Lou V.

City of Ponderay, Idaho

Stormwater Masterplan Report and Recommendations

Submitted: May 16, 2005

Submitted by:

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Introduction

This report details the findings of a comprehensive study of the existing stormwater system for the City of Ponderay. Using the XP-SWMM computer modeling program, along with background calculations to calibrate the results, the runoff and flow routing of stormwater within the boundaries of Ponderay were determined. These results were used to identify potential problem areas, and evaluate the most efficient solutions. The following steps were taken in the creation of this report:

- Review of the 1981 study "Kootenai Vicinity Drainage: State Highway 200" by S.J. Scribner and the 1998 study "Drainage Study and Preliminary Drainage Designs for City of Ponderay, Idaho" by Clearwater Engineering and Toothman-Orton Engineering Co.
- Study of existing topo maps and aerial photographs to identify the drainage basins and routing of stormwater flows.
- A field review to assess the stormwater system and identify the condition and size of its components.
- Review plans for the U.S. 95 Sandpoint to Kootenai Cutoff project to ensure the new design will meet the future demands of the system.

Using this background information, Black Diamond Engineering was able to:

- Define the drainage basin boundaries and determine the flow path of rainfall runoff into the stormwater system.
- Compute the capacity of all culverts and drainage channels in the system.
- Create a dynamic computer model of each basin and evaluate the flow rates in the system throughout a simulated storm event.
- Model the changes in runoff with future land development as well as a storm event with saturated soils at the onset.
- Identify problems in the system, and model different options to solve the problems.

The following design objectives were established for evaluating the stormwater system:

1) The stormwater system must be capable of passing flows from a 25-year storm without damaging infrastructure or posing risks to public health and safety.
2) Adequate treatment must be provided by the stormwater system to remove pollutants from the runoff before being deposited into Lake Pend Oreille or Sand Creek.
3) Erosion and sedimentation should be minimized by controlling runoff velocity and providing stable channels to convey the runoff.

Simulated Storm Event:

The design storm simulated for the modeling program produces 3.1 inches of rain in a 48-hour period. This design storm was similar to the recent storm event on March 26 and 27 of 2005. The modeling program was used to create a dynamic representation of the stormwater flow resulting from the rainfall over the 48-hour period. Keep in mind that a much larger runoff event will occur during a similar storm with snow on the ground.

Land Conditions:

The soils within the study area are deep, drain poorly, and have a seasonally high water table. In order to accurately calculate the variability of runoff rates, three different land conditions were evaluated for this study.

1) Unsaturated Soil: In this scenario, a portion of the rainfall infiltrates directly into the soil, reducing the overland flow that enters the stormwater system.
2) Saturated Soil: Storm events during the wet months often occur with the soils saturated at the onset of the storm. Consequently, nearly all of the rainfall becomes runoff into the stormwater system.
3) Developed: In the future, up to 80% of the land area may be covered by impermeable surfaces such as paved roads, parking lots, and rooftops. This will create larger rates of runoff due to a loss of pervious surface area.

Conditions 2 and 3 produce similar flows since the majority of rainfall is converted to runoff in each. For simplicity, this report will focus on conditions 1 and 3. In condition 3, it is important to understand that impermeable surfaces generally have higher levels of pollution associated with vehicular traffic and industrial contaminants. Consequently, more treatment areas (grassy swales, wetlands) will be needed to remove pollutants from the runoff.

Hydrology:

This study focuses on the culverts and channels within the primary drainages. Minor culverts associated with roadside ditch lines were not analyzed for this report. The capacity of the channels and culverts were calculated using the surface roughness, slope, size, and the flow conditions both upstream and downstream. Some of the culverts were damaged or had sediment buildup, reducing the capacity of the culvert.

Runoff rates were computed in XP-SWMM using the Runoff Method. The Runoff Method computes runoff rates based on rainfall, catchment area, length of drainage, surface slope, soil permeability, and the percentage of impermeable area. The runoff was assigned to the appropriate drainage, and a model was created to simulate the flow through that drainage.

With the capacities and runoff rates determined, we were able to identify the components in the system undersized or unable to properly convey the calculated flow. In addition

the XP-SWMM program was used to determine the necessary storage volumes needed to capture the flow beyond the capacity of a culvert or channel. With this information, different alternatives were evaluated to correct the inadequate components of the system.

Need For Action:

As outlined in this report, parts of the current stormwater system do not have adequate capacity for the rainfall, land use and soil conditions in the City of Ponderay. Consequently, flooding occurs on a regular basis. The following list highlights the adverse effects flooding and inadequate stormwater treatment has on the city.

- Roadways are damaged raising maintenance costs and creating hazardous driving conditions.
- Poor water quality from erosion and lack of detention storage for treatment.
- Septic systems fail, and release contaminants into the waterways.
- Wastewater treatment plant cannot properly treat all of the excess water entering their collection system.
- Property values suffer and property may be damaged.
- Normal business operations are interrupted.
- Storm water quality standards may be enforced in the very near future. Using mechanical treatment to meet the standards would be costly.

Glossary

Capacity:
The maximum quantity of water, in cubic feet per second, a drainage structure can convey.

Detention Area:
Area with defined boundaries that temporarily stores runoff to reduce peak flows and treat the water through sedimentation and percolation.

Development:
Land disturbing activities such as the building of structures and creating impervious surfaces.

Drainage Channel
A drainage pathway with a well defined bed and banks indicating frequent conveyance of stormwater runoff.

Erosion:
The process in which, by the actions of water or wind, soil particles are displaced and transported.

Impervious Area:
Area with impermeable surfaces that prevent infiltration of rainfall into the soil.

Invert:
The lowest point that water can be conveyed in a drainage structure.

Grassy Swale:
Grass lined channel or depression that provides treatment to surface runoff.

Sedimentation:
The movement and deposition of eroded material

Stormwater:
The portion of precipitation that does not naturally percolate into the ground or evaporate, but flows overland into channels and pipes and is deposited into a defined surface body of water.

Stormwater System:
Constructed and natural features which function together as a system to collect, convey, detain, and treat stormwater.

Description of Drainage

This report focuses on approximately 1200 acres of land, most of which is inside the city limits of the City of Ponderay. About 75% of the land area drains east into Lake Pend Oreille, while the other 25% flows west into Sand Creek. The land draining east is comprised mainly of pastureland and residential neighborhoods. The land use on the western drainage is primarily commercial.

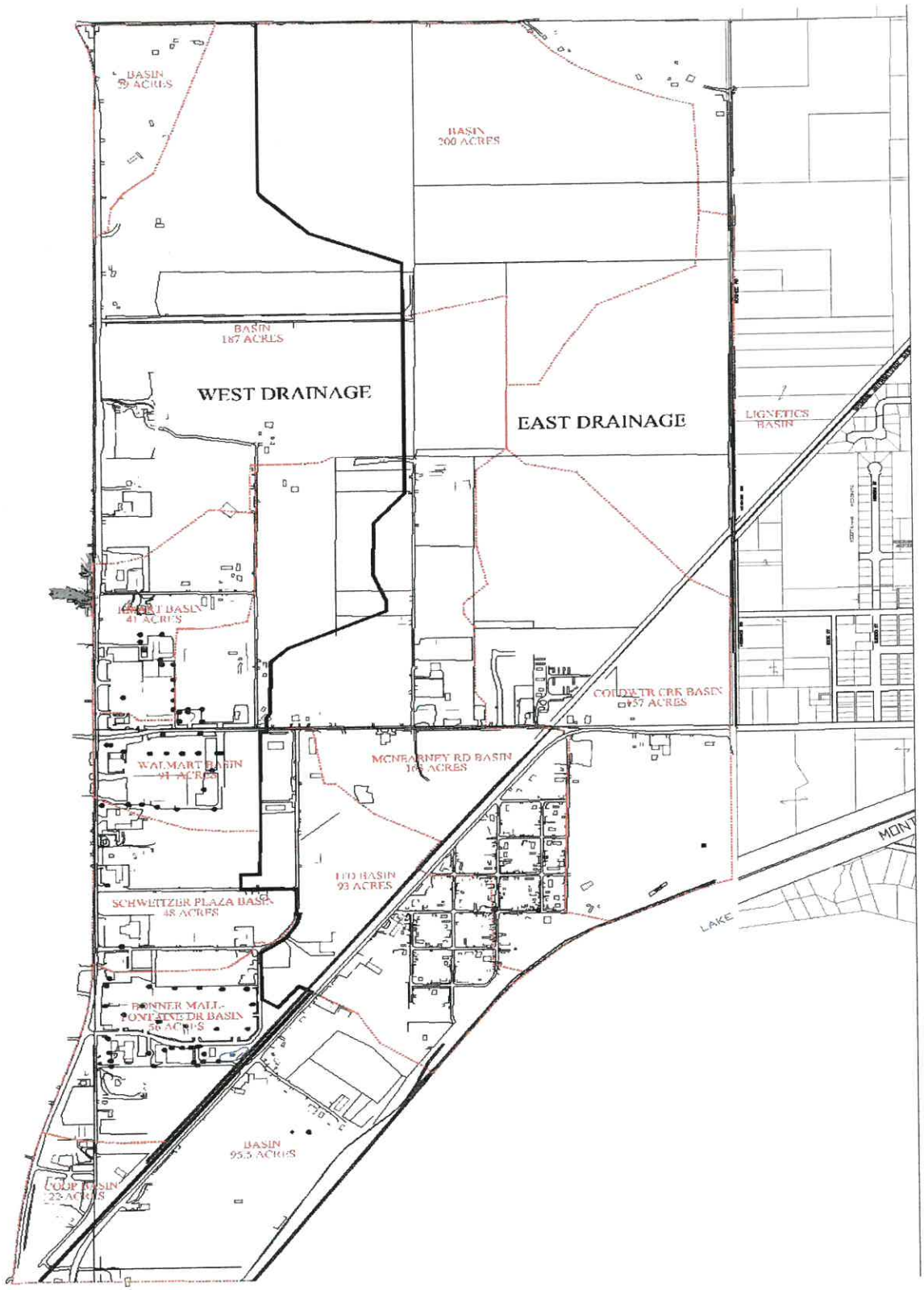
The area studied is relatively flat, with an average slope of 3-4%. According to the Soil Survey of the Bonner County Area, Idaho the predominant soil types in the study area are Mission and Odenson. These soils are composed mainly of silt loam and silty clay loam, and have low permeability rates. In addition, a hardpan layer at a depth of .5ft-2ft creates a perched water table leading to fully saturated soils during parts of the winter and spring.

The study area is broken down into the following nine drainage basins:

- ITD Basin
- McNearney Road Basin
- Coldwater Creek Basin
- Lignetics Basin
- COOP Basin
- Bonner Mall/Fontaine Drive Basin
- Schweitzer Plaza Drive Basin
- Wal-Mart Basin
- K-Mart Basin

Each basin has a common outlet into either Lake Pend Oreille or Sand Creek. The report gives an overview of each basin, identifies problem areas within the basin, and makes recommendations to improve the system.

Drainage Basins



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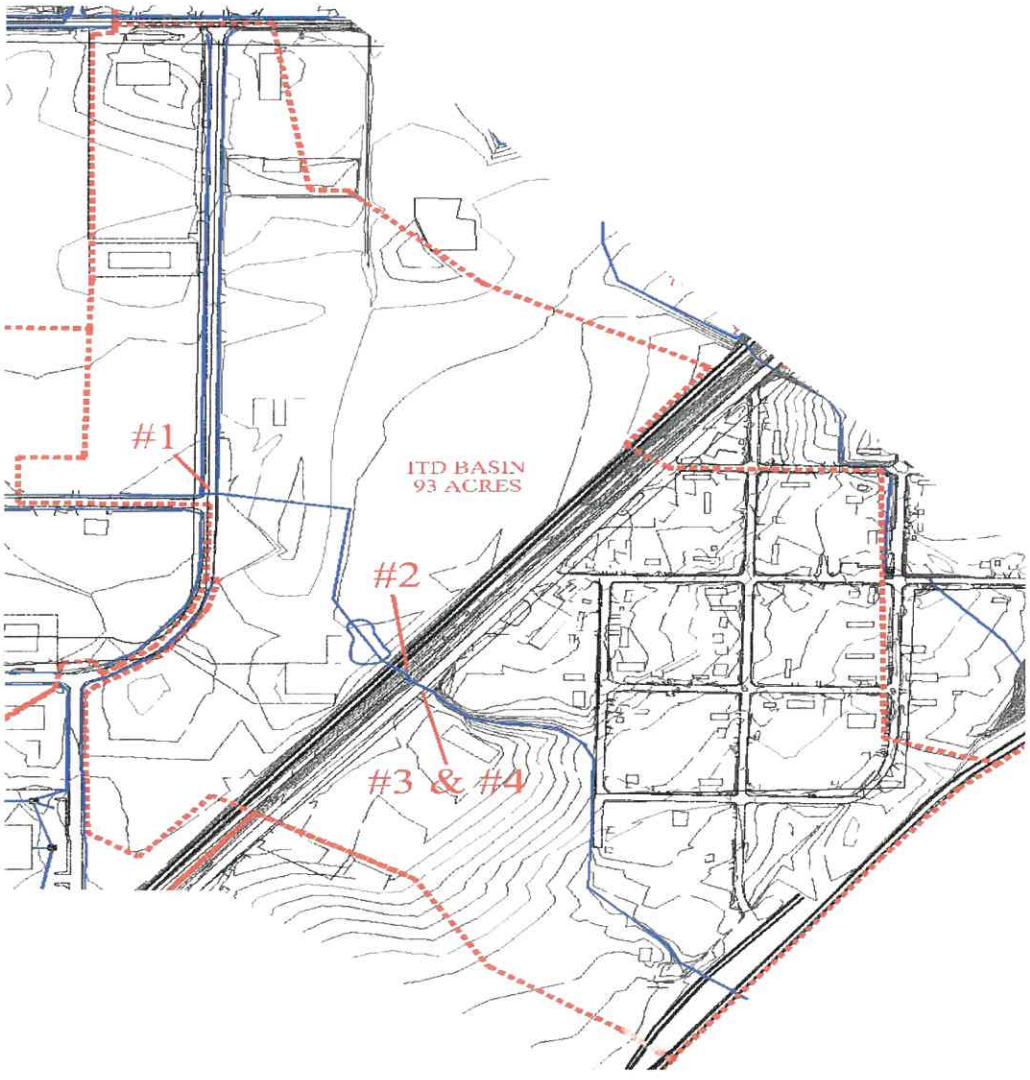
ITD Basin

The ITD Basin is approximately 93 acres in size, and extends southeast from Triangle Drive to the outfall at the lake. Culvert 1 at Triangle Drive is 12" in diameter and has a damaged inlet. The culvert is undersized for the simulated event when the land becomes developed in the future. At this time, the estimated peak flow will be 3 cfs, which is well over the current 1.5 cfs capacity of the pipe. This will cause flooding of the ditch lines and saturation of the road base. The flow moves from culvert 1 into an open channel and downstream into a shallow detention area at the inlet of culvert 2. It would be beneficial to increase the capacity of this pond and upstream channel to provide additional treatment and storage. If the land is developed and this storage capacity removed, the downstream culverts (2-6) would all need to be enlarged. As it is, culverts 2-6 are all near capacity for the simulated storm after full land development has occurred. The drainage continues under the UPRR tracks and HWY 200 into a channel alongside the ITD offices. The channel has accumulated an excessive amount of sediment, causing adverse outlet conditions for culverts 3 and 4.

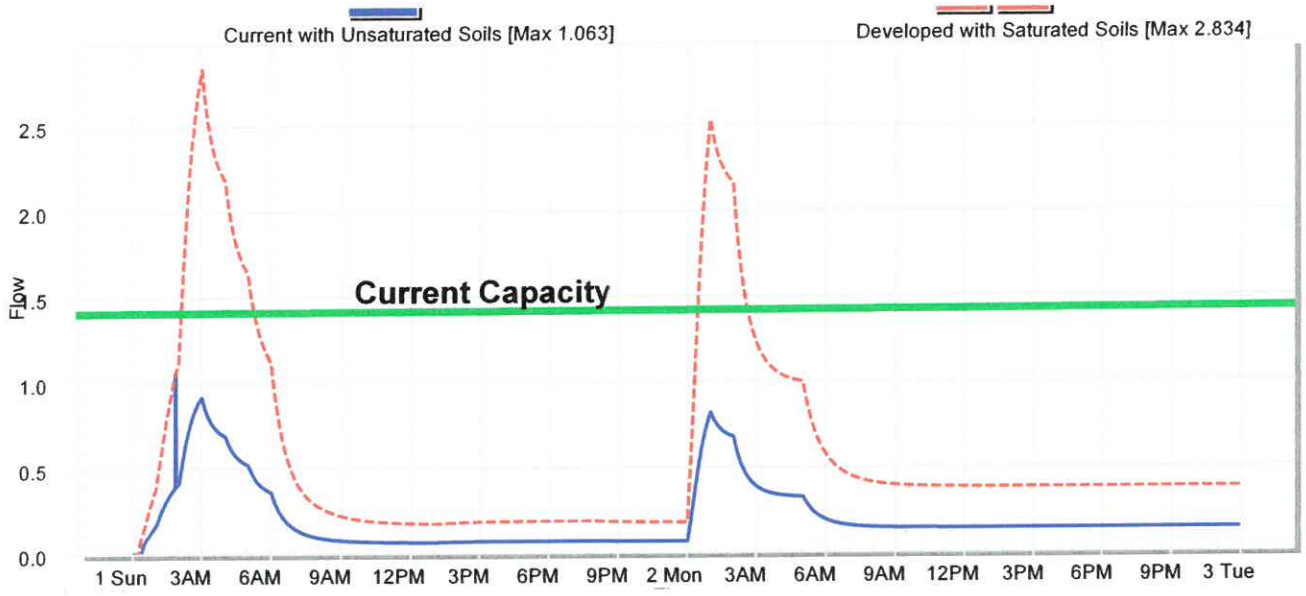


ITD Basin - Recommendations for Culvert 1 (3 options):

Option 1

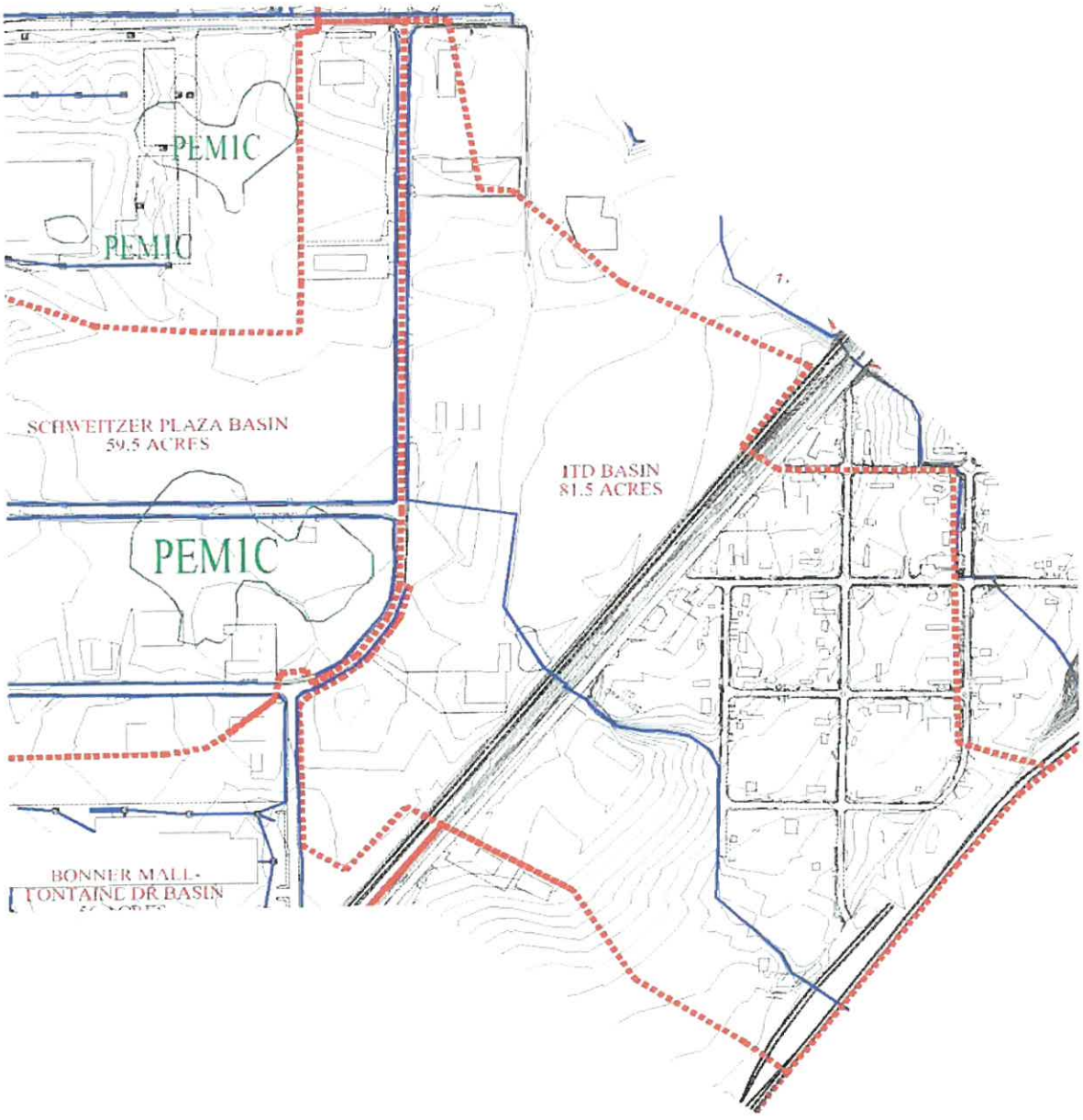
Replace culvert 1 with a pipe arch capable of passing 3 cfs. From the Handbook of Steel Drainage and Highway Construction Products (Table 3.15) a 17 x 13 arch would be adequate for the flow.

Culvert #1



Option 2

Another option is to remove culvert 1 and drain the runoff from the west of Triangle Drive down Schweitzer Plaza Drive.



Option 3

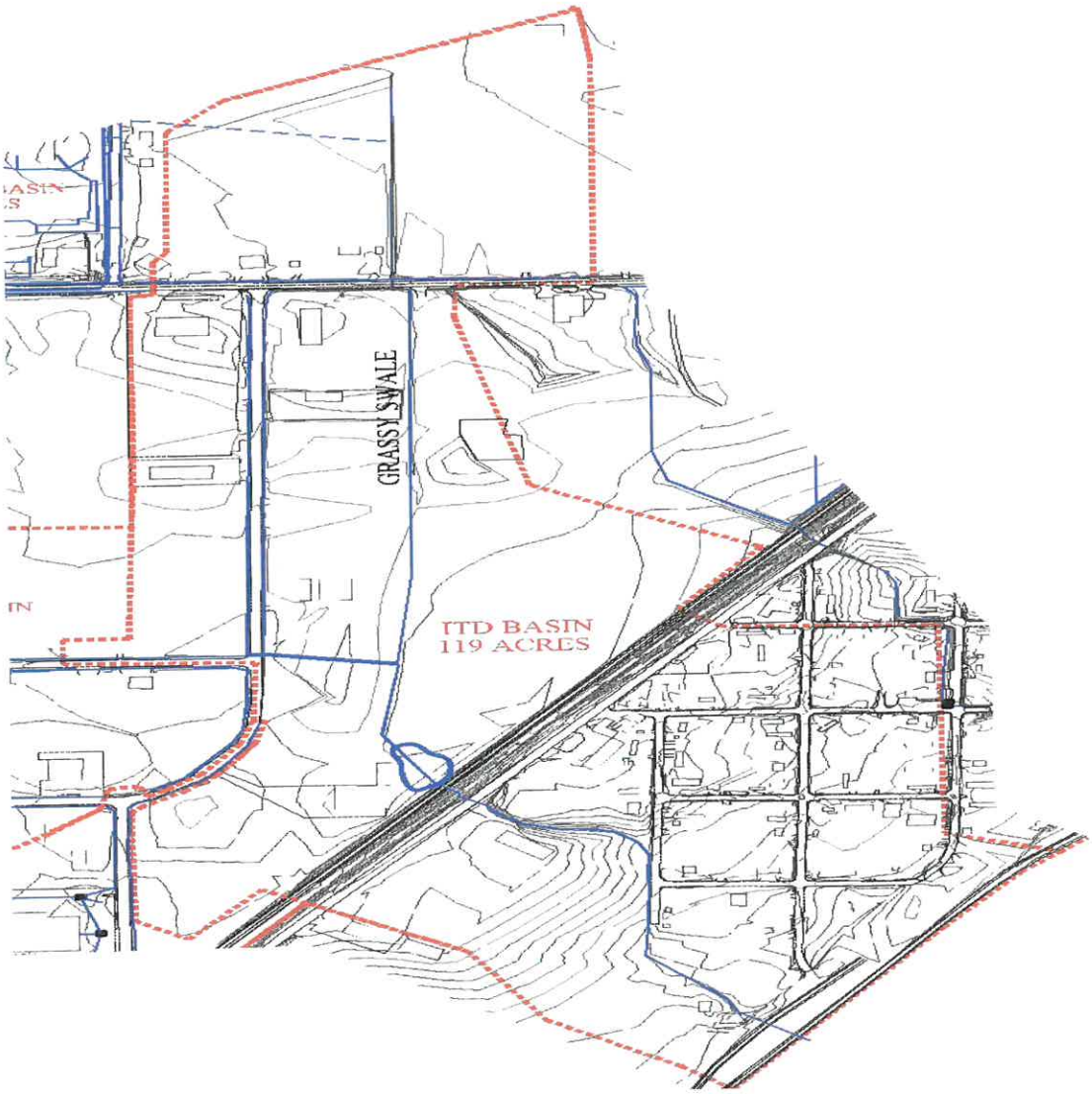
Provide more roadside storage capacity in grassy swales along Triangle Drive and Schweitzer Plaza Drive.

ITD Basin - Recommendations for Culverts 3 and 4:

- Remove sediment buildup from the downstream channel to improve outlet conditions and restore the full flow capacity to culverts 3 and 4.

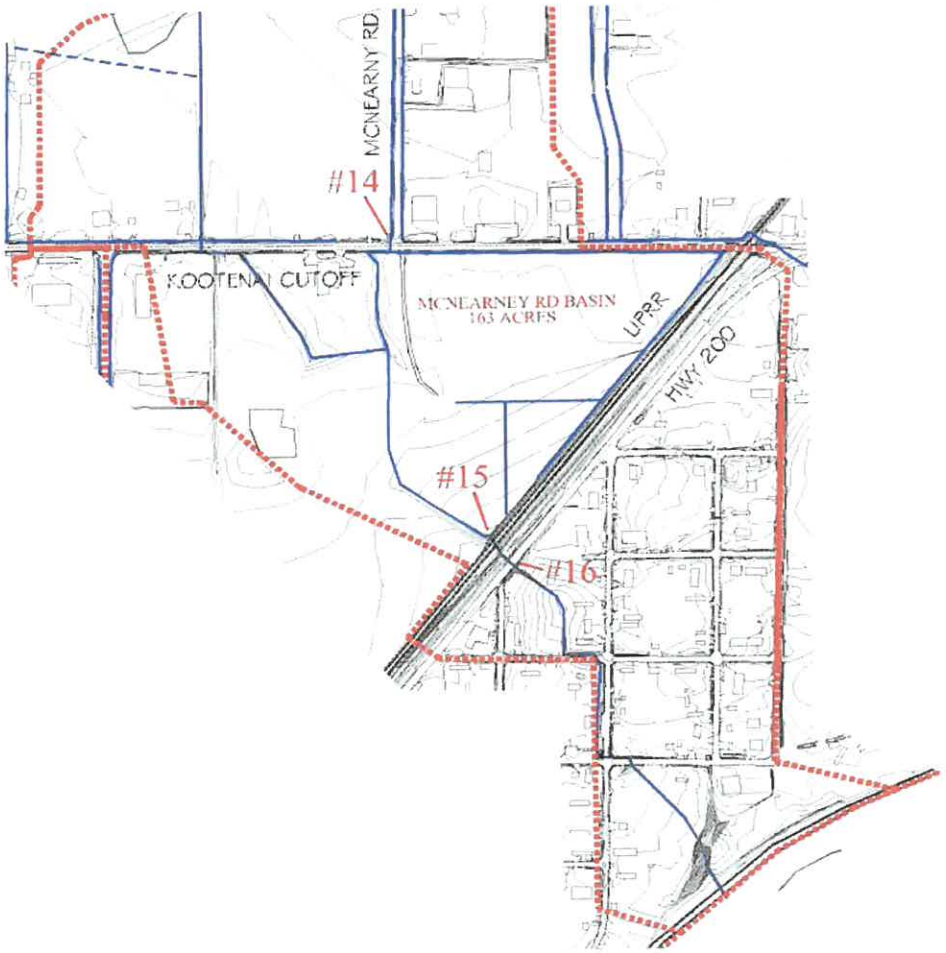
ITD Basin - Recommendations for Storage and Treatment

- Enlarge and deepen the channel between culverts 1 and 2.
- Enlarge and deepen the detention area north of culvert 2.
- Enlarge and deepen ditch line along Triangle Drive to create grassy swales.
- Route runoff from McNearney Road Basin at Kootenai Cutoff Road down a grassy swale on the west side of the proposed Alder Creek Subdivision. This flow could be accommodated by increasing the storage capacity north of culvert 2. The map below identifies the boundaries of the drainage basin if this change were made.



McNearney Road Basin

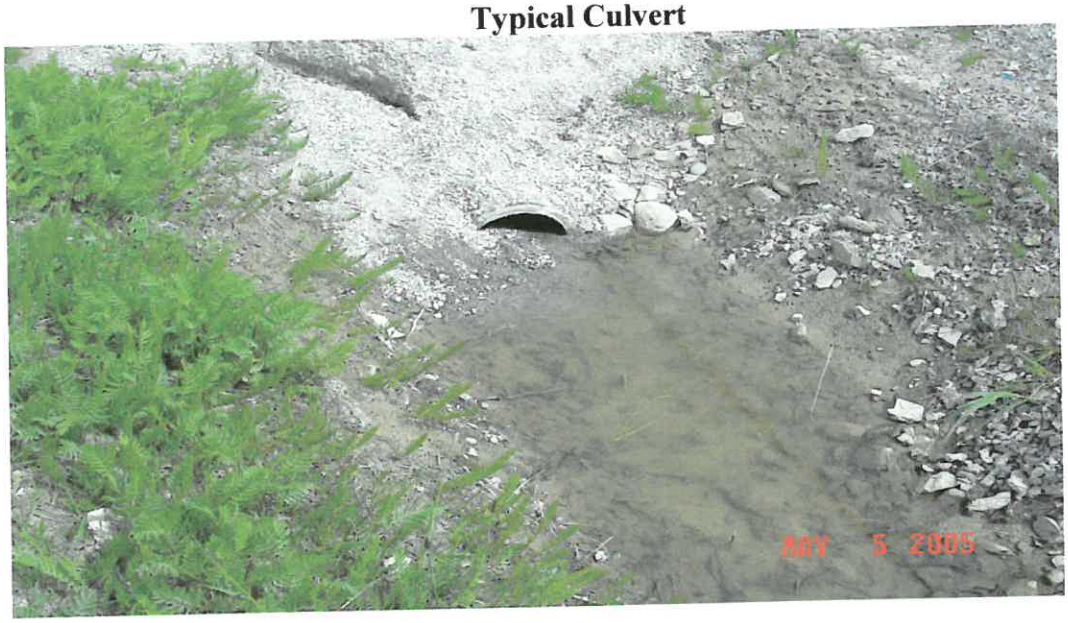
The McNearney Road Basin is approximately 163 acres in size and extends south along McNearney Road, crosses Kootenai Cutoff Road and HWY 200 and flows into the lake. The ditch lines along McNearney Road are undersized, and many of the culverts are plugged with debris. As a result, saturation of the road base and surrounding land occurs during large storm events. The runoff crosses Kootenai Cutoff Road and enters a natural channel that flows into a shallow detention area north and west of culvert 15. In the past several years, two new apartment complexes have been built on the land to the north of this detention area. The detention storage specified in the stormwater plans for the two developments was never created, and flooding of the area occurs north of culvert 15. The runoff then flows south under the UPRR tracks and HWY 200 through culverts 15, 16, and 17. Culvert 15 (24" dia) has a tree obstructing the outlet and a minimal slope which reduce its flow capacity to about 8 cfs. This creates flooding of the upstream detention area during major runoff events. Culvert 16 (18" diameter) is also under capacity, which causes flooding alongside HWY 200 and saturation of the road base. The rest of the system has adequate capacity for the design storm.



McNearney Road Basin - Recommendations for McNearney Road:

- Clean and widen ditch lines to create grassy swale treatment and storage areas.
- Remove debris from culverts.
- Divert flow off the northern half of McNearney Road into the Coldwater Creek Basin. This would require that the recommended changes be made to the Coldwater Creek Basin.

Typical Culvert



Typical Shallow Ditch Line

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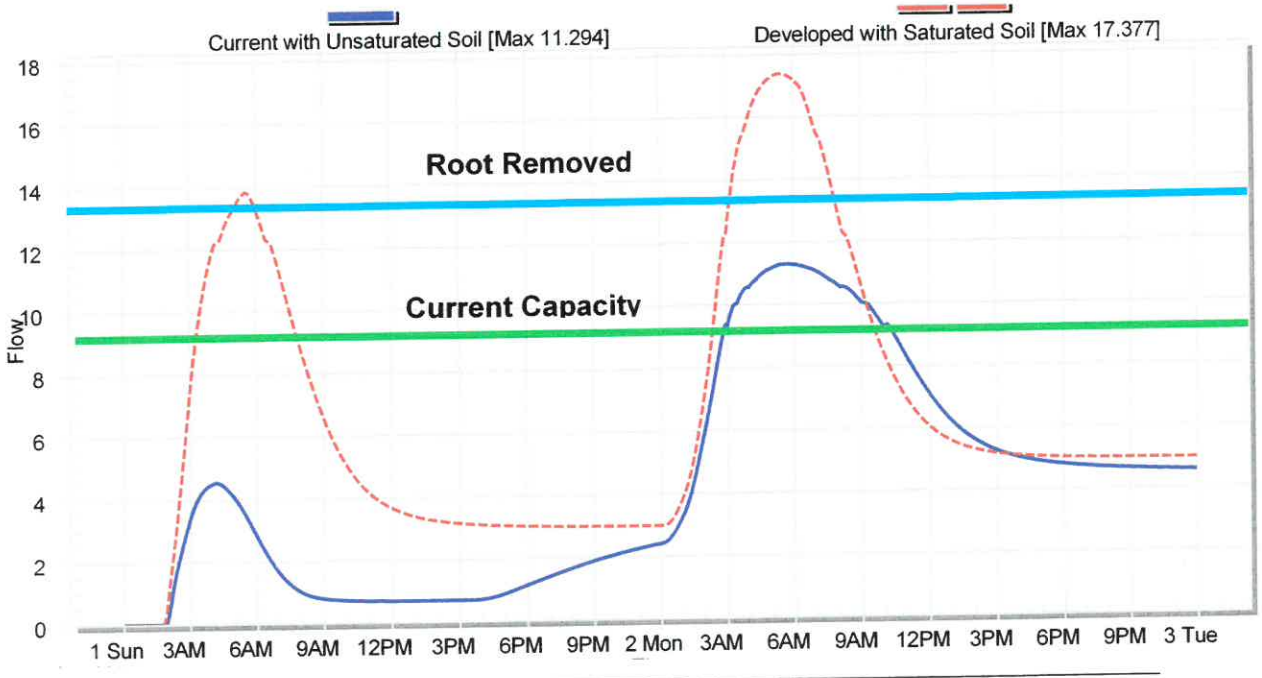
McNearney Road Basin - Recommendations for Culvert 15

- Remove the tree from the outlet of the culvert. This would increase the capacity by 50% and reduce the flooding north of the tracks.

Culvert 15



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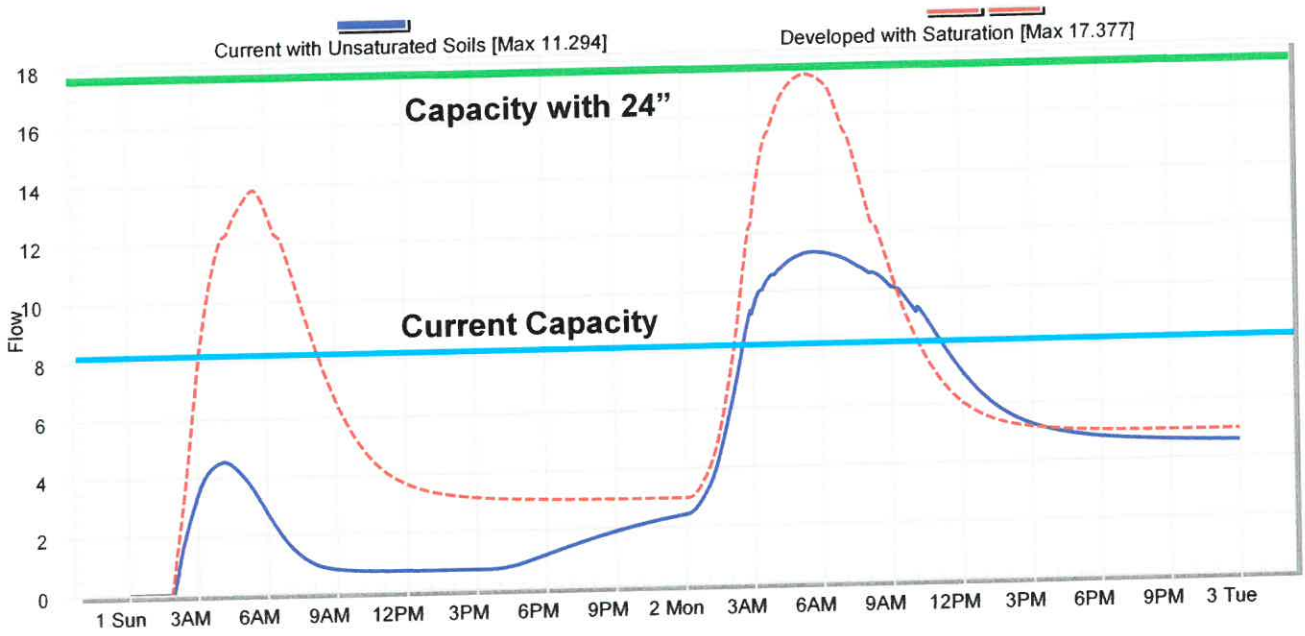
McNearney Road Basin - Recommendations for Culvert 16

- Replace with a 24" culvert (or equivalent arch) to accommodate the increased flows from culvert 15 and reduce the flooding along HWY 200.

Culvert 16



McNearney Road Basin - Recommendations for Storage and Treatment

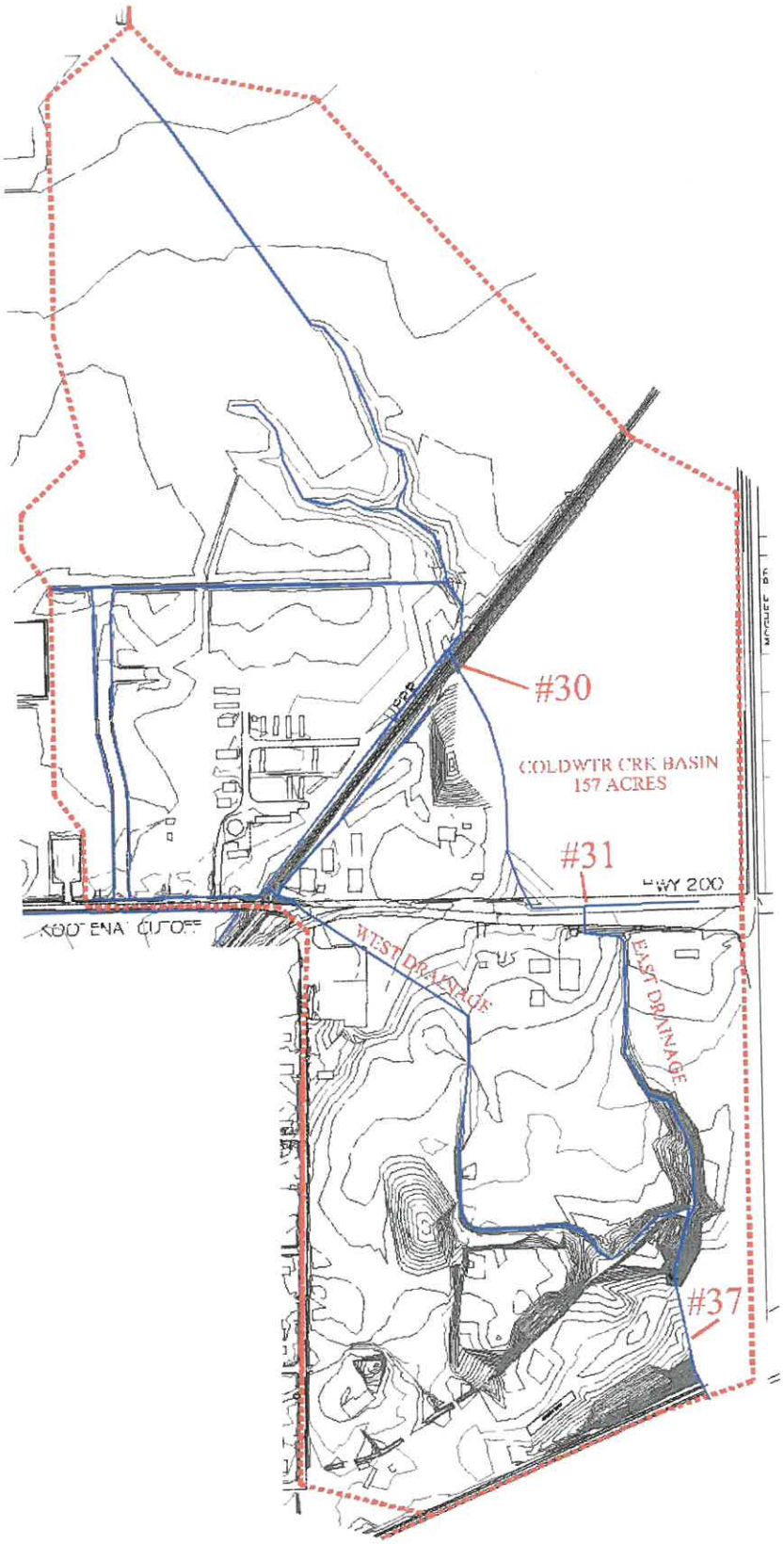
- Enlarge and deepen existing detention area north of the UPRR tracks.
- Require developers to complete the detention areas at the south end of the properties that were specified in the stormwater plans.
- Clean and deepen the channel between the UPRR tracks and HWY 200.

Coldwater Creek Basin

The Coldwater Creek Basin is approximately 157 acres in size, flowing south across the UPRR tracks and HWY 200 into natural drainage channels that deposit the flows in the lake. Two separate drainages in this basin converge to the north of the MRLRR tracks, and combine to form the total outfall from the CWC Basin.

The culverts in the western drainage have adequate capacity, and will be able to handle the flows generated from future land development. However, the drainage channels and wetlands south and east of HWY 200 are in poor condition. A combination of garbage, loose fill dirt, and excessive debris pollute the waterway and prevent natural wetland processes from occurring. In addition, unstable channels lead to erosion and sedimentation of the runoff.

The eastern drainage has several areas that need improvement. First, culvert 30 (30" dia) under the UPRR tracks has an outlet set 2 feet below the elevation of the downstream channel. This creates adverse outlet conditions, and reduces the capacity of the culvert from about 30 cfs to 9 cfs. The reduced capacity causes flooding of the trailer park and areas on the north side of the tracks. Second, culvert 31 (36" dia) passing under HWY 200 has been shown both by observation and in the model to have severe flooding at the upstream end. Theoretically, the culvert should pass the 25 cfs flow that results from the design storm. However, an inspection of the culvert reveals a low point in the middle of the highway, sediment buildup at the outlet, and a constriction in the downstream channel. These conditions reduce the culvert capacity from 35 cfs to approximately 14 cfs. Third, the channel immediately downstream of culvert 31 is undersized and has two 90 degree bends that create turbulent flows and excessive erosion. The remainder of the drainage south of HWY 200 has debris buildup and a highly erodeable channel. The grate on the vertical pipe inlet of culvert 37 (48" dia) was found to be plugged with debris.



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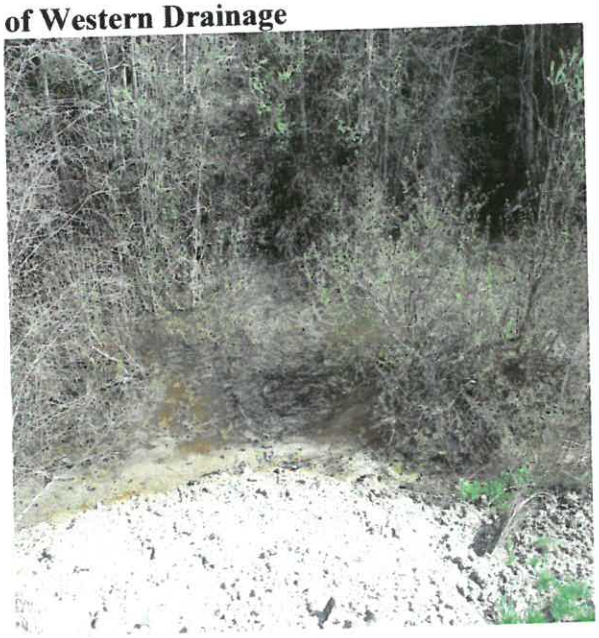
Coldwater Creek Basin - Recommendations for Western Drainage South of HWY 200

- Drainage channels and wetlands need to be cleaned and stabilized with rock and stream grade control structures to reduce velocity and minimize erosion.

Current Condition of Western Drainage



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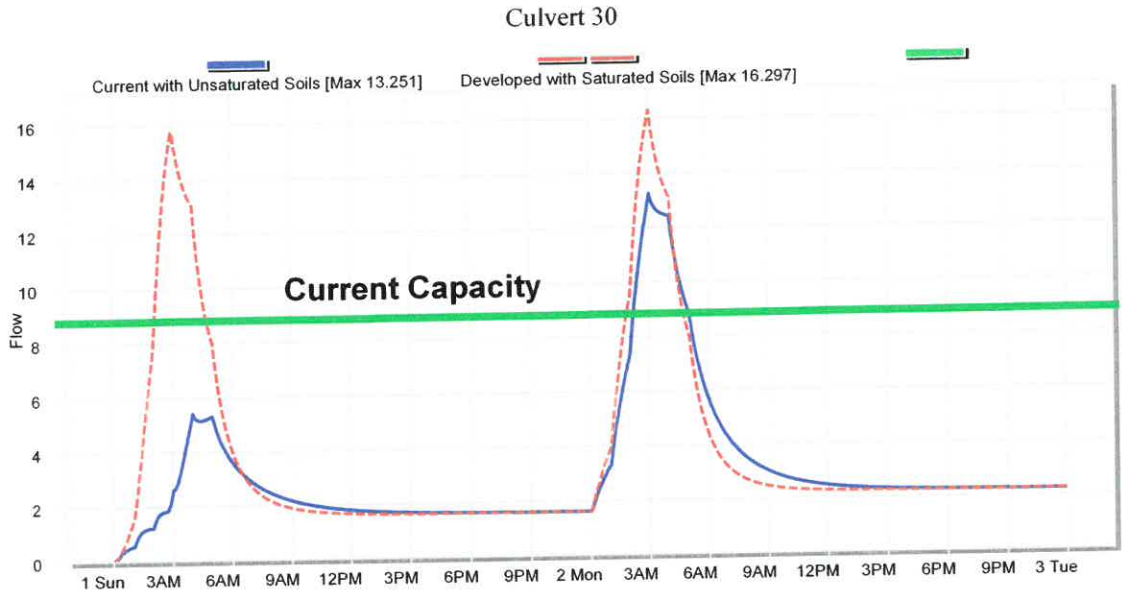
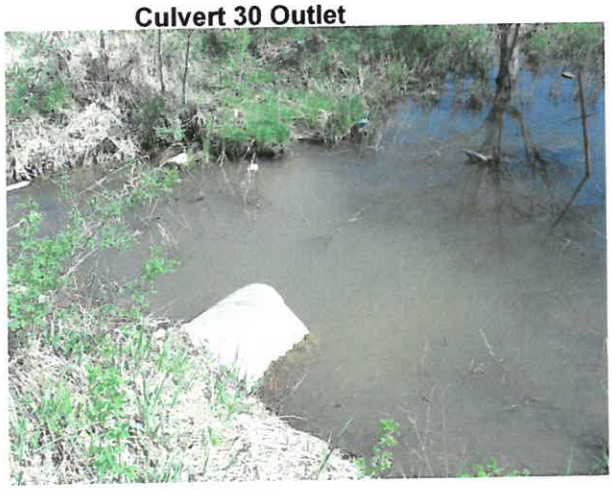
Coldwater Creek Basin - Recommendations for Culvert 30 (2 Options)

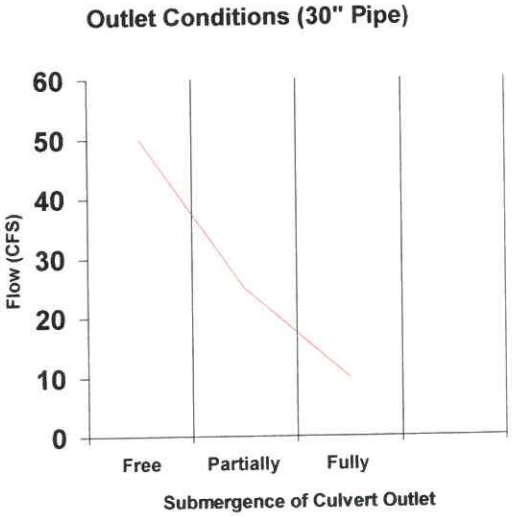
Option 1

- Raise the outlet of culvert 30 by 2 feet in order to increase the capacity of the culvert to 30 cfs (currently 4' fall from inlet to outlet).



Culvert 30 Outlet



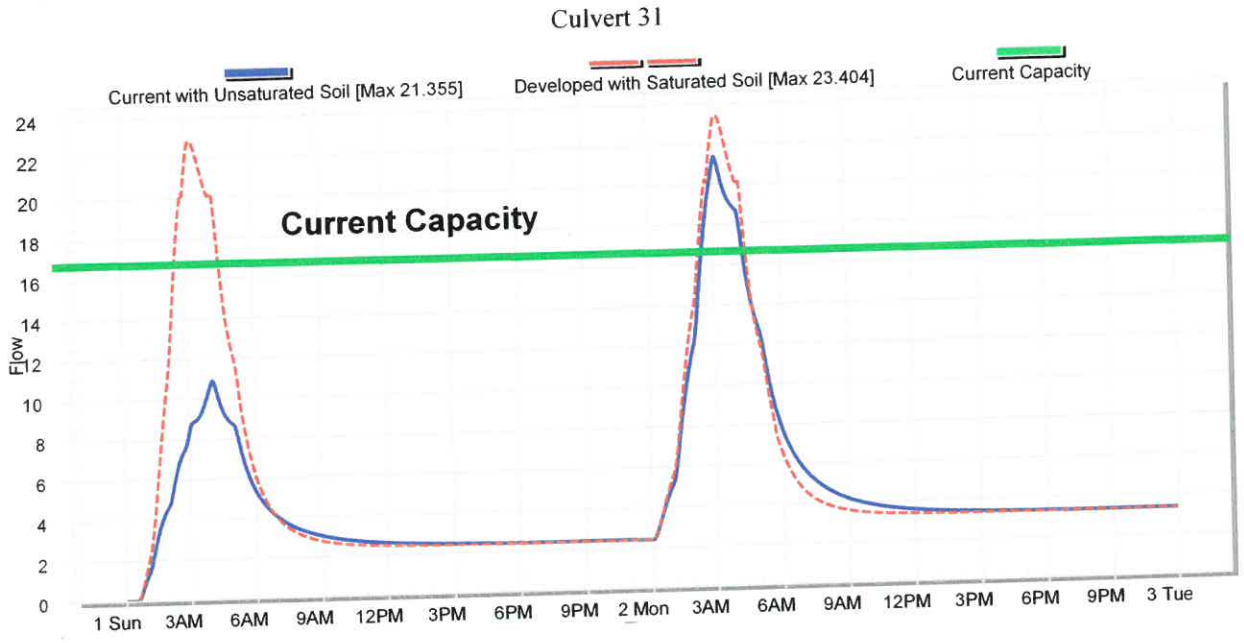


Option 2

- Install and 18" overflow pipe next to culvert 30 to reduce the surcharged flow.
- Create storage capacity behind the tracks to prevent flooding and provide treatment of the water.

Coldwater Creek Basin - Recommendations for Culvert 31

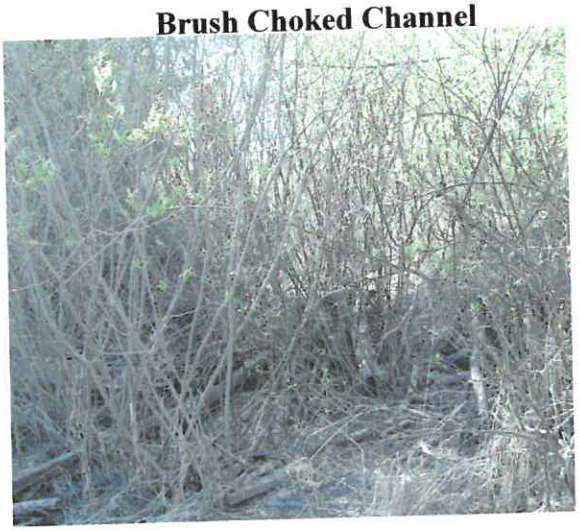
- Replace culvert 31 with a 49"x33"pipe arch (or larger).
- Realign new culvert with the downstream drainage channel to improve exit conditions.
- Utilize entrance and exit structures to reduce energy losses and erosion.
- Enlarge, stabilize and slope the downstream channel to create a free outfall from culvert 31 and reduce the velocity and erosion of the channel.



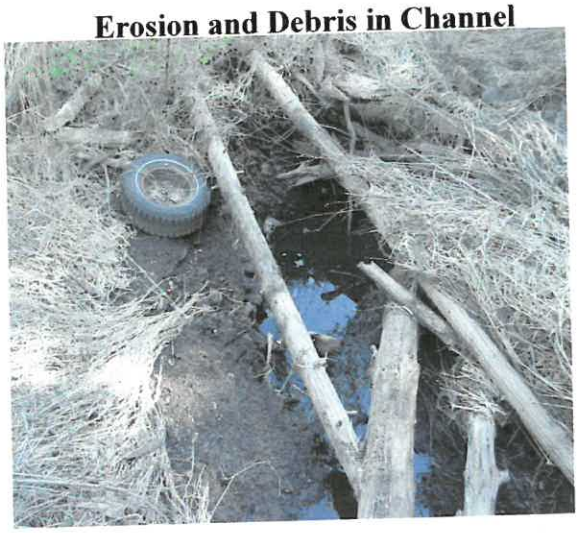
Coldwater Creek Basin - Recommendations for Eastern Drainage South of HWY 200

- Improvements upstream will lead to increased peak flows. Debris buildup and other obstructions should be removed to facilitate efficient flow and allow adjacent properties to drain properly.

Brush Choked Channel



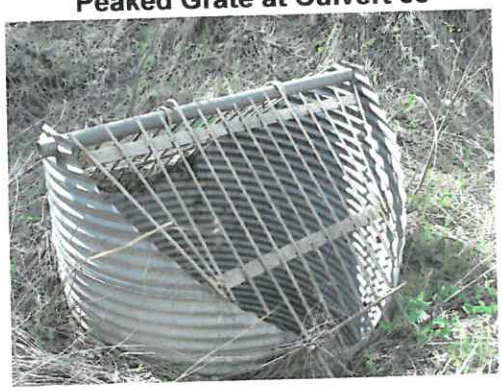
Erosion and Debris in Channel



- Portions of the drainage channels should be stabilized with rock and stream grade control structures to reduce velocity and minimize erosion.
- Remove garbage from the vicinity of the drainage channel.
- Replace the flat grate on the vertical inlet of culvert 37 with a peaked grate to prevent debris buildup.

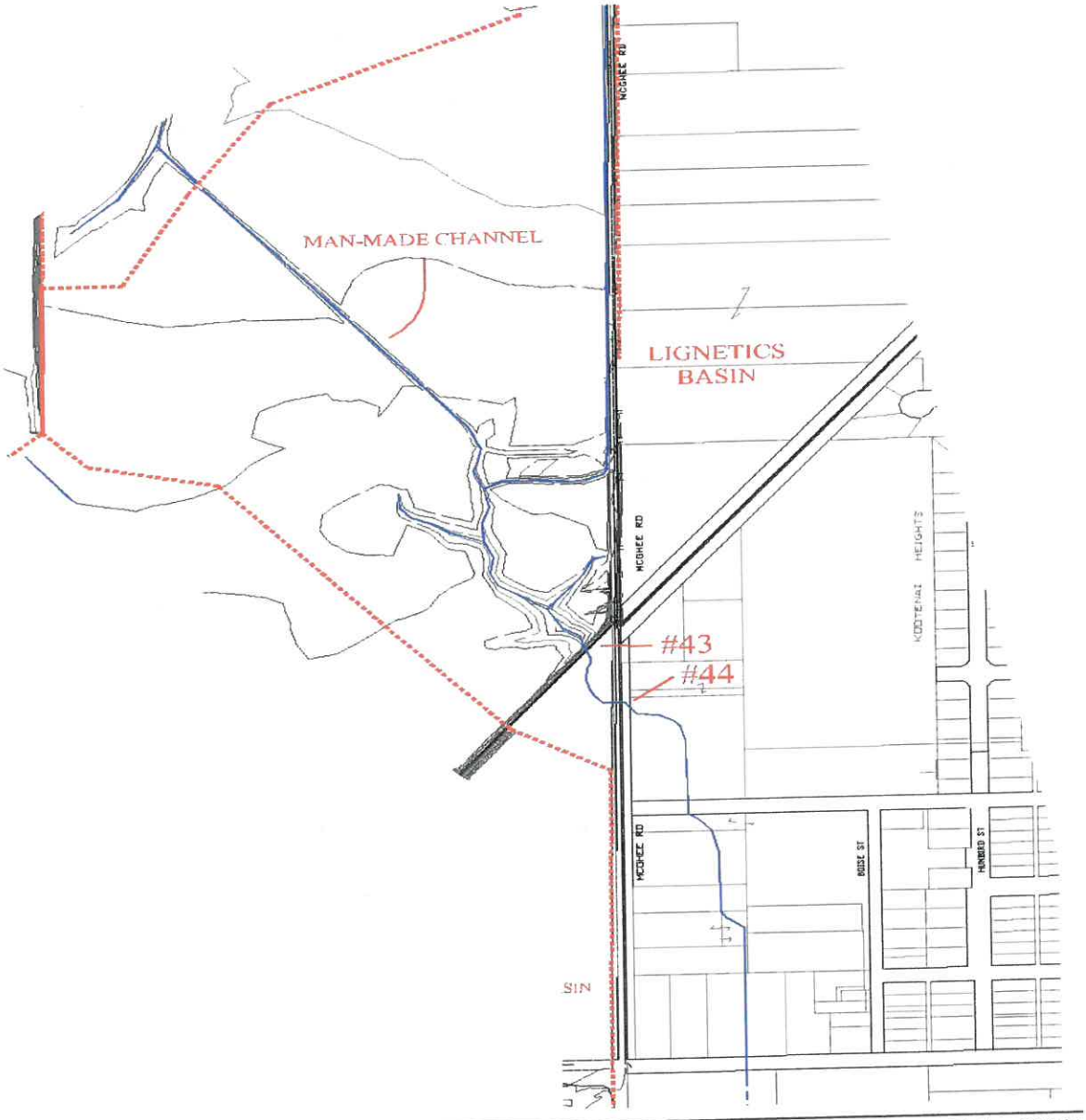
Current Condition

Peaked Grate at Culvert 38



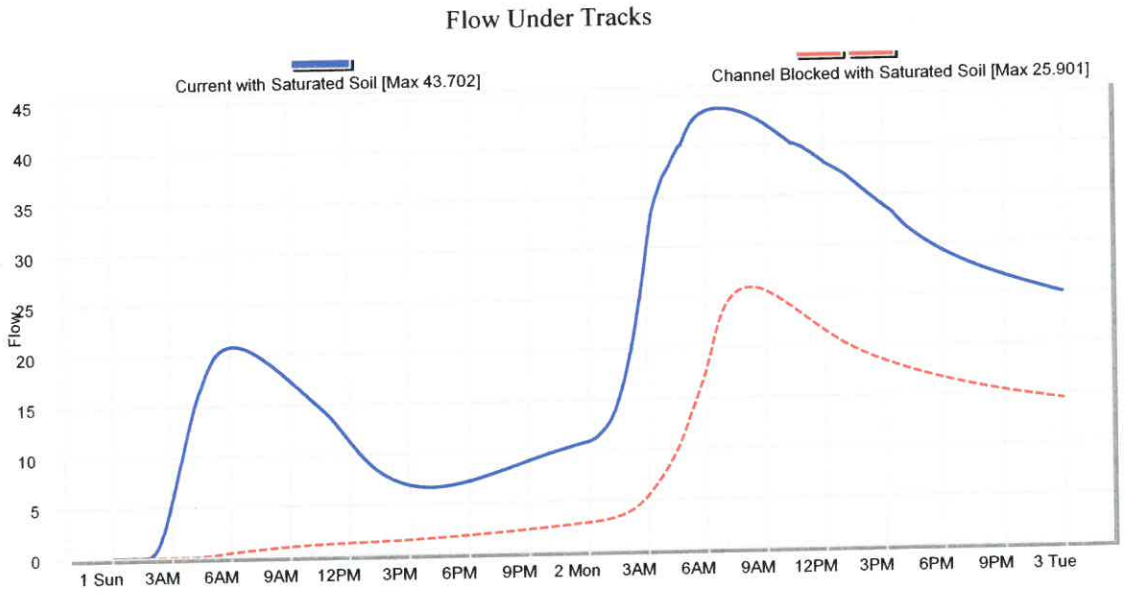
Lignetics Basin

The Lignetics Basin is approximately 500 acres in size, draining pastureland south under the UPRR tracks and McGhee Road. A manmade channel was dug years ago to route runoff from approximately 300 acres to the north, into the Lignetics basin. This modification more than doubled the volume of runoff contributing to the drainage upstream of culvert 43. Currently, culvert 43 (30" dia) has a damaged inlet that reduces capacity from 27 cfs to about 15 cfs. Culvert 44 (36" dia) has about 1.5 feet of sediment buildup both at the inlet and the outlet. The sediment reduces capacity from about 50 cfs down to 20 cfs. The limited capacities of culverts 43 and 44 cause large scale flooding of the pastureland north of the UPRR tracks. Fortunately, the land is undeveloped and presently acts as a large detention area to reduce the peak flows on the rest of the system.



Lignetics Basin - Recommendations for Drainage Channel:

- The manmade channel could be blocked, forcing the runoff back into the natural drainage that drains north and east into Boyer Slough. This would eliminate many of the problems in the Lignetics Drainage, but would require an increased capacity in the Boyer Slough drainage. Since the Boyer Slough Drainage already needs major improvements, we recommend blocking the man-made channel and increasing the capacity of the Boyer Slough Drainage at the same time. The chart below illustrates the flow reduction that would occur in the Lignetics Basin if the man-made channel were blocked.

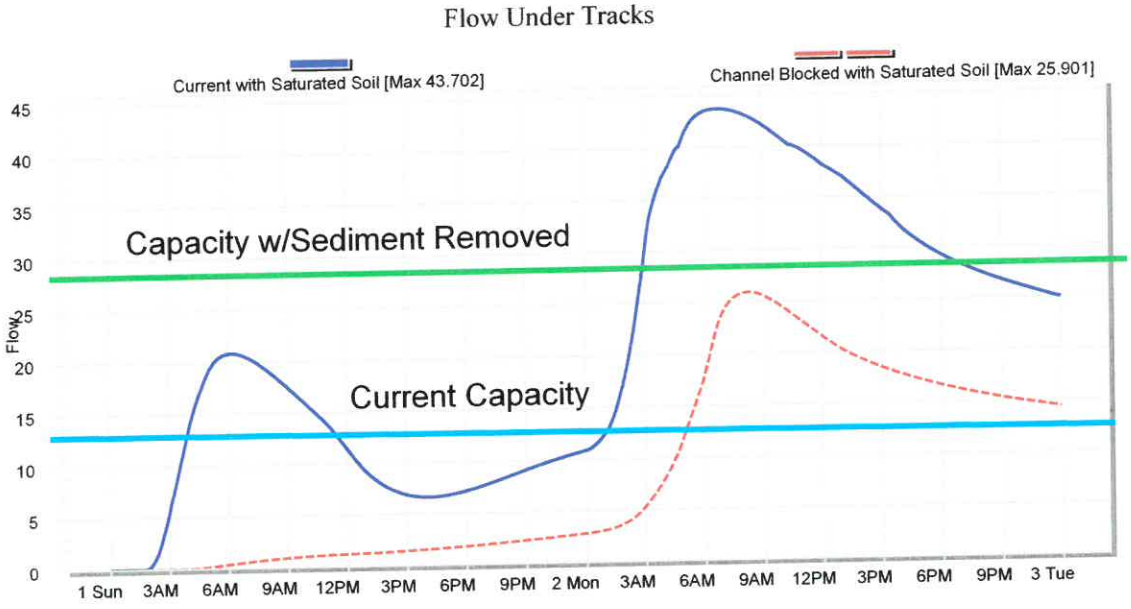


Lignetics Basin - Recommendations for Culvert 43

- Straighten the inlet and install an entrance apron to improve the efficiency of the culvert and protect the culvert and bank from future damage. This would reduce flooding north of the tracks, and still not overload the downstream system.

Lignetics Basin - Recommendations for Culvert 44

- Remove sediment from the culvert to restore flow capacity.



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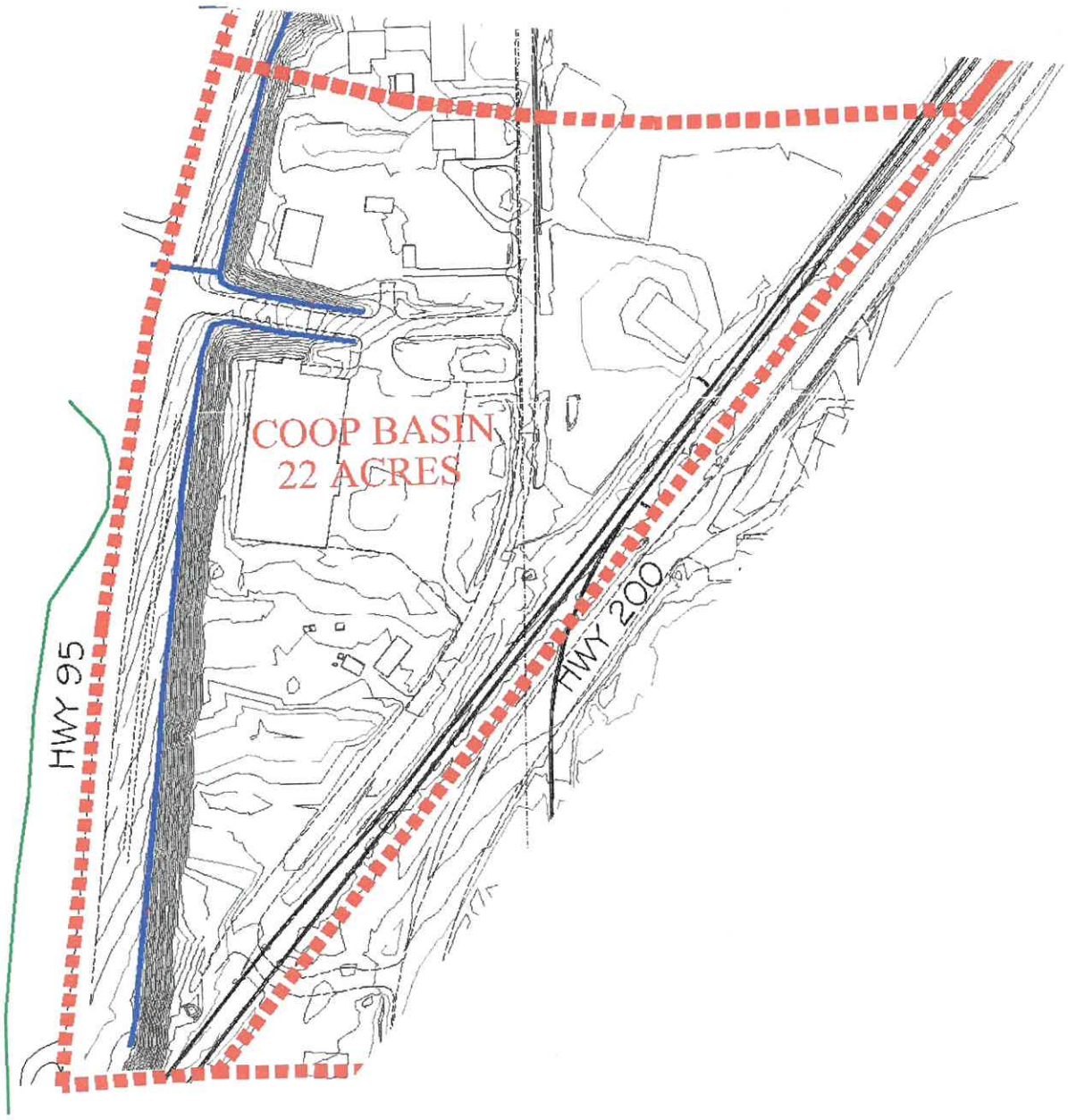
COOP Basin

The COOP Basin is approximately 22 acres in size. It is bounded on the east by the UPRR tracks, and flows west across Fontaine Drive and HWY 95 before entering Sand Creek. The drainage has adequate capacity for the design storm both today and with future land development. However, there is very little on-site grassy swale treatment area for the runoff from impervious surfaces.



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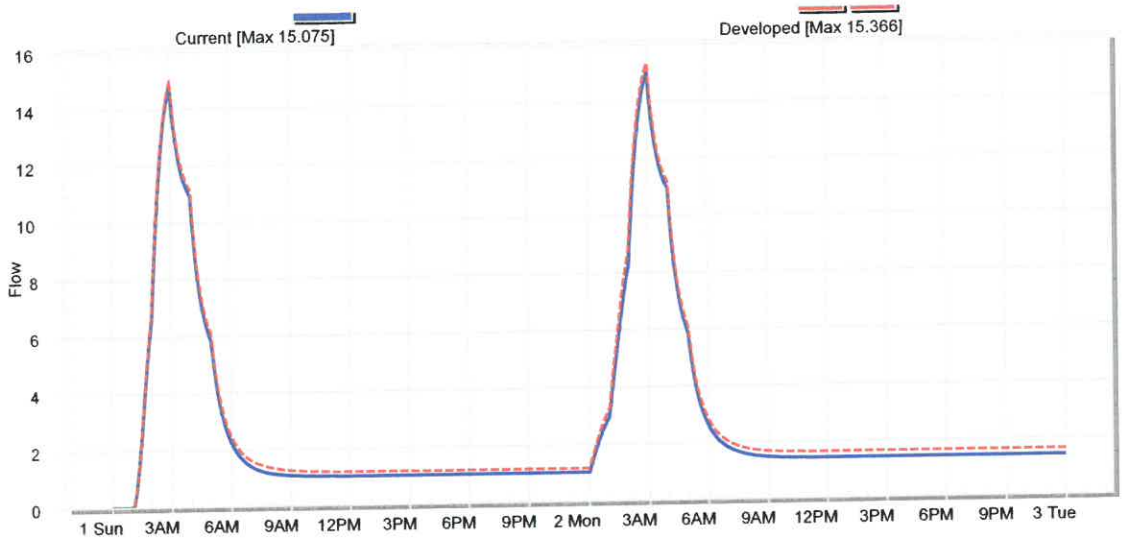
Bonner Mall/Fontaine Drive Basin

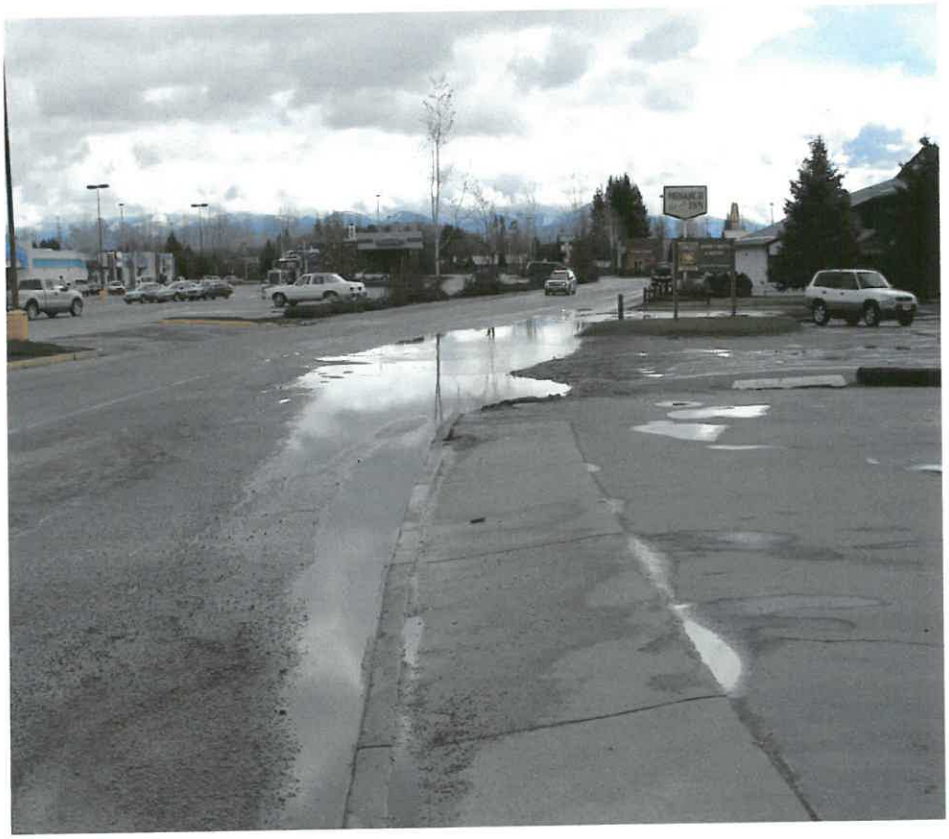
The Bonner Mall/Fontaine Drive Basin is approximately 56 acres in size with the UPRR tracks and Triangle Drive forming the eastern boundary. A storm drainage system associated with the Bonner Mall and surrounding businesses collects the runoff in catch basins. A low area on the south side of Bonner Mall Road in front of Les Schwab prevents runoff from entering a catch basin, and the road has long periods where standing water saturates the road section. During inspection of the basins, some were found to have excessive sediment buildup. A lift station is used to move the runoff from the east side of the Bonner Mall to the west side. The runoff then flows through a series of storm pipes and catch basins and into a wetland east of Fontaine Drive. Over the years, this wetland has filled with sediment and debris, and the outlet culvert could not be located during this study. However, the water is able to find the outlet, and the flow moves through a culvert under Fontaine Drive and into a wetland on the east side of HWY 95. The runoff then crosses HWY 95 and is deposited into Sand Creek.

Bonner Mall Basin Outfall



Bonner Mall/Fontaine Drive Basin – Recommendations for Flooding of Roadway:

- Install a catch basin at the low area on the south side of Bonner Mall Road and use a storm pipe to drain the runoff to a catch basin behind the Monarch Inn.



Bonner Mall/Fontaine Drive Basin – Recommendations for Sediment and Debris Buildup:

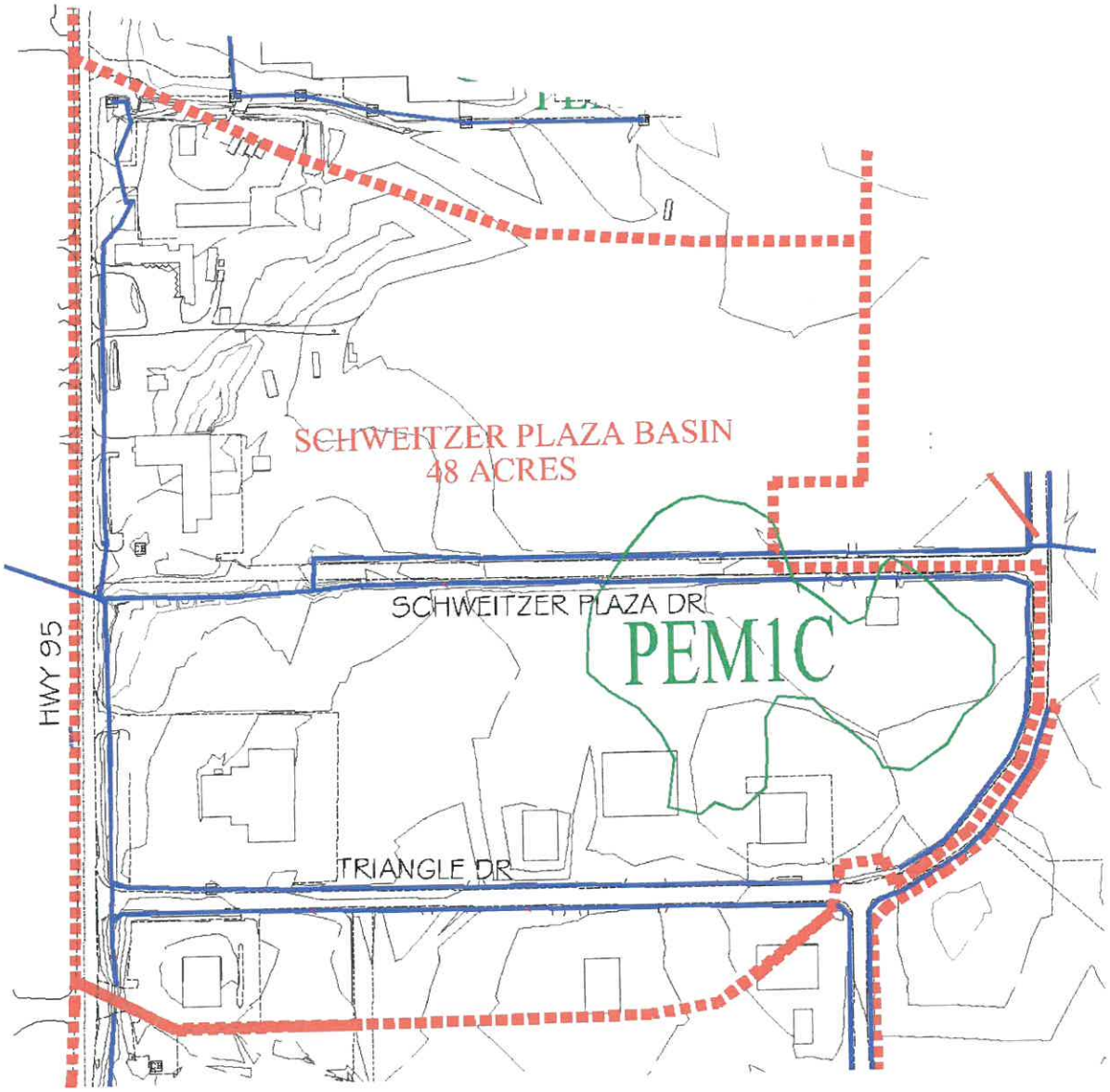
- Clean the wetland east of Fontaine Drive to restore capacity.
- Remove sediment from the catchbasins associated with the Bonner Mall Complex.

Bonner Mall/Fontaine Drive Basin – Recommendations for Storage and Treatment:

- Provide additional grassy swale treatment area for the runoff from impervious surfaces.

Schweitzer Plaza Drive Basin

The Schweitzer Plaza Drive Basin is approximately 48 acres in size, and flows west from Triangle Drive and across HWY 95 before entering Sand Creek. The culverts have adequate capacity for the design storm, but the ditch lines along Triangle Drive and Schweitzer Plaza Drive are too shallow, narrow, and have a minimal slope. Consequently, the road base is saturated throughout the wet months and the paved roads are rapidly deteriorating.



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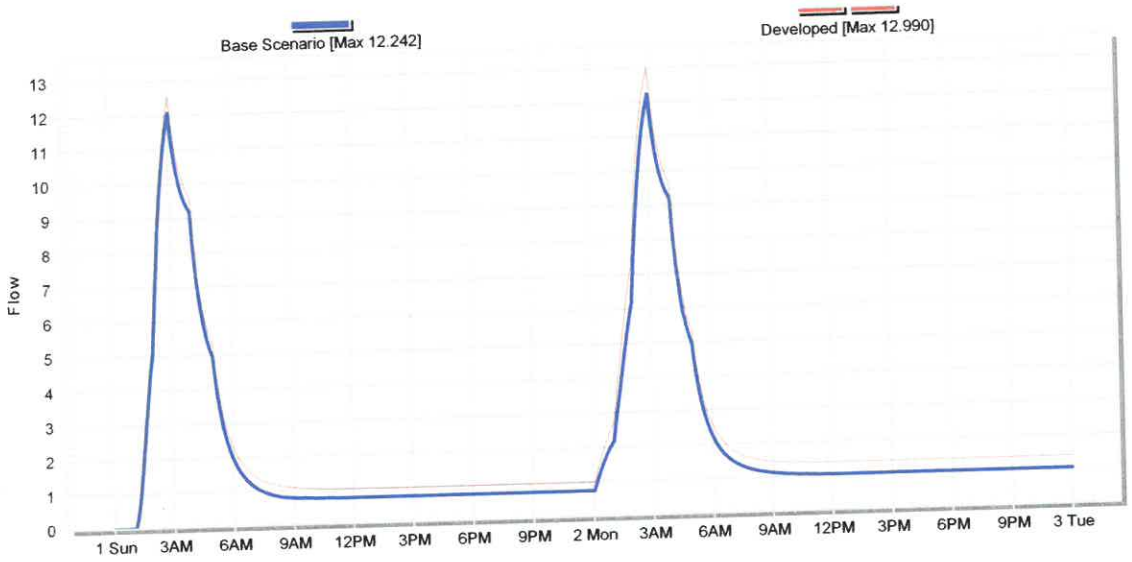
Outfall from Schweitzer Plaza Basin



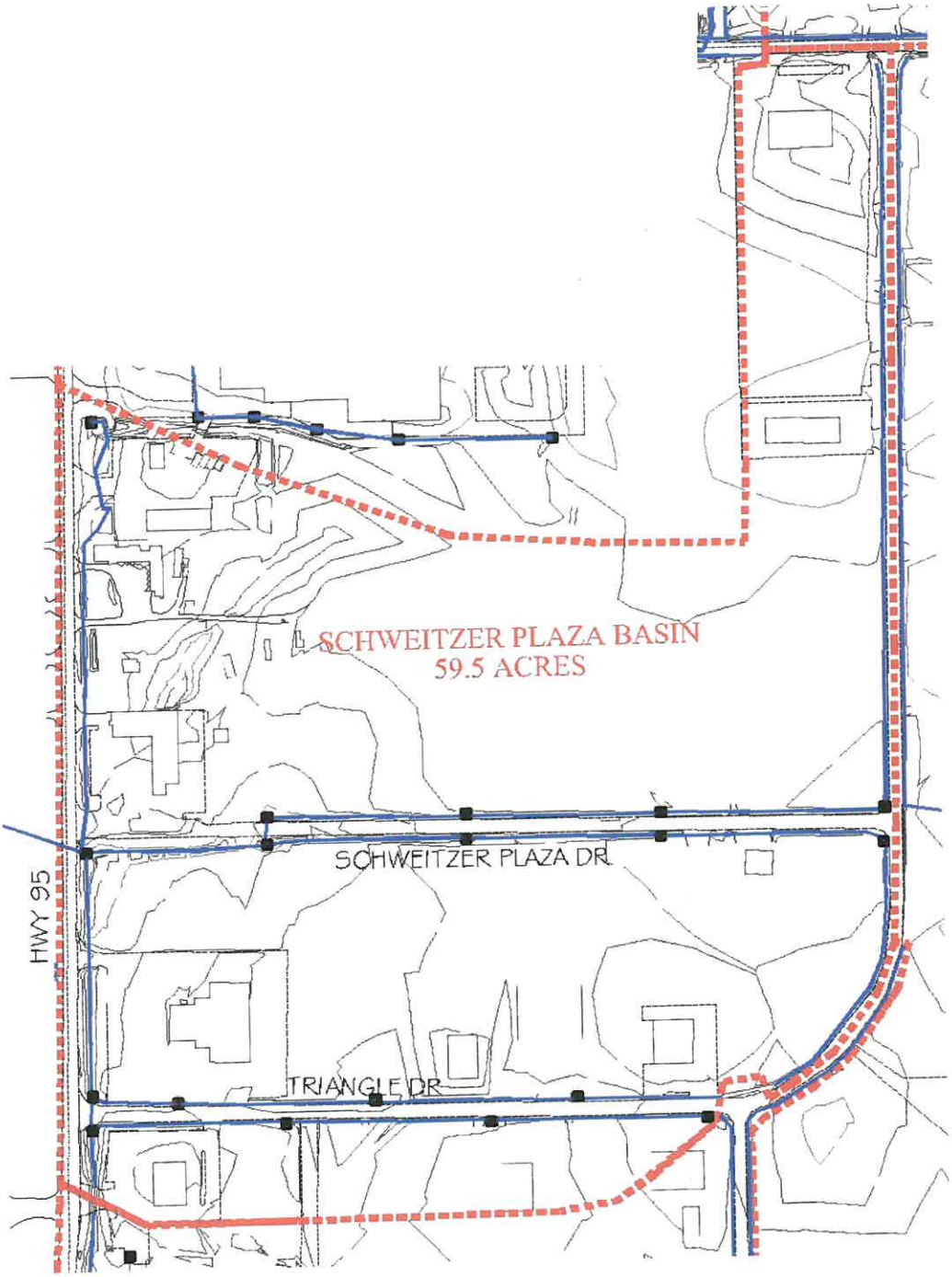
Schweitzer Plaza Drive Basin – Recommendations (2 Options)

Option 1

Enlarge and deepen existing ditch lines to create grassy swales that will provide treatment and reduce saturation of the road base.

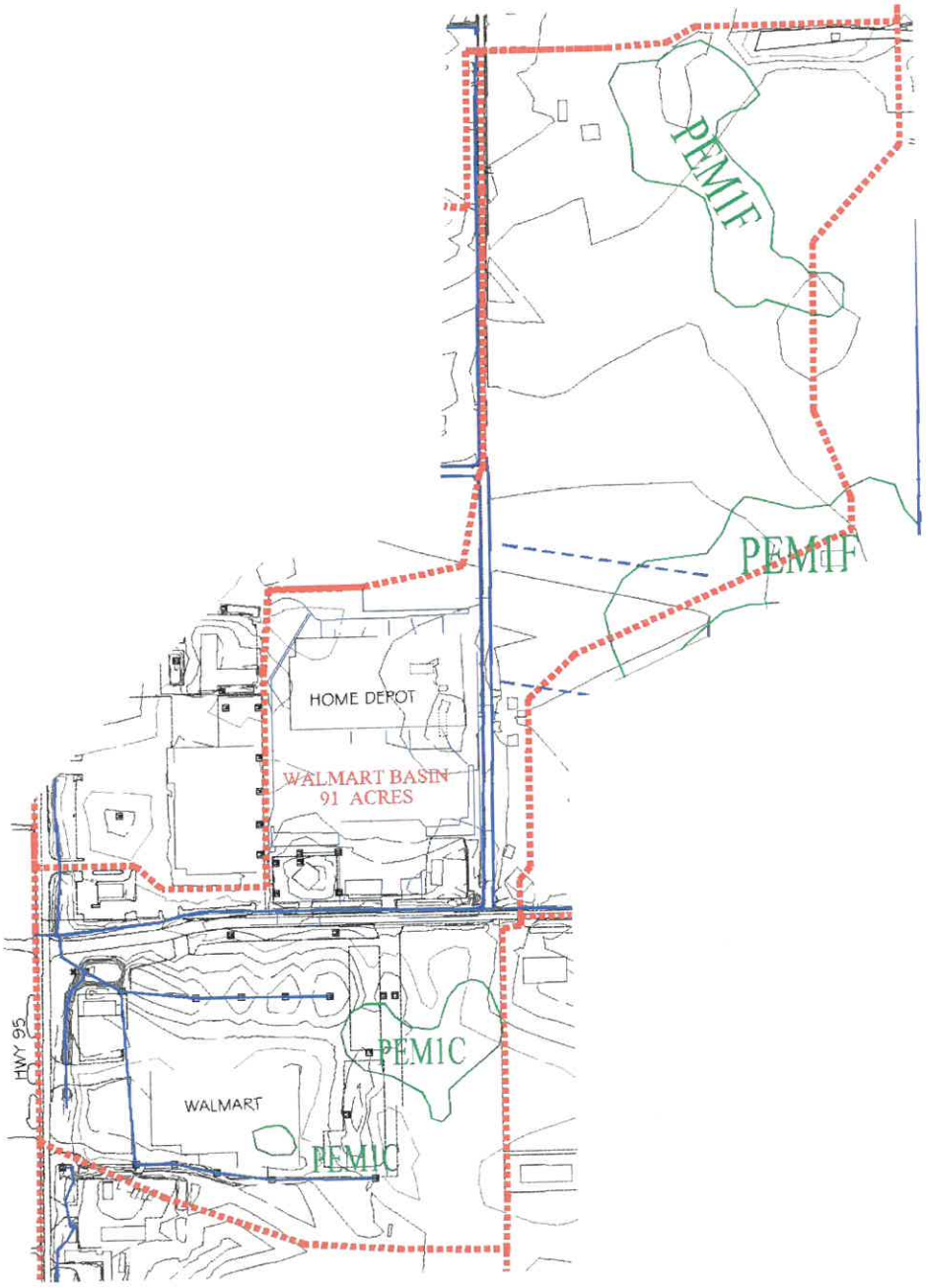
Option 2

Install a storm drain system with catch basins and buried storm pipe to capture runoff and move it west into a catch basin that will be installed during the reconstruction of HWY 95.



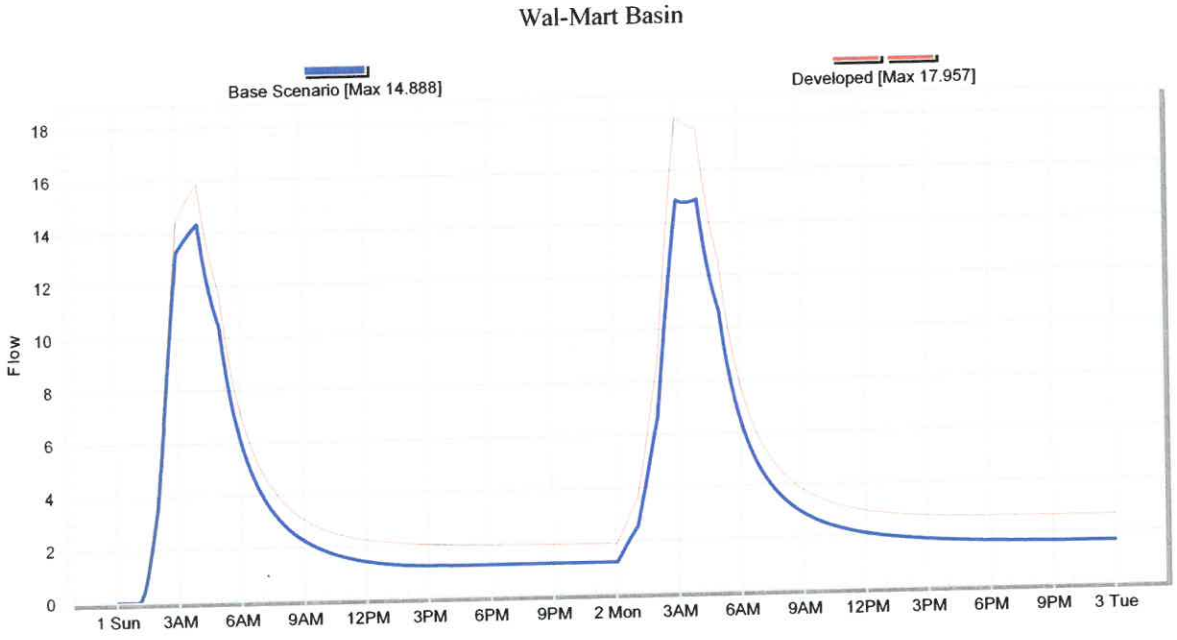
Wal-Mart Basin

The Wal-Mart Basin is approximately 91 acres in size. The drainage flows south along the east side of Starr Lane, and west down Kootenai Cutoff Road. The runoff from Home Depot and Wal-Mart join the drainage before the flow crosses HWY 95 and enters Sand Creek. The ditch lines along Starr Lane are too shallow, narrow, and have a minimal slope. As a result, saturation of the road base occurs. The rest of the storm drainage is in good condition.



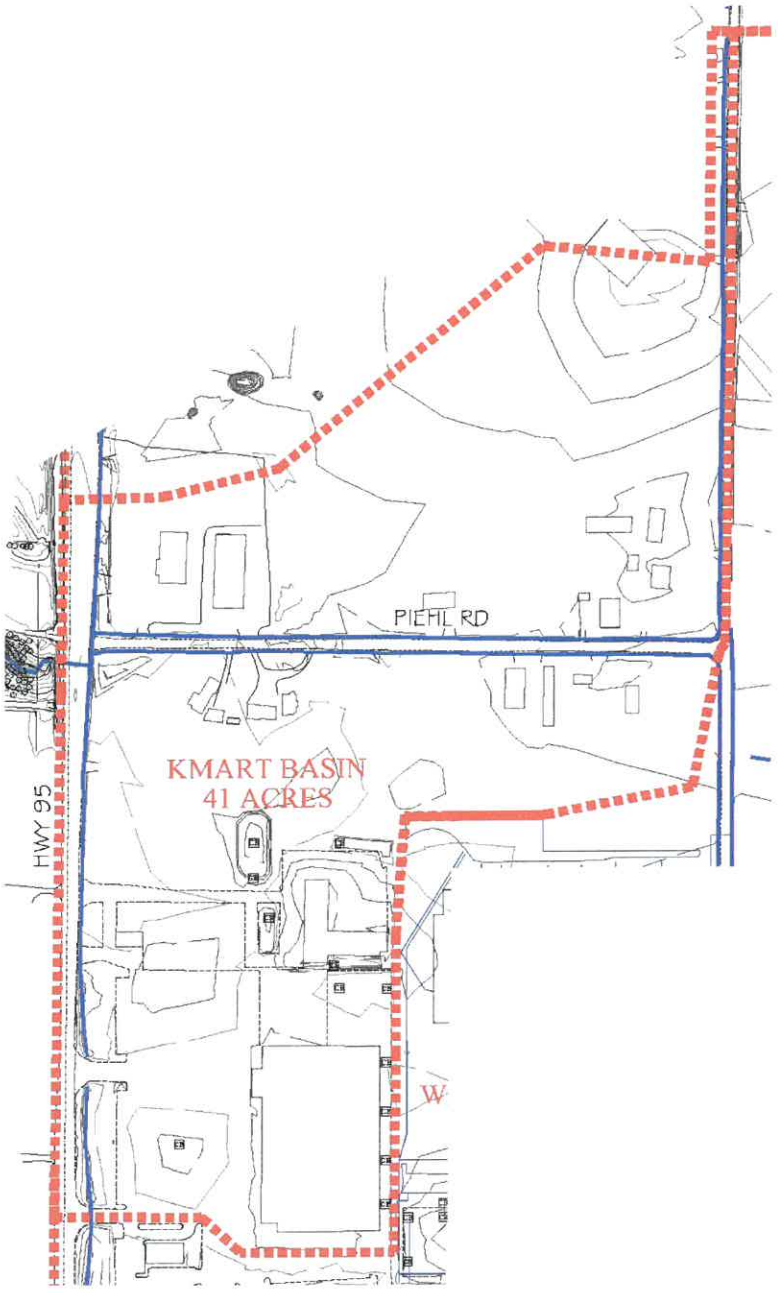
Wal-Mart Basin – Recommendations

- Saturated Road Base
  Enlarge and deepen existing ditch lines along Starr Lane to create grassy swales that will provide treatment and reduce saturation of the road base.

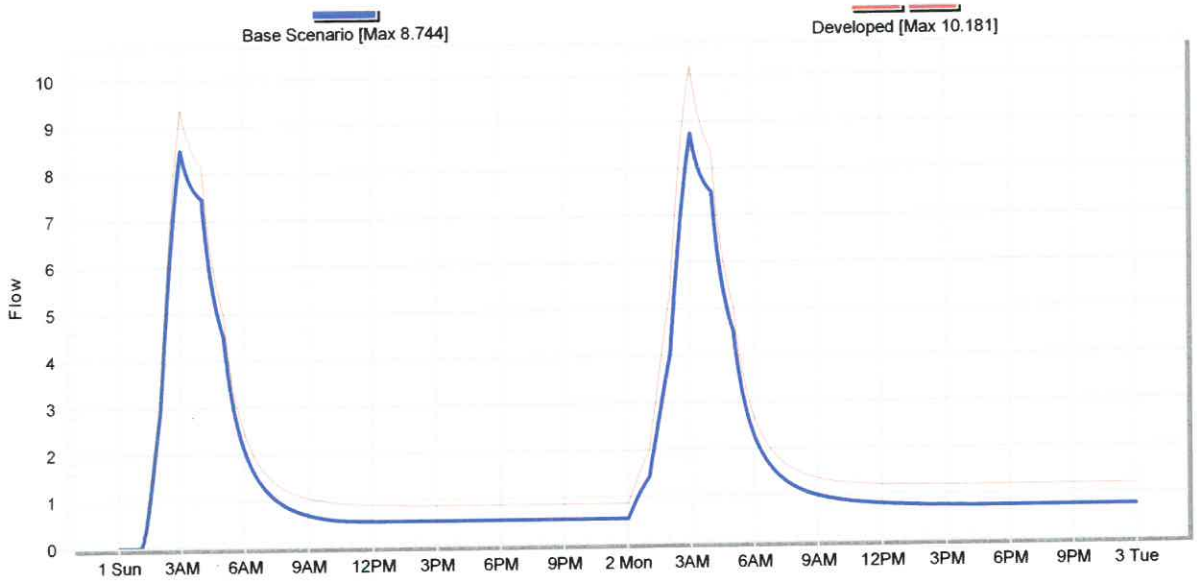


K-Mart Basin

The K-Mart Basin is approximately 41 acres in size. It drains the northern half of Starr Lane, Piehl Road, and the old K-Mart property before crossing HWY 95 and entering Sand Creek. The ditch lines along Starr Lane and Piehl Road are too shallow, narrow, and have a minimal slope. This leads to saturation of the road base during any significant storm event. In addition, the runoff from the K-Mart property does no have on-site treatment.



K-Mart Basin



K-Mart Basin – Recommendations

- Saturated Road Base
  Enlarge and deepen existing ditch lines along Starr Lane to create grassy swales that will provide treatment and reduce saturation of the road base.

- Storage and Treatment
  Create grassy swale treatment areas for the runoff from the K-Mart property.

Conclusion

As the City of Ponderay continues to grow, the current deficiencies in the stormwater system will be amplified. Replacing pastureland and forests with paved surfaces and buildings will increase the total runoff volume as well as add pollution to the runoff. To protect the City's infrastructure and enhance water quality long-term, it is essential that corrective measures be taken. The following list outlines some general recommendations for the stormwater system beyond those made in this report.

- Establish a general maintenance program to prevent excessive debris buildup in the catch basins, culverts and ditch lines.
- Ensure new land developments meet the stormwater standards and allow for the conveyance of the natural drainage through the development.
- Obtain drainage easements for primary drainages to provide access for future maintenance or modification.

City of Ponderay
Summary of Recommendations

ITD Basin

#1: Flooding of roadside ditch lines along Triangle and Schweitzer Plaza Drive from the surcharging of Culvert 1 (12").
Recommendations:

- Enlarge drainage swales for more storage.

OR

- Replace culvert 1 with a 17"x13" pipe arch or pipe of equivalent capacity.

OR

- Remove culvert 1 and drain flow from the west of Triangle Drive down Schweitzer Plaza Drive.

#2: Minimal storage and treatment for runoff north of culvert 2 for both current and future levels of development.
Recommendation:

- Enlarge and improve existing detention area north of UPRR tracks.
- Utilize city property adjacent to Triangle Drive for a detention and retention pond.
- Enlarge and deepen roadside drainage ditches and create grassy swales.
- Route runoff from McNearney Road Basin at Kootenai Cutoff Road down a grassy swale on the west side of the proposed Alder Creek Subdivision. This flow could be accommodated by increasing the storage capacity north of culvert 2.

McNearney Road Basin

#1: Flooding of undeveloped land north of Kootenai Cutoff Road and ditches along McNearney Road.
Recommendations:

- Clean and widen ditch lines to create grassy swale treatment and storage areas.
- Remove debris buildup from culverts.
- Divert a portion of the flow from the northern portion of McNearney Road into the Coldwater Creek Basin. This would require the changes to the Coldwater Creek Basin recommended in this report.

#2: Flooding of the woodlands north of the UPRR tracks at culvert 15.
Recommendations:

- Remove the tree partially blocking the outlet of culvert 15.
- Create detention pond north of the tracks to contain flooding and treat runoff

#3: Flooding of road base along HWY 200 at culvert 16.
Recommendations:

- Replace culvert 16 (18"dia) across HWY 200 with a 24" pipe to reduce flooding.
- Clean and deepen roadside channel between UPRR and HWY 200 to provide storage and treatment and minimize saturation of the road base.

#4: Planned development is on land the current drainage flows through.
Recommendation:

- Route flows down the west side of proposed Alder Creek Subdivision in a grass lined channel into the detention area west of culvert 2 (in the ITD Basin). This would improve treatment and help reduce flooding north of culvert 15.

Coldwater Creek Basin

#1: The western drainage channel between Dads Auto and Anderson Autobody and the associated wetlands have been degraded with automotive parts, tires, loose fill dirt, and excessive brush and other debris.
Recommendation:

- Obtain a drainage easement and funds to restore the channels and wetlands to a stable condition.
- Install detention ponds to reduce velocity and erosion and provide treatment.

#2: Flooding of the trailer park to the west of culvert 30.
Recommendations:

- Raise the outlet of culvert 30 by 2 feet to coincide with the elevation of the downstream channel to improve capacity without damaging downstream wetlands.

OR

- Install an 18" overflow pipe next to culvert 30 to reduce the surcharged flow.
- Create additional storage capacity north of tracks to reduce peak flows.

#3: Flooding of HWY 200 and the McGhee Road intersection.
Recommendations:

- Replace culvert 31 (36") with a 49"x33" pipe arch (or larger).
- Realign new culvert with downstream drainage channel.
- Armor and widen entrance and exit structures to maximize flow capacity and prevent erosion.

#4: Overtopping and excessive velocity and erosion in drainage channel south of culvert 31.
Recommendations:

- Obtain easement to allow the city to enlarge downstream channel to prevent flooding and reduce erosion from increased flow due to upstream improvements.

- Stabilize banks of channel and use check dams to control velocity.

#5: The grate on the vertical inlet of culvert 37 plugs with debris, and could fail in the future.
Recommendation:

- Replace flat grate with a peaked grate similar to the grate at culvert 38.

Lignetics Basin

#1: Large-scale flooding of pastureland north of the UPRR tracks.
Recommendations:

- Block manmade drainage channel to reduce runoff entering the system and force it back into the natural drainage flowing into Boyer Slough.
- Straighten the inlet and add an entrance apron at the inlet of culvert 43.
- Remove sediment buildup from the inlet and outlet of culvert 44 and the drainage swale south to HWY 200.

COOP Basin

#1: Lack of on site detention area to provide treatment for the runoff from impermeable surfaces.
Recommendation:

- Identify suitable locations and create grassy swale treatment areas.

Bonner Mall/Fontaine Drive Basin

#1: Lack of on site detention area to provide treatment for the runoff from impermeable surfaces.
Recommendation:

- Identify suitable locations and create grassy swale treatment areas.

#2: Road degradation from standing water on roadway in front of Les Schwab.
Recommendation:

- Install catch basins and culverts from the roadway to the existing storm drain behind Monarch Mountain Inn.

#3: Sediment and debris buildup.
Recommendation:

- Clean the wetland east of Fontaine Drive to restore capacity.
- Clean sediment from catch basins associated with the Bonner Mall stormwater system..

Schweitzer Plaza Drive Basin

#1: Roadway degradation caused by standing water in the shallow ditch lines.
Recommendations:

- Enlarge and deepen ditch lines to create grassy swales that will provide treatment and reduce saturation of the road base.

  OR

- Install a storm drain system with catch basins and buried storm pipe to capture runoff and move it west along Schweitzer Plaza Drive and Triangle Drive into a catch basin that will be installed during the reconstruction of HWY 95.

Wal-Mart Basin

#2: Roadway degradation caused by standing water in the ditch lines along Starr Lane.
Recommendation:

- Enlarge and deepen ditch lines to create grassy swales that will provide treatment and reduce saturation of the road base.

K-Mart Basin

#1: Lack of on site detention area to provide treatment for the runoff from the K-Mart complex.
Recommendation:

- Create additional grassy swale detention areas for the outflows of the stormwater system.

#2: Roadway degradation on Piehl Road and Starr Lane caused by standing water in the ditch lines.
Recommendation:

- Enlarge and deepen ditch lines to create grassy swales that will provide treatment and reduce saturation of the road base.