    - Improve the east ditch by blading from CR6 to Webster Boulevard.
    - The west ditch, approximately 250 feet north of CR6 install a wing ditch with check dams to keep water off the adjacent property.
    - North of Webster Boulevard install a permeable grass pavement system to the lake. Figure 3 is a brochure that summarizes a grass pavement system.
    - Install raingarden.
    - Place culverts at the existing access points.

Figure 4 Grassring Brochure.

D. Cottage Drive

Webster Boulevard divides Cottage Drive into two segments. The southern segment is 300-feet-long by 33-feet wide south of Webster Boulevard. The road surface is recycled crushed concrete. The channel adjacent to Cottage Drive starts at the CR6 culvert. This segment of the channel that meanders through a wooded area to culverts located at the sanitary lift station. The west channel is a trapezoidal ditch with variable width and approximately 2 ½ feet deep. On the east channel is an undefined ditch filled with sediment.

At the northern portion of Cottage Drive is 220-foot-long public access to the lake. The gravel access begins a Webster Boulevard which turns into to grass pathway. Two culverts on each side of Cottage Drive pass under Webster Boulevard are filled with sediment. These two culverts outlet into sediment filled ditches that flow to the two culverts at the lake access point along the shoreline. Work areas are shown on sheets 9 and 10

Photograph 11 is looking north down Cottage Drive from Webster Boulevard. This photograph is an example of ditch re-establishment and improving the surface using a grass pavement system (Dan Pearson - 2019).

- **Proposed improvements**
  - Maintenance:
    - Blade maintenance of road.
    - Ditch cleaning and remove secondary ditch.
    - Clean culverts at the lift station.

        - Remove debris and manage vegetation in the meandering channel.
    - Intermediate work:
        - Design and sizing of the west ditch improvements starting at the culverts near the lift station. Reconstruct the channel with a consistent width and retaining wall system to stabilize the banks. This improvement would reduce the erosive soils and gravel entering the channel and being deposited downstream at the Webster Boulevard culvert.
        - The west ditch improvements starting at Webster Boulevard going north consist of resizing and replacing the culvert and reconstructing the ditch to the lake.
        - Re-establish the east ditch beginning at the private driveway going north to Webster Boulevard.
        - Clean out the existing ditch from Webster Boulevard to the lake.
        - Cottage Drive surface improvements from Webster Boulevard to the lake is to install a permeable grass pave/ring system. This system consists of plastic ring structure that will provide drainage and support vehicles.

E. Huggett Lane and Parking Area

Huggett is a private road that begins at CR6. The high point of Huggett Lane is at CR6. The road surface consists of pit-run fine gravel that is highly erodible. Secondary ditches are forming in the road which prevents water from flowing into the ditches or buffer area adjacent to the road. North of CR6 on the east side of the road is a drainage swale that wraps around the lodge at a higher elevation and terminates in a detention area just north of the lodge building. The detention area has a drain that discharges into the lake east of the boat refueling area. Work areas are shown on sheets 11 and 12.

- **Propose improvement**
    - Maintenance:
        - Resurface the road with SD DOT specified gravel surface.
        - Ditch cleaning.
        - Install wing ditches to remove secondary ditches.
    - Intermediate work:
        - In the southeast corner of Short Street and Webster Boulevard create a rain garden system.
        - Create a pervious parking area with a subsurface collection system in the parking area south of the docks and beach area.
        - Create a grass pave/ring buffer along the shoreline of the lake. The grass pave/ring is a permeable paving system that can be driven on.

Photograph 12 is looking uphill at Huggett Lane from the intersection of Webster Boulevard. This is an example of where the secondary ditches in the road need to be repaired (Dan Pearson - 2019).

Photograph 13 is facing north from the intersection of Webster Boulevard and Huggett Lane. This is an example of where a permeable parking system would allow water to soak into the ground and runoff at a lower rate (Dan Pearson - 2019).

Photograph 14 is facing northeast from the west building of the lodge. In the background of the photograph near the dock is the proposed location of the grass pavement system. This system will filter the surface water through the grass and allow water to soak into a course rock subgrade (Dan Pearson - 2019).

6. Comprehensive Planning

As an investigator, it became obvious that additional detailed information is needed to identify and quantify the small, unique drainage pattern and structures that exist in the South End neighborhood. For this initial study, we relied on LIDAR remote sensing data to generate contours and streamstats to determine the watershed. We did field verification of elevation with our survey equipment and found the LIDAR contours checked with tolerances along Webster Boulevard. The verification along CR6 was anywhere from one to two feet out of tolerance. Differences of this nature can have dramatic effects when trying to calculate stormwater volumes and rates into a developed neighborhood. Based on the information gathered and listening to input from the residents' it has been determined the drainage system is not sized correctly for the current conditions. We recommend completing an additional study of the three contributing local watersheds. The largest watershed is to the south of CR6 and the area to the east and west. Once the quantities of runoff are accurately determined, Best Management Practices can be correctly sized and properly placed within the watershed. The topography and available space north of CR6 are not adequate for a truly effective Best Management System. For a Best Management System to be effective it needs to be longer than it is wide. The existing channel and ditch system along Cottage Drive is not large enough to treat the upstream watershed and the south end stormwater.

One of the other challenges is that the South End faces the future production of additional runoff from improvements to cabins in the neighborhood. The South End residents naturally want to improve their property. One item that is overlooked is the increase in roof and concrete spaces that occur with property improvements. Additional impervious surfaces such as roofs and concrete increase the amount of runoff. The residents need to be aware of the increased potential of greater flooding in the future if some limits are not set today. When calculating runoff, the volume of water is determined by using standard coefficients. For example, the coefficient of 0.9 is used for impervious surfaces, roofs, and pavements. The coefficient for parks and cemeteries is 0.10-0.25. A typical two-year rain event produces between 2.5 and 2.75 inches of precipitation for this region. The volume of runoff produced by an impervious surface nine times more than a pervious surface in a park. Considering a two-year rain event on impervious surface, 2.25 to 2.50 inches of runoff will be generated. Increasing the amount of impervious surfaces can dramatically increase water runoff. With the increased urbanization of the South End neighborhood runoff levels will increase and tax the existing drainage system. The question is how the South End will handle the increase in nonpoint water pollution. Photographs 2,3, 4, 5, 11, 12, 13, and 14 in previous sections of this report illustrate the erosive effect of rain events and sediment buildup in the drainage systems.

The challenge for the Pickerel Lake Conservancy and the South End Association is how to develop a water management plan that will not be outdated or overrun by increases in impervious surfaces in the neighborhood. It is our recommendation that zoning and building regulations be adopted to control the increase of impervious surfaces.

7. Recommendations

The overall goal of the Pickerel Lake Conservancy and South End Association is to reduce pollutants that enter the lake. There are effective maintenance tasks that can be implemented immediately, there are small practical heavy maintenance and long-term projects. The following is a list of recommended priorities.

Maintenance

- **CR6 Ice Block**
    1. Steam open the culvert in the spring
    2. Clean downstream culverts
    3. Vegetation management

- **Re-Gravel Road Priorities**
    1. Huggett Lane
    2. Webster Boulevard
    3. Peabody
    4. Huggett Parking
    5. Scenic Avenue

6. Short Street

- **Heavy Maintenance**
    1. Huggett Lane
    2. Huggett Parking Lot
    3. Webster Boulevard
    4. Peabody Avenue
    5. Scenic Avenue
    6. Cottage Drive
    7. Short Street

- **Intermediate Work**
    1. Huggett Parking Area
    2. Webster Boulevard
    3. Cottage Drive
    4. Scenic Avenue
    5. Peabody Avenue

- **CR6 Ice Block Structure**

- **Comprehensive Plan**

7. References:

1. US Department of Transportation, FHA, SD DOT LTAP, Gravel Road Maintenance and Design Manual, 2000 https://www.epa.gov/sites/production/files/2015-10/documents/2003_07_24_nps_gravelroads_gravelroads.pdf

2. SD Department of Transportation Office of Research, Rural Road Condition Survey Guide, ERES Consultants, Inc., 1995 https://www.ugpti.org/resources/reports/downloads/MPC-SD95-16-G1.pdf

3. Environmentally Sensitive Maintenance for Dirt and Gravel Roads, US EPA, PA DOT, Penn State, 2007 https://www.epa.gov/sites/production/files/2015-10/documents/environmentallysensitivemaintenance_dirtgravelroads.pdf

4. Rain Gardens, NRCS, 2005 https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_011366.pdf

5. Driveway best management practices http://culpeperswcd.org/wp-content/uploads/Guide-to-Driveway-Best-Management-Practices.pdf

6. US Army Corps of Engineers Cold Region Research Engineering Laboratory, Cold Regions Technical Digest No. 84-2 September 1984, Solving Problems of Ice Blocked Drainage, Kevin L. Carey

7. Basic Information about Nonpoint Source (NPS) Pollution, EPA Website, https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution

8. http://sdlegislature.gov/docs/interim/2014/documents/HNF08-26-14TownshipRdConditionCostAssessment.pdf