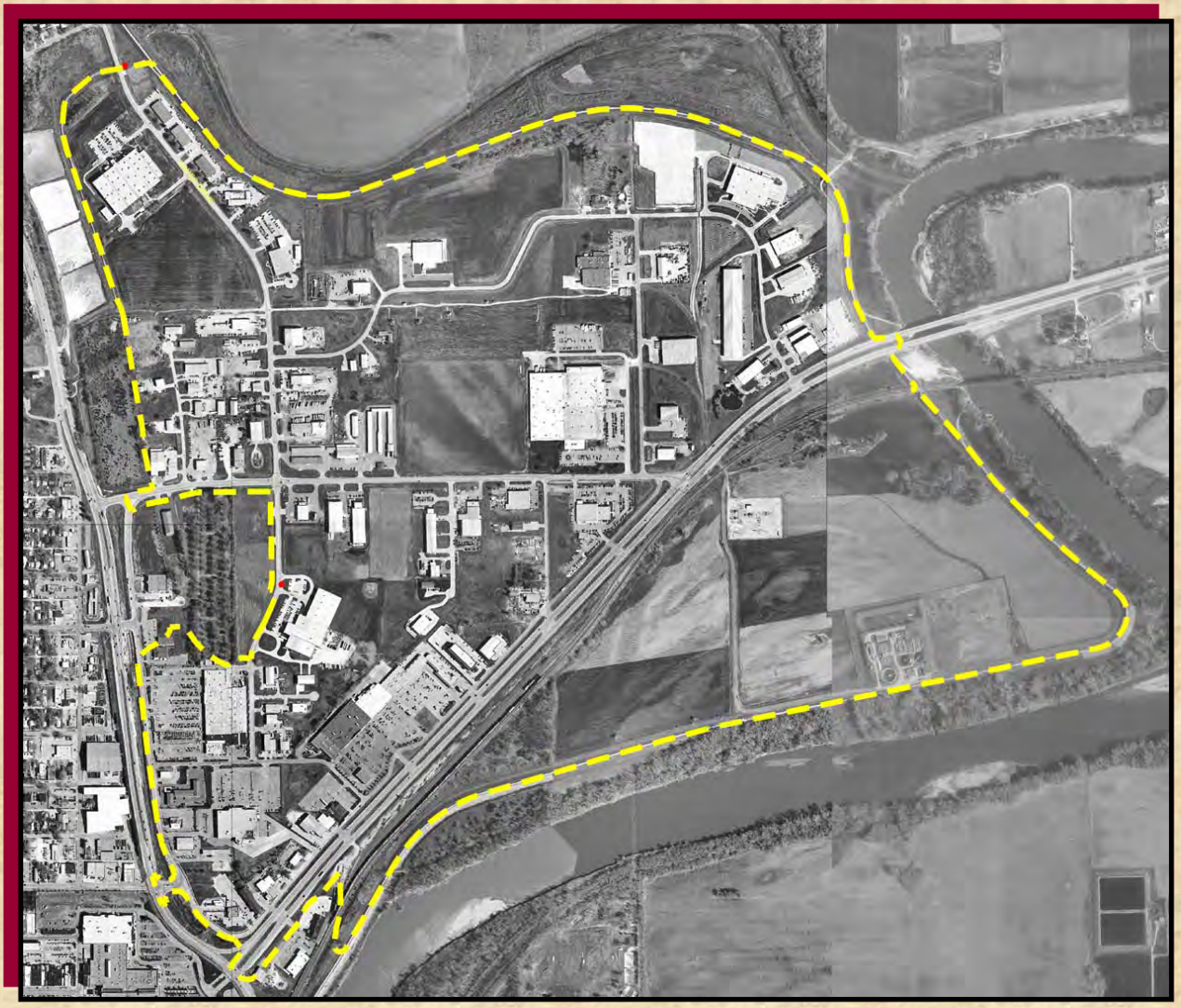
# 2006 Eastside Drainage Plan

# FINAL REPORT



**Project Number**
**05-025M**

CITY OF MANHATTAN
KANSAS

**BG CONSULTANTS, INC.**
*Engineers – Architects - Surveyors*

**BG CONSULTANTS, INC.** / Engineers-Architects-Surveyors

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October 18, 2006

Mr. Jeff Hancock, P.E.
Director of Public Works
City of Manhattan
1101 Poyntz Avenue
Manhattan, KS 66502-5497

Re: 2006 Eastside Drainage Plan
Project No. 05-025M

Dear Mr. Hancock:

We are pleased to present this Final Report of the 2006 Eastside Drainage Plan. As discussed, the City will receive a total of fifteen hardcopies of the report and one digital copy saved to a CD in Adobe format.

It has been a great opportunity to conduct this drainage study and build upon our previous work for the City including the Northview Drainage Study and the Stormwater Management Master Plan. We look forward to serving more the of the City of Manhattan's engineering needs concerning stormwater.

Thank you for your support in the preparation of this report. Please contact us with any questions or should you need further assistance.

Sincerely,

Monty Prescott, P.E.
Corporate Secretary

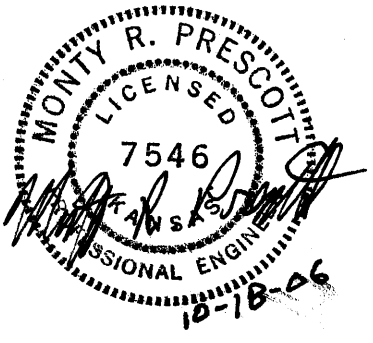
Karen L. Weathers, P.E.
Project Engineer

Enclosures

# *2006 Eastside Drainage Plan*
# *Final Report*

City of Manhattan, Kansas

October 2006

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# EXECUTIVE SUMMARY

## ***Authorization And Scope***

In January of 2005, the City of Manhattan authorized BG Consultants, Inc. to perform engineering services for the Eastside Drainage Study. This area, located in the southeast portion of the City's limits, has historically experienced drainage issues. Initially an industrial area, economic development and redevelopment of this area is transforming it more towards commercial businesses. This comprehensive study was necessary to determine recommendations for improvements to existing drainage problems and to provide guidance to the City and developers for infrastructure needed upon further development. The scope of services includes an analysis of all existing public stormwater systems 15" diameter pipes and larger. This analysis was performed under existing flow conditions and under increased future flow conditions after the study area is fully developed. Recommendations for improvements that incorporate prioritization and cost estimates were determined through the analysis.

The area of the study encompasses approximately 630 Ac (approximately 1mi.$^2$). The study area follows the (Main) Levee on the north, wrapping around on the east to parallel the Big Blue River and on the south to parallel the Kansas River. The west boundary parallels Tuttle Creek Blvd. but does not include the newly developed area around Wal-mart, whose storm drainage was studied as part of the development.

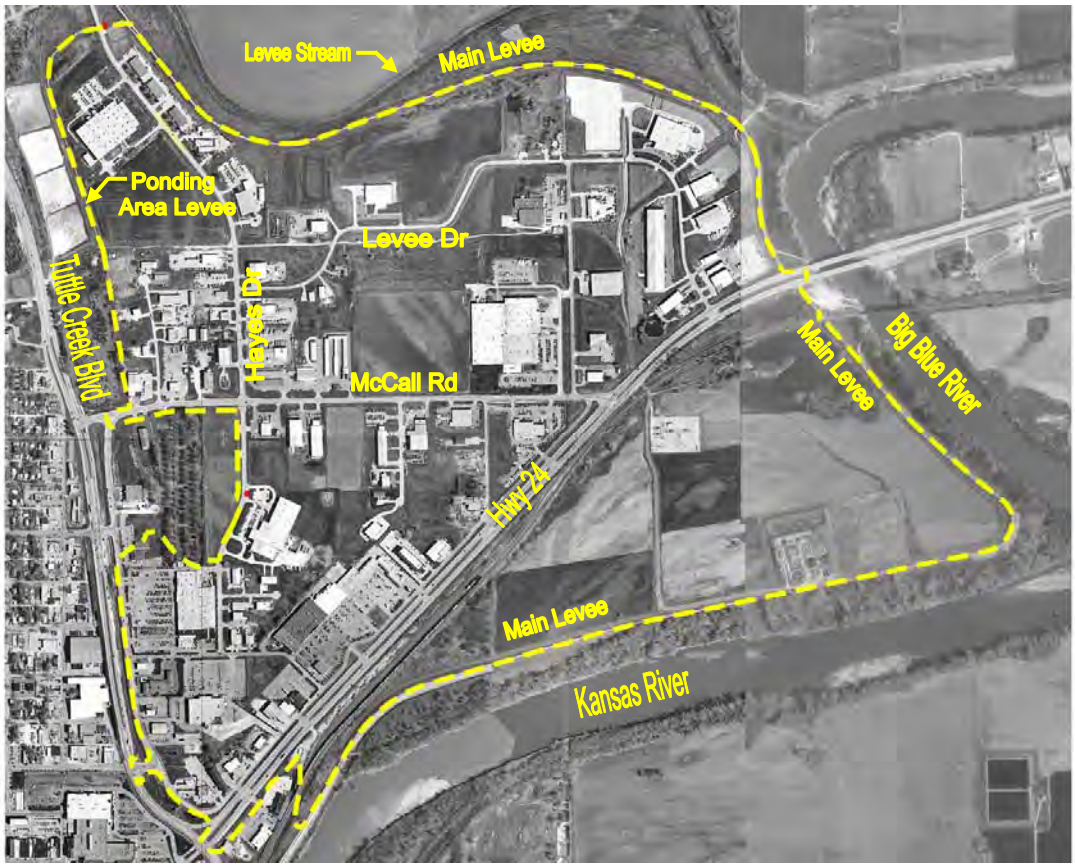



Figure ES-1: Eastside Drainage Study Boundary

***Model Development***

Once the inlets, pipes, open channels and reservoirs were identified through field investigations and GPS surveying, a map of the existing storm drainage in the study area was created. By analyzing the storm drainage system with respect to topography, five Major Watersheds were identified; North Hayes, West McCall, Levee Drive, Sarber Lane, and Hwy 24. Each watershed was assigned a series of numbers by which all elements, pipes and ditches, could be identified. The series are 100-500, respectively. Additionally, all pipe designations begin with a "P" (i.e. P230 in the West McCall Watershed) and all ditch designations begin with a "D" (i.e. D516 in the Hwy 24 Watershed). Hydrologic models of each Major Watershed were developed using HEC-HMS computer software. The HEC-HMS computer model is designed to simulate the runoff (unit hydrograph) from each minor watershed going to each inlet, pipe, or open channel and calculate the peak flows (joining unit hydrographs) through the interconnected system of pipes and open channels. The peak flows were calculated for 2, 5, 10, 25, 50, and 100 year Design Storms using frequency-based rainfall intensity tables as published in the City's Stormwater Management Criteria. Within HEC-HMS, the SCS Method was utilized to calculate watershed runoff volumes and the Muskingum-Cunge Method was chosen for channel and pipe routing. Typical input data includes minor watershed drainage areas, SCS Curve Number (CN), SCS time of concentration ($t_c$); diameter or width, slope, Manning's "n" value, and length for pipes and box culverts; and a typical cross section, length, slope, and Manning's "n" value for open channels.

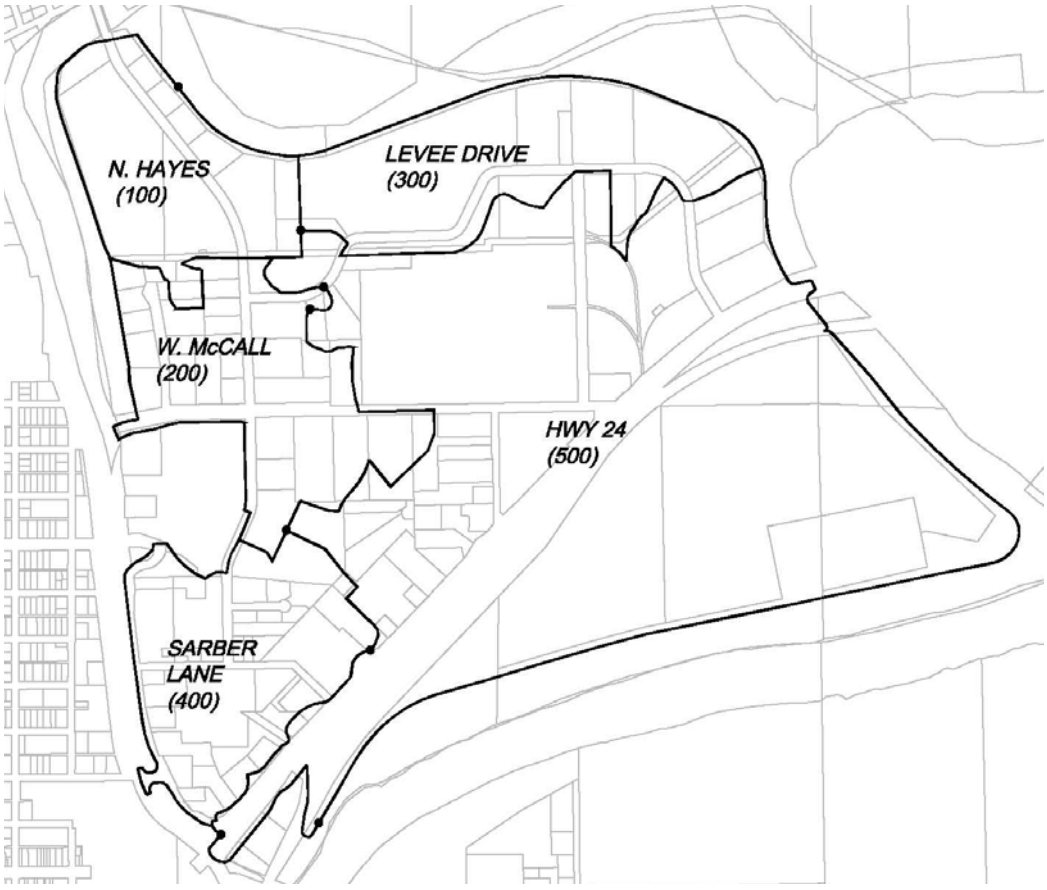



Figure ES-2: Major Watersheds

| Table ES-1: Watershed Summary | | | | | |
|---|---|---|---|---|---|
| **Watershed** | **Total Acres** | **Developable Acres** | **No. of Culverts** | **No. of Channels** | **Common Discharge Point** |
| North Hayes | 53 | 20 | 14 | 14 | Ponding Area Levee Stream |
| West McCall | 70 | 18* | 52 | 29 | (North) Tuttle Creek Blvd. Channel |
| Levee Drive | 75 | 33 | 15 | 12 | Levee Stream |
| Sarber Lane | 70 | 8 | 53 | 10 | (Middle) Tuttle Creek Blvd. Channel |
| Hwy 24 | 360 | 51** | 66 | 34 | Kansas River |
| **Total** | **628** | **130** | **200** | **99** | |

*Includes approx. 6 Ac. currently being redeveloped near the intersection of McCall Rd and Hostetler Dr.
**Excludes 110 Acres of farm ground around the WWTP

***Existing System Analysis***

The first step of analysis utilized HEC-HMS to model the peak flows through the Existing Elements of each Major Watershed with the Existing Flow for the 2-100 year Design Storms. Existing Flows reflect how the land is currently being used. Within Appendix A are Level of Service tables for each Major Watershed. These tables show all of the elements in each watershed, indexing each ones maximum hydraulic capacity, the existing flows going through it, and its current Level of Service (LOS). Each element's maximum hydraulic capacity was determined through an analysis of its inlet and outlet control characteristics. It was assumed that the maximum water level upstream is equal to the overtopping elevation and that the downstream water elevation is at the centerline of the structure. The results of the existing analysis showed that the current stormdrainage is deficient in many areas. Not only do many of the pipes have an existing LOS<10-yr design storm, many areas lack sufficient storm drainage infrastructure while silt removal is almost universally needed for the channels in the study area. An Existing Conditions Map at the end of Section 3 shows all deficient elements in the system in red for easy reference.

North Hayes Watershed

- Deficient Elements: 4 Pipes (29%) and no Ditches
- There are two areas where ponding occurs. The first area is on the Farrar Property east of Big Lakes and north of NGML. The land is very flat and there is no clear path for storm drainage. A lot of infiltration is occurring in this area. Right now drainage area (DA) 117 includes the western portion of this property. It appears that in a significant storm, some runoff travels south along the tree line (west Farrar property line) and then west along the Well Access Road to the drainage ditch in front of Big Lakes (D106). The second area is DA 118 located south of the Well Access Road between Central Mechanical and Irvine's Floor Covering (more in the area of the West McCall Watershed). This DA acts as a reservoir with an overflow that travels north and breaks over the Well Access Road into ditch D101.
- The "Hayes Reservoir" located north of Parker Hannifin provided plenty of storage through a 100-yr. design storm.

| Table ES-2: Hayes Reservoir Existing Conditions | | | |
|---|---|---|---|
| **Design Storm** | **Peak Storage (Ac-Ft)** | **Peak Elevation (Ft)** | Outlet is P113: Fl (In) = 1002.26<br>Top of Levee = 1009.00<br><br>P113 maximum capacity = 18 cfs<br>(rated to the top of the Levee)<br><br>The lowest point on Parker Hannifin's Parking lot is approx. 1007.50 so it is not expected to experience flooding even for a 100-year storm. |
| $Q_2$ | 2.00 | 1004.13 | |
| $Q_5$ | 3.05 | 1005.26 | |
| $Q_{10}$ | 3.90 | 1006.03 | |
| $Q_{25}$ | 4.97 | 1006.25 | |
| $Q_{50}$ | 6.11 | 1006.49 | |
| $Q_{100}$ | 7.29 | 1006.73 | |

West McCall Watershed

- Deficient Elements: 33 Pipes (63%) and 1 Ditches (3%)
- With most of the piping system of this watershed deficient, only the system on the north side of McCall Road and east of Hayes Drive is adequate. One interesting aspect regarding the deficiencies is that the as-builts for the Manhattan Industrial Park Street plans (dated 1979) show that a 2-8'x4' RCB was originally specified as the crossroad pipe for Hostetler Drive but a 48" CMP (P229) was installed instead. Additionally, the plans show a $Q_{future}$ = 220 cfs. It would seem appropriate that this flow would be for a 10-year storm, depending on the design standards at that time. Our model's existing $Q_{10}$ = 171 cfs and future $Q_{10}$ = 190 cfs for P229, which seem to correlate well.
- A lot of localized ponding occurs after rain events of any significance - in the ditches themselves and between businesses along common property lines. The ditch slopes are very flat and six of them actually have negative slopes. The one deficient ditch is D203 located on the west side of Hayes Drive in front of Bob's Plumbing with an LOS just less than a 10-yr design storm.
- One notable item is the area labeled 900 and located at the intersection of the Well Access Road and Levee Drive. This area currently drains into a non-discharging detention area. The area was labeled as 900 because the stormwater does not currently contribute to any of the five major watersheds. After improvements the stormwater will likely flow to both the Levee Drive and West McCall Watersheds. Right now it appears that stormwater from the business property (NGML) located just north of the Well Access Road has runoff that breaks over the road and into the non-discharging detention area.

Levee Drive Watershed

- Deficient Elements: 4 Pipes (27%) and no Ditches
- The watershed actually performs quite well. Two of the deficient pipes (P301 and P302) are entrance culverts for Farrar located along the north side of Levee Drive while the other two deficient pipes (P313 and P314) are located between the National Guard property and 2 Wire Electric. Though modeled to account for the subbasin's flatness, it is unlikely that all of the Farrar property is truly contributing stormwater runoff to P301 and P302. Further development on the Farrar property will determine recommended improvement to these culverts. P313 and P314 will not be receiving increased flow from further development so a recommendation for upgrade may not be justified by past performance.
- The Levee Reservoir located northwest of the Animal Shelter provided plenty of storage through a 100-yr. storm.

**Table ES-3: Levee Reservoir Existing Conditions**

| Design Storm | Peak Storage (Ac-Ft) | Peak Elevation (Ft) | |
|---|---|---|---|
| $Q_2$ | 2.36 | 1004.59 | Outlet is P315: Fl (In) = 1001.45<br>Top of Levee = 1019.00<br>FF of Animal Shelter = 1010.14 |
| $Q_5$ | 4.51 | 1005.24 | P315 maximum capacity = 39.9 cfs<br>(rated for 1' of freeboard to the Animal Shelter) |
| $Q_{10}$ | 6.3 | 1005.77 | |
| $Q_{25}$ | 8.17 | 1006.22 | |
| $Q_{50}$ | 10.25 | 1006.64 | Water will get quite close to the Animal Shelter for any storm > $Q_5$ due to the 3:1 grade north of the Shelter. |
| $Q_{100}$ | 12.39 | 1007.08 | |

Sarber Lane Watershed

- Deficient Elements: 17 Pipes (32%) and no Ditches
- Unlike the other four watersheds, the Sarber Watershed is mostly an improved, underground drainage system. The open channel portion is located along Service Circle and Hayes Drive, which is the area where most deficiencies occur.
- The most prominent drainage feature in the watershed is a 68"x43" RCPHE located along the south side of Sarber Lane which is adequate for a 100-year storm for the entire length under existing conditions.
- Ponding occurs in various places generally located between K-Mart, Service Circle and Manko. The flatness of the area contributes to slow drainage and excessive siltation.

Hwy 24 Watershed

- Deficient Elements: 20 Pipes (30%) and 2 Ditches (8%)
- There are four main areas of deficiencies from the model. The first group includes the 6'x4' RCB under Hwy 24 and three of the four pipes that discharge directly into it. Also included are a couple of upstream pipes along McCall Road. The second group includes six pipes along Levee Drive. The Levels of Service are in the 2-5-yr. design storm range. There are only eight pipes in the Levee Dr. system of the Hwy 24 Watershed. The two that have adequate Levels of Service are located at the top of the system. The third group is located in the roadside ditch along the north side of Hwy 24 from Tuttle Creek Blvd to the 6'x4' RCB. This roadside ditch is the main route for stormwater traveling to the 6'x4' RCB from the southwest. Four pipes in this roadside ditch have LOS's around a 2-yr. design storm. The fourth group is in the Carlson Street Cul-de-Sac area. There are only two pipes here, both 12" CMP entrance pipes.
- Two pipes carry flow underneath the railroad. P539, a 42" CMP, accepts flow primarily from the Levee Drive system and drainage along the northeast segment of Hwy 24. P544, a 96" CMP, accepts flow from all other systems and the southwest segment of Hwy 24. Stormwater from both P539 and P544 is intended to make its way to P562 (4-49"x33" CMAPs and 1-28"x20" CMAP) located under the WWTP access road. *However, the lowest flowline in of P562 (1000.83') is 2.59' higher than the flowline out of upstream pipe P544 (998.24').* Additionally, the ground level between these two pipes is high. This elevation discrepancy causes the entire drainage system upstream of the 96" CMP to be in a reservoir condition. The flowline out of the 42" CMP under the railroad (1002.05) is high enough to drain to P562 making the local Levee Drive System the only one with positive drainage. P562 (and P567) drain into P563, an 84" RCP located under the levee that is the common discharge point for the entire basin. The flowline in of P563 is 994.60, so it is low enough for positive drainage from P544, albeit at a very flat slope of 0.11%. It was originally thought that the weir located in P543, the 6'x4' RCB under Hwy 24 (located upstream of the 96" CMP under the RR) was the sole source of the very noticeable reservoir condition in the concrete channels on the north and east of the Jon Murdock property. The turf channels on the south and west of the property also experience very noticeable flooding, being referred to as a "lake" by the adjacent property owner, Purple Wave Auction. The original intention of the weir is unknown. Perhaps when it was constructed, it was known that stormwater would not make it past P544 and the weir was installed to lessen the anticipated flooding condition along the Hwy 24 corridor. Before the flowlines were analyzed, it was noticed that stormwater was at least 6" above the weir in the 6'x4' RCB after a rain event so it was known that there was some other obstruction downstream. The weir is approximately 2'-2" in height making the top at elevation 1001.10. With ground elevations at 1002.50 and above, the flooding above the weir makes sense. Without the model analysis, it is very easy to realize that channels are necessary in the downstream portion of this watershed through the farmground around the WWTP. The flowline of the pipes under the WWTP Access Road must be lowered and will likely be replaced.
- The plaza located along the west side of Levee Drive in which FedEx is located has a non-discharging reservoir in the back (west) of the property. This area may actually have been designed this way. The reservoir size is adequate and flows to it will not increase as its drainage basin is fully developed. However, to eliminate it and drain the area, it is possible to extend a ditch (or pipe) south from the reservoir area along the railroad spur to the Hwy 24 ditch west of P535 (1,150'). It would have to be quite flat at 0.20% and the bottom of the reservoir would have

to be filled in a bit. It is not possible to drain this area to the north to P311 located in the Levee Watershed.

- Enoch Lane lacks stormwater infrastructure on the west side. A swale behind the residence located between RSC Equipment Rental and Purple Wave Auction takes flow to a small ditch between the residence and Purple Wave Auction. The ditch essentially ends at the NE corner of the Purple Wave property causing the ditch and swale to act as a non-discharging reservoir. Employees of Purple Wave have never seen the water break over Enoch Lane or their parking lot. The east side of Enoch Lane has a developed ditch that doesn't drain well.
- The Carlson Cul-de-Sac area lacks stormwater infrastructure. Drainage in this area is in a non-discharging reservoir condition. This area includes the GTM, Best Western, Hampton Inn, Pioneer Seeds, Ag Tech and KSU properties located there.

***Developed System Analysis***

To perform the Developed System Analysis, all green space areas were identified. Additionally, areas currently undergoing redevelopment or likely to undergo redevelopment were identified throughout the study area. Adjustments were made to the existing HEC-RAS models for development. Minor subbasin SCS Curve numbers (surface runoff coefficients) were increased. Minor subbasin boundaries also changed, sending overland flow in different directions than existing. New time of concentrations for surface runoff were calculated. The network of flow through pipes and ditches had minor adjustments. For instance, non-discharging reservoir areas (areas lacking stormwater infrastructure) were connected to the common drainage system.

Fully developed conditions increase flows. The models were run again to analyze how the existing drainage system would react under these increased flows. Appendix B includes Level of Service tables for each Major Watershed under developed conditions. Elements that were already deficient for existing conditions are highlighted in yellow while additional deficiencies caused by development are highlighted in blue. The Level of Service of all elements decreased slightly. Only 14 more pipes and 1 more channel became deficient after development. The total watershed area has 200 pipes in which 78 of them already have an LOS < 10-yr. design storm under existing conditions.

**Table ES-4: Summary of Deficient Elements after Development**

| Watershed | Existing Analysis | | Developed Analysis | |
|---|---|---|---|---|
| | Pipes | Channels | Pipes | Channels |
| North Hayes | 4 | - | 6 | - |
| West McCall | 33 | 1 | 36 | 2 |
| Levee Drive | 4 | - | 4 | - |
| Sarber Lane | 17 | - | 20 | - |
| Hwy 24 | 20 | 2 | 26 | 2 |
| Total | 78 | 3 | 92 | 4 |

*Includes approx. 6 Ac. currently being redeveloped near the intersection of McCall Rd and Hostetler Dr.
**Excludes the farm ground around the WWTP (discussed in Section 4.6)

The Hayes Reservoir and the Levee Reservoir both performed well under developed conditions. Improvements to them are not recommended, though they should be monitored. Any development on the Farrar property that encroaches upon the reservoir must not decrease its current volume. Silt accumulation or excessive growth of vegetation could also affect the efficacy of either reservoir.

| Table ES-5: Hayes Reservoir Developed Conditions | | | |
|---|---|---|---|
| **Design Storm** | **Peak Storage (Ac-Ft)** | **Peak Elevation (Ft)** | Outlet is P113: Fl (In) = 1002.26<br>Top of Levee = 1009.00<br><br>P113 maximum capacity = 18 cfs<br>(rated to the top of the Levee)<br><br>Again, the lowest point on Parker Hannifin's Parking lot is approx. 1007.50 so flooding is still not expected for a 100-year storm. |
| $Q_2$ | 2.70 | 1004.88 | |
| $Q_5$ | 3.99 | 1006.05 | |
| $Q_{10}$ | 5.20 | 1006.30 | |
| $Q_{25}$ | 6.50 | 1006.67 | |
| $Q_{50}$ | 7.88 | 1006.85 | |
| $Q_{100}$ | 9.29 | 1007.14 | |

| Table ES-6: Levee Reservoir Developed Conditions | | | |
|---|---|---|---|
| **Design Storm** | **Peak Storage (Ac-Ft)** | **Peak Elevation (Ft)** | Outlet is P315: Fl (In) = 1001.45<br>Top of Levee = 1019.00<br>FF of Animal Shelter = 1010.14<br><br>P315 maximum capacity = 39.9 cfs<br>(rated for 1' of freeboard to the Animal Shelter)<br><br>Water will get quite close to the Animal Shelter for any storm ≥ $Q_5$ due to the 3:1 grade north of the Shelter. |
| $Q_2$ | 4.37 | 1005.19 | |
| $Q_5$ | 6.99 | 1005.98 | |
| $Q_{10}$ | 9.13 | 1006.42 | |
| $Q_{25}$ | 11.38 | 1006.87 | |
| $Q_{50}$ | 13.72 | 1007.34 | |
| $Q_{100}$ | 16.13 | 1007.83 | |

Detailed improvements for each watershed are itemized in Chapter 4. The improvements are generally split into two categories. The first category is to itemize improvements to Pipes. Every pipe classified as having an LOS < 10-yr design storm is listed in the first table with specific instructions for replacement, repair, or cleaning. The second category is for significant projects. Significant projects are in a second table and are defined as those requiring a more detailed explanation because they are new improvements where storm drainage doesn't currently exist. Special consideration is given to the McCall corridor for the street improvements currently being planned for it.

***Recommendation Summary***

Ten Capital Improvement Projects were identified and prioritized according to existing need, future development dependence, safety and probability of property damage. Prioritization categories range from 1-3. A Priority 1 project indicates an immediate need to improve existing conditions in which the services of an Engineer are necessary. Priority 2 Projects are typically those that must be accomplished for fostering further development and aren't performing particularly well under existing conditions. Priority 2 Projects will also require the services of an Engineer. Priority 3 Projects consist of "Groups" that were compiled. The improvements of Chapter 4 are a case-by-case analysis of each and every pipe, channel or area lacking infrastructure. Instead of providing costs for each pipe, Project Groups were formed that include multiple recommendations, including general regrading of ditches, silt removal, pipe replacements and some of the Significant Improvements identified. Alone, single pipe replacement projects do not bare sizeable costs, together they are a substantial amount that must be accounted for. The Group projects can be executed through the City's maintenance department, by negotiating with a contractor for maintenance services, or through an Engineer's services utilizing the traditional design/bid/build approach. Cost Estimates for Priority 3 projects include a contingency for Engineering as a conservative number to plan by. Projects classified for When Developed or Discretionary were not estimated. It should be noted that pipes designated as "clean or replace with" (Chapter 4 and the Developed Conditions Map) were often estimated for replacement as a conservative approach.

Appendix C includes the detailed Cost Estimates while the methods of estimating are discussed in Section 2.6. For a graphical representation of the recommendations, refer to the Developed Conditions Map located at the end of Section 4. The ten projects are as follows:

- **WWTP Channels (I-15) Total Estimated Cost: $1.45 Mil. Priority: 1**

  In the WWTP Area, Construct New 550' Channel from P544 to P562, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4' depth. Construct New 650' Channel from P539 to P562, 4' bottom, 4:1 sides, 0.69% slope, no concrete ditch lining. Replace existing five pipe CMP combination of P562 with a 2-5'x3' RCB. Construct New 2,650' Channel from P562 to P563, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4.5' depth. Construct New 900' Channel from P567 to NW corner of WWTP property, 4' bottom, 4:1 sides, 0.50% slope (min.), no concrete ditch lining. Easements were estimated for all channels, though 1,800' of the 8' bottom channel may be able to be located on the WWTP property. Remove the weir in existing P543, the 6'x4' RCB south of Jon Murdocks.

- **Carlson Street (I-11 & I-5) Total Estimated Cost: $630,000 Priority: 1**

  I-11: Construct a system of New Channels, approximately 3,500', in the Carlson Cul-de-Sac area to drain southeast to D530 *Now*. All Channels shall have a 4' bottom, 4:1 sides and 0.20-0.30% slope. Reference Developed Conditions Map. Replace P549 from 12" CMP to 15" RCP and P550 from 12" CMP to 3-23"x14" RCPHE. This system of New Channels will require approximately 1,800' of easements. All channels to be lined with concrete beginning with a 2' depth at the discharge into D530 and decreasing to 1' at the top of the channels.

  I-5: Construct New 600' Channel south of Maximum Performance and Abbott Aluminum *Now*, 4' bottom, 4:1 sides, 0.20% slope. The new channel will flow into a short 12" RCP that is stubbed out from the inlet at the top of P244.

- **Enoch Lane (I-12) Total Estimated Cost: $260,000 Priority: 2**

  Regrade 650' Channel along the east side of Enoch Lane, 4' bottom, 4:1 sides, 0.35% slope. Channel shall be lined with concrete from a 1.5' depth at the discharge end to a 1' depth at the top of the channel. Install New 30"x19" RCP ($Q_{Design}$=22cfs) under frontage road draining into D528. Install New 18" RCP ($Q_{Design}$=8.6 cfs) under Enoch Lane. Construct New 800' Channel along the west side of Enoch Lane turning west between Martin Cat and RSC Equipment Rental, 4' bottom, 4:1 sides, 0.20% slope. Concrete ditch lining at a 1.25' average depth. Install three 15" entrance pipes, one for the residence and two for RSC Equipment Rental.

- **3-3'x2' RCB (I-13) Total Estimated Cost: $160,000 Priority: 2**

  Add an additional 2-3'x2' RCB to existing 3'x2' RCB (P535) under Hwy 24. $Q_{Design}$=92 cfs > $Q_{50}$=86 cfs.

- **3-6'x4' RCB Combo (I-14) Total Estimated Cost: $475,000 Priority: 2**

  Add an additional 2-6'x4' RCB to existing 6'x4' RCB (P543) under Hwy 24. $Q_{Design}$=485 cfs > $Q_{50}$=479 cfs. Add an additional 5'x3' RCB to existing 5'x3' RCB (P541). Replace P542 from 24" CMP to 24" RCP. Replace P566 from 24" CMP to 7'x3' RCB, P545 from 34"x22" RCPHE to 7'x3' RCB, P547 from 30"x24" RCPHE to 6'x3' RCB, P551 from 34"x22" RCPHE to 2-34"x22" RCPHE.

- **North Hayes Group: Total Estimated Cost: $70,000 Priority: 3**

  General Regrading and Silt Removal for 4,700' of channel (D101-D114).

  **I-2:** Construct New 200' Channel along the east property line of Irvines Floor Covering, 4' bottom, 4:1 sides, 0.50% slope (min). Install 15" RCP under Well Access Road connecting new channel to D101. An Easement will be needed through the Irvine property.

  **I-3 E-W leg:** Construct New 400' E-W leg of Channel in the Right-of-Way along the north side of Well Access Road adjacent to the Big Lakes (south) property line, 4' bottom, 4:1 sides, 0.32%.

  **I-6:** Construct New 450' Channel south and east from P301 in the Right-of-Way along the north side of Levee Dr. and the Well Access Road, 4' bottom, 4:1 sides, slope will likely vary. Install 15" RCP entrance pipe for NGML. The slope of the E-W roadside ditch must be kept down for 80' from P301 west for construction of the NW branch of the ditch - Construct New 400' Channel north and west from the roadside Channel on the Farrar property along the adjacent property line with NGML, 4' bottom, 4:1 sides, 0.40% slope (max). This project need not wait for further development and should be constructed now to improve existing drainage conditions.

  Upgrade: P104 from 12" CMP to 2-23"x14" RCPHE
  P105 from 18" CMP to 18" RCP
  Repair: P114 18" CMP discharge end
  Clean: P107 (24" CMP) or replace with a 24" RCP
  P112 (42"x29" CMAP) or replace with a 45"x29" RCPHE

- **West McCall Group Total Estimated Cost: $150,000 Priority: 3**

  General Regrading and Silt Removal for 2,500' of channel (D201-D215 and D223) along the Hayes Drive corridor only.

  Upgrade: P203-P206 with 15" RCP
  P207 from 28"x20" CMAP to 21" RCP
  P208 from 28"x20" CMAP to 24" RCP
  P209 from 28"x20" CMAP to 24" RCP
  P210 from 28"x20" CMAP to 34"x22" RCPHE
  P211from 30" CMP to a 30" RCP
  P212 from 30" CMP to a 30" RCP
  P214 from 23"x14" RCPHE to 2-30"x19" RCPHE
  P215 from 28"x20" CMAP to 34"x22" RCPHE
  P216 from 28"x20" CMAP to 34"x22" RCPHE
  P217 from 28"x20" CMAP to 38"x24" RCPHE
  P218 from 28"x20" CMAP to 38"x24" RCPHE
  P219 from 35"x24" CMAP to 38"x24" RCPHE
  P220 from 35"x24" CMAP to 38"x24" RCPHE
  P246 from 2-18" CMP to 2-18" RCP
  P248 from 21" CMP to 30"x19" RCPHE
  P249 from 23"x14" RCPHE to 2-23"x14" RCPHE

- **Sarber Lane Group Total Estimated Cost: $82,000 Priority: 3**

  General Regrading and Silt Removal for 1,700' of channel (D402-D409).

  Upgrade: P404 from 18" CMP to 38"x24" RCPHE
  P405 from 24" CMP to 38'x24" RCPHE
  P406 from 23"x14" RCPHE to 21" RCP
  P407 from 24" CMP to 36" RCP
  P408 from 18" CMP to 18" RCP
  P409 from 18" CMP to 18" RCP
  P410 from 21" RCP to 36" RCP

- ***Sarber Lane Group Cont.***

  Upgrade: P411 from 12" PVC to 24" RCP
  P412 from 12" HDPE to 2-15" RCP
  P431 from 15" RCP to 18" RCP
  P433 from 15" RCP to 30"x19" RCPHE
  P446 from 12" RCP to 30"x19" RCPHE

- **Hwy 24 Group Total Estimated Cost: $93,000 Priority: 3**

  General Regrading and Silt Removal for 6,300' of channel (D501-D534). (Approximately 7,700' of additional channels are in KDOT Right-of-way along US 24)

  Upgrade: P517 from 30" RCP to 42" RCP
  P525 from 18" HDPE to 18" RCP
  P526 from 24" CMP to 24" RCP
  P527 from 24" CMP to 24" RCP
  P528 from 30" CMP to 24" RCP
  P529 from 18" CMP to 18" RCP
  P530 from 24" CMP to 24" RCP
  Clean: P554 (38"x24" RCPHE)

- **McCall Road Improvements Total Estimated Cost: $2.65 Mil. Priority: NA**

  The street improvements planned for McCall Road will turn it into a standard curb and gutter section transforming the existing storm drainage from an open channel system to an enclosed system. Stormwater drainage splits about midway on McCall Road near the McCall Pattern west property line. The enclosed system improvements are discussed in terms of East and West as they are two separate systems.

  **West McCall**
  - 1,200' of 8'x4' RCB from Tuttle Creek Blvd. Channel to the northwest corner of the Hayes Dr./McCall Rd. intersection. It is envisioned that half of the RCB will be underneath the new street section from Hostetler Dr. to Hayes Dr.
  - From Hayes Dr. to the east, underground storm drainage will be maintained on each side of McCall Rd. with pipe sizes very similar to those indicated in this study, depending on actual inlet locations determined during the McCall Rd. design. Along the north side of McCall Road required 80' of 42" RCP, 400' of 36" RCP and 400' of 24" RCP. Crossing McCall Road and along the south side required 185' of 36" RCP, 250' of 30" RCP, 250' of 24" RCP, 400' of 30"x19" RCPHE and 300' of 23"x14" RCPHE.
  - Flow from the ditch and culvert sections along Hayes Drive will enter the new system in the same manner at the McCall Rd./Hayes Dr. intersection and P233 located just west of the intersection will remain as the singular crossing (36" RCP) underneath McCall Rd. to discharge storm drainage on the south side into the new 8'x4' RCB.

  **East McCall**
  - 1000' of 4'x3.5' RCB from the west property line of the McCall Pattern factory to the proposed second channel on the McCall property located just west of the existing building
  - 750' of 5'x3.5' RCB from the McCall channel, crossing McCall Road to the south, going past D516 and ending at the discharge of P514
  - 220' of 2-5'x3.5' RCB from the top of existing D516 to the top of P543, the proposed 3-6'x3' RCB crossing Hwy 24.
  - P517 should be upgraded from a 30" RCP to a 42" RCP as specified in Table 4.6.1. P514 should also be converted from a 24" CMP to a 24" RCP.

***Special Consideration for Development in the WWTP Area***

According to the FEMA flood insurance study, a 10-year flood on the Kansas River is expected to be at an elevation of 1004.8 near the 84" RCP (P563) discharge. The lowest point on the access road to the WWTP is approximately 1005.30 so a 10-year flood on the river would cause substantial flooding in this area. We know that the sluice gate is closed much sooner than this when the river rises. The sluice gate is most likely shut for 5-year floods and greater on the Kansas River. Frequency mixing recommendations from KDOT suggest that when the Kansas River is experiencing a 2-yr. design storm, the Hwy 24 Watershed is experiencing a 100-yr. design storm and vice-versa. To determine the area available for development, it was assumed that even a 100-yr. storm must be contained in a non-discharging reservoir within the WWTP Area. A 100-yr. storm from the Hwy 24 Watershed creates a volume of approximately 155 Ac.Ft. for Developed Conditions. KDHE guidelines require a 350' building setback for new development next to an existing WWTP. This leaves a maximum of approximately 110 Ac. available for development. There are two options for a non-discharging reservoir in this area. The maximum depth of detention was figured to elevation 1005.00 so that back-ups will not flood streets and businesses.

- **Natural Detention:** Approximately 70 Ac. must be left in its natural state for detention leaving 40 Ac. available for development. See Figure 4.6.1 at the end of Section 4. (The Channels recommended in I-15 must still be constructed.)

- **Man-Made Detention:** Construct a man-made detention pond essentially contained in the area of the 350' Bldg. Setback around the WWTP property. This is approximately 25 Ac. of ground, leaving the full 110 Ac. available for development. The excavation from the Man-Made Detention pond can be used to build up the developable area by the developer. See Figure 4.6.2 at the end of Section 4.

Based on these observations, Man-Made Detention is recommended as it is an efficient use of otherwise unbuildable area and maximizes the amount of developed area available should development proceed.

# Section 1 – General Information

## 1.1 Authorization and Scope

In January of 2005, the City of Manhattan authorized BG Consultants, Inc. to perform engineering services for the Eastside Drainage Study. This area, located in the southeast portion of the City's limits, has historically experienced drainage issues. Initially an industrial area, economic development and redevelopment of this area is transforming it more towards commercial businesses. This comprehensive study was necessary to determine recommendations for improvements to existing drainage problems and to provide guidance to the City and developers for infrastructure needed upon further development. The scope of services is as follows:

TASK A: Analyze the existing public stormwater system (15" diameter pipes and greater)

- Conduct field work to determine location and size of drainage system components
- Attend and conduct public meetings
- Set up hydrology computer models and run design storms
- Analyze pipes, inlets, and ditches for hydraulic capacity.
- Provide information in a report format

TASK B: Recommend improvement projects with cost estimates and priorities

- Determine improvements to be studied and preliminary design of improvements
- Project prioritization, cost estimates and report preparation
- Attend and conduct meetings.

The area of the study encompasses approximately 630 Ac (approximately 1mi.$^2$). The study area follows the (Main) Levee on the north, wrapping around on the east to parallel the Big Blue River and on the south to parallel the Kansas River. The west boundary parallels Tuttle Creek Blvd. but does not include the newly developed area around Wal-mart, whose storm drainage was studied as part of the development.

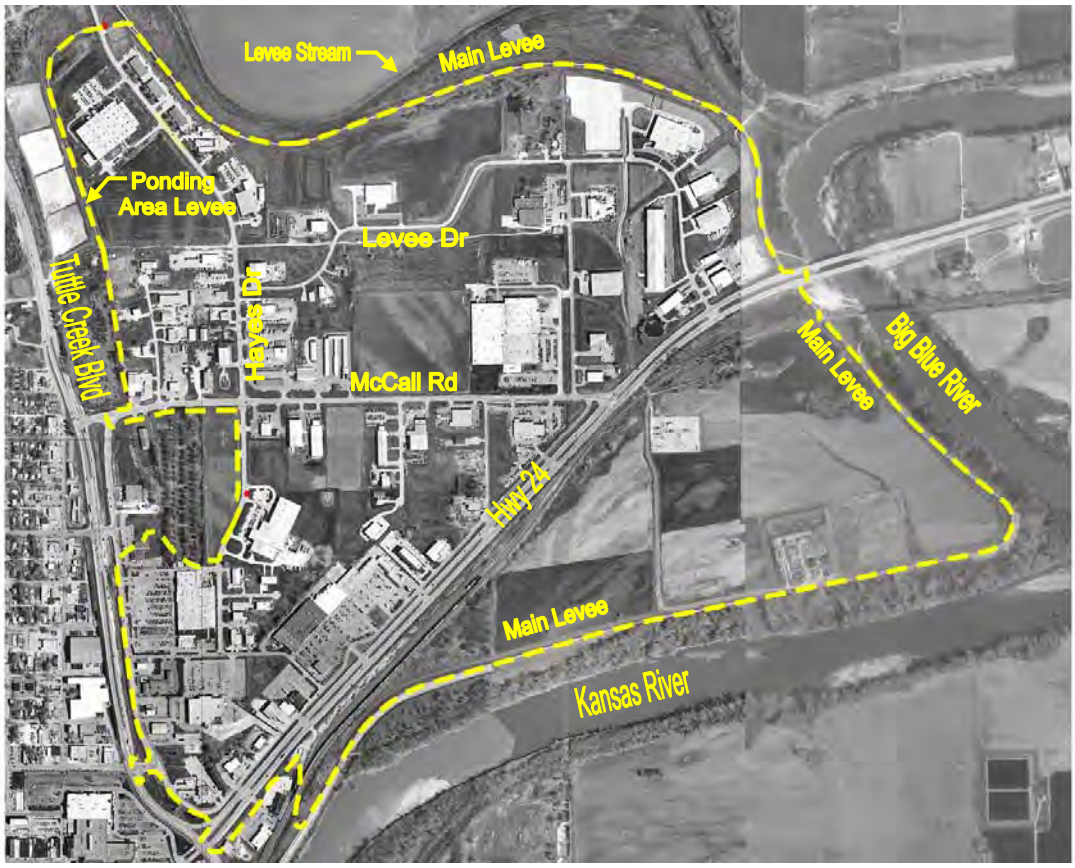



Figure 1.1.1 Eastside Drainage Study Boundary

### 1.2 Definition of Terms

**CMP** – Corrugated Metal Pipe

**CMAP** – Corrugated Metal Arched Pipe

**Curve Number (CN) –** SCS Method runoff coefficient whose value depends on the soil type, land use and the initial degree of saturation known as the antecedent moisture condition.

**Detention Facility** – Any structure, device or combination thereof that functions to accept inflow from surface runoff and discharge it at a controlled rate less than the peak inflow rate.

**Development** – Any activity that alters the surface of the land to create addition impervious surfaces, including, but not limited to, pavement, buildings, and structures.

**Easement** – Authorization by a property owner for the use by another for a specified purpose, of any designated part of the property.

**Elements** – Refers to ALL pipes and ditches in a particular drainage system.

**Enclosed Drainage System** – A drainage system consisting of curb or area inlets connected by piping concealed underground.

**Freeboard** – The vertical difference in elevation between the hydraulic gradient and a referenced point. Examples are the difference between the maximum water surface level behind a dam and the top of a dam, or the difference in elevation between the water surface at a culvert beneath the roadway and the surface of the roadway.

**GPS** – Global Positioning System. A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

**GIS** – Geographic Information System. A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface.

**HEC-HMS –** Hydrologic Engineering Center-Hydrologic Modeling System by the U.S. Army corps of Engineers is computer modeling software designed to simulate the precipitation-runoff processes of dendritic watershed systems. The program includes a variety of mathematical models for simulating precipitation, evapotranspiration, infiltration, excess precipitation transformation, baseflow, and open channel routing.

**Inlets** – A drainage structure that allows stormwater to enter into an enclosed system. (i.e. curb inlet or area inlet)

**Level of Service** – The return period for which a drainage system, or an individual element of that system has adequate hydraulic capacity.

**Open Channel System** – A drainage system consisting of open channels with only comparatively short lengths enclosed by pipes or culverts.

**RCB** – Reinforced Concrete Box

**RCP** – Reinforced Concrete Pipe

**RCPHE** – Reinforced Concrete Pipe Horizontal Elliptical

**Return Period** – A statistical term for the average frequency that a given event may be expected to occur although it does not imply that the event will occur regularly at even intervals. It can also be defined as the reciprocal of the probability of an event. For example, a storm having a 10-year return period statistically can be expected to occur in a period of 10 years, an annual probability of occurrence of 0.10, or 10%. However, the event may happen at any time and two such events may actually occur on successive days.

**SCS Method –** In 1972 the U.S. Soil Conservation Service suggested an empirical model for estimating rainfall runoff which is based on the potential for the soil to absorb a certain amount of moisture. On the basis of field observations, this potential storage was related to a 'curve number' *CN* which is a characteristic of the soil type, land use and the initial degree of saturation known as the antecedent moisture condition.

**Storm Drainage System** – All of the natural and constructed facilities and appurtenances, such as ditches, natural channels, pipes, culverts, bridges, improved channels, street gutters, inlets, and detention facilities, that serve to collect and convey surface drainage within the City.

**Time of Concentration ($t_c$)** – The amount of time it takes for the first raindrop landing at the most remote point in the drainage area to travel to the outlet point. Until this time has elapsed, the outflow has not reached its peak because the entire drainage area is not contributing to the flow.

**Watershed** – All land that drains surface water runoff to a common point (or outlet). Also referred to as drainage area, drainage basin, tributary area, and catchment area.

### 1.3 Addresses of Businesses Referenced

Throughout the discussion in Chapters 3 and 4 of this report, business names are referenced for the location of pipes, ditches and problem areas. For the posterity of this report, as businesses will relocate or shut down, a list of the referenced businesses and their associated address has been compiled. In this way, future personal applying the results of this report will be able to orient themselves to the proper locations as described in the text.

| | | |
|---|---|---|
| Abbot Aluminum, Inc.<br>430 McCall Rd | Animal Shelter<br>605 Levee Dr. | Comfort Inn<br>150 E. Poyntz Ave. |
| Ace Hardware<br>800 Tuttle Creek Blvd. | Autocraft<br>201 Service Cir. | Dillions Store #15<br>130 Saber Ln. |
| Agtech<br>805 Carlson | Best Western<br>601 Poyntz Ave. | Eastside Market<br>219 E. Poyntz Ave. |
| American Legion<br>114 McCall Rd. | Big Lakes Dev. Center<br>1416 Hayes Dr. | Farm Bureau<br>1200 Kretschmer Dr. |
| American Pest Mgmt.<br>220 Levee Dr. | Bob's Plumbing & Heating<br>1127 Hayes Dr. | Farrar Corp.<br>301 Levee Dr. |
| Ampride Service Station<br>215 E. Poyntz Ave. | Central Mechanical<br>1131 Hayes Dr. | FedEx<br>809 Levee Dr. |

Flint Hills Beverage
825 Levee Dr.

Griffth Lumber
820 Levee Dr.

GTM Sportswear
520 McCall Rd.

Hampton Inn
501 E. Poyntz Ave.

Hastings
628 Tuttle Creek Blvd.

Hill & Co.
1132 Hayes Dr.

Hobby Lobby
638 Tuttle Creek Blvd.

Irvine's Floor Covering
1218 Hostetler Dr.

John Murdock
600 McCall Rd.

Kansas Entrepreneual Center
1500 Hayes Dr.

K-Mart
401 E. Poyntz Ave.

KSU Testing Facility
510 McCall Rd.

Manko
800 Hayes Dr.

Maximum Performance
426 McCall Rd.

McCall Pattern Factory
615 McCall Rd.

Midstate Mechanical
230 Levee Dr.

National Guard Armory
721 Levee Dr.

NGML
245 Levee Dr.

Parker Hannifin Corp.
1501 Hayes Dr.

Pioneer Seeds
801 Carlson St.

Purple Wave Auction
701 Enoch Ln.

RSC Rental
915 Enoch Ln.

Staples
632 Tuttle Creek Blvd.

Super 8 Motel
200 Tuttle Creek Blvd.

Wal-Mart
102 Bluemont Ave.

# Section 2 – Technical Methods

## 2.1 Preliminary Investigation

To begin the study, a preliminary field investigation was undertaken to assess the overall drainage of the study area and generally identify elements in the system, referencing the City's existing stormwater drainage maps, for further instruction to the project surveyor.

## 2.2 System Mapping

Using GPS units, the inlet and discharge flowline elevations and locations of each culvert were ascertained. Additionally, the overtopping elevation of each element was identified. For instance, the overtopping elevation of an entrance pipe was taken at the centerline of the driveway over the pipe. For channel geometry, select cross sections were taken throughout the study area. The project surveyor also measured the size of all existing culverts. This GIS data was imported into Autocad, creating a map of the system over the City/County flown aerials. GIS data in Autocad maintains its attributes so that the elevation, northing, easting, size or type of pipe or type of channel shot can easily be referenced.

## 2.3 Modeling

Five (5) Major Watersheds were identified. Each watershed is defined by its common discharge point. The North Hayes area discharges into the Ponding Area Levee Stream, the Levee Drive area discharges in the (Main) Levee Stream, the West McCall area discharges into the north segment of the Tuttle Creek Blvd. Channel, the Sarber Lane area discharges into the middle segment of the Tuttle Creek Blvd. Channel and the Hwy 24 area discharges into the Kansas River. Data from the System Mapping portion of the study was entered into the HEC-HMS model. Each watershed is modeled independently. A total of 200 pipes and 99 channels were entered into the HEC-HMS software to model the five watersheds.

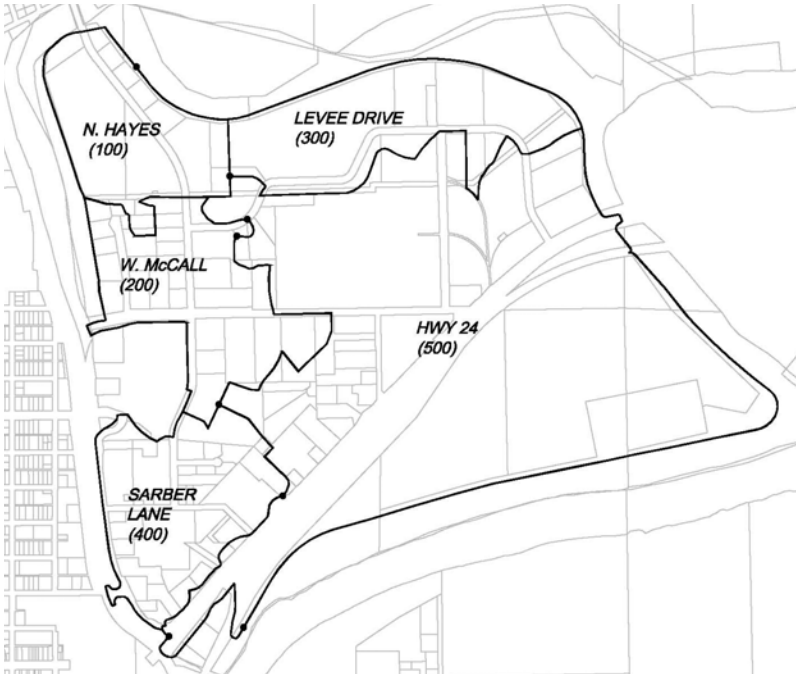



Figure 2.3.1 Major Watersheds

### 2.3.1 Runoff-Volume Method

The Soil Conservation Service (SCS) Curve Number (CN) method was used to model stormwater runoff volumes. Each watershed is divided into a system of subbasins contributing stormwater runoff to the conveyance elements, i.e. pipes and channels. Parameters for each subbasin, including area, curve number and time of concentration ($t_c$), were entered into the model.

### 2.3.2 Design Storm Data

Runoff volume calculations are based on frequency-based rainfall intensity tables as published in the City's Stormwater Management Criteria. Each watershed model was run at the 2, 5, 10, 25, 50, and 100-yr. design storm return periods. HEC-HMS models are unsteady-flow models in that they describe changes in flow over time to determine the peaks occurring in the system. For the Eastside Drainage Study, a 24-hr storm hydrograph was used.

### 2.3.3 Conveyance Method

The Muskingum-Cunge standard section method was used to describe all pipes and channels. Pipe parameters include the length, slope, Manning's "n" coefficient, shape and diameter. Horizontal elliptical shapes are not available in the model, therefore equivalent circular areas were used for elliptical pipes. The channel parameters are very similar, however, instead of diameter a trapezoidal section is described by entering the bottom width and side slopes. Channel cross sections were analyzed to determine equivalent trapezoidal sections. Slopes of channels were figured by using the flowlines of the upstream and downstream pipe or RCB divided by the actual length of the channel. Though the channel bottoms are undoubtedly not uniform, this method approximates a uniform slope for the correlating assumption with the hydraulic gradient slope. With all pipes, RCBs and channels, the model will not accept a negative slope. In these cases, a 0.04% positive slope was used as it is the minimum that the model will accept.

## 2.4 Methods of Analysis

### 2.4.1 System Evaluation Criteria

The theoretical maximum capacity of each pipe (or RCB) was determined through the use of a computer program called Culvert Master by Haestad Methods. The flowline in, flowline out, length, size, Manning's "n" and overtopping elevation were specified for each element. Tailwater elevations were assumed at ½ the diameter of the pipe or height of the RCB. The program uses the U.S. Federal Highway Administration (FHWA) Hydraulic Design of Highway Culverts (HDS-5) methodology to determine the maximum flow ($Q_{MAX}$) through the pipe or RCB using inlet and outlet control computations. The $Q_{MAX}$ was compared to the flow results of HEC-HMS for the 2, 5, 10, 25, 50, and 100-yr Design Storms to determine each pipes Level of Service (LOS). The Level of Service is defined as the largest Design Storm that the element is able to convey without overtopping.

The $Q_{MAX}$ for channels was determined through the standard Manning's Open Channel equation. As with the pipes, the channel $Q_{MAX}$ was compared to the flow results of HEC-HMS to determine each channel's LOS. The standardized trapezoidal section used in HEC-HMS was also used for the $Q_{MAX}$ calculations. Negative slopes were also assumed at 0.04% in accord with the HEC-HMS model for positive hydraulic gradient.

When an elements LOS is less than a 10-yr Design Storm, the element is considered deficient in accordance with the City's Stormwater Management Criteria. Contributing to this method of evaluation were the visual observations by the project surveyor and/or engineer. The theoretical $Q_{MAX}$ of pipes in particular was decreased by physical damage or substantial siltation. The decreases are based off of loss of cross-sectional area of the pipe. For instance, if a pipe is 40% blocked by silt, the $Q_{MAX}$ is multiplied by 60% as the amount of effective area available for flow.

The LOS charts in Appendix A indicate the percentages of effective area in the comments column that correspond to the column for Adjusted $Q_{MAX.}$

An elements LOS was not the only factor in the deficiency of a watershed's system. Maintenance of channels or lack of localized stormdrainage systems also contribute greatly to the analysis of the study area.

### 2.4.2 Existing System Analysis

The analysis of the Existing System is quite straightforward. The geometry of the systems in the Existing Conditions Model represents what is truly present in the field. Each watershed model was run through the 2-100 year Design Storms and the flows were compared to the $Q_{MAX}$ of each element. Deficiencies in LOS or lack of existing stormdrainage were notated. Preliminary recommendations for improvement were formulated based on the results. However, final recommendations for improvements were reserved for after the results of the Developed Conditions Analysis were completed. The Level of Service chart in Appendix A itemizes all elements and highlights in yellow those with an LOS less than a 10-yr. Design Storm. Furthermore, an Existing Conditions Map is included at the end of Section 3 with deficient elements shown in red.

### 2.4.3 Developed System Analysis

To begin the Developed Conditions analysis, all areas of potential development were identified. Areas of potential development were not limited to empty lots. They include partial lots in which an established business has room to expand or do a lot split and sell. They also include some areas of redevelopment, particularly those areas currently undergoing redevelopment. Though the market seems wide open for expansive redevelopment, in many cases redevelopment would not increase the existing runoff coefficient (SCS CN) and associated volume of runoff beyond its current classification. The consideration of development changes flow patterns and thus, boundaries of subbasins. The properties of subbasins affected by development were adjusted in the model (Area, CN, $t_c$). In addition to accounting for full development in the study area, the Developed Conditions models were adjusted to provide stormdrainage systems in the areas that don't currently have them (i.e. Carlson Street, etc.). Each watershed model was again run through the 2-100 year Design Storms and the flows were compared to the $Q_{MAX}$ of each element. Increased flows caused the deficiencies of more elements. The Level of Service chart in Appendix B itemizes all elements and highlights in blue the additional elements whose LOS has dropped lower than a 10-yr Design Storm.

### 2.4.4 Design Criteria and Constraints

The design of all recommended improvements follows the City's Stormwater Management Criteria. Open and Enclosed System improvements were sized for a 10-yr return period peak flow except for the elements crossing Hwy 24 which is classified as an arterial street, requiring that improvements are sized for a 50-yr return period peak flow. Because Hwy 24 is under the jurisdiction of the Kansas Department of Transportation (KDOT), further analysis may be necessary to meet their stormwater design criteria. For improved channels, the minimum bottom width is 4'. Side slopes were generally specified as 4:1. Concrete lining of channels to height of 6 inches above the 10-yr design discharge is anticipated when the longitudinal slope is less than 0.5% or when the 10-yr design discharge is ≥ 200 cfs and ≤ 500 cfs.

## 2.5 Recommendations

Recommended improvements in each watershed were itemized for every pipe and channel whether it is a replacement, rehabilitation or completely new in Section 4: Developed Conditions. All improvements are also illustrated on the Developed Conditions Map at the back of Section 4. Improvements fall into two main categories – Improvements Now and Improvements When Developed. Improvements that should be pursued now are illustrated in red while improvements that should occur upon development are illustrated in blue. Improvements illustrated in green

indicate Discretionary Improvements. The Discretionary Improvements are comprised of optional recommendations based on the (adequate) historical functioning of a particular element or other various reasons.

## 2.6 Estimating Methods

Within Chapter 5: Prioritization and Estimation, improvements have been grouped to facilitate capital improvement and maintenance planning. For example, all of the silt removal, pipe replacements and new structures needed now in the North Hayes watershed make up one group. Other improvements are stand-alone projects for substantial new construction. In addition, special attention has been given to the upcoming McCall Road street improvements in which changing the existing open system to an enclosed system is desired. Assumptions for estimating are as follows:

Driveway Replacement: The length of the driveway trench (or width of the drive) was assumed to be 8' less than the total length of the pipe. Unit price reflects 50% asphalt/50% Concrete.

Seeding: The reseeding for channel cleaning was considered to be the area of the bottom of the ditch plus 2 feet of each side slope (an additional 4 feet total). Reseeding for the channel improvements were considered to be the disturbed area of the channel plus 4' on each side of the channel

Channel Construction: All Earthwork quantities are neat line

Street Removal: RCB - Pavement removal was considered to be the width of the road by width required for construction. The width required for construction was considered to be the width of the box plus the slope cut back at a 3:1 from flow line to top of roadway on each side.

Pipe/RCB: New pipes and RCBs were estimated using the latest KDOT bid tabs.

Easements: Minimum of 30' or actual top width of channel plus 10' on either side, whichever is greater.

# Section 3 – Existing System Analysis

## 3.1 General

After the existing storm drainage system in the study area was identified in the field, drainage areas were determined. There are five major watersheds in the study area; North Hayes, West McCall, Levee Drive, Sarber Lane, and Hwy 24. Each watershed was assigned a series of numbers by which all elements, pipes and ditches, could be identified. The series are 100-500, respectively. Additionally, all pipe designations begin with a "P" (i.e. P230 in the West McCall Watershed) and all ditch designations begin with a "D" (i.e. D516 in the Hwy 24 Watershed). All data was entered into HEC-HMS and the model was run at 2, 5, 10, 25, 50 and 100-yr. design storm frequencies. Each elements maximum capacity was figured and compared to the flows that resulted in the HEC-HMS model to determine each elements existing Level of Service (LOS). Existing Level of Service tables are included in Appendix A. The following discussion analyzes each watershed for existing conditions. Deficient pipes and ditches are defined as those with a LOS < 10-yr. design storm frequency. A comprehensive Existing Conditions map is included at the end of this section.

## 3.2 North Hayes Watershed (100)

### 3.2.1 Description

The North Hayes Watershed is approximately 53 Acres and is essentially the north part of Hayes Drive between Casement Road and McCall Road. It is bounded on the north near Casement Road, to the west by the Ponding Area Levee, to the south by the Well Access Road and to the east by the Main Levee. The overland slopes in this watershed mostly range between 0.5-1.0%. There are a couple of areas that are quite flat including the area east of Big Lakes Developmental Center on the Farrar property and the west end of the Central Mechanical property. The common discharge point is the Ponding Area Levee Stream flowing north along the west side of the watershed. There are three points of discharge into the Ponding Area Levee Stream.

### 3.2.2 Land Use

The North Hayes Watershed is both Industrial and Commercial. However, there is a lot of open space including approximately 20 Acres of farm ground south of Parker Hannifin. A wide range of SCS Curve Numbers, surface runoff coefficients, were used ranging from 72-91.

### 3.2.3 Drainage System

This watershed consists of 14 pipes, 14 channels, and 18 minor subbasins. The system is open channel with culverts underneath driveways. Most of the stormwater runoff travels northwest discharging through P113, an 18" CMP with flapgate underneath the northern part of the Ponding Area Levee. The total drainage area to P113 is approximately 38 Ac. All of the drainage on the east side of Hayes Drive is directed to P113 by way of two culvert crossings underneath Hayes Drive, a 42"x29" CMAP on the north (P110) and a 2-42"x29" CMAP to the south (P102). The ditch upstream of P113 also acts as a reservoir. There are two other pipes through the Ponding Area Levee. P114, an 18" CMP, is located somewhat in the middle of the farm ground. The total drainage area to P114 is approximately 7 Ac. This pipe was not part of the original Army Corp. of Engineers plans and was installed later by the City to drain ponding water on the farm ground. It appears that a mower or other vehicle drove over P114's discharge, severely damaging it. The last pipe through the Ponding Area Levee is another 18" CMP with flapgate (P101) located on the south part of the Ponding Area Levee. The total drainage area to P101 is approximately 8 Ac.

There are two areas where ponding occurs. The first area is on the Farrar Property east of Big Lakes and north of NGML. The land is very flat and there is no clear path for storm drainage. A lot of infiltration is occurring in this area. Right now drainage area (DA) 117 includes the western portion of this property. It appears that in a significant storm, some runoff travels south along the

tree line (west property line) and then west along the Well Access Road to the drainage ditch in front of Big Lakes (D106). The second area is DA 118 located south of the Well Access Road, more in the area of the West McCall Watershed. This DA acts as a reservoir with an overflow that travels north and breaks over the Well Access Road into ditch D101.

### 3.2.4 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the North Hayes Watershed are $Q_{10}$ = 36 cfs and $Q_{100}$ = 60 cfs. These flows are the sum of P101, P113 and P114 contributing to the Ponding Area Levee Stream so they are *after* detention. The 10-yr. and 100-yr. peak flows into the reservoir are $Q_{10}$ = 54 cfs and $Q_{100}$ = 91 cfs. Overall, this watershed rates average with 4 deficient pipes (29%) and no deficient ditches. Deficient pipes (and ditches) are highlighted yellow in the Existing Conditions Level of Service (LOS) Tables in Appendix A and appear in red on the Existing Conditions Map at the back of this section. Deficient pipe P104 (12" CMP) is located on the east side of Hayes Dr. under the south entrance of Big Lakes. It has an LOS <2-yr. design storm. Though it is quite silted in with only 25% of its area available for flow, cleaning it will not improve the LOS. It is simply undersized. P105 (18" CMP) is located on the east side of Hayes Dr. under the Kansas Entrepreneurial Center drive and has an existing LOS <10 yr. It is slightly silted in and cleaning would improve it a small, amount. Deficient pipe P107 (24" CMP) is also located on the east side of Hayes Drive. This pipe only has 10% of its area available for flow and would have an LOS >100 yr. if cleaned. The last deficient pipe is P114, the 18" CMP under the Ponding Area Levee that sustained damage to its discharge. It has approximately 50% effective area available for flow. If the discharge end section was replaced, this pipe would have a 10-yr. LOS. The "Hayes Reservoir" located north of Parker Hannifin provided plenty of storage through a 100-yr. design storm. The results are as follows.

**Table 3.2.1: Hayes Reservoir Existing Conditions**

| Design Storm | Peak Storage (Ac-Ft) | Peak Elevation (Ft) | |
|---|---|---|---|
| $Q_2$ | 2.00 | 1004.13 | Outlet is P113: Fl (In) = 1002.26<br>Top of Levee = 1009.00<br><br>P113 maximum capacity = 18 cfs<br>(rated to the top of the Levee)<br><br>The lowest point on Parker Hannifin's Parking lot is approx. 1007.50 so it is not expected to experience flooding even for a 100-year storm. |
| $Q_5$ | 3.05 | 1005.26 | |
| $Q_{10}$ | 3.90 | 1006.03 | |
| $Q_{25}$ | 4.97 | 1006.25 | |
| $Q_{50}$ | 6.11 | 1006.49 | |
| $Q_{100}$ | 7.29 | 1006.73 | |

### 3.2.5 Picture Gallery

**Figure 3.2.1:** Looking North along Hayes Drive at D113

**Figure 3.2.2:** Looking South along Hayes Drive at D112

**Figure 3.2.3:** Looking South along Hayes Drive at D103

## 3.3 West McCall Watershed (200)

### 3.3.1 Description

The West McCall Watershed is approximately 70 Acres. It is bounded on the north by the by the Well Access Road, on the west by the old lime sludge ponds, on the south (roughly) by McCall Road and on the east (roughly) by the McCall Pattern Factory property line. The overland slopes in this watershed are generally 0.5% or less. All stormwater runoff is directed to main drainage system along McCall Rd. The common discharge point is a 48" RCP on the north side of McCall Rd. that crosses to the south and empties into the Tuttle Creek Boulevard Channel.

### 3.3.2 Land Use

The West McCall Watershed is both Industrial and Commercial with SCS Curve numbers ranging from 76-95. With the construction of the new Wal-Mart, the trend in development is moving towards increased Commercial. At this time, a new commercial development for five new restaurants is in the platting stage for the area just north of the intersection of Hostetler Drive and McCall Road. Unlike the North Hayes Watershed, there are no wide expanses of open space. The green space areas left for development combine for approximately 12 Acres and include the NW corner of the Hayes Dr and McCall Rd. intersection and various properties along Hostetler Drive. The commercial development mentioned above is a redevelopment with existing infrastructure on the site. Many of the existing developed areas could be redeveloped in this Watershed and, in fact, in the entire study area.

### 3.3.3 Drainage System

Drainage along McCall Road splits east and west at approximately midpoint near McCall Pattern Factory's west property line. This watershed is the west portion of that flow. Stormwater runoff in this watershed is directed towards McCall Road where it flows west to the Tuttle Creek Blvd. Channel. The system is mostly open channel with culverts underneath driveways. The only underground drainage is located along Hostetler Drive (two A-5 inlets) and connects to the 48" RCP (P229, P230) that crosses diagonally underneath McCall Road. This 48" RCP is the final leg

of the entire stormdrainage system. This watershed consists of 52 pipes, 29 channels, and 44 minor subbasins. There are no reservoirs. Additionally, the recent Wal-Mart development area including Ace Hardware, the American Legion, and the plaza south of Wal-Mart do not contribute stormwater into the West McCall Watershed. In fact, this area is independent of all Watersheds in this study. The Wal-Mart area storm drainage was studied prior to development so it is not included as part of this study.

One notable item is the area labeled 900 and located at the intersection of the Well Access Road and Levee Drive. This area currently drains into a non-discharging detention area. The area was labeled as 900 because the stormwater does not currently contribute to any of the five major watersheds. After improvements the stormwater will likely flow to both the Levee Drive and West McCall Watersheds. Right now it appears that stormwater from the business property (NGML) located just north of the Well Access Road has runoff that breaks over the road and into the non-discharging detention area.

### 3.3.4 System Performance

The total 10-yr. and 100-yr. design storms flows from the West McCall Watershed (through P231) are $Q_{10}$ = 205 cfs and $Q_{100}$ = 297 cfs. Overall, this watershed rated poorly with 33 deficient pipes (63%) and one deficient ditch (3%). The deficiency of the pipes is not necessarily caused by siltation. Without siltation, only 6 of the pipes would then have LOS's greater than a 10-yr design storm. The majority of the pipes are simply undersized.

With most of the piping system of this watershed deficient, only the system on the north side of McCall Road east of Hayes Drive is adequate. One interesting aspect regarding the deficiencies is that the as-builts for the Manhattan Industrial Park Street plans (dated 1979) show that a 2-8'x4' RCB was originally specified as the crossroad pipe for Hostetler Drive but a 48" CMP (P229) was installed instead. Additionally, the plans show a $Q_{future}$ = 220 cfs. It would seem appropriate that this flow would be for a 10-year storm, depending on the design standards at that time. Our model's existing $Q_{10}$ = 171 cfs and future $Q_{10}$ = 190 cfs for P229, which seem to correlate well.

The results of the West McCall watershed are not surprising. There is a lot of localized ponding after rain events of any significance. Ponding occurs in the ditches themselves and between businesses along common property lines. The ditch slopes are very flat and six of them actually have negative slopes. The one deficient ditch is D203 located on the west side of Hayes Drive in front of Bob's Plumbing with an LOS just less than a 10-yr design storm.

### 3.3.5 Picture Gallery

**Figure 3.3.1:** Looking West along McCall Road at D229

**Figure 3.3.2:** Looking West along McCall Road at D228

**Figure 3.3.3:** Looking East along McCall Road at small ditch between P240 and P241


**Figure 3.3.4:** Looking West along McCall Road at D227

**Figure 3.3.5:** Looking West along McCall Road at D226

**Figure 3.3.6:** Looking East along McCall Road at D217

**Figure 3.3.7:** Looking West along McCall Road at D218

**Figure 3.3.8:** Looking East along McCall Road at D219


**Figure 3.3.9:** Looking East along McCall Road at D220

**Figure 3.3.10:** Looking West along McCall Road at D221

## 3.4 Levee Drive Watershed (300)

### 3.4.1 Description

The Levee Watershed is approximately 75 Acres. It is bounded on the north by the Main Levee, to the west by the Farrar property line, to the south (roughly) by the Well Access Road and to the east by the National Guard property line. The overland slopes are generally 0.50% or less and are very flat on the outskirts of this watershed, particularly on the western half of the Farrar property (30+ Acres) where drainage patterns are difficult to discern. Overland slopes nearer to the Levee Reservoir increase to approximately 1.5%. The common discharge point is a 24" RCP with flapgate through the Main Levee which discharges in the Main Levee stream.

### 3.4.2 Land Use

The Levee watershed is primarily Industrial. There is quite a bit of open space in the City's wellfield on the south side of Levee Drive and on the Farrar property on the north side of Levee Drive. On the other extreme, the National Guard properties are almost entirely paved. SCS Curve numbers range from 70-95.

### 3.4.3 Drainage System

This watershed consists of only 15 pipes, 12 channels, and 17 minor subbasins. The system is open channel with culverts underneath driveways. Most of the stormwater runoff is directed towards the drainage channels along Levee drive. Two large channels, D304 and D306, on either side of the Animal Shelter direct flow into the Levee Reservoir. Some drainage is also directed from the backs of the properties along the south side of the Levee to the Reservoir.

Some ponding occurs in this watershed. In the overland areas of ponding, a lot of infiltration is occurring, which is why the low SCS Curve numbers were used in the model. Though some of the channels have very flat slopes, they are at least all positive.

### 3.4.4 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the North Hayes Watershed are $Q_{10}$ = 30 cfs and $Q_{100}$ = 36 cfs. These are the flows through P315 so they are *after* detention. The 10-yr. and 100-yr. peak flows into the reservoir are $Q_{10}$ = 133 cfs and $Q_{100}$ = 218 cfs. Overall, this watershed rates average with 4 deficient pipes (27%) and no deficient ditches. P301 and P302 are located in the Farrar frontage along Levee Drive while P312 and P313 are located near the National Guard property. Though modeled to account for the subbasins flatness, it is unlikely that all of DA 300 is truly contributing to P301 and P302. It isn't a huge concern because development in this area will tell a better story about future improvement to these culverts. P313 and P314 will not be receiving increased flow from further development so a recommendation for upgrade may not be justified by past performance. The Levee Reservoir located northwest of the Animal Shelter provided plenty of storage through a 100-yr. storm. The results are as follows.

**Table 3.4.1: Levee Reservoir Existing Conditions**

| Design Storm | Peak Storage (Ac-Ft) | Peak Elevation (Ft) | |
|---|---|---|---|
| $Q_2$ | 2.36 | 1004.59 | Outlet is P315: Fl (In) = 1001.45<br>Top of Levee = 1019.00<br>FF of Animal Shelter = 1010.14 |
| $Q_5$ | 4.51 | 1005.24 | P315 maximum capacity = 39.9 cfs<br>(rated for 1' of freeboard to the Animal Shelter) |
| $Q_{10}$ | 6.3 | 1005.77 | |
| $Q_{25}$ | 8.17 | 1006.22 | |
| $Q_{50}$ | 10.25 | 1006.64 | Water will get quite close to the Animal Shelter for any storm > $Q_5$ due to the 3:1 grade north of the Shelter. |
| $Q_{100}$ | 12.39 | 1007.08 | |

### 3.4.5 Picture Gallery

**Figure 3.4.1:** Looking West along Levee Drive at D301

**Figure 3.4.2:** Looking Northwest between Farrar Corporation and NGML upstream of P301

**Figure 3.4.3:** Looking NE between Kansas National Guard and 2 Wire Electric at D311


**Figure 3.4.4:** Looking Northwest along Levee Drive at D310

## 3.5 Sarber Lane Watershed (400)

### 3.5.1 Description

The Sarber Watershed is approximately 70 Acres and is bounded on the north midway between McCall Road and Sarber Lane, to the west by Tuttle Creek Blvd, to the south by Hwy 24 and to the east through the middle of Town West Plaza. The watershed is mostly developed and the development has provided most overland slopes at 0.5% or greater. The common discharge is the Tuttle Creek Blvd. (TCB) Channel. There are actually seven outlets into the TCB Channel from the Sarber Lane Watershed. There are two main outlets; a 68”x43” RCPHE located along the south side of Sarber Lane that drains the north area of the watershed and a 36” RCP that originates just south of Dillons traveling west between properties that drains the south area of the watershed.

### 3.5.2 Land Use

The Sarber Watershed is very highly commercially developed. The SCS Curve numbers range from 73-98. Only a few DA’s, mostly located in the Service Circle cul-de-sac area, have the low surface runoff coefficients. Most DA’s are in the upper range of runoff coefficients (in the 90s).

### 3.5.3 Drainage System

Unlike the other four watersheds, the Sarber Watershed is mostly an improved, underground drainage system. It consists of 53 pipes, 10 ditches, and 52 minor subbasins. There are no reservoirs. The open channel portion is located along Service Circle and Hayes Drive. The most prominent drainage feature in the watershed is a 68”x43” RCPHE (many segments labeled between P420-P430) that runs along the south side of Sarber Lane. This RCPHE collects stormwater runoff from approximately 42 Acres including a large portion of the Town West plaza, the Hayes Drive open channel system and a wide swath of properties on the south side of Sarber Lane. A 36” RCP (P438) in the southern part of the watershed collects stormwater runoff from about 11 Acres. The remaining 17 Acres are drained by the other 5 smaller discharge pipes, 12”-24” diameter (P441, P443, P445, P446, P449), that cross the frontage road.

Ponding water is a problem in the Service Circle area. The areas are notated on the Existing Drainage map located at the end of this section. The ponding area located in DA 411 is caused by complete siltation of pipe P409, an 18” CMP.

### 3.5.4 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the North Hayes Watershed are $Q_{10}$ = 251 cfs and $Q_{100}$ = 350 cfs. These flows are sum of the seven pipes that discharge into the TCB Channel. Overall, this watershed rates average with 17 deficient pipes (32%). There were no deficient ditches. The good news is that the main 68"x43" RCPHE under Sarber Lane is adequate for a 100-year storm for the entire length under existing conditions. It was suspected that P404 (18" CMP) and P405 (24" CMP) would be deficient due to the fact the upstream pipe, P403 (34"x22" RCPHE), is larger. P409 is completely silted in causing its DA, 411, to act as a reservoir. For their size, P411 (12" PVC) and P412 (12" HDPE) take on quite large drainage areas that include the southern part of the Manko property. The DA's (452 and 407) that contribute to these pipes are very much in a reservoir condition, not only because of the size of P411 and P412 but also due to poor grading. P439 (12" HDPE) is a private drainage system between Ampride and Motel 8. Its drainage area is about 0.5 Acre and most of it is paved. A lot of leaves and debris collect in P439. At the time of inspection, it had about 50% of effective area available for flow. Though deficient, it will likely be up to the property owners to fix this system by installing a new, deeper area inlet and a larger drainage pipe. The 12" RCP, P446, that is supposed to drain a substantial portion of the Hobby Lobby parking lot is completely silted in. Drainage areas to the (deficient) pipes P447, 448, and 449 located on the frontage road in front of Staples were difficult to assess due to aerials that do not show the new development. They may be somewhat better than the model suggests. The analysis of pipes P451 (18" RCP) and P452 (18" and 30"x19" RCPHE – changes somewhere in the middle) may not be justified by past performance. The DA's that contribute to them, 450 and 451, between K-Mart and the Service Circle/Manko area are extremely flat and difficult to model.

### 3.5.5 Picture Gallery


**Figure 3.5.1:** Looking South along Hayes Drive at ditch between P403 and P404

**Figure 3.5.2:** Looking Northwest along Hayes Drive at D403

## 3.6 Hwy 24 Watershed (500)

### 3.6.1 Description

The Hwy 24 Watershed is quite large with approximately 360 Acres. Its boundary is not easy to describe. The eastern half of the Hwy 24 Watershed is bounded on the north by Levee Drive and on the west by the Main Levee along the Big Blue River. The south boundary follows the Main Levee along the Kansas River. As the south boundary moves to the western half, it turns north to Hwy 24 near the Comfort Inn. The very western edge is the intersection of Tuttle Creek Blvd and Hwy 24. The boundary then follows around on the north side of the Hwy 24 frontage road until it reaches Town West Plaza where it turns north across McCall Road and up towards Levee Drive. Slopes in this watershed are 0.5% or less with quite a few trouble areas. The common discharge is an 84" RCP with flapgate at the southeast corner of the watershed under the Main Levee that discharges to the Kansas River.

### 3.6.2 Land Use

The Hwy 24 Watershed is both Commercial and Industrial. SCS Curve numbers range between 70-97. The runoff coefficient of 70 is used for the farmground located south of Hwy 24 in the area of the Wastewater Treatment Plant (WWTP).

### 3.6.3 Drainage System

Though the acreage of this watershed is about fives times that for any of the other basins, it does not have five times the amount of elements. There are 66 pipes, 34 ditches, and 76 minor subbasins. The general flow of water is to the southeast. Minor watersheds north of Hwy 24 include the Levee Drive system, the Kretschmer Drive system, the East McCall system and the Carlson Street system. Stormwater runoff from these minor watersheds flows south towards Hwy 24. The drainage along Hwy 24 culminates near the entrance to the WWTP. Two pipes carry flow underneath the railroad. P539, a 42" CMP, accepts flow primarily from the Levee Drive system and drainage along the northeast segment of Hwy 24. P544, a 96" CMP, accepts flow from all other systems and the southwest segment of Hwy 24. Stormwater from both P539 and P544 is intended to make its way to P562 (4-49"x33" CMAPs and 1-28"x20" CMAP) located under the WWTP access road. *However, the lowest flowline in of P562 (1000.83') is 2.59' higher than the flowline out of upstream pipe P544 (998.24')*. Additionally, the ground level between these two pipes is high. Two spot shots located between these pipes are at elevations 1002.50 and 1003.20. This elevation discrepancy causes the entire drainage system upstream of P544 to be in a reservoir condition. The flowline out of P539 (1002.05) is high enough to drain to P562 making the local Levee Drive System the only one with positive drainage. P562 (and P567) drain into P563, an 84" RCP located under the levee that is the common discharge point for the entire basin. The flowline in of P563 is 994.60, so it is low enough for positive drainage from P544, albeit at a very flat slope of 0.11%.

It was originally thought that the weir located in P543, the 6'x4' RCB upstream of P544 (96" CMP under RR) was the sole source of the very noticeable reservoir condition in the concrete channels on the north and east of the Jon Murdock property. The turf channels on the south and west of the property also experience very noticeable flooding, being referred to as a "lake" by the adjacent property owner, Purple Wave Auction. The original intention of the weir is unknown. Perhaps when it was constructed, it was known that stormwater would not make it past P544 and the weir was installed to lessen the anticipated flooding condition along the Hwy 24 corridor. Before the flowlines were analyzed, it was noticed that stormwater was at least 6" above the weir in the 6'x4' RCB after a rain event so it was known that there was some other obstruction downstream. The weir is approximately 2'-2" in height making the top at elevation 1001.10. With ground elevations at 1002.50 and above, the flooding above the weir makes sense. Without the model analysis, it is very easy to realize that channels are necessary in the downstream portion

of this watershed through the farmground connecting P544 to P562 and P562 to P563. The flowline of P562 must be lowered and will likely be replaced.

The major deficiency of the Hwy 24 Watershed having been discussed, it is now time to focus on some of the local problems that exist. There are three main areas that do not drain and act as non-discharging reservoirs.

1) DA 552 – this area is located behind the strip mall located on the west side of Levee Drive where FedEx is. All runoff flows to a non-discharging reservoir at the back (west) of the property. This area was modeled as a non-discharging reservoir so its flow does not contribute to the common drainage system. This area may actually have been designed this way. No new development is expected to increase flows to the reservoir. To eliminate this reservoir and drain the area, it is possible to extend a ditch (or pipe) south from the reservoir area along the railroad spur to the Hwy 24 ditch west of P535 (1,150'). It would have to be quite flat at 0.20% and the bottom of the reservoir would have to be filled in a bit. It is not possible to drain this area to the north to P311 located in the Levee Watershed.

2) DA 554 – this area is located on the west side of Enoch Lane. A swale behind the residence located between RSC Equipment Rental and Purple Wave Auction takes flow to a small ditch between the residence and Purple Wave Auction. The ditch essentially ends at the NE corner of the Purple Wave property causing the ditch and swale to act as a non-discharging reservoir. Employees of Purple Wave have never seen the water break over Enoch Lane or their parking lot. This area was not modeled as a non-discharging reservoir. A more detailed topo would be necessary to do so. However, the flow from DA 554 was figured without contributing to the common drainage system. Options are available to drain this area to the east underneath Enoch Lane or to the south under the Hwy 24 frontage. Drainage from this area could also be added to the improvement that will be needed for the non-discharging reservoir in the Carlson Cul-de-Sac area discussed below. Improvements will be decided after the watershed is modeled for full development.

3) DA 556, 557 and 558 – the Carlson Cul-de-Sac area. Drainage from these three basins is also in a non-discharging reservoir condition. As with DA 554, the flows were calculated without contributing to the common drainage system. Detailed recommendations for improvement are made after the area is modeled for full development. Mitigation measures will involve an improved ditch system, likely with an outlet to the south through the odd-shaped property located west of Purple Wave Auction.

### 3.6.4 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the North Hayes Watershed are $Q_{10}$ = 296 cfs and $Q_{100}$ = 478 cfs. These flows are the sum of P539 and P544 under the railroad. South of the railroad, an indisdinct reservoir condition occurs. For comparison with developed flows later, these two pipes will provide a better basis. Overall this Watershed rated very similarly as three of the other watersheds with 20 deficient pipes (30%) and 2 deficient ditches (8%). The ditches include D534, a roadside ditch in front of Ampride/Eastside Market, and D524, a roadside ditch south of Hwy 24 across from Griffith Lumber. Both ditches have Levels of Service <2-yr. design storm. There are four main groups of deficient pipes.

The first group includes the 6'x4' RCB under Hwy 24 and three of the four pipes that discharge directly into it. Also included are a couple of upstream pipes along McCall Road. The Levels of Service are the 2-5-yr. design storm range. The pipes discharging into the RCB include P541 (5'x3' RCB), P542 (24" CMP) and P566 (24" CMP). Additionally, the 30" pipe (P517) under McCall Road that drains the west roadside ditch along Kretschmer Dr. and the 42"x29" CMAP (P521) on the south side of McCall Road have Levels of Service around a 5-yr. design storm.

The second group includes six pipes (P525-P530) along Levee Drive. The Levels of Service are in the 2-5-yr. design storm range. There are only eight pipes in the Levee Dr. system of the Hwy 24 Watershed. The two that have adequate Levels of Service are located at the top of the system. The ditches rated okay in this area although quite a bit of ponding occurs in D518 due to its flatness and unevenness. Also included in this group is the 3'x2' RCB (P535) underneath Hwy 24 which has an LOS <2-yr.

The third group is located in the roadside ditch along the north side of Hwy 24 from Tuttle Creek Blvd to the 6'x4' RCB. This roadside ditch is the main route for stormwater traveling to the 6'x4' RCB from the southwest. Four pipes in this roadside ditch have LOS's around a 2-yr. design storm, P545, P547, P551, P554. The deficiency begins at the Town East Plaza entrance with P554. These are the last four pipes in the Hwy 24 ditch before entering the 6'x4' RCB through P566, a 24" RCP that is also deficient as discussed previously.

The fourth group is in the Carlson Street Cul-de-Sac area. There are only two pipes here, P549 and P550, both 12" CMP's. This entire area doesn't drain. Stormwater both infiltrates and evaporates. The model for this area is not set up to treat it as a non-discharging reservoir. More topography would be necessary to do so. Flows from the drainage areas located in the Carlson Street area were figured with localized flows going through P549 and P550. The total flow was not added to the common drainage system. P549 and P550 are both undersized with approximate 2-yr. design storm LOS's.

### 3.6.5 Picture Gallery

**Figure 3.6.1:** Looking E along McCall Rd at D512

**Figure 3.6.2:** Looking E along McCall Rd at D513

**Figure 3.6.3:** Looking E along McCall Rd at D514

**Figure 3.6.4:** Looking Southwest at D516

**Figure 3.6.5:** Looking South at D516 and Entrance to P541 South of Jon Murdock

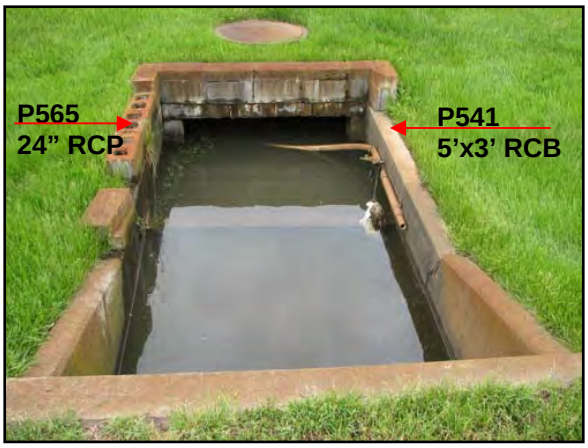



**Figure 3.6.6:** Looking North at P543, 6'x4' RCB

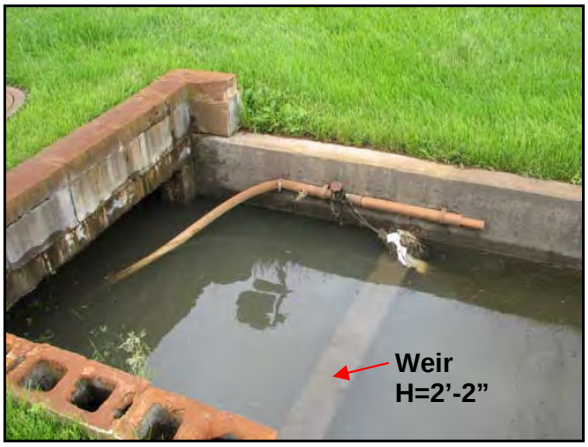



**Figure 3.6.7:** Closer view of weir in P543
Note water level ±6" above weir

**Figure 3.6.8:** Looking North on Kretschmer Drive at D507

**Figure 3.6.9:** Looking South on Carlson Street near GTM

**Figure 3.6.10:** Looking East at GTM Expansion from Carlson Street


**Figure 3.6.11:** Looking West at ditch between Ag Tech and Pioneer Seeds


**Figure 3.6.12:** Looking Northwest from Pioneer Seeds

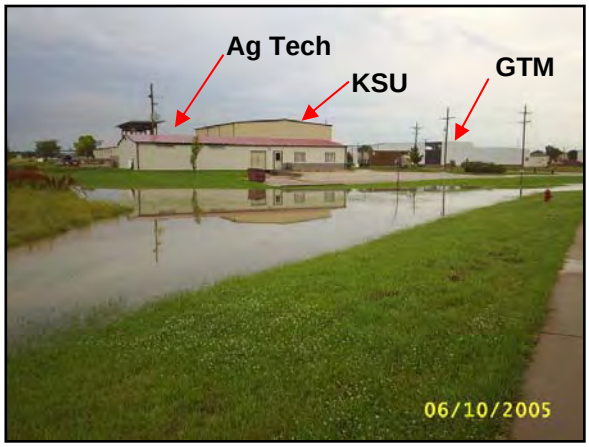



**Figure 3.6.13:** Looking North at ditch between Ag Tech and Pioneer Seeds


**Figure 3.6.14:** Looking SE from Pioneer Seeds towards Best Western

**Figure 3.6.15:** Looking North at Enoch Lane

**Figure 3.6.16:** Looking South along Levee Drive at D518

**Figure 3.6.17:** Looking Southwest along HWY 24 at D522

**Figure 3.6.18:** Looking East along HWY 24 at D534

**Figure 3.6.19:** Looking East along HWY 24 at D534

Main Levee Stream

Main Levee

Ponding Area Levee

Well Access Road

LEVEE DRIVE

HAYES DRIVE

HOSTETLER DRIVE

KRETSCHMER DRIVE

MCCALL ROAD

ENOCH LANE

CARLSON STREET

FRONTAGE ROAD

HIGHWAY 24

SERVICE CIRCLE

SARBER LANE

LEAVENWORTH STREET

TUTTLE CREEK BOULEVARD

BIG BLUE RIVER

KANSAS RIVER

NORTH

200' 0 200' 400'

Lowest E. Out = 1002.05

E. Out = 998.24

Lowest E. In = 1000.83

Lowest E. Out = 1000.37

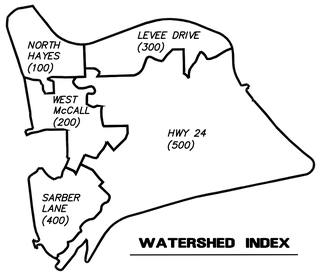
E. In = 994.60

Lowest E. Out = 1000.26

## LEGEND

- Major Watershed Boundaries
- Subarea Watershed Boundaries
- Property Lines
- 101 — Drainage Area
- P110 — Pipe Numbers
- D110 — Ditch Numbers
- 18" CMP — Existing Pipe
- Area or Curb Inlet
- Manhole
- Discharging Reservoir
- Non-Discharging Reservoir/ Ponding Water
- Deficient (LOS<10-Yr) Pipes and Ditches

## WATERSHED INDEX




# Eastside Drainage Study
## Existing Conditions

05-025M


BG CONSULTANTS, INC.
ENGINEERS—ARCHITECTS—SURVEYORS
MANHATTAN, KANSAS HUTCHINSON, KANSAS
LAWRENCE, KANSAS EMPORIA, KANSAS

# Section 4 – Developed System Analysis

## 4.1 General

To perform the Developed System Analysis, all green space areas were identified. Additionally, areas currently undergoing redevelopment or likely to undergo redevelopment were identified throughout the study area. Fittingly, each section that follows concentrates on the five major watersheds and begins discussion with the Developable Area.

Adjustments were made to the existing HEC-RAS models for development. Minor subbasin SCS Curve numbers (surface runoff coefficients) were increased. Minor subbasin boundaries also changed, sending overland flow in different directions than existing. New time of concentrations for surface runoff were calculated. The network of flow through pipes and ditches had minor adjustments. For instance, non-discharging reservoir areas were connected to the common drainage system.

**Table 4.1.1: Area Available for Development**

| Watershed | Acres |
|---|---|
| North Hayes | 20 |
| West McCall | 18* |
| Levee Drive | 33 |
| Sarber Lane | 8 |
| Hwy 24 | 51** |
| **Total** | **130** |

*Includes approx. 6 Ac. currently being redeveloped near the intersection of McCall Rd and Hostetler Dr.
**Excludes the farm ground around the WWTP (discussed in Section 4.6)

The resulting increased flows and deficiencies in the systems are discussed as part of System Performance followed by Recommended Improvements. The improvements are divided into two categories. Improvements to Pipes include replacement, repair, and cleaning categories. The second category is for significant projects. Significant projects are defined as those requiring a more detailed explanation because they are new improvements where storm drainage doesn't currently exist.

## 4.2 North Hayes Watershed (100)

### 4.2.1 Developable Area

The North Hayes Watershed model was adjusted to develop out an additional 20 Acres. The area of development included the farm ground south of Parker Hannifin, a small area south of the Well Access Rd and another small area from the Farrar Property.

### 4.2.2 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the North Hayes Watershed increased to $Q_{10}$ = 46 cfs (Exist. $Q_{10}$ = 36) and $Q_{100}$ = 65 cfs (Exist. $Q_{100}$ = 60 cfs) for developed conditions. These flows are the sum of P101, P113 and P114 contributing to the Ponding Area Levee Stream so they are *after* detention. The peak flows *into* the North Hayes Reservoir increased to $Q_{10}$ = 65 cfs (Exist. $Q_{10}$ = 54) and $Q_{100}$ = 105 cfs (Exist. $Q_{100}$ = 91 cfs). The increased flows caused two more pipes to be deficient for a total of six (43%). The two pipes include P101, the 18" CMP going through the Ponding Area Levee at the southwest corner of the watershed, and P112, the 2-42"x29" CMAP under the north entrance to Parker Hannifin. P101's lower level of service is caused more by the diversion of flow going through P114 to P101. One ditch also became deficient. D114 is the channel that is part of the Hayes Reservoir. It essentially serves as a pilot channel. Since this area is supposed to detain water, D114's conveyance "deficiency" is of little consequence. Its LOS is approximately an 8-yr. design storm, so it is close to being adequate anyway. The Hayes Reservoir itself provides enough volume to still adequately contain stormwater through a 100-yr. storm without flooding the Parker Hannifin parking lot.

| Table 4.2.1: Hayes Reservoir Developed Conditions | | | |
|---|---|---|---|
| **Design Storm** | **Peak Storage (Ac-Ft)** | **Peak Elevation (Ft)** | Outlet is P113: Fl (In) = 1002.26<br>Top of Levee = 1009.00<br><br>P113 maximum capacity = 18 cfs<br>(rated to the top of the Levee)<br><br>Again, the lowest point on Parker Hannifin's Parking lot is approx. 1007.50 so flooding is still not expected for a 100-year storm. |
| $Q_2$ | 2.70 | 1004.88 | |
| $Q_5$ | 3.99 | 1006.05 | |
| $Q_{10}$ | 5.20 | 1006.30 | |
| $Q_{25}$ | 6.50 | 1006.67 | |
| $Q_{50}$ | 7.88 | 1006.85 | |
| $Q_{100}$ | 9.29 | 1007.14 | |

### 4.2.3 Recommended Improvements

Ditch cleaning and general silt removal from pipes is needed throughout the Hayes Drive system. It is recommended that the City monitor the Hayes Reservoir after the Watershed fully develops. Though the elevations (Table 4.2) are low enough so that Parker Hannifin's parking lot will not experience flooding, excessive siltation and growth of vegetation in the reservoir may affect the current model results by the time the Watershed fully develops.

| Table 4.2.2: North Hayes Pipes | |
|---|---|
| **Upgrade** | • P104 from 12" CMP to 2-23"x14" RCPHE *Now*<br>• P105 from 18" CMP to 18" RCP *Now*<br>• P101 from 18" CMP to 24" RCP *When Developed* |
| **Repair** | • P114 18" CMP discharge end *Now* |
| **Clean** | • P107 (24" CMP) or replace with a 24" RCP *Now*<br>• P112 *Now* |

| Table 4.2.3: North Hayes Significant Projects | | |
|---|---|---|
| **Type** | **Project No.** | **Description** |
| **New** | **I-1** | Construct New 500' Channel along the west property line of the farm ground south of Parker Hannifin *When Developed*, 4' bottom, 4:1 sides, 0.50% slope (min.). Abandon existing P114 (18" CMP). |
| **New** | **I-2** | Construct New 200' Channel along the east property line of Irvines Floor Covering *Now*, 4' bottom, 4:1 sides, 0.50% slope (min). Install 15" RCP under Well Access Road connecting new channel to D101. An Easement will be needed through the Irvine property. |
| **New** | **I-3** | *Phase 1:* Construct New 400' E-W leg of Channel in the Right-of-Way along the north side of the Well Access Road adjacent to the Big Lakes (south) property line *Now*, 4' bottom, 4:1 sides, 0.32%<br><br>*Phase 2:* Construct New 450' N-S leg of Channel along the west property line of NGML and Farrar *When Developed*, 4' bottom, 4:1 sides, 0.32% slope (approx.). An Easement through the NGML property will be needed. |

## 4.3 West McCall Watershed (200)

### 4.3.1 Developable Area

The West McCall Watershed model was adjusted to develop out an additional 18 Acres. The developed area includes everything on the west side of Hostetler Drive. There are some existing businesses located there but due to the redevelopment of approximately 6 Acres at the NE and NW corners of the Hostetler Drive and McCall Road intersection, this seemed like a conceivable vision of the future. Not all of the properties on the east side were adjusted for development because the existing SCS runoff coefficients are already quite high and wouldn't change much if redeveloped. Everything on the north side of McCall Road between Hwy 24 and Hayes Road was adjusted for development or redevelopment. Also included is the remainder of property around Hill and Co. affecting DA's 217 and 229. Once improvements are made to mitigate the existence of the non-discharging reservoir located in this area, this property will be available for Hill and Co. to expand or partition their lot and sell for development. A small area of green space is available on the Sunflower Self Storage property mostly located in DA 223. Green space in the back of the Manko, Maximum Performance and Abbot Aluminum properties (DA 238) was also adjusted for full development that would most likely occur in the form of existing business expansion.

### 4.3.2 System Performance

The total 10-yr. and 100-yr. design storms flows from the West McCall Watershed increased to $Q_{10}$ = 240 cfs (Exist. $Q_{10}$ = 205) and $Q_{100}$ = 337 cfs (Exist. $Q_{100}$ = 297 cfs) for developed conditions. These are the flows occurring in the singular 48" RCP discharge point (P231). The increased flows caused three more pipes to be deficient for a total of 36 (69%). This watershed already had serious deficiency under existing conditions. New development is *not* the primary cause of the improvements that are needed. The existing pipes, as a whole, are undersized. There is a lot of siltation and a few of the pipes are damaged, however, the main instigator of the poor performance of pipes in this watershed is due to the flatness and shallow nature of the system. Larger pipes are needed to compensate for the flat hydraulic gradient.

### 4.3.3 Recommended Improvements

The list of recommended improvements is long. Most of them speak for themselves so only the highlights and main ideas will be touched on. Additionally, the scheduled street improvements to McCall Road require some special consideration, so all improvements along McCall Rd. are addressed in section 4.3.4 following.

The 15" HDPE (P223) located under the Midstate Mechanical Drive is almost totally silted in with only 5% of the cross-sectional area available for flow. Flow is intended to travel along the south side of Levee drive to the west but the area is so flat, substantial silting is occurring. Topography suggests that P223 is at a high point and that it can be totally removed (Ref. I-10 in Sect 4.6.3).

Ditch cleaning and general silt removal is needed for the West McCall culvert systems. Most of the work is needed along Hayes Drive north of McCall Rd. Since almost all of the entrance pipes are recommended for replacement, it is advised that pipe replacement and ditch cleaning occur simultaneously. For a complete project, the few existing CMP's that exceed the 10-yr. design storm LOS should also be replaced with equivalent RCP's in accord with the Stormwater Master Plan. A comprehensive project to regrade the Hayes Dr. system ditches and replace the entrance pipes could be part of a traditional design/bid/build contract or even become a part of the McCall Road Improvements.

Improvement I-4 which provides a defined ditch system around the Hill and Co. property (area 900) need not occur until further development necessitates filling of the non-discharging reservoir located there. Improvement I-5 should occur now to drain a the flat and indistinct area for stormwater runoff located in DA 238.

| Table 4.3.1: West McCall Pipes | |
|---|---|
| **Upgrade** | • P201 from 21" RCP to 2-21" RCP *When Developed*<br>• P202 from 24" RCP to 2-34"x22" RCPHE *When Developed*<br>• P208 from 28"x20" CMAP to 24" RCP *Now*<br>• P209 from 28"x20" CMAP to 24" RCP *Now*<br>• P210 from 28"x20" CMAP to 34"x22" *Now*<br>• P211from 30" CMP to a 30" RCP *Now*<br>• P212 from 30" CMP to a 30" RCP *Now*<br>• P213 from 18" RCP to 30"x19" RCPHE *When Developed*<br>• P214 from 23"x14" RCPHE to 2-30"x19" RCPHE *Now*<br>• P215 from 28"x20" CMAP to 34"x22" RCPHE *Now*<br>• P216 from 28"x20" CMAP to 34"x22" RCPHE *Now*<br>• P217 from 28"x20" CMAP to 38"x24" RCPHE *Now*<br>• P218 from 28"x20" CMAP to 38"x24" RCPHE *Now*<br>• P219 from 35"x24" CMAP to 38"x24" RCPHE *Now*<br>• P220 from 35"x24" CMAP to 38"x24" RCPHE *Now*<br>• P221 from 12" CMP to 23"x14" RCPHE *When Developed*<br>• *P227 from 42" CMP to 8'x4' RCB *Now*<br>• *P228 from 48" CMP to 8'x4' RCB *Now*<br>• *P229 from 48" CMP to 8'x4' RCB *Now*<br>• *P230 from 48" RCP to 8'x4' RCB *Now*<br>• *P231 from 48" RCP to 8'x4' RCB *Now*<br>• *P233 from 30" CMP to 36" RCP *Now*<br>• *P236 from 30" RCP to 36" RCP *Now*<br>• *P237 from 24" CMP to 30" RCP *Now*<br>• *P238 from 24" CMP to 30" RCP *Now*<br>• *P239 from 24" CMP to 24" RCP *Now*<br>• *P240 from 24"x18" CMAP to 30"x19" RCPHE *Now*<br>• *P241 from 24"x18" CMAP to 30"x19" RCPHE *Now*<br>• *P242 from 24"x18" CMAP to 30"x19" RCPHE *Now*<br>• *P243 from 10" HDPE to 23"x14" RCPHE *Now*<br>• P246 from 2-18" CMP to 2-18" RCP *Now*<br>• P248 from 21" CMP to 30"x19" RCPHE *Now*<br>• P249 from 23"x14" RCPHE to 2-23"x14" RCPHE *Now* |
| **Repair** | P223 can be Removed *Now or when West McCall Property Develops* (Reference I-10) |
| **Clean** | • P203-P206 or replace with 15" RCP *Now*<br>• P207 (28"x20" CMAP) or replace with 21" RCP *Now* |

***** Reference Special Considerations for West McCall Road in Section 4.3.4

| Table 4.3.2: West McCall Significant Projects | | |
|---|---|---|
| **Type** | **Project No.** | **Description** |
| **New & Rehab** | **I-4** | Construct New 600' Channel in Well Access Road ROW adjacent to north property line of Hill and Company *When Developed*, 4' bottom, 4:1 sides, 0.50% slope (min.). Tie new ditch into D207. Regrade D207 as necessary.<br><br>Regrade D244 for 550' to deepen and even out the existing ditch bottom *When Developed*, 4' bottom, 4:1 sides, 0.40% slope (max.). |
| **New** | **I-5** | Construct New 600' Channel south of Maximum Performance and Abbott Aluminum *Now*, 4' bottom, 4:1 sides, 0.20% slope. The new channel will flow into a short 12" RCP that is stubbed out from the inlet at the top of P244. |

### 4.3.4 Special Considerations

- **Hostetler Structures:** The existing underground storm drainage (P201, P202 and curb inlets) along Hostetler drive may not need to upgraded to the size specified depending on how development proceeds, particularly on the west side of Hostetler Drive. The redevelopment planning currently occurring in this area takes some of the stormwater west to the area of the old lime sludge ponds that are now stormwater detention. Other properties on the west side of Hostetler Drive may also direct a portion (i.e. the west half of the lots) to the new detention area as well, lessening the effect of development/redevelopment on the existing storm drainage structures. These structures should be checked with each plan for development along the Hostetler corridor.

- **West McCall Road:** Street Improvements to McCall Road are currently in the early stages of planning. McCall Road will be converted into a standard curb and gutter street section with curb inlets and underground storm drainage. With this in mind, recommendations for the underground storm drainage must be made. It is natural to replace P227-P231 and associated ditches with a continuous 8'x4' RCB (approximately 1200') in lieu of one long 800' stretch of 8'x4' RCB followed by two 8'x4' RCB culverts separated by ditch sections. Some preliminary planning by the City showed a major RCB being installed directly under the new McCall Road. With this in mind, the 8'x4' RCB *could* decrease to a 4'x3' RCB near the Hayes Drive intersection and extend east for another 500' at which time the section would decrease again. *However, it is recommended that the existing pattern of flow be maintained with the improvements*. In this way, storm drainage will be more accessible for maintenance and there will be less storm drainage crossings for inlets on the side to connect to the main RCB. The recommendations are as follows:
    - 1,200' of 8'x4' RCB from Tuttle Creek Blvd. Channel to the northwest corner of the Hayes Dr./McCall Rd. intersection. It is envisioned that half of the RCB will be underneath the new street section from Hostetler Dr. to Hayes Dr.
    - From Hayes Dr. to the east, underground storm drainage will be maintained on each side of McCall Rd. with pipe sizes very similar to those indicated in this study, depending on actual inlet locations determined during the McCall Rd. design. Along the north side of McCall Road required 80' of 42" RCP, 400' of 36" RCP and 400' of 24" RCP. Crossing McCall Road and along the south side required 185' of 36" RCP, 250' of 30" RCP, 250' of 24" RCP, 400' of 30"x19" RCPHE and 300' of 23"x14" RCPHE.
    - Flow from the ditch and culvert sections along Hayes Drive will enter the new system in the same manner at the McCall Rd./Hayes Dr. intersection and P233 located just west of the intersection will remain as the singular crossing underneath McCall Rd. to discharge storm drainage on the south side into the new 8'x4' RCB.

## 4.4 Levee Drive Watershed (300)

### 4.4.1 Developable Area

The Levee Drive Watershed model was adjusted to develop out an additional 33 Acres. Approximately 30 Acres is on the Farrar property. Also included are smaller areas around the Animal Shelter and on the south side of Levee drive across from Pepsi in DA 309. City property south of Levee Dr. where the water wells are located was not considered available for development.

### 4.4.2 System Performance

The total 10-yr. and 100-yr. design storm peak flows from the Levee Drive Watershed increased to $Q_{10}$ = 35 cfs (Exist. $Q_{10}$ = 30) and $Q_{100}$ = 39 cfs (Exist. $Q_{100}$ = 36 cfs) for developed conditions. These are the flows through P315 so they are after detention. The peak flows *into* the Levee Drive Reservoir increased to $Q_{10}$ = 219 cfs (Exist. $Q_{10}$ = 133) and $Q_{100}$ = 326 cfs (Exist. $Q_{100}$ = 218 cfs). The increased flows did not cause any other element's LOS to drop below a 10-yr. storm. This is because most all of the development occurs on the Farrar property. The same four pipes discussed in Section 3 are still deficient. The increased development on the Farrar Property caused the already low LOS's of P301 and P302 to drop further. The flows through P313 and P314 were unchanged by any new development, so their deficient ~2-yr. design storm LOS remains the same as for Existing Conditions.

**Table 4.4.1: Levee Reservoir Developed Conditions**

| Design Storm | Peak Storage (Ac-Ft) | Peak Elevation (Ft) | |
|---|---|---|---|
| $Q_2$ | 4.37 | 1005.19 | Outlet is P315: Fl (In) = 1001.45<br>Top of Levee = 1019.00<br>FF of Animal Shelter = 1010.14 |
| $Q_5$ | 6.99 | 1005.98 | P315 maximum capacity = 39.9 cfs<br>(rated for 1' of freeboard to the Animal Shelter) |
| $Q_{10}$ | 9.13 | 1006.42 | |
| $Q_{25}$ | 11.38 | 1006.87 | |
| $Q_{50}$ | 13.72 | 1007.34 | Water will get quite close to the Animal Shelter for any storm ≥ $Q_5$ due to the 3:1 grade north of the Shelter. |
| $Q_{100}$ | 16.13 | 1007.83 | |

### 4.4.3 Recommended Improvements

Ditch cleaning and general silt removal from pipes is needed throughout the Levee Drive system. Further Development on the Farrar property must see to it that the existing storage in the Levee Reservoir is maintained. Should development require it, new designs for the reservoir can include excavation as well as the installation of another discharge pipe through the levee if necessary (with approval from the Army Corps. of Engineers).

**Table 4.4.2: Levee Drive Pipes**

| | |
|---|---|
| **Upgrade** | • P301 from 21"x15" CMAP to 2-30"x19" RCPHE *When Developed*<br>• P301 from 21"x15" CMAP to 2-30"x19" RCPHE *When Developed*<br>• P313 from 2-24"x18" CMAP to 2-30"x19" RCPHE *Discretionary*<br>• P314 from 2-21"x15" CMAP to 2-30"x19" RCPHE *Discretionary* |

| Table 4.4.3: Levee Drive Significant Projects | | |
|---|---|---|
| **Type** | **Project No.** | **Description** |
| **New** | **I-6** | Construct New 450' Channel south and east from P301 in the Right-of-Way along the north side of Levee Dr. and the Well Access Road *Now*, 4' bottom, 4:1 sides, slope will likely vary. Install 15" RCP entrance pipe for NGML. The slope of the E-W roadside ditch must be kept down for 80' from P301 west for construction of the NW branch of the ditch - Construct New 400' Channel north and west from the roadside Channel on the Farrar property along the adjacent property line with NGML *Now*, 4' bottom, 4:1 sides, 0.40% slope (max). This project need not wait for further development and should be constructed now to improve existing drainage conditions. |
| **New** | **I-7** | Construct New 1,800' Channel along the south side of the Main Levee on the Farrar property *When Developed*, 4' bottom, 4:1 sides, 0.40% (approx.). A Corps of Engineer Permit with Seepage Testing will be required for excavation near the Levee. |

## 4.5 Sarber Lane Watershed (400)

### 4.5.1 Developable Area

As stated earlier, this watershed is well-developed. Only 8 Acres were adjusted in the model for development. Of this, approximately 3 Acres are currently being developed including the lot east of Dillons in DA's 422 and 423 and the lot east of the intersection of Leavenworth Street with the frontage road in DA's 437 and 438. The remaining areas identified for future development are less desirable in terms of visibility and access. Most of them would serve the purpose of existing business expansion in lieu of new development. These remaining areas include the green space south of Dillons in DA 435, the east half of the Autocraft property in DA's 406 and 452 and the green space adjacent to the northwest property line of Town West Plaza (K-Mart, etc).

### 4.5.2 System Performance

The total 10-yr. and 100-yr. design storms flows from the West McCall Watershed increased to $Q_{10}$ = 302 cfs (Exist. $Q_{10}$ = 251) and $Q_{100}$ = 414 cfs (Exist. $Q_{100}$ = 350 cfs) for developed conditions. These flows are sum of the seven pipes that discharge into the TCB Channel. The increased flows caused three more pipes to be deficient for a total of 20 (38%). There are no deficient ditches. Again, it should be noted that the performance of P447-P449 system (LOS ~ 2-Yr.) located under the frontage road in front of Staples may be somewhat better than the model suggests due to the lack of updated aerials for more accurate determination of the respective drainage areas. The deficiency of P446 is, however, quite accurate. This 12" RCP located under the Tuttle Creek Blvd. frontage road and originating in the Hobby Lobby/Hastings parking lot and discharging to the TCB Channel is completely clogged by debris. For the most part, deficiencies in this watershed occur in the Service Circle area system. The main drainage structure in this watershed, the 68"x43" RCPHE located primarily along the south side of Sarber Lane is adequate for the entire length. Most segments of this structure have LOS's >100-yr. design storm. Only the last three segments begin to drop in LOS with the last segment rated >25-yr. design storm.

### 4.5.3 Recommended Improvements

There are no Significant Projects identified for this area. P404-P412 constitute pipe improvements to the Service Circle drainage system. To make the Service Circle project comprehensive, ditch grading and universal replacement of all additional CMP's that exceed the 10-yr. design storm LOS with equivalent RCP's in accord with the Stormwater Master Plan. P425, a 15" RCP from the Dillons property is listed as discretionary because its LOS is approximately an 8-yr. design storm. It should only be replaced if significant problems/complaints arise. A small system that needs to

be replaced is the private system located in the Ampride parking lot and consisting of an area inlet and 12" HDPE pipe. The system is very shallow and collects a lot of debris. The recommendation for replacement of P433 and P431, both 15" RCP's located in the SW corner of the Staples/Hobby Lobby/Hastings parking lot to 18" RCP's also requires replacement of the area inlet. The new area inlet should be constructed 1.5' deeper to lower the flowline of P433, increasing the available headwater depth and thus, P433's $Q_{MAX}$.

| **Table 4.5.1: Sarber Lane Pipes** | |
|---|---|
| **Upgrade** | • P404 from 18" CMP to 38"x24" RCPHE *Now*<br>• P405 from 24" CMP to 38'x24" RCPHE *Now*<br>• P406 from 23"x14" RCPHE to 21" RCP *Now*<br>• P407 from 24" CMP to 36" RCP *Now*<br>• P408 from 18" CMP to 18" RCP *Now*<br>• P409 from 18" CMP to 18" RCP *Now*<br>• P410 from 21" RCP to 36" RCP *Now*<br>• P411 from 12" PVC to 24" RCP *Now*<br>• P412 from 12" HDPE to 2-15" RCP *Now*<br>• P425 from 15" RCP to 18" RCP *Discretionary*<br>• P431 from 15" RCP to 18" RCP *Now*<br>• P433 from 15" RCP to 30"x19" RCPHE *Now*<br>• P438 from 36" RCP to 53"x34" RCPHE *When Developed*<br>• P439 from 12" HDPE to 15" RCP *Now* (Privately Owned)<br>• P446 from 12" RCP to 30"x19" RCPHE *Now*<br>• P447 from 18" RCP to 24" RCP *Discretionary*<br>• P448 from 18" RCP to 24" RCP *Discretionary*<br>• P449 from 18" RCP to 24" RCP *Discretionary*<br>• P451 from 18" RCP to 34"x22" RCPHE *When Developed*<br>• P452 from 18" RCP/30'x19" RCPHE to 34"x22" RCPHE *When Dev.* |

## 4.6 Hwy 24 Watershed (500)

### 4.6.1 Developable Area

The Hwy 24 Watershed model was adjusted to develop out an additional 51 Acres. This number does not include the farm ground surrounding the WWTP which will be discussed separately. The McCall property includes approximately 31 Ac. for development. The Carlson St. and Enoch Lane area have approximately 14 Ac. while there is 6 Ac. along the east side of Kretschmer Dr.

### 4.6.2 System Performance

The total 10-yr. and 100-yr. design storms flows from the Hwy 24 Watershed increased to $Q_{10}$ = 462 cfs (Exist. $Q_{10}$ = 296) and $Q_{100}$ = 690 cfs (Exist. $Q_{100}$ = 478 cfs) for developed conditions. These flows are sum of P539 and P544 under the railroad. The total flows through P563 , the 84" RCP that discharges in the Kansas River, are somewhat irrelevant for existing conditions due to the reservoir nature of the farm ground surrounding the WWTP. After development (and improvements) the flow through P653 is $Q_{10}$ = 525 cfs and $Q_{100}$ = 830 cfs. The flow increase for developed conditions is caused not only by developing out the entire watershed, but by modeling improvements to connect the areas that have non-discharging reservoirs to the common drainage system. The increased flows caused six more pipes and one more ditch to be deficient for a total of 26 pipes (39%) and 3 ditches (8%). According to these numbers, one would think that the watershed wouldn't require large amounts of improvements. In fact, the opposite is true. There are six major improvements recommended with five of them directly related to the lack of existing storm drainage instead of deficiencies in the system.

### 4.6.3 Recommended Improvements

The recommended improvements address the four deficient areas discussed earlier as part of the Existing Conditions analysis including the Carlson Street, 6'x4' RCB (P543), Levee Drive and Hwy 24 areas. A system of new channels is recommended for the Carlson Street area as project I-11. It is recommended that the 6'x4' RCB (P543) become a 3-6'x4' RCB as discussed for project I-14. This recommendation is based on a $Q_{50}$ design flow (480 cfs) in accordance with the SWMMP design standards for culverts crossing arterial streets. Improvements to the Levee Drive area, including upgrades to P525-P530, and the Hwy 24 area, including P536, P545, P547 and P551 are as listed in Table 4.11. Other improvements include a defined culvert and ditch system along Enoch Lane (I-12), adding a 2-3'x2' RCB to the existing 3'x2' RCB (P535) (also a $Q_{50}$ design) (I-13) and constructing channels in the WWTP area to create positive drainage for the entire watershed. Projects I-8 and I-10 recommend new channel systems for developable properties including the west half of the McCall Pattern lot and the Farm Bureau lot. Though the non-discharging reservoir located behind (west) the strip mall in DA 552 may have been intentional, there is a way to drain this area to the south as discussed in I-9. Project I-10 provides a channel system for P501 to drain to. A lot of pooling of water and siltation is currently occurring in the area of P501 and P223 (in W. McCall discussion Section 4.3.3).

| **Table 4.6.1: Hwy 24 Pipes** | |
|---|---|
| **Upgrade** | • P507 from 2-24" CMP to 2-24" RCP *When Developed*<br>• P508 from 21"x15" CMAP to 24" RCP *Now* (Privately Owned)<br>• P510 from 24" CMP to 30" RCP *When Developed*<br>• P515 from 42" CMP to 5'x3' RCB *When Developed*<br>• P517 from 30" RCP to 42" RCP *Now*<br>• P521 from 42"x29" CMAP to 5'x3' RCB *When Developed*<br>• P522 from 2-36" CMP to 5'x3' RCB *When Developed*<br>• P525 from 18" HDPE to 18" RCP *Now*<br>• P526 from 24" CMP to 24" RCP *Now*<br>• P527 from 24" CMP to 24" RCP *Now*<br>• P528 from 30" CMP to 24" RCP *Now*<br>• P529 from 18" CMP to 18" RCP *Now*<br>• P536 from 23"x14" RCPHE to 2-23"x14" RCPHE *When Developed* $Q_{Design}$ for $Q_{50}$<br>• P545 from 34"x22" RCPHE to 7'x3' RCB *Now*<br>• P547 from 30"x24" RCPHE to 6'x3' RCB *Now*<br>• P549 from 12" CMP to 15" RCP *Now*<br>• P550 from 12" CMP to 2-23"x14" RCPHE *Now*<br>• P551 from 34"x22" RCPHE to 2-34"x22" RCPHE *Now* |
| **Clean** | • P501 or replace with 24" RCP *When west McCall Prop. Develops*<br>• P530 (24" CMP) or replace with 24" RCP<br>• P554 (38"x24" RCPHE) *Now* |

| Table 4.6.2: Hwy 24 Significant Projects | | |
|---|---|---|
| **Type** | **No.** | **Description** |
| **New** | **I-8** | Construct New 800' Channel along the east property line of Farm Bureau (DA 508) *When Developed*, 4' bottom, 4:1 sides, 0.45% slope (max.). |
| **New** | **I-9** | Construct New 900' Channel along the east side of the railroad spur to drain the non-discharging reservoir in DA 552, 4' bottom, 4:1 sides, 0.20% slope. This project is *Discretionary* depending on the desire of the property owners in the strip mall located in DA 552. Regrade the westbound Hwy 24 roadside ditch from the railroad spur to P535 (0.20% slope). An easement through the Flint Hills Beverage property would be needed. |
| **New** | **I-10** | Construct New N-S 1000' Channel along west property line of McCall Pattern property at 0.25% slope and N-S 1200' Channel in middle of McCall property at 0.65% slope *When Developed*, 4' bottom, 4:1 sides. Legs off of the west channel include a 400' segment to the west along the south property line of Midstate Mechanical and American Pest Mgmt (esmt through Midstate Mechanical needed) and a 350' segment northwest between Midstate Mechanical and a currently vacant lot. The legs off of the main channel are to be 4' bottom, 4:1 sides, and 0.25% slope. D510, the roadside ditch along the north side of McCall Rd. that will connect this new channel to P515, must be regraded to the same section and slope as well. Concrete Ditch Lining required in D510, 1000' N-S channel and its branches ranging in depth from 2' near P515 to 1' at the top portions of the channel. Reference Developed Conditions Map. Remove P223 and replace P501 – grade to drain. |
| **New** | **I-11** | Construct a system of New Channels, approximately 3,500', in the Carlson Cul-de-Sac area to drain southeast to D530 *Now*. All Channels shall have a 4' bottom, 4:1 sides and 0.20-0.30% slope. Reference Developed Conditions Map. Replace P549 from 12" CMP to 15" RCP and P550 from 12" CMP to 3-23"x14" RCPHE. This system of New Channels will require approx. 1,800' of easements. All channels to be lined with concrete beginning with a 2' depth at the discharge into D530 and decreasing to 1' at the top of the channels. |
| **New** | **I-12** | Regrade 650' Channel along the east side of Enoch Lane, 4' bottom, 4:1 sides, 0.35% slope. Channel shall be lined with concrete from a 1.5' depth at the discharge end to a 1' depth at the top of the channel. Install New 30"x19" RCP ($Q_{Design}$=22cfs) under frontage road draining into D528. Install New 18" RCP ($Q_{Design}$=8.6 cfs) under Enoch Lane. Construct New 800' Channel along the west side of Enoch Lane turning west between Martin Cat and RSC Equip. Rental, 4' bottom, 4:1 sides, 0.20% slope. Concrete ditch lining from a 1.5' depth at the discharge end to a 1' depth at the top of the channel. Install three 15" entrance pipes, one for the residence and two for RSC. |
| **New** | **I-13** | Add an additional 2-3'x2' RCB to existing 3'x2' RCB (P535) under Hwy 24. $Q_{Design}$=92 cfs > $Q_{50}$=86 cfs. |
| **New** | **I-14** | Add an additional 2-6'x4' RCB to existing 6'x4' RCB (P543) under Hwy 24. $Q_{Design}$=485 cfs > $Q_{50}$=479 cfs. Remove the weir in existing P543. Add an additional 5'x3' RCB to existing 5'x3' RCB (P541). Replace P542 from 24" CMP to 24" RCP. Replace P566 from 24" CMP to 7'x3' RCB, P545 from 34"x22" RCPHE to 7'x3' RCB, P547 from 30"x24" RCPHE to 6'x3' RCB, P551 from 34"x22" RCPHE to 2-34"x22" RCPHE. |
| **New** | **I-15** | In the WWTP Area, Construct New 550' Channel from P544 to P562, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4' depth. Construct New 650' Channel from P539 to P562, 4' bottom, 4:1 sides, 0.69% slope, no concrete ditch lining. Replace existing five-pipe CMP combination of P562 with a 2-5'x3' RCB. Construct New 2,650' Channel from P562 to P563, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4.5' depth. Construct New 900' Channel from P567 to NW corner of WWTP property, 4' bottom, 4:1 sides, 0.50% slope (min.), no concrete ditch lining. Esmts for all channels. |

### 4.6.4 Special Considerations

- **East McCall Road:** The street improvements planned for McCall Road will turn it into a standard curb and gutter section. An in-depth look at how to convert the existing storm drainage along the East half of McCall from ditch and culvert to underground structures with curb inlets is needed. Replacement of the existing culverts relied on the ability to develop a small amount of headwater making P515, P521 and P522 5'x3' RCB's for developed conditions. A continuous structure does not have the ability to develop headwater the way culverts do, therefore, the recommendations along the East half of McCall Road improvements require slightly larger structures than those previously calculated for the existing geometry. There are essentially two flows that converge at the top of D516 at the intersection of Kretschmer Drive and McCall Rd. One flow collects stormwater along McCall Road flowing east and the second flow collects stormwater along Kretschmer Drive. The flows are almost equal. For example, a 10-yr. design storm creates a peak flow from McCall Road of 123 cfs while the peak flow from the Kretschmer Drive area is 134 cfs (combining P513, P517, and P517 which cross McCall Rd.) at the top of D516. The recommendations below include an RCB from McCall that doubles in size at the top of D516 due to this flow regime. The recommendations are as follows:
    - 1000' of 4'x3.5' RCB from the west property line of the McCall Pattern factory to the proposed second channel on the McCall property located just west of the existing building
    - 750' of 5'x3.5' RCB from the McCall channel, crossing McCall Road to the south, going past D516 and ending at the discharge of P514
    - 220' of 2-5'x3.5' RCB from the top of existing D516 to the top of P543, the proposed 3-6'x3' RCB crossing Hwy 24.
    - P517 should be upgraded from a 30" RCP to a 42" RCP as specified in Table 4.6.1. P514 should also be converted from a 24" CMP to a 24" RCP.

- **Development in the WWTP Area:** According to the FEMA flood insurance study, a 10-year flood on the Kansas River is expected to be at an elevation of 1004.8 near the 84" RCP (P563) discharge. The lowest point on the access road to the WWTP is approximately 1005.30 so a 10-year flood on the river would cause substantial flooding in this area. We know that the sluice gate is closed much sooner than this when the river rises. The sluice gate is most likely shut for 5-year floods and greater on the Kansas River. Frequency mixing recommendations from KDOT suggest that when the Kansas River is experiencing a 2-yr. design storm, the Hwy 24 Watershed is experiencing a 100-yr. design storm and vice-versa. To determine the area available for development, it was assumed that even a 100-yr. storm must be contained in a non-discharging reservoir within the WWTP Area. A 100-yr. storm from the Hwy 24 Watershed creates a volume of approximately 155 Ac.Ft. for Developed Conditions. KDHE guidelines require a 350' building setback for new development next to an existing WWTP. This leaves a maximum of approximately 110 Ac. available for development. There are two options for a non-discharging reservoir in this area. The maximum depth of detention was figured to elevation 1005.00 so that back-ups will not flood streets and businesses.
    - **Natural Detention:** Approximately 70 Ac. must be left in its natural state for detention leaving 40 Ac. available for development. See Figure 4.6.1 following. (The Channels recommended in I-15 must still be constructed.)
    - **Man-Made Detention:** Construct a man-made detention pond essentially contained in the area of the 350' Bldg. Setback around the WWTP property. This is approximately 25 Ac. of ground, leaving the full 110 Ac. available for development. The excavation from the Man-Made Detention pond can be used to build up the developable area by the developer. See Figure 4.6.2 following.

  Based on these observations, Man-Made Detention is recommended as it is an efficient use of otherwise unbuildable area and maximizes the amount of developed area available should development proceed.

05-025M

KRETSCHMER DRIVE

MCCALL PATTERN COMPANY

JON M. IRDOCK

CMAP

CLEAN EXIST. OR 24" RCP

Main Levee

BIG BLUE RIVER

*Area ≈ 70 Ac.*
*Volume = 150 Ac. Ft.*

*Detention Water Elevation = 1005.00*

*350' KDHE Bldg. Setback*

*Area Available for Development ≈ 40 Ac.*

*(Assumed any Developed area will be filled to a min. of 1008.00)*

WASTEWATER TREATMENT PLANT

E. Out = 1002.05

E. Out = 998.24

E. In = 994.60

P512 53"x34" RCPHE

P513 60"x42" RCPHE

P514 24" CMP

P515 5'x3' RCB

P516 24" CMP

P517 42" RCP

P521 5'x3' RCB

P522 5'x3' RCB

P520 24" CMP

P541 2-5'x3' RCB

P542 24" RCP

P543 3-6'x4' RCB

P544 36" CMP

P546 7'x3' RCB

P564 24" CMP

P565 24" RCP

P566 7'x3' RCB

P561 48" CMP

P536 2-23"x14" RCPHE

P538 2-23"x14" RCPHE

P540 23"x14" RCPHE

P539 42" CMP

P532 34"x22" RCPHE

P533 24"x18" CMAP

P534 15"x22" Concrete

P535 3-3'x2' RCB

P562 2-5'x3' RCB

P567 1-24" CMP 2-28"x20" CMAP

P563 84" RCP

P560 12" CMP

P546 18"x11" RCAP

P547 6'x6' RCB

INSTALL NEW 30"x19" RCPHE

INSTALL NEW 49"x32" RCPHE

I-12

I-13

I-14

I-15

KANSAS RIVER

NORTH

*Natural Detention*
*Figure 4.6.1*

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LAWRENCE, KANSAS EMPORIA, KANSAS

05-025M

KRETSCHMER DRIVE

MCCALL PATTERN COMPANY

JON M. IRDOCK ENGINEERING

Main Levee

BIG BLUE RIVER

KANSAS RIVER

*Area Available for Development ≈ 110 Ac.*

*(Assumed any Developed area will be filled to a min. of 1008.00)*

*350' KDHE Bldg. Setback*

*Area = 25 Ac. Volume = 155 Ac. Ft.*

*Detention Water Elevation = 1005.00*

E. Out = 1002.05

E. Out = 998.24

E. In = 994.60

P512 53"x34" RCPHE

P513 60"x42" RCPHE

P514 24" CMP

P515 5'x3' RCB

P516 24" CMP

P517 42" RCP

P521 5'x3' RCB

P522 5'x3' RCB

P520 24" CMP

P541 2-5'x3' RCB

P542 24" RCP

P543 3-6'x4' RCB

P565 24" RCP

P566 7'x3' RCB

P564 24" CMP

P561 12" CMP

P546 7'x3' RCB

P544 96" CMP

P562 2-5'x3' RCB

P567 1-24" CMP 2-28"x20" CMAP

P563 84" RCP

P561 48" CMP

P536 2-23"x14" RCPHE

P537 84"x38" CMAP

P535 3-3'x2' RCB

P534 15"x22" Concrete

P532 34"x22" RCPHE

P533 24"x18" CMAP

P539 42" CMP

P540 23"x14" RCPHE

P547 6'x6' RCB

INSTALL NEW 30"x19" RCPHE

INSTALL NEW 49"x32" RCPHE

CLEAN EXIST. OR 24" RCP

I-12

I-13

I-14

I-15

WASTEWATER TREATMENT PLANT

NORTH

*Man-made Detention*
*Figure 4.6.2*


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LAWRENCE, KANSAS EMPORIA, KANSAS

Main Levee Stream

Main Levee

Ponding Area Levee

REPAIR DISCHARGE NOW WHEN DEVELOPED, REMOVE AND ABANDON

MONITOR DEPTH OF RESERVOIR

REMOVE SILT

REMOVE SILT ON RESERVOIR WITH 24" RCP

INSTALL NEW 15" RCP CROSS ROAD PIPE

CLEAN OR REPLACE WITH 15" RCP

CLEAN OR REPLACE WITH 2 RCPE

LEVEE DRIVE

Well Access Road

HAYES DRIVE

ROSTETTER DRIVE

KRETSCHMER DRIVE

MCCALL ROAD

CARLSON STREET

ENOCH LANE

FRONTAGE ROAD

HIGHWAY 24

SERVICE CIRCLE

SARBER LANE

SEVENWORTH STREET

TUTTLE CREEK BOULEVARD

BIG BLUE RIVER

KANSAS RIVER

REGRADE DITCH

DITCH CLEANING

INSTALL NEW 15" RCP

INSTALL NEW 30"x19" RCPHE

INSTALL NEW 49"x30" RCPHE

CLEAN EXIST. DR. PIPE

E. Cut = 1002.05

E. Out = 998.24

E. In = 994.60

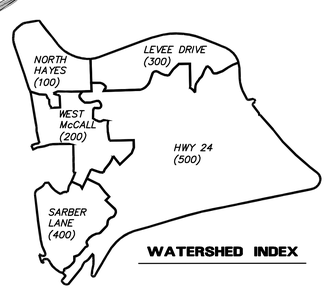
NORTH

200' 0 200' 400'

## LEGEND

- Major Watershed Boundaries
- Subarea Watershed Boundaries
- Property Lines
- 101 — Drainage Area
- Improvements Now
- Improvements when Developed
- Optional Improvements
- Area Available for Development
- P110 — Pipe Numbers
- D110 — Ditch Numbers
- 18" CMP — Existing Pipe
- New Pipe
- Area or Curb Inlet
- Manhole
- I-2 — Significant Improvement Number
- Discharging Reservoir
- Non-Discharging Reservoir/ Ponding Water

## WATERSHED INDEX




# Eastside Drainage Study
## Developed Conditions

05-025M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# Section 5 – Prioritization and Estimation

## 5.1 General

Ten Capital Improvement Projects were identified and prioritized according to existing need, future development dependence, safety and probability of property damage. Prioritization categories range from 1-3. A Priority 1 project indicates an immediate need to improve existing conditions in which the services of an Engineer are necessary. Priority 2 Projects are typically those that must be accomplished for fostering further development and aren't performing particularly well under existing conditions. Priority 2 Projects will also require the services of an Engineer. Priority 3 Projects consist of "Groups" that were compiled. The improvements of Chapter 4 are a case-by-case analysis of each and every pipe, channel or area lacking infrastructure. Instead of providing costs for each pipe, Project Groups were formed that include multiple recommendations, including general regrading of ditches, silt removal, pipe replacements and some of the Significant Improvements identified. Alone, single pipe replacement projects do not bare sizeable costs, together they are a substantial amount that must be accounted for. The Group projects can be executed through the City's maintenance department, by negotiating with a contractor for maintenance services, or through an Engineer's services utilizing the traditional design/bid/build approach. Cost Estimates for Priority 3 projects include a contingency for Engineering as a conservative number to plan by. Projects classified for When Developed or Discretionary were not estimated. It should be noted that pipes designated as "clean or replace with" (Chapter 4 and the Developed Conditions Map) were often estimated for replacement as a conservative approach.

## 5.2 Summary

Appendix C includes the detailed Cost Estimates while the methods of estimating are discussed in Section 2.6. For a graphical representation of the recommendations, refer to the Developed Conditions Map located at the end of Section 4. The ten projects are as follows:

- **WWTP Channels (I-15)** **Total Estimated Cost: $1.45 Mil.** **Priority: 1**

  In the WWTP Area, Construct New 550' Channel from P544 to P562, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4' depth. Construct New 650' Channel from P539 to P562, 4' bottom, 4:1 sides, 0.69% slope, no concrete ditch lining. Replace existing five pipe CMP combination of P562 with a 2-5'x3' RCB. Construct New 2,650' Channel from P562 to P563, 8' bottom, 4:1 sides, 0.11% slope, concrete ditch lining to 4.5' depth. Construct New 900' Channel from P567 to NW corner of WWTP property, 4' bottom, 4:1 sides, 0.50% slope (min.), no concrete ditch lining. Easements were estimated for all channels, though 1,800' of the 8' bottom channel may be able to be located on the WWTP property. Remove the weir in existing P543, the 6'x4' RCB south of Jon Murdocks.

- **Carlson Street (I-11 & I-5)** **Total Estimated Cost: $630,000** **Priority: 1**

  I-11: Construct a system of New Channels, approximately 3,500', in the Carlson Cul-de-Sac area to drain southeast to D530 *Now*. All Channels shall have a 4' bottom, 4:1 sides and 0.20-0.30% slope. Reference Developed Conditions Map. Replace P549 from 12" CMP to 15" RCP and P550 from 12" CMP to 3-23"x14" RCPHE. This system of New Channels will require approximately 1,800' of easements. All channels to be lined with concrete beginning with a 2' depth at the discharge into D530 and decreasing to 1' at the top of the channels.

  I-5: Construct New 600' Channel south of Maximum Performance and Abbott Aluminum *Now*, 4' bottom, 4:1 sides, 0.20% slope. The new channel will flow into a short 12" RCP that is stubbed out from the inlet at the top of P244.

- **Enoch Lane (I-12)** **Total Estimated Cost: $260,000** **Priority: 2**

  Regrade 650' Channel along the east side of Enoch Lane, 4' bottom, 4:1 sides, 0.35% slope. Channel shall be lined with concrete from a 1.5' depth at the discharge end to a 1' depth at the top of the channel. Install New 30"x19" RCP ($Q_{Design}$=22cfs) under frontage road draining into D528. Install New 18" RCP ($Q_{Design}$=8.6 cfs) under Enoch Lane. Construct New 800' Channel along the west side of Enoch Lane turning west between Martin Cat and RSC Equipment Rental, 4' bottom, 4:1 sides, 0.20% slope. Concrete ditch lining from a 1.5' depth at the discharge end to a 1' depth at the top of the channel. Install three 15" entrance pipes, one for the residence and two for RSC.

- **3-3'x2' RCB (I-13)** **Total Estimated Cost: $160,000** **Priority: 2**

  Add an additional 2-3'x2' RCB to existing 3'x2' RCB (P535) under Hwy 24. $Q_{Design}$=92 cfs > $Q_{50}$=86 cfs.

- **3-6'x4' RCB Combo (I-14)** **Total Estimated Cost: $475,000** **Priority: 2**

  Add an additional 2-6'x4' RCB to existing 6'x4' RCB (P543) under Hwy 24. $Q_{Design}$=485 cfs > $Q_{50}$=479 cfs. Add an additional 5'x3' RCB to existing 5'x3' RCB (P541). Replace P542 from 24" CMP to 24" RCP. Replace P566 from 24" CMP to 7'x3' RCB, P545 from 34"x22" RCPHE to 7'x3' RCB, P547 from 30"x24" RCPHE to 6'x3' RCB, P551 from 34"x22" RCPHE to 2-34"x22" RCPHE.

- **North Hayes Group:** **Total Estimated Cost: $70,000** **Priority: 3**

  General Regrading and Silt Removal for 4,700' of channel (D101-D114).

  **I-2:** Construct New 200' Channel along the east property line of Irvines Floor Covering, 4' bottom, 4:1 sides, 0.50% slope (min). Install 15" RCP under Well Access Road connecting new channel to D101. An Easement will be needed through the Irvine property.

  **I-3 E-W leg:** Construct New 400' E-W leg of Channel in the Right-of-Way along the north side of Well Access Road adjacent to the Big Lakes (south) property line, 4' bottom, 4:1 sides, 0.32%.

  **I-6:** Construct New 450' Channel south and east from P301 in the Right-of-Way along the north side of Levee Dr. and the Well Access Road, 4' bottom, 4:1 sides, slope will likely vary. Install 15" RCP entrance pipe for NGML. The slope of the E-W roadside ditch must be kept down for 80' from P301 west for construction of the NW branch of the ditch - Construct New 400' Channel north and east from the roadside Channel on the Farrar property along the adjacent property line with NGML, 4' bottom, 4:1 sides, 0.40% slope (max). This project need not wait for further development and should be constructed now to improve existing drainage conditions.

  Upgrade: P104 from 12" CMP to 2-23"x14" RCPHE
  P105 from 18" CMP to 18" RCP
  Repair: P114 18" CMP discharge end
  Clean: P107 (24" CMP) or replace with a 24" RCP
  P112 (42"x29" CMAP) or replace with a 45"x29" RCPHE

- **West McCall Group** **Total Estimated Cost: $150,000** **Priority: 3**

  General Regrading and Silt Removal for 2,500' of channel (D201-D215 and D223) along the Hayes Drive corridor only.

  Upgrade: P203-P206 with 15" RCP
  P207 from 28"x20" CMAP to 21" RCP
  P208 from 28"x20" CMAP to 24" RCP
  P209 from 28"x20" CMAP to 24" RCP
  P210 from 28"x20" CMAP to 34"x22" RCPHE
  P211from 30" CMP to a 30" RCP
  P212 from 30" CMP to a 30" RCP
  P214 from 23"x14" RCPHE to 2-30"x19" RCPHE
  P215 from 28"x20" CMAP to 34"x22" RCPHE
  P216 from 28"x20" CMAP to 34"x22" RCPHE
  P217 from 28"x20" CMAP to 38"x24" RCPHE
  P218 from 28"x20" CMAP to 38"x24" RCPHE
  P219 from 35"x24" CMAP to 38"x24" RCPHE
  P220 from 35"x24" CMAP to 38"x24" RCPHE
  P246 from 2-18" CMP to 2-18" RCP
  P248 from 21" CMP to 30"x19" RCPHE
  P249 from 23"x14" RCPHE to 2-23"x14" RCPHE
  Repair: P223 shall be Removed

- **Sarber Lane Group** **Total Estimated Cost: $82,000** **Priority: 3**

  General Regrading and Silt Removal for 1,700' of channel (D402-D409).

  Upgrade: P404 from 18" CMP to 38"x24" RCPHE
  P405 from 24" CMP to 38'x24" RCPHE
  P406 from 23"x14" RCPHE to 21" RCP
  P407 from 24" CMP to 36" RCP
  P408 from 18" CMP to 18" RCP
  P409 from 18" CMP to 18" RCP
  P410 from 21" RCP to 36" RCP
  P411 from 12" PVC to 24" RCP
  P412 from 12" HDPE to 2-15" RCP
  P431 from 15" RCP to 18" RCP
  P433 from 15" RCP to 30"x19" RCPHE
  P446 from 12" RCP to 30"x19" RCPHE

- **Hwy 24 Group** **Total Estimated Cost: $93,000** **Priority: 3**

  General Regrading and Silt Removal for 6,300' of channel (D501-D534). (Approximately 7,700' of additional channels are in KDOT Right-of-way along US 24)

  Upgrade: P501 from 24" CMP to 24" RCP
  P517 from 30" RCP to 42" RCP
  P525 from 18" HDPE to 18" RCP
  P526 from 24" CMP to 24" RCP
  P527 from 24" CMP to 24" RCP
  P528 from 30" CMP to 24" RCP
  P529 from 18" CMP to 18" RCP
  P530 from 24" CMP to 24" RCP
  Clean: P554 (38"x24" RCPHE)

- **McCall Road Improvements Total Estimated Cost: $2.65 Mil. Priority: NA**

  The street improvements planned for McCall Road will turn it into a standard curb and gutter section transforming the existing storm drainage from an open channel system to an enclosed system. Stormwater drainage splits about midway on McCall Road near the McCall Pattern west property line. The enclosed system improvements are discussed in terms of East and West as they are two separate systems.

  **West McCall**

  - 1,200' of 8'x4' RCB from Tuttle Creek Blvd. Channel to the northwest corner of the Hayes Dr./McCall Rd. intersection. It is envisioned that half of the RCB will be underneath the new street section from Hostetler Dr. to Hayes Dr.
  - From Hayes Dr. to the east, underground storm drainage will be maintained on each side of McCall Rd. with pipe sizes very similar to those indicated in this study, depending on actual inlet locations determined during the McCall Rd. design. Along the north side of McCall Road assumed 80' of 42" RCP, 400' of 36" RCP and 400' of 24" RCP. Crossing McCall Road and along the south side assumed 185' of 36" RCP, 250' of 30" RCP, 250' of 24" RCP, 400' of 30"x19" RCPHE and 300' of 23"x14" RCPHE.
  - Flow from the ditch and culvert sections along Hayes Drive will enter the new system in the same manner at the McCall Rd./Hayes Dr. intersection and P233 located just west of the intersection will remain as the singular crossing (36" RCP) underneath McCall Rd. to discharge storm drainage on the south side into the new 8'x4' RCB.

  **East McCall**

  - 1000' of 4'x3.5' RCB from the west property line of the McCall Pattern factory to the proposed second channel on the McCall property located just west of the existing building
  - 750' of 5'x3.5' RCB from the McCall channel, crossing McCall Road to the south, going past D516 and ending at the discharge of P514
  - 220' of 2-5'x3.5' RCB from the top of existing D516 to the top of P543, the proposed 3-6'x3' RCB crossing Hwy 24.
  - P517 should be upgraded from a 30" RCP to a 42" RCP as specified in Table 4.6.1. P514 should also be converted from a 24" CMP to a 24" RCP.

**BG CONSULTANTS, INC.**

*Engineers – Architects - Surveyors*

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P101 | 18" CMP | 62 | | 7.01 | | | | 0.024 | 10.0 | | 5.05 | 8.69 | 11.68 | 13.97 | 17.10 | 20.53 | <10 | Flap Gate |
| P102 | 2 - 42" x 29" CMAP | 59 | | 0.97 | | | | 0.024 | 101.0 | 60.6 | 19.24 | 27.42 | 33.68 | 38.82 | 45.03 | 51.28 | >100 | 60% |
| P103 | 21" CIP | 44 | | 0.68 | | | | 0.013 | 19.0 | | 4.71 | 7.64 | 9.97 | 11.82 | 14.18 | 16.58 | >100 | |
| P104 | 12" CMP | 40 | | 0.81 | | | | 0.024 | 2.6 | 0.7 | 4.47 | 7.30 | 9.56 | 11.38 | 13.69 | 16.03 | <2 | 25% |
| P105 | 18" CMP | 38 | | 0.58 | | | | 0.024 | 9.0 | 8.6 | 5.33 | 7.63 | 9.25 | 9.82 | 11.51 | 12.92 | <10 | 95% |
| P106 | 35" x 24" CMAP | 40 | | 0.66 | | | | 0.024 | 27.0 | 13.5 | 3.28 | 4.58 | 5.55 | 5.86 | 6.76 | 7.65 | >100 | 50% |
| P107 | 24" CMP | 35 | | 0.39 | | | | 0.024 | 14.0 | 1.4 | 3.29 | 4.59 | 5.56 | 5.91 | 6.81 | 7.71 | <2 | 10% |
| P108 | 35" x 24" CMAP | 53 | | 0.75 | | | | 0.024 | 25.0 | 12.5 | 2.09 | 3.00 | 3.68 | 3.95 | 4.58 | 5.21 | >100 | 50% |
| P109 | 35" x 24" CMAP | 58 | | 0.31 | | | | 0.024 | 27.0 | | 3.93 | 5.66 | 6.90 | 7.36 | 8.55 | 9.69 | >100 | |
| P110 | 42" x 29" CMAP | 60 | | 1.88 | | | | 0.024 | 51.0 | 25.5 | 6.92 | 10.26 | 12.80 | 13.52 | 15.89 | 18.24 | >100 | 50% |
| P111 | 2 - 42" x 29" CMAP | 45 | | 0.18 | | | | 0.024 | 101.0 | 85.9 | 22.50 | 32.97 | 41.15 | 47.27 | 55.43 | 63.23 | >100 | 85% |
| P112 | 2 - 42" x 29" CMAP | 45 | | 0.45 | | | | 0.024 | 112.0 | 50.4 | 27.73 | 41.04 | 51.44 | 58.72 | 68.56 | 78.63 | 10 | 45% |
| P113 | 18" CMP - Reservoir | 52 | | 5.79 | | | | 0.024 | 18.0 | | 6.94 | 10.60 | 13.06 | 13.47 | 13.91 | 14.37 | >100 | Flap Gate |
| P114 | 18" CMP | 67 | | 6.50 | | | | 0.024 | 17.0 | 8.5 | 7.17 | 12.43 | 16.72 | 20.35 | 24.85 | 29.45 | >2 | 50%, Damaged |
| | | | | | | | | | | | | | | | | | | |
| D101 | N. side of Well Rd. | 850 | 12 | 0.24 | 5 | 5 | 2.5 | 0.080 | 77.5 | | 5.05 | 8.69 | 11.69 | 13.99 | 17.12 | 20.54 | >>100 | |
| D102 | Hays Dr. SE-Bound Roadside | 340 | 5 | 0.21 | 10 | 15 | 3.0 | 0.030 | 395.1 | | 2.34 | 3.87 | 5.13 | 5.88 | 7.19 | 8.31 | >>100 | |
| D103 | Hays Dr. SE-Bound Roadside | 500 | 8 | 0.15 | 4 | 4 | 4.0 | 0.030 | 325.7 | | 22.55 | 33.00 | 41.25 | 47.35 | 55.50 | 63.28 | >>100 | |
| D104 | Big Lakes Frontage | 190 | 4 | 0.18 | 4 | 6 | 4.0 | 0.030 | 336.1 | | 4.69 | 7.61 | 9.89 | 11.78 | 14.14 | 16.50 | >>100 | |
| D105 | Big Lakes Frontage | 225 | 4 | 0.12 | 4 | 4 | 2.0 | 0.030 | 45.9 | | 4.71 | 7.64 | 9.97 | 11.82 | 14.19 | 16.59 | >>100 | |
| D106 | Big Lakes Frontage | 135 | 4 | 1.90 | 4 | 4 | 1.5 | 0.030 | 96.9 | | 4.48 | 7.31 | 9.57 | 11.41 | 13.73 | 16.08 | >>100 | |
| D107 | KEC Frontage | 230 | 4 | -0.19 | 4 | 4 | 3.0 | 0.030 | 75.0 | | 5.35 | 7.65 | 9.27 | 9.84 | 11.54 | 12.93 | >>100 | |
| D108 | Pawnee Frontage | 160 | 4 | 0.76 | 4 | 4 | 2.0 | 0.030 | 115.5 | | 3.30 | 4.60 | 5.57 | 5.96 | 6.86 | 7.76 | >>100 | |
| D109 | Hawley Frontage | 160 | 4 | 1.14 | 5 | 5 | 2.0 | 0.030 | 162.8 | | 2.11 | 3.01 | 3.70 | 3.99 | 4.62 | 5.25 | >>100 | |
| D110 | Tri City Frontage | 190 | 1 | 0.38 | 4 | 4 | 2.3 | 0.030 | 80.0 | | 3.94 | 5.66 | 6.99 | 7.45 | 8.66 | 9.81 | >>100 | |
| D111 | Levy Trail Pkg. Frontage | 220 | 4 | 1.18 | 4 | 4 | 2.3 | 0.030 | 197.3 | | 3.23 | 4.93 | 6.28 | 7.04 | 8.31 | 9.60 | >>100 | |
| D112 | Parker Frontage | 440 | 8 | 0.14 | 4 | 4 | 4.0 | 0.030 | 314.7 | | 27.76 | 41.07 | 51.44 | 58.77 | 68.59 | 78.65 | >>100 | |
| D113 | Parker Pkg. Frontage | 440 | 9 | -0.02 | 4 | 4 | 4.5 | 0.030 | 257.4 | | 24.40 | 37.02 | 46.98 | 54.11 | 64.17 | 73.90 | >>100 | |
| D114 | Reservoir Stream | 640 | 8 | 0.10 | 3 | 3 | 2.0 | 0.028 | 57.7 | | 24.77 | 39.16 | 51.08 | 60.90 | 72.77 | 84.94 | <25 | |

Elements deficient under Existing Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P201 | 21" RCP | 24 | | 0.92 | | | | 0.013 | 17.1 | | 6.67 | 11.02 | 14.55 | 17.21 | 20.75 | 24.35 | 25 | |
| P202 | 24" RCP | 477 | | 0.60 | | | | 0.013 | 20.0 | | 17.17 | 25.04 | 31.12 | 34.98 | 40.95 | 46.96 | >2 | |
| P203 | 15" CMP | 41 | | 0.29 | | | | 0.024 | 4.7 | | 2.77 | 3.76 | 4.50 | 4.81 | 5.49 | 6.15 | >10 | |
| P204 | 24" CMP | 40 | | 0.40 | | | | 0.024 | 11.6 | 4.6 | 2.76 | 3.75 | 4.49 | 4.80 | 5.47 | 6.13 | >10 | 40% |
| P205 | 28"x20" CMAP | 41 | | 0.57 | | | | 0.025 | 15.9 | 6.4 | 5.90 | 8.02 | 9.61 | 10.49 | 11.96 | 13.43 | >2 | 40% |
| P206 | 28"x20" CMAP | 31 | | 0.77 | | | | 0.025 | 16.1 | 6.4 | 5.73 | 7.84 | 9.39 | 10.23 | 11.61 | 13.03 | >2 | 40% |
| P207 | 28"x20" CMAP | 31 | | 0.26 | | | | 0.025 | 16.3 | 6.5 | 9.26 | 12.60 | 15.08 | 16.05 | 18.40 | 20.56 | <2 | 40% |
| P208 | 28"x20" CMAP | 36 | | 0.47 | | | | 0.025 | 17.7 | 2.7 | 14.57 | 19.99 | 24.08 | 26.00 | 29.79 | 33.40 | <2 | 15% |
| P209 | 28"x20" CMAP | 36 | | 0.87 | | | | 0.025 | 17.2 | 1.7 | 14.37 | 19.70 | 23.66 | 25.14 | 28.91 | 32.46 | <2 | 10% |
| P210 | 28"x20" CMAP | 34 | | 1.13 | | | | 0.025 | 18.3 | 5.5 | 17.44 | 24.31 | 29.46 | 31.23 | 36.08 | 40.70 | <2 | 30% |
| P211 | 30" CMP | 64 | | 0.28 | | | | 0.024 | 28.3 | 2.8 | 20.79 | 29.18 | 35.55 | 37.47 | 43.14 | 48.66 | <2 | 10% |
| P212 | 30" CMP | 43 | | 0.05 | | | | 0.024 | 23.1 | | 19.84 | 28.00 | 34.31 | 36.16 | 41.74 | 47.09 | >2 | |
| P213 | 18" CMP | 37 | | 0.03 | | | | 0.024 | 8.4 | 5.0 | 1.49 | 2.38 | 3.10 | 3.54 | 4.24 | 4.95 | 100 | 60% |
| P214 | 23"x14" RCPHE | 50 | | 0.34 | | | | 0.013 | 10.9 | 4.4 | 3.35 | 5.20 | 6.64 | 7.49 | 8.86 | 10.24 | >2 | 40% |
| P215 | 28"x20" CMAP | 29 | | 1.62 | | | | 0.025 | 19.1 | 3.8 | 5.77 | 8.85 | 11.27 | 12.80 | 15.17 | 17.57 | <2 | 20%, Damaged |
| P216 | 28"x20" CMAP | 37 | | 1.63 | | | | 0.025 | 15.4 | 4.6 | 6.70 | 10.12 | 12.90 | 14.68 | 17.33 | 20.12 | <2 | 30%, Damaged |
| P217 | 28"x20" CMAP | 60 | | 1.11 | | | | 0.025 | 17.3 | 5.2 | 12.56 | 18.42 | 23.00 | 25.53 | 29.74 | 34.03 | <2 | 30%, Damaged |
| P218 | 28"x20" CMAP | 64 | | 0.31 | | | | 0.025 | 17.6 | 8.8 | 13.31 | 19.43 | 24.26 | 27.37 | 31.92 | 36.65 | <2 | 50% |
| P219 | 35"x24" CMAP | 67 | | 0.24 | | | | 0.025 | 29.8 | 20.9 | 16.67 | 24.32 | 30.26 | 33.84 | 39.34 | 44.93 | >2 | 70% |
| P220 | 35"x24" CMAP | 25 | | 0.31 | | | | 0.025 | 45.2 | | 17.10 | 25.04 | 30.95 | 34.78 | 40.57 | 46.52 | <100 | |
| P221 | 12" CMP | 70 | | 0.00 | | | | 0.024 | 2.4 | | 1.61 | 2.36 | 2.93 | 3.18 | 3.73 | 4.27 | 5 | |
| P222 | 15" HDPE | 36 | | 1.04 | | | | 0.018 | 6.5 | 6.2 | 1.07 | 1.56 | 1.94 | 2.17 | 2.52 | 2.88 | >100 | 95% |
| P223 | 15" HDPE | 24 | | 0.72 | | | | 0.018 | 6.7 | 0.3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | N/A | 5%, Receives no flow |
| P224 | 2-28"x20" CMAP | 56 | | 0.30 | | | | 0.025 | 28.8 | | 11.66 | 15.23 | 17.92 | 18.42 | 20.91 | 23.25 | >100 | |
| P225 | 2-42"x29" CMAP | 60 | | 0.30 | | | | 0.025 | 89.5 | | 16.17 | 21.56 | 25.41 | 25.66 | 29.10 | 32.63 | >100 | |
| P226 | 42" CMP | 79 | | 0.93 | | | | 0.024 | 78.3 | | 35.68 | 49.65 | 60.04 | 65.04 | 74.78 | 84.79 | >50 | |
| P227 | 42" CMP | 53 | | 0.15 | | | | 0.024 | 62.6 | | 96.41 | 136.19 | 167.34 | 183.79 | 212.53 | 241.57 | <2 | |
| P228 | 48" CMP | 50 | | 0.04 | | | | 0.024 | 113.9 | | 97.62 | 137.79 | 169.11 | 185.53 | 214.81 | 244.06 | <5 | |
| P229 | 48" CMP | 250 | | 0.23 | | | | 0.024 | 80.9 | | 95.26 | 134.73 | 165.07 | 180.56 | 209.37 | 238.06 | <2 | |
| P230 | 48" RCP | 246 | | 0.04 | | | | 0.013 | 118.4 | | 111.88 | 159.65 | 196.50 | 216.59 | 251.85 | 287.05 | >2 | |
| P231 | 48" RCP | 280 | | 0.42 | | | | 0.013 | 119.0 | | 111.92 | 159.97 | 197.02 | 217.35 | 252.82 | 288.16 | >2 | |
| P232 | 15" RCP | 15 | | 3.00 | | | | 0.013 | 11.9 | | 2.02 | 3.02 | 3.79 | 4.32 | 5.06 | 5.79 | >100 | |
| P233 | 30" CMP | 85 | | 0.30 | | | | 0.025 | 39.3 | | 39.04 | 55.31 | 67.98 | 75.44 | 87.45 | 99.26 | 2 | |
| P234 | 15" RCP | 57 | | 0.30 | | | | 0.013 | 9.4 | | 1.89 | 2.69 | 3.30 | 3.69 | 4.26 | 4.82 | >100 | |
| P235 | 15" RCP | 197 | | 0.30 | | | | 0.013 | 5.8 | | 1.43 | 2.03 | 2.50 | 2.60 | 3.02 | 3.43 | >100 | |
| P236 | 30" RCP | 99 | | 0.65 | | | | 0.013 | 46.0 | | 37.00 | 52.17 | 63.97 | 70.77 | 81.92 | 92.88 | >2 | |
| P237 | 24" CMP | 62 | | 0.50 | | | | 0.024 | 21.3 | | 21.78 | 31.34 | 38.74 | 44.33 | 51.75 | 58.99 | 2 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P238 | 24" CMP | 68 | | 0.15 | | | | 0.024 | 18.3 | | 21.23 | 31.47 | 37.61 | 43.26 | 50.38 | 57.37 | <2 | |
| P239 | 24" CMP | 59 | | 0.21 | | | | 0.024 | 18.7 | | 16.90 | 23.51 | 28.45 | 31.71 | 36.51 | 41.01 | >2 | |
| P240 | 24"x18" CMAP | 56 | | 0.04 | | | | 0.025 | 12.9 | | 16.62 | 22.88 | 27.61 | 30.21 | 34.55 | 38.94 | <2 | |
| P241 | 24"x18" CMAP | 45 | | 0.45 | | | | 0.025 | 12.2 | | 16.82 | 23.10 | 27.80 | 30.43 | 34.79 | 39.19 | <2 | |
| P242 | 24"x18" CMAP | 45 | | 0.29 | | | | 0.025 | 11.9 | | 12.11 | 16.53 | 19.83 | 21.62 | 24.86 | 27.81 | 2 | |
| P243 | 10" HDPE | 50 | | 0.66 | | | | 0.018 | 3.2 | | 4.86 | 6.66 | 8.01 | 8.62 | 9.85 | 11.08 | <2 | |
| P244 | 24" RCP | 346 | | 0.46 | | | | 0.013 | 19.2 | | 5.03 | 8.29 | 10.90 | 13.13 | 15.81 | 18.53 | >100 | |
| P245 | 54"x34" RCPHE | 30 | | 3.90 | | | | 0.013 | 113.3 | | 15.88 | 21.65 | 26.11 | 27.58 | 31.62 | 35.67 | >>100 | |
| P246 | 2-18" CMP | 59 | | 0.55 | | | | 0.024 | 14.6 | | 12.33 | 16.92 | 20.34 | 21.97 | 25.14 | 28.32 | >2 | |
| P247 | 2-18" CMP | 40 | | 0.03 | | | | 0.024 | 15.6 | | 9.23 | 12.71 | 15.32 | 16.65 | 19.05 | 21.45 | 10 | |
| P248 | 21" CMP | 49 | | 0.16 | | | | 0.024 | 9.4 | | 9.36 | 12.86 | 15.48 | 16.79 | 19.19 | 21.60 | 2 | |
| P249 | 23"x14" RCPHE | 53 | | 1.43 | | | | 0.013 | 10.0 | | 9.51 | 13.07 | 15.73 | 17.08 | 19.52 | 21.97 | 2 | |
| P250 | 18" RCP | 36 | | 1.00 | | | | 0.013 | 16.6 | | 3.03 | 4.35 | 5.33 | 5.59 | 6.49 | 7.37 | >100 | |
| P251 | 15" CMP | 83 | | 1.00 | | | | 0.024 | 6.6 | | 3.04 | 4.37 | 5.34 | 5.63 | 6.52 | 7.41 | 50 | |
| P252 | 15" RCP | 88 | | 0.40 | | | | 0.013 | 8.0 | | 0.75 | 1.11 | 1.38 | 1.51 | 1.76 | 2.01 | >>100 | |
| | | | | | | | | | | | | | | | | | | |
| D201 | Bryant Frontage | 83 | 0.5 | -0.43 | 4 | 4 | 2.4 | 0.030 | 27.0 | | 5.75 | 7.86 | 9.42 | 10.27 | 11.66 | 13.08 | >100 | |
| D202 | McKinzie Pest Frontage | 145 | 0.5 | 0.18 | 4 | 4 | 2.4 | 0.030 | 58.0 | | 9.30 | 12.68 | 15.17 | 16.20 | 18.57 | 20.74 | >100 | |
| D203 | Bob's Frontage | 75 | 2 | -0.04 | 4 | 4 | 2.0 | 0.030 | 21.0 | | 14.39 | 19.71 | 23.68 | 25.29 | 29.08 | 32.64 | <10 | |
| D204 | Gymnastics Frontage | 241 | 3.5 | 0.40 | 4 | 3 | 1.5 | 0.030 | 39.0 | | 17.20 | 23.85 | 28.95 | 29.96 | 34.38 | 38.72 | 100 | |
| D205 | Empty Lot on Hayes Dr. | 58 | 5 | -1.50 | 4 | 3 | 3.0 | 0.030 | 67.0 | | 20.13 | 28.34 | 34.68 | 36.60 | 42.22 | 47.59 | >100 | |
| D206 | Empty Lot on Hayes Dr. | 125 | 5 | 1.91 | 4 | 3 | 3.3 | 0.030 | 552.0 | | 24.70 | 35.02 | 43.10 | 46.51 | 53.84 | 60.93 | >>100 | |
| D207 | Hill and Co. Frontage | 190 | 4 | 0.90 | 4 | 4 | 2.0 | 0.030 | 126.0 | | 1.54 | 2.45 | 3.18 | 3.60 | 4.31 | 5.02 | >>100 | |
| D208 | Transportation Frontage | 46 | 4 | 1.74 | 4 | 4 | 2.0 | 0.030 | 175.0 | | 5.78 | 8.86 | 11.27 | 12.83 | 15.19 | 17.60 | >>100 | |
| D209 | Transportation Frontage | 127 | 4 | -0.56 | 4 | 4 | 2.0 | 0.030 | 26.0 | | 6.70 | 10.13 | 12.91 | 14.71 | 17.36 | 20.16 | >100 | |
| D210 | Transportation Frontage | 139 | 6 | 0.65 | 5 | 2 | 2.5 | 0.030 | 195.0 | | 12.58 | 18.45 | 23.02 | 25.55 | 29.75 | 34.17 | >>100 | |
| D211 | Transportation Frontage | 100 | 7 | 0.43 | 5 | 2 | 2.5 | 0.030 | 172.0 | | 13.37 | 19.59 | 24.47 | 27.68 | 32.29 | 37.08 | >>100 | |
| D212 | Storage Unit on Hayes Dr. | 63 | 7 | 0.60 | 5 | 2 | 3.0 | 0.030 | 300.0 | | 16.78 | 24.51 | 30.52 | 34.04 | 39.66 | 45.52 | >>100 | |
| D213 | Storage Unit on Hayes Dr. | 85 | 7 | 0.51 | 5 | 2 | 3.0 | 0.030 | 277.0 | | 17.12 | 24.93 | 30.99 | 34.91 | 40.72 | 46.70 | >>100 | |
| D214 | S. of Hill and Co. on Levee Dr. | 349 | 7 | 0.77 | 8 | 9 | 1.5 | 0.030 | 121.0 | | 1.70 | 2.45 | 3.05 | 3.28 | 3.83 | 4.38 | >>100 | |
| D215 | N. of Transportation on Levee | 480 | 6 | 0.03 | 8 | 6 | 1.5 | 0.030 | 20.0 | | 0.63 | 0.95 | 1.21 | 1.42 | 1.66 | 1.92 | >>100 | |
| D216 | Storage Unit on McCall Rd. | 200 | 0.5 | 0.30 | 5 | 13 | 2.3 | 0.030 | 138.0 | | 11.64 | 15.31 | 18.05 | 18.67 | 21.20 | 23.57 | >>100 | |
| D217 | Storage Unit on McCall Rd. | 230 | 0.5 | 0.30 | 4 | 6 | 2.8 | 0.030 | 132.0 | | 16.30 | 21.71 | 25.56 | 26.01 | 29.42 | 33.03 | >>100 | |
| D218 | Storage Unit on McCall Rd. | 270 | 0.5 | 0.30 | 4 | 6 | 3.3 | 0.030 | 204.0 | | 19.40 | 25.78 | 30.20 | 30.51 | 34.51 | 38.60 | >>100 | |
| D219 | Empty Lot on McCall Rd. | 123 | 6 | 0.11 | 4 | 4 | 4.0 | 0.030 | 249.0 | | 97.40 | 137.30 | 168.55 | 185.07 | 213.88 | 243.01 | 100 | |
| D220 | Waste Mgmt. Frontage | 101 | 6 | 0.62 | 4 | 4 | 4.3 | 0.030 | 682.0 | | 98.34 | 138.61 | 167.84 | 186.48 | 215.82 | 245.14 | >>100 | |
| D221 | Waste Mgmt. Frontage | 90 | 6 | 0.43 | 4 | 4 | 4.5 | 0.030 | 649.0 | | 99.38 | 140.40 | 171.86 | 188.28 | 218.07 | 247.74 | >>100 | |
| D222 | Wal-Mart on McCall Rd. | 287 | 8 | 0.36 | 6 | 4 | 2.0 | 0.030 | 126.0 | | 0.74 | 1.09 | 1.35 | 1.46 | 1.72 | 1.97 | >>100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D223 | Burnetts on Hayes Dr. | 170 | 4 | 0.48 | 4 | 4 | 2.0 | 0.030 | 92.0 | | 15.89 | 21.66 | 26.12 | 27.61 | 31.65 | 35.71 | >>100 | |
| D224 | Quiznos Frontage | 40 | 3 | 1.65 | 3 | 3 | 3.0 | 0.022 | 36.0 | | 12.37 | 16.96 | 20.40 | 22.21 | 25.41 | 28.61 | >100 | |
| D225 | Burnetts on McCall Rd. | 143 | 0.5 | -0.07 | 6 | 5 | 3.8 | 0.030 | 119.0 | | 21.84 | 31.43 | 38.85 | 44.61 | 52.06 | 59.37 | >100 | |
| D226 | Max. Performance Frontage | 111 | 0.5 | 0.12 | 6 | 5 | 3.5 | 0.030 | 47.0 | | 19.66 | 27.50 | 33.53 | 37.16 | 42.78 | 48.22 | 100 | |
| D227 | Abbott Aluminum Frontage | 81 | 1 | -0.11 | 5 | 7 | 2.5 | 0.030 | 52.0 | | 17.10 | 23.80 | 28.81 | 32.10 | 36.96 | 41.51 | >100 | |
| D228 | Willie's Car Wash Frontage | 178 | 1 | 0.13 | 5 | 7 | 2.5 | 0.030 | 84.0 | | 16.88 | 23.18 | 27.97 | 30.72 | 35.11 | 39.54 | >100 | |
| D229 | KSU Research Frontage | 311 | 5 | 0.13 | 8 | 6 | 2.0 | 0.030 | 74.0 | | 12.19 | 16.64 | 19.99 | 21.78 | 25.06 | 28.03 | >100 | |

Elements deficient under Existing Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P301 | 21" X 15" CMAP | 40 | | 0.15 | | | | 0.025 | 6.9 | | 5.39 | 9.51 | 12.90 | 15.80 | 19.35 | 23.00 | >2 | |
| P302 | 21" X 15" CMAP | 48 | | 0.33 | | | | 0.025 | 8.2 | | 7.64 | 12.70 | 16.82 | 20.44 | 24.74 | 29.14 | 2 | |
| P303 | 24" RCP | 78 | | 0.26 | | | | 0.013 | 33.5 | 30.2 | 5.59 | 9.32 | 12.34 | 14.73 | 17.89 | 20.91 | >100 | 90% |
| P304 | 18" CMP | 73 | | 2.21 | | | | 0.024 | 10.9 | | 3.89 | 5.52 | 6.77 | 7.56 | 8.71 | 9.82 | >100 | |
| P305 | 57"x38" CMAP | 310 | | 0.21 | | | | 0.013 | 59.3 | | 29.05 | 41.47 | 51.07 | 56.21 | 65.23 | 74.27 | >25 | |
| P306 | 30" RCP | 53 | | 0.53 | | | | 0.013 | 37.0 | | 3.28 | 5.14 | 6.60 | 7.49 | 8.93 | 10.34 | >>100 | |
| P307 | 12" RCP | 20 | | 6.20 | | | | 0.013 | 7.5 | | 2.85 | 4.18 | 5.19 | 5.83 | 6.79 | 7.74 | 100 | |
| P308 | 6'x2' RCB | 30 | | 0.23 | | | | 0.013 | 115.0 | | 25.05 | 35.48 | 43.49 | 46.49 | 53.68 | 60.86 | >100 | |
| P309 | 18" RCP | 52 | | 0.23 | | | | 0.013 | 16.4 | | 2.93 | 4.35 | 5.45 | 5.98 | 7.03 | 8.08 | >100 | |
| P310 | 57"x38" CMAP | 48 | | 0.54 | | | | 0.025 | 80.5 | | 18.49 | 26.37 | 32.56 | 35.57 | 41.20 | 46.73 | >100 | |
| P311 | 24" RCP | 56 | | 0.21 | | | | 0.013 | 30.6 | | 5.21 | 6.89 | 8.15 | 8.03 | 9.21 | 10.29 | >>100 | |
| P312 | 2 - 30" CMP | 20 | | 1.98 | | | | 0.024 | 42.1 | | 16.04 | 22.80 | 28.18 | 30.42 | 35.39 | 40.20 | 100 | |
| P313 | 2 - 24" X 18" CMAP | 80 | | 0.21 | | | | 0.025 | 16.2 | | 15.66 | 22.19 | 27.26 | 29.17 | 33.78 | 38.25 | 2 | 90 Deg. Bends |
| P314 | 2 - 21" X 15" CMAP | 41 | | 0.02 | | | | 0.025 | 12.6 | | 13.57 | 19.27 | 23.71 | 25.60 | 29.50 | 33.33 | <2 | |
| P315 | 24" RCP | 95 | | 6.00 | | | | 0.013 | 39.9 | | 22.54 | 26.41 | 29.62 | 32.01 | 33.89 | 35.83 | >100 | |
| D301 | Farrar Frontage | 330 | 8 | 0.10 | 13 | 4 | 1.5 | 0.030 | 45.3 | | 5.39 | 9.48 | 12.86 | 15.72 | 19.27 | 22.91 | >100 | |
| D302 | North roadside ditch | 90 | 4 | 0.14 | 16 | 4 | 3.0 | 0.030 | 257.4 | | 9.35 | 15.90 | 21.24 | 25.71 | 31.22 | 36.85 | >>100 | |
| D303 | South roadside ditch (by wells) | 134 | 4 | 0.11 | 4 | 3.5 | 3.0 | 0.030 | 107.1 | | 2.96 | 5.23 | 7.12 | 8.72 | 10.74 | 12.64 | >>100 | |
| D304 | W. of Animal Shelter | 450 | 8 | 0.37 | 3 | 3 | 6.0 | 0.080 | 401.0 | | 15.67 | 26.67 | 35.78 | 43.62 | 53.00 | 62.36 | >>100 | Lots of Brush |
| D305 | Quaker Frontage | 535 | 6 | 0.65 | 6 | 4 | 1.0 | 0.030 | 34.1 | | 3.89 | 5.53 | 6.77 | 7.56 | 8.72 | 9.82 | >>100 | |
| D306 | E. of Animal Shelter | 700 | 8 | 0.31 | 3 | 3 | 6.0 | 0.090 | 325.6 | | 31.05 | 45.43 | 56.43 | 63.98 | 74.77 | 85.29 | >>100 | Lots of Brush |
| D307 | W. side of RR tracks | 530 | 4 | 0.50 | 8 | 4 | 3.5 | 0.030 | 435.4 | | 3.29 | 5.15 | 6.60 | 7.52 | 8.96 | 10.38 | >>100 | |
| D308 | E. side of RR tracks | 530 | 2 | 0.50 | 4 | 5 | 3.5 | 0.030 | 292.6 | | 5.22 | 6.95 | 8.22 | 8.13 | 9.32 | 10.41 | >>100 | |
| D309 | TDM Frontage | 300 | 6 | 1.83 | 8 | 5 | 4.0 | 0.030 | 1447.1 | | 18.50 | 26.39 | 32.66 | 35.66 | 41.32 | 46.86 | >>100 | |
| D310 | TDM Frontage | 105 | 6 | 0.02 | 8 | 5 | 3.0 | 0.030 | 76.0 | | 16.05 | 22.82 | 28.19 | 30.45 | 35.42 | 40.24 | >100 | |
| D311 | Between TDM and 2-Wire | 154 | 6 | 0.27 | 30 | 6 | 2.0 | 0.030 | 227.4 | | 15.89 | 22.66 | 27.86 | 29.86 | 34.56 | 39.11 | >>100 | |
| D312 | Between TDM and 2-Wire | 230 | 6 | 0.21 | 30 | 6 | 2.1 | 0.030 | 226.4 | | 13.72 | 19.43 | 23.87 | 25.88 | 29.80 | 33.65 | >>100 | |

Elements deficient under Existing Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P401 | 23"x14" RCPHE | 57 | | 0.76 | | | | 0.013 | 9.2 | 4.6 | 1.67 | 2.43 | 3.02 | 3.33 | 3.88 | 4.43 | >100 | 50% |
| P402 | 24" CMP | 31 | | 0.20 | | | | 0.024 | 13.2 | 10.6 | 2.36 | 3.55 | 4.47 | 5.03 | 5.91 | 6.78 | >100 | 80% |
| P403 | 34"x22" RCPHE | 49 | | 0.16 | | | | 0.013 | 32.7 | | 11.91 | 17.42 | 21.65 | 24.22 | 28.30 | 32.37 | 100 | |
| P404 | 18" CMP | 33 | | 1.26 | | | | 0.024 | 10.4 | 1.0 | 13.69 | 20.13 | 25.14 | 28.12 | 32.90 | 37.74 | <<2 | 10% |
| P405 | 24" CMP | 39 | | 0.28 | | | | 0.024 | 15.6 | 9.4 | 15.46 | 22.58 | 28.03 | 31.11 | 36.35 | 41.72 | <2 | 60%, Damaged |
| P406 | 23"x14" RCPHE | 52 | | -0.57 | | | | 0.013 | 17.2 | | 12.95 | 17.18 | 20.26 | 20.97 | 23.78 | 26.59 | 5 | |
| P407 | 24" CMP | 62 | | 0.79 | | | | 0.024 | 20.7 | | 24.45 | 34.47 | 42.09 | 47.50 | 55.00 | 62.36 | <2 | |
| P408 | 18" CMP | 72 | | 3.61 | | | | 0.024 | 6.3 | | 3.04 | 4.47 | 5.59 | 6.28 | 7.41 | 8.55 | 25 | |
| P409 | 18" CMP | 29 | | 0.91 | | | | 0.024 | 8.3 | 0.0 | 1.41 | 2.41 | 3.21 | 3.79 | 4.61 | 5.45 | <<2 | Clogged |
| P410 | 21" RCP | 55 | | 0.98 | | | | 0.013 | 32.7 | | 27.35 | 38.73 | 47.41 | 53.55 | 62.10 | 70.52 | >2 | |
| P411 | 12" PVC | 40 | | 0.35 | | | | 0.012 | 6.2 | | 8.61 | 12.58 | 15.62 | 17.00 | 19.88 | 22.75 | <2 | |
| P412 | 12" HDPE | 20 | | 0.70 | | | | 0.018 | 4.5 | 2.7 | 5.80 | 8.23 | 10.06 | 11.12 | 12.84 | 14.56 | <2 | 60% |
| P413 | 12" CMP | 23 | | 0.78 | | | | 0.024 | 5.8 | 5.2 | 1.08 | 1.71 | 2.21 | 2.54 | 3.03 | 3.52 | >100 | 90% |
| P414 | 30"x19" RCPHE | 113 | | 0.68 | | | | 0.013 | 23.0 | | 7.51 | 9.75 | 11.43 | 11.79 | 13.27 | 14.78 | >100 | |
| P415 | 45"x29" RCPHE | 113 | | 0.00 | | | | 0.013 | 53.7 | | 10.24 | 13.37 | 15.66 | 15.84 | 17.95 | 20.06 | >100 | |
| P416 | 45"x29" RCPHE | 112 | | 0.26 | | | | 0.013 | 53.2 | | 12.97 | 16.89 | 19.81 | 20.96 | 23.73 | 26.48 | >100 | |
| P417 | 53"x34" RCPHE | 146 | | 0.35 | | | | 0.013 | 72.4 | | 16.40 | 21.32 | 25.03 | 26.43 | 29.90 | 33.35 | >100 | |
| P418 | 53"x34" RCPHE | 107 | | 1.01 | | | | 0.013 | 80.0 | | 22.71 | 29.61 | 34.80 | 37.01 | 41.86 | 46.70 | >100 | |
| P419 | 38"x24" RCPHE | 43 | | 2.56 | | | | 0.013 | 51.4 | | 1.65 | 2.34 | 2.86 | 3.20 | 3.70 | 4.19 | >>100 | |
| P420 | 68"x43" RCPHE | 266 | | 0.49 | | | | 0.013 | 137.0 | | 27.80 | 36.76 | 43.51 | 47.00 | 53.48 | 59.82 | >100 | |
| P421 | 18" RCP | 142 | | 0.65 | | | | 0.013 | 12.4 | | 7.99 | 10.36 | 12.14 | 12.81 | 14.44 | 16.09 | 10 | |
| P422 | 68"x43" RCPHE | 102 | | -0.03 | | | | 0.013 | 192.3 | | 40.32 | 54.52 | 65.11 | 71.36 | 81.34 | 91.52 | >100 | |
| P423 | 68"x43" RCPHE | 112 | | 0.16 | | | | 0.013 | 213.4 | | 67.35 | 92.81 | 111.93 | 123.40 | 141.87 | 160.10 | >100 | |
| P424 | 68"x43" RCPHE | 280 | | 0.16 | | | | 0.013 | 188.0 | | 68.36 | 93.71 | 113.12 | 123.12 | 141.01 | 159.18 | >100 | |
| P425 | 15" RCP | 48 | | 1.29 | | | | 0.013 | 10.8 | | 7.75 | 10.30 | 12.22 | 13.35 | 15.16 | 16.98 | <10 | |
| P426 | 15" RCP | 78 | | 1.15 | | | | 0.013 | 9.7 | | 4.02 | 5.21 | 6.09 | 6.31 | 7.10 | 7.90 | >100 | |
| P427 | 15" RCP | 27 | | 1.74 | | | | 0.013 | 11.6 | | 2.44 | 3.46 | 4.23 | 4.73 | 5.46 | 6.19 | >100 | |
| P428 | 68"x43" RCPHE | 203 | | 0.05 | | | | 0.013 | 212.3 | | 73.19 | 100.50 | 121.40 | 131.83 | 151.16 | 170.78 | >100 | |
| P429 | 68"x43" RCPHE | 174 | | 0.33 | | | | 0.013 | 201.6 | | 75.48 | 103.64 | 125.15 | 136.01 | 155.65 | 176.06 | >100 | |
| P430 | 68"x43" RCPHE | 125 | | 0.11 | | | | 0.013 | 197.5 | | 85.07 | 116.07 | 139.81 | 152.53 | 173.99 | 196.49 | 100 | |
| P431 | 15" RCP | 45 | | 1.27 | | | | 0.013 | 12.9 | | 10.13 | 13.24 | 15.59 | 16.95 | 19.15 | 21.35 | 5 | |
| P432 | 15" HDPE | 84 | | 3.10 | | | | 0.018 | 8.0 | | 1.27 | 1.81 | 2.23 | 2.41 | 2.79 | 3.17 | >100 | |
| P433 | 15" RCP | 20 | | 3.75 | | | | 0.013 | 7.2 | | 9.27 | 12.03 | 14.10 | 15.01 | 16.92 | 18.83 | <2 | |
| P434 | 18" RCP | 271 | | 0.32 | | | | 0.013 | 9.2 | | 5.77 | 7.58 | 8.92 | 9.60 | 10.84 | 12.09 | 25 | |
| P435 | 27" RCP | 125 | | 0.88 | | | | 0.013 | 32.6 | | 7.28 | 9.55 | 11.24 | 12.14 | 13.74 | 15.31 | >100 | |
| P436 | 24" RCP | 336 | | 0.37 | | | | 0.013 | 18.9 | | 3.55 | 4.67 | 5.51 | 5.61 | 6.36 | 7.11 | >100 | |
| P437 | 42"x32" RCPHE | 80 | | 0.76 | | | | 0.013 | 73.3 | | 15.17 | 19.84 | 23.33 | 25.23 | 28.52 | 31.77 | >100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P438 | 36" RCP | 495 | | 0.24 | | | | 0.013 | 39.2 | | 23.30 | 31.64 | 38.05 | 41.62 | 47.43 | 53.38 | >10 | |
| P439 | 12" HDPE | 275 | | 0.28 | | | | 0.018 | 1.7 | 0.8 | 2.06 | 2.61 | 3.04 | 3.19 | 3.58 | 3.97 | <2 | 50% |
| P440 | 18" RCP | 39 | | 0.04 | | | | 0.013 | 15.3 | | 4.38 | 6.33 | 7.81 | 8.74 | 10.14 | 11.53 | >100 | |
| P441 | 24" RCP | 64 | | 0.04 | | | | 0.013 | 32.8 | | 5.06 | 7.16 | 8.77 | 10.02 | 11.60 | 13.18 | >100 | |
| P442 | 18" RCP | 39 | | 0.07 | | | | 0.013 | 14.8 | | 6.56 | 8.83 | 10.53 | 11.59 | 13.19 | 14.78 | 100 | |
| P443 | 24" RCP | 14 | | 12.82 | | | | 0.013 | 37.1 | | 7.35 | 9.84 | 11.70 | 13.17 | 14.96 | 16.75 | >100 | |
| P444 | 15" RCP | 40 | | 4.82 | | | | 0.013 | 10.5 | | 1.85 | 2.39 | 2.79 | 2.94 | 3.31 | 3.68 | >100 | |
| P445 | 15" RCP | 18 | | 10.14 | | | | 0.013 | 14.1 | | 3.26 | 4.21 | 4.92 | 5.18 | 5.83 | 6.49 | >100 | |
| P446 | 12" RCP | 72 | | 4.53 | | | | 0.013 | 5.1 | 0.0 | 9.14 | 11.89 | 13.94 | 14.87 | 16.77 | 18.67 | <<2 | Clogged |
| P447 | 18" RCP | 93 | | 2.29 | | | | 0.013 | 8.0 | | 14.28 | 18.54 | 21.72 | 23.10 | 26.05 | 28.97 | <2 | |
| P448 | 18" RCP | 48 | | 1.49 | | | | 0.013 | 21.7 | | 19.63 | 25.49 | 29.86 | 31.79 | 35.85 | 39.87 | >2 | |
| P449 | 18" RCP | 18 | | 0.33 | | | | 0.013 | 23.0 | | 21.94 | 28.49 | 33.38 | 35.54 | 40.07 | 44.58 | >2 | |
| P450 | 18" CMP | 30 | | 0.40 | | | | 0.024 | 7.4 | | 0.52 | 0.75 | 0.93 | 1.03 | 1.20 | 1.37 | >>100 | |
| P451 | 18" RCP | 496 | | 0.62 | | | | 0.013 | 9.3 | | 8.04 | 11.69 | 14.47 | 16.24 | 18.89 | 21.54 | >2 | |
| P452 | 18" RCP and 30"x19" RCPHE | 209 | | 0.18 | | | | 0.013 | 12.6 | | 5.90 | 8.64 | 10.74 | 12.16 | 14.17 | 16.17 | >25 | Transitions in middle |
| P453 | 30"x19" RCPHE | 115 | | 1.89 | | | | 0.013 | 33.2 | | 6.19 | 8.00 | 9.35 | 9.75 | 10.98 | 12.22 | >100 | |
| | | | | | | | | | | | | | | | | | | |
| D401 | Rear of Hobby Lobby/Staples | 508 | 4 | 0.50 | 0 | 0 | 2.5 | 0.014 | 80.7 | | 13.18 | 17.46 | 20.56 | 21.36 | 24.20 | 27.04 | >>100 | |
| D402 | Manko Frontage on Hayes Dr. | 57 | 4 | 1.71 | 6 | 6 | 1.5 | 0.030 | 116.0 | | 2.37 | 3.57 | 4.49 | 5.05 | 5.92 | 6.80 | >>100 | |
| D403 | Autocraft Frontage on Hayes | 175 | 6 | 0.67 | 6 | 7 | 2.3 | 0.030 | 225.1 | | 3.32 | 4.87 | 6.05 | 6.83 | 7.98 | 9.13 | >>100 | |
| D404 | Westgate Auto Frontage | 103 | 6 | 0.25 | 4 | 6 | 2.5 | 0.030 | 148.3 | | 15.53 | 22.69 | 28.24 | 31.36 | 36.64 | 42.06 | >>100 | |
| D405 | Goodson Auto Frontage | 184 | 6 | 1.36 | 4 | 4 | 2.5 | 0.030 | 304.0 | | 16.78 | 24.42 | 30.34 | 33.54 | 39.16 | 44.89 | >>100 | |
| D406 | N. ditch on Service Cir. | 136 | 3 | 0.82 | 7 | 6 | 2.0 | 0.030 | 152.6 | | 8.76 | 12.81 | 15.92 | 17.53 | 20.49 | 23.44 | >>100 | |
| D407 | N. ditch on Service Cir. | 106 | 2 | -0.30 | 6 | 5 | 1.7 | 0.030 | 47.5 | | 8.64 | 12.62 | 15.67 | 17.12 | 20.02 | 22.91 | >>100 | |
| D408 | S. ditch on Service Cir. | 188 | 3 | -0.02 | 4 | 6 | 1.8 | 0.030 | 14.3 | | 1.81 | 2.78 | 3.53 | 3.99 | 4.70 | 5.48 | >>100 | |
| D409 | Ekart Frontage on Sarber Ln. | 56 | 2 | 0.16 | 6 | 8 | 2.0 | 0.030 | 65.9 | | 3.04 | 4.47 | 5.60 | 6.28 | 7.42 | 8.55 | >>100 | |
| D410 | Near Sirloin Stock. on Sarber | 212 | 5 | 0.40 | 4 | 6 | 2.0 | 0.030 | 105.3 | | 5.50 | 7.21 | 8.47 | 9.27 | 10.48 | 11.67 | >>100 | |

Elements deficient under Existing Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P501 | 24" CMP | 20 | | 1.98 | | | | 0.024 | 2.1 | 0.8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | N/A | 40%, Receives no flow |
| P502 | 21"x15" CMAP | 29 | | 0.35 | | | | 0.025 | 7.3 | | 0.51 | 0.79 | 1.01 | 1.11 | 1.32 | 1.53 | >>100 | |
| P503 | 38"x24" RCPHE | 57 | | -0.37 | | | | 0.013 | 38.0 | | 1.85 | 3.09 | 4.14 | 4.76 | 5.76 | 6.77 | >>100 | |
| P504 | 35"x24" CMAP | 65 | | 0.28 | | | | 0.025 | 28.0 | | 8.62 | 11.50 | 13.64 | 14.55 | 16.55 | 18.54 | >100 | |
| P505 | 24"x18" CMAP | 61 | | -0.99 | | | | 0.025 | 9.1 | | 4.39 | 5.73 | 6.73 | 6.96 | 7.86 | 8.76 | 100 | |
| P506 | 38"x24" RCPHE | 93 | | 0.81 | | | | 0.013 | 43.3 | | 12.68 | 17.60 | 21.35 | 23.24 | 26.87 | 30.45 | >100 | |
| P507 | 2-24" CMP | 49 | | 0.16 | | | | 0.024 | 32.0 | | 13.44 | 19.28 | 23.84 | 26.48 | 30.93 | 35.38 | >50 | |
| P508 | 21"x15" CMAP | 36 | | 0.50 | | | | 0.025 | 11.0 | | 7.79 | 11.08 | 13.57 | 15.30 | 17.69 | 20.08 | 5 | Privately owned |
| P509 | 24" RCP | 65 | | 1.27 | | | | 0.013 | 24.9 | | 1.96 | 3.38 | 4.54 | 5.41 | 6.57 | 7.75 | >>100 | |
| P510 | 24" CMP | 77 | | 0.96 | | | | 0.024 | 17.3 | | 8.59 | 12.46 | 15.41 | 17.63 | 20.52 | 23.40 | 25 | |
| P511 | 2-35"x24" CMAP | 43 | | 0.86 | | | | 0.025 | 67.6 | | 16.90 | 24.93 | 31.23 | 35.71 | 42.02 | 48.33 | >100 | |
| P512 | 53"x34" RCPHE | 41 | | -0.02 | | | | 0.013 | 75.6 | | 15.56 | 23.62 | 30.05 | 34.97 | 41.79 | 48.27 | >100 | |
| P513 | 60"x42" RCPHE | 295 | | 0.37 | | | | 0.013 | 109.2 | | 17.16 | 26.04 | 33.19 | 38.44 | 45.84 | 52.91 | >100 | |
| P514 | 24" CMP | 56 | | 2.21 | | | | 0.024 | 21.8 | | 2.47 | 3.64 | 4.54 | 5.06 | 5.90 | 6.74 | >>100 | |
| P515 | 42" CMP | 63 | | -1.21 | | | | 0.024 | 55.5 | | 23.89 | 41.12 | 55.28 | 67.67 | 82.01 | 97.34 | 10 | |
| P516 | 24" CMP | 76 | | 0.08 | | | | 0.024 | 16.0 | | 7.45 | 10.05 | 11.99 | 12.99 | 14.83 | 16.66 | <100 | |
| P517 | 30" RCP | 59 | | 0.73 | | | | 0.013 | 45.2 | | 33.15 | 45.39 | 54.49 | 59.53 | 68.90 | 76.52 | 5 | |
| P518 | 18" CMP | 34 | | 1.57 | | | | 0.024 | 7.8 | | 1.38 | 1.99 | 2.45 | 2.75 | 3.19 | 3.62 | >100 | |
| P519 | 18" CMP | 35 | | 0.55 | | | | 0.024 | 8.2 | | 3.16 | 4.34 | 5.20 | 5.66 | 6.41 | 7.24 | >100 | |
| P520 | 24" CMP | 54 | | 0.22 | | | | 0.024 | 17.6 | | 5.04 | 7.27 | 8.97 | 10.39 | 12.07 | 13.76 | >100 | |
| P521 | 42"x29" CMAP | 40 | | 0.17 | | | | 0.025 | 47.7 | | 26.37 | 44.93 | 60.06 | 73.45 | 88.78 | 105.01 | >5 | |
| P522 | 2-36" CMP | 40 | | 0.33 | | | | 0.024 | 102.4 | | 27.59 | 46.61 | 62.12 | 75.65 | 91.45 | 108.02 | <100 | |
| P523 | 24" CMP | 42 | | 0.87 | | | | 0.024 | 12.8 | | 1.89 | 2.72 | 3.36 | 3.79 | 4.40 | 5.00 | >100 | |
| P524 | 18" HDPE | 41 | | 0.51 | | | | 0.018 | 9.1 | | 3.22 | 4.69 | 5.81 | 6.27 | 7.30 | 8.33 | >100 | |
| P525 | 18" HDPE | 41 | | 0.66 | | | | 0.018 | 8.6 | 1.7 | 3.77 | 5.55 | 6.91 | 7.41 | 8.70 | 9.99 | <2 | 20% |
| P526 | 24" CMP | 52 | | 0.21 | | | | 0.024 | 14.7 | | 10.93 | 15.32 | 18.70 | 20.14 | 23.28 | 26.03 | <5 | |
| P527 | 24" CMP | 40 | | 0.79 | | | | 0.024 | 13.9 | | 9.35 | 14.51 | 18.55 | 22.09 | 26.18 | 30.30 | <5 | |
| P528 | 30" CMP | 100 | | 0.25 | | | | 0.024 | 25.1 | 12.6 | 11.73 | 16.44 | 20.03 | 21.77 | 25.12 | 28.14 | >2 | 50%, Damaged |
| P529 | 18" CMP | 140 | | 0.23 | | | | 0.024 | 15.1 | | 9.76 | 15.00 | 19.08 | 22.71 | 26.84 | 30.97 | 5 | |
| P530 | 24" CMP | 40 | | 0.42 | | | | 0.024 | 21.7 | 10.9 | 12.07 | 17.02 | 20.81 | 22.68 | 26.32 | 29.65 | <2 | 50% |
| P531 | 23"x14" RCPHE | 60 | | 1.42 | | | | 0.013 | 14.8 | | 4.17 | 6.11 | 7.59 | 8.40 | 9.79 | 11.18 | >100 | |
| P532 | 34"x22" RCPHE | 45 | | 1.01 | | | | 0.013 | 40.9 | | 15.15 | 22.70 | 28.52 | 33.70 | 39.63 | 45.50 | >50 | |
| P533 | 24"x18" CMAP | 30 | | 0.50 | | | | 0.025 | 7.1 | | 3.11 | 5.44 | 7.34 | 8.96 | 10.94 | 12.98 | 10 | |
| P534 | 23"x14" RCPHE | 60 | | 1.42 | | | | 0.013 | 14.8 | | 2.00 | 2.91 | 3.61 | 3.98 | 4.63 | 5.28 | >100 | |
| P535 | 3'x2' RCB | 120 | | 0.21 | | | | 0.013 | 30.6 | | 36.99 | 53.42 | 65.96 | 74.33 | 86.49 | 98.17 | <2 | |
| P536 | 23"x14" RCPHE | 53 | | 4.04 | | | | 0.013 | 12.8 | | 4.35 | 6.76 | 8.67 | 10.26 | 12.20 | 14.16 | 50 | |
| P537 | 54"x38" CMAP | 70 | | 0.32 | | | | 0.025 | 95.4 | | 40.49 | 61.37 | 77.77 | 89.65 | 107.14 | 122.95 | >25 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P538 | 23"x14" RCPHE | 61 | | 1.95 | | | | 0.013 | 19.8 | | 2.86 | 4.66 | 6.11 | 7.23 | 8.70 | 10.19 | >100 | |
| P539 | 42" CMP | 86 | | 0.76 | | | | 0.024 | 96.7 | | 41.07 | 62.38 | 79.07 | 91.15 | 108.87 | 124.92 | >25 | |
| P540 | 23"x14" RCPHE | 66 | | 3.45 | | | | 0.013 | 15.0 | | 3.26 | 4.28 | 5.04 | 5.40 | 6.11 | 6.81 | >>100 | |
| P541 | 5'x3' RCB | 62 | | 0.39 | | | | 0.013 | 125.3 | | 70.01 | 105.85 | 134.47 | 159.07 | 188.65 | 218.01 | <10 | |
| P542 | 24" CMP | 36 | | 6.87 | | | | 0.024 | 7.5 | | 5.02 | 6.89 | 8.26 | 8.58 | 9.80 | 11.00 | >5 | |
| P543 | 6'x4' RCB | 180 | | 0.16 | | | | 0.013 | 176.1 | | 111.31 | 166.12 | 208.97 | 242.77 | 284.74 | 327.91 | >5 | |
| P544 | 96" CMP | 72 | | 0.03 | | | | 0.024 | 610.1 | | 111.69 | 169.51 | 217.22 | 256.84 | 304.20 | 353.02 | >100 | |
| P545 | 34"x22" RCPHE | 42 | | -0.21 | | | | 0.013 | 34.2 | | 31.95 | 46.48 | 57.65 | 64.03 | 73.51 | 85.09 | >2 | |
| P546 | 18"x11" RCAP | 61 | | 3.70 | | | | 0.013 | 9.1 | | 2.67 | 3.88 | 4.79 | 5.28 | 6.15 | 7.02 | >100 | |
| P547 | 30"x24" RCPHE | 74 | | 0.03 | | | | 0.013 | 32.4 | | 31.31 | 45.12 | 55.79 | 61.86 | 71.06 | 81.03 | >2 | |
| P548 | 23"x14" RCPHE | 57 | | 3.04 | | | | 0.013 | 13.5 | | 2.42 | 3.50 | 4.33 | 4.81 | 5.59 | 6.38 | >100 | |
| P549 | 12" CMP | 31 | | 1.17 | | | | 0.024 | 2.8 | | 2.29 | 3.34 | 4.14 | 4.59 | 5.35 | 6.11 | >2 | |
| P550 | 12" CMP | 32 | | 0.31 | | | | 0.024 | 2.8 | | 7.39 | 11.86 | 15.44 | 18.56 | 22.20 | 25.90 | <2 | |
| P551 | 34"x22" RCPHE | 64 | | 0.67 | | | | 0.013 | 26.7 | | 24.38 | 34.87 | 42.99 | 47.23 | 54.78 | 63.00 | >2 | |
| P552 | 23"x14" RCPHE | 57 | | 1.54 | | | | 0.013 | 16.1 | | 2.67 | 3.88 | 4.79 | 5.28 | 6.14 | 7.01 | >100 | |
| P553 | 23"x14" RCPHE | 56 | | 1.08 | | | | 0.013 | 23.4 | | 10.00 | 13.16 | 15.51 | 16.70 | 18.88 | 21.06 | >100 | |
| P554 | 38"x24" RCPHE | 42 | | 7.17 | | | | 0.013 | 39.9 | 8.0 | 10.86 | 16.20 | 20.37 | 23.09 | 26.95 | 30.95 | <2 | 20% |
| P555 | 23"x14" RCPHE | 61 | | 1.24 | | | | 0.013 | 16.9 | | 2.83 | 4.00 | 4.89 | 5.43 | 6.27 | 7.11 | >100 | |
| P556 | 34"x22" RCPHE | 42 | | 0.39 | | | | 0.013 | 26.6 | | 10.45 | 15.26 | 18.90 | 20.35 | 23.27 | 27.15 | <100 | |
| P557 | 23"x14" RCPHE | 63 | | 1.24 | | | | 0.013 | 17.8 | | 4.42 | 6.22 | 7.59 | 7.91 | 9.09 | 10.28 | >100 | |
| P558 | 23"x14" RCPHE | 37 | | 0.50 | | | | 0.013 | 8.3 | | 3.45 | 5.56 | 7.23 | 8.03 | 9.64 | 11.27 | 25 | |
| P559 | 34"x22" RCPHE | 42 | | 0.07 | | | | 0.013 | 31.8 | 19.1 | 5.46 | 7.64 | 9.29 | 10.16 | 11.67 | 13.21 | >100 | 60% |
| P560 | 12" RCP | 55 | | 0.54 | | | | 0.013 | 5.7 | | 3.14 | 4.38 | 5.30 | 5.78 | 6.64 | 7.50 | 25 | |
| P561 | 18" CMP | 21 | | 0.54 | | | | 0.024 | 5.4 | | 1.67 | 2.42 | 2.99 | 3.34 | 3.88 | 4.42 | >100 | |
| P562 | 4-49"x33" & 1-28"x20" CMAP | 90 | | 0.39 | | | | 0.025 | 220.6 | 178.8 | 81.25 | 113.35 | 139.37 | 165.35 | 192.96 | 221.16 | >25 | Composite Values, 81% |
| P563 | 84" RCP | 120 | | 1.73 | | | | 0.013 | 807.0 | | 123.93 | 190.68 | 220.30 | 256.84 | 298.08 | 306.40 | >100 | |
| P564 | 24" CMP | 41 | | 0.93 | | | | 0.024 | 19.8 | | 5.25 | 8.22 | 10.56 | 12.13 | 14.46 | 16.81 | >100 | |
| P565 | 24" RCP | 197 | | 0.87 | | | | 0.013 | 21.1 | | 7.89 | 11.77 | 14.80 | 16.91 | 19.89 | 22.90 | <100 | |
| P566 | 24" CMP | 18 | | 0.16 | | | | 0.024 | 23.9 | | 31.85 | 46.22 | 57.32 | 64.03 | 73.12 | 83.94 | <2 | |
| P567 | 2-28"x20" CMAP & 1-24" CMP | 56 | | 0.33 | | | | 0.024 | 67.8 | 66.4 | 6.74 | 12.19 | 16.74 | 21.10 | 26.00 | 31.03 | >100 | Composite Values, 98% |
| | | | | | | | | | | | | | | | | | | |
| D501 | Quaker Ditch on Kretschmer | 173 | 4.5 | 0.93 | 4 | 4 | 2.2 | 0.030 | 161.3 | | 4.62 | 6.25 | 7.47 | 7.81 | 8.92 | 10.04 | >>100 | |
| D502 | Kretschmer Dr. | 190 | 5 | 0.83 | 5.5 | 4 | 3.0 | 0.030 | 371.0 | | 1.88 | 3.16 | 4.23 | 4.83 | 5.85 | 6.88 | >>100 | |
| D503 | Manhattan Wrecker Frontage | 142 | 6 | 0.21 | 5 | 4 | 4.0 | 0.030 | 249.3 | | 12.70 | 17.63 | 21.38 | 23.28 | 26.92 | 30.51 | >>100 | |
| D504 | Kretschmer Dr. | 349 | 4 | 0.52 | 4 | 3.5 | 3.0 | 0.045 | 231.2 | | 13.69 | 19.60 | 24.21 | 26.83 | 31.31 | 35.80 | >>100 | Brush |
| D505 | Kretschmer Dr. | 450 | 5.25 | 0.46 | 3 | 4 | 2.5 | 0.030 | 153.9 | | 1.96 | 3.38 | 4.55 | 5.41 | 6.57 | 7.76 | >>100 | |
| D506 | Farm Bureau Frontage | 130 | 7 | 0.61 | 4 | 4 | 4.0 | 0.030 | 622.0 | | 16.91 | 24.95 | 31.25 | 35.78 | 42.10 | 48.41 | >>100 | |
| D507 | McCall Ditch on Kretschmer | 763 | 9 | 0.26 | 2 | 5 | 2.5 | 0.030 | 155.2 | | 26.25 | 35.94 | 43.12 | 47.12 | 54.67 | 60.51 | >>100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D508 | Kretschmer Dr. | 421 | 10 | 0.05 | 4 | 5.5 | 2.0 | 0.030 | 52.3 | | 15.66 | 23.78 | 30.26 | 35.20 | 42.06 | 48.57 | >100 | |
| D509 | Orcheln Frontage on McCall | 162 | 5 | 0.07 | 4.5 | 4 | 2.0 | 0.030 | 40.1 | | 3.16 | 4.34 | 5.21 | 5.70 | 6.45 | 7.28 | >>100 | |
| D510 | McCall Rd. | 830 | 6 | 0.14 | 3 | 3 | 3.0 | 0.030 | 123.8 | | 24.25 | 41.58 | 55.80 | 68.17 | 82.53 | 97.88 | >100 | |
| D511 | McCall Pattern Frontage | 495 | 4 | 0.38 | 5.3 | 3.8 | 2.0 | 0.030 | 88.4 | | 7.67 | 10.33 | 12.30 | 13.26 | 15.13 | 16.99 | >>100 | |
| D512 | McCall Rd. | 174 | 4 | 0.33 | 2.5 | 2.5 | 3.5 | 0.020 | 198.9 | | 26.40 | 44.95 | 60.13 | 73.62 | 88.92 | 105.19 | >100 | Brush in Cracks |
| D513 | Jon Murdock along McCall Rd. | 271 | 6 | 0.21 | 2.5 | 2.5 | 4.5 | 0.020 | 331.3 | | 27.59 | 46.62 | 62.16 | 75.70 | 91.53 | 108.09 | >>100 | Brush in Cracks |
| D514 | Jon Murdock along McCall Rd. | 116 | 6 | 0.07 | 2.5 | 2.5 | 4.5 | 0.020 | 191.3 | | 27.46 | 46.38 | 61.85 | 75.24 | 91.03 | 107.56 | >100 | Brush in Cracks |
| D515 | McCall Rd. | 92 | 6 | 0.31 | 2.5 | 2.5 | 4.5 | 0.014 | 862.5 | | 18.27 | 27.72 | 35.37 | 40.90 | 48.69 | 56.18 | >>100 | |
| D516 | East side of Jon Murdock | 221 | 6 | 0.64 | 2.5 | 2.5 | 5.0 | 0.014 | 1568.1 | | 70.05 | 105.86 | 134.49 | 159.26 | 188.81 | 218.22 | >>100 | |
| D517 | Bailey Storage Frontage | 87 | 6 | -0.12 | 4.5 | 3.5 | 2.0 | 0.045 | 22.8 | | 3.78 | 5.55 | 6.91 | 7.42 | 8.71 | 10.01 | >100 | Trees |
| D518 | FedEx Frontage | 644 | 7 | 0.31 | 3 | 8 | 2.0 | 0.035 | 74.3 | | 11.03 | 15.54 | 18.96 | 20.37 | 23.55 | 26.34 | >>100 | Low Areas |
| D519 | Levee Dr. | 290 | 5 | 0.20 | 5 | 4 | 2.0 | 0.030 | 70.0 | | 9.35 | 14.51 | 18.56 | 22.10 | 26.19 | 30.31 | >>100 | |
| D520 | Griffith Lumber Frontage | 89 | 6 | 0.71 | 6 | 4 | 2.0 | 0.030 | 152.2 | | 9.82 | 15.14 | 19.29 | 23.00 | 27.23 | 31.46 | >>100 | |
| D521 | Flint Hills Bev. on Levee Dr. | 67 | 8 | 0.00 | 3.7 | 3.3 | 2.8 | 0.030 | 69.4 | | 12.11 | 17.05 | 20.88 | 22.74 | 26.38 | 29.72 | >>100 | |
| D522 | Flint Hills Bev. on Hwy 24 | 372 | 7 | 0.27 | 3 | 3 | 3.9 | 0.030 | 328.2 | | 29.58 | 42.90 | 53.19 | 60.72 | 70.98 | 80.85 | >>100 | |
| D523 | East Hwy 24 | 350 | 5 | 0.50 | 4 | 4.5 | 2.0 | 0.035 | 91.9 | | 5.04 | 8.73 | 11.78 | 14.17 | 17.32 | 20.50 | >>100 | Taller Grass |
| D524 | East Hwy 24 | 364 | 6 | -0.01 | 5.3 | 4 | 2.0 | 0.035 | 29.7 | | 35.74 | 53.77 | 67.69 | 77.44 | 92.47 | 105.84 | <2 | Taller Grass |
| D525 | McCall Rd.& Hwy 24 | 329 | 8 | 0.22 | 3 | 4 | 3.0 | 0.030 | 195.5 | | 5.02 | 6.89 | 8.26 | 8.58 | 9.80 | 11.00 | >>100 | |
| D526 | Jon Murdock on Hwy 24 | 173 | 5 | 0.19 | 5 | 4 | 3.6 | 0.030 | 262.1 | | 31.98 | 46.41 | 57.53 | 64.26 | 73.36 | 84.22 | >>100 | |
| D527 | Jon Murdock on Frontage Rd. | 175 | 8 | 0.50 | 5 | 4 | 2.0 | 0.025 | 169.4 | | 5.26 | 8.23 | 10.57 | 12.19 | 14.52 | 16.88 | >>100 | |
| D528 | West Hwy 24 | 632 | 7 | 0.12 | 3.4 | 4 | 3.9 | 0.030 | 248.0 | | 31.37 | 45.40 | 55.99 | 62.42 | 71.03 | 81.34 | >>100 | |
| D529 | East Hwy 24 | 3000 | 4.5 | 0.20 | 2.7 | 2.3 | 5.0 | 0.030 | 363.7 | | 10.40 | 18.11 | 24.45 | 30.14 | 36.76 | 43.50 | >>100 | |
| D530 | Best Western Frontage | 228 | 6 | 0.41 | 3.5 | 3.5 | 3.5 | 0.035 | 279.1 | | 31.75 | 45.61 | 56.35 | 62.50 | 71.72 | 81.73 | >>100 | Taller Grass |
| D531 | Hampton Inn/Linweld | 502 | 6 | 0.09 | 3.5 | 3.5 | 3.0 | 0.035 | 92.8 | | 28.17 | 40.19 | 49.61 | 55.20 | 63.13 | 71.64 | >100 | Taller Grass |
| D532 | Town West Frontage | 659 | 4 | 0.19 | 3.5 | 3.5 | 3.0 | 0.035 | 114.2 | | 22.68 | 32.24 | 39.74 | 43.80 | 50.35 | 57.03 | >100 | Taller Grass |
| D533 | Sirloin Stock/K-Mart | 510 | 6 | 0.09 | 3.5 | 3 | 4.0 | 0.030 | 131.1 | | 10.86 | 16.20 | 20.38 | 23.10 | 26.96 | 30.96 | >>100 | |
| D534 | Ampride Frontage | 566 | 4 | 0.16 | 4.7 | 4.3 | 2.0 | 0.030 | 7.8 | | 10.46 | 15.26 | 18.96 | 20.45 | 23.36 | 27.26 | <2 | |

Elements deficient under Existing Conditions

## Level of Service

**2006 Eastside Drainage Study**
**N. Hayes Watershed (100)**
**Developed Conditions**

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P101 | 18" CMP | 62 | | 7.01 | | | | 0.024 | 10.0 | | 10.11 | 14.41 | 17.59 | 19.59 | 22.76 | 25.85 | 2 | Flap Gate |
| P102 | 2 - 42" x 29" CMAP | 59 | | 0.97 | | | | 0.024 | 101.0 | 60.6 | 23.99 | 33.38 | 40.44 | 45.50 | 52.20 | 58.93 | 100 | 60% |
| P103 | 21" CIP | 44 | | 0.68 | | | | 0.013 | 19.0 | | 8.70 | 12.26 | 14.94 | 16.88 | 19.42 | 22.01 | 50 | |
| P104 | 12" CMP | 40 | | 0.81 | | | | 0.024 | 2.6 | 0.7 | 8.29 | 11.62 | 14.14 | 15.70 | 18.08 | 20.46 | <2 | 25% |
| P105 | 18" CMP | 38 | | 0.58 | | | | 0.024 | 9.0 | 8.6 | 5.33 | 7.63 | 9.25 | 9.82 | 11.51 | 12.92 | <10 | 95% |
| P106 | 35" x 24" CMAP | 40 | | 0.66 | | | | 0.024 | 27.0 | 13.5 | 3.28 | 4.58 | 5.55 | 5.86 | 6.76 | 7.65 | >100 | 50% |
| P107 | 24" CMP | 35 | | 0.39 | | | | 0.024 | 14.0 | 1.4 | 3.29 | 4.59 | 5.56 | 5.91 | 6.81 | 7.71 | <2 | 10% |
| P108 | 35" x 24" CMAP | 53 | | 0.75 | | | | 0.024 | 25.0 | 12.5 | 2.09 | 3.00 | 3.68 | 3.95 | 4.58 | 5.21 | >100 | 50% |
| P109 | 35" x 24" CMAP | 58 | | 0.31 | | | | 0.024 | 27.0 | | 3.93 | 5.66 | 6.90 | 7.36 | 8.55 | 9.69 | >100 | |
| P110 | 42" x 29" CMAP | 60 | | 1.88 | | | | 0.024 | 51.0 | 25.5 | 6.92 | 10.26 | 12.80 | 13.52 | 15.89 | 18.24 | >100 | 50% |
| P111 | 2 - 42" x 29" CMAP | 45 | | 0.18 | | | | 0.024 | 101.0 | 85.9 | 35.48 | 49.47 | 59.98 | 66.98 | 77.29 | 87.74 | 100 | 85% |
| P112 | 2 - 42" x 29" CMAP | 45 | | 0.45 | | | | 0.024 | 112.0 | 50.4 | 39.27 | 55.44 | 67.90 | 76.08 | 87.99 | 100.11 | <5 | 45% |
| P113 | 18" CMP - Reservoir | 52 | | 5.79 | | | | 0.024 | 18.0 | | 9.37 | 13.10 | 13.56 | 14.06 | 14.60 | 15.14 | >100 | Flap Gate |
| P114 | 18" CMP | 67 | | 6.50 | | | | 0.024 | 17.0 | 8.5 | NA | NA | NA | NA | NA | NA | NA | Recommend Abandon |
| D101 | N. side of Well Rd. | 850 | 12 | 0.24 | 5 | 5 | 2.5 | 0.080 | 77.5 | | 10.11 | 14.42 | 17.59 | 19.59 | 22.79 | 25.89 | >>100 | |
| D102 | Hays Dr. SE-Bound Roadside | 340 | 5 | 0.21 | 10 | 15 | 3.0 | 0.030 | 395.1 | | 6.15 | 8.65 | 10.54 | 11.80 | 13.53 | 15.27 | >>100 | |
| D103 | Hays Dr. SE-Bound Roadside | 500 | 8 | 0.15 | 4 | 4 | 4.0 | 0.030 | 325.7 | | 35.53 | 49.52 | 60.11 | 67.20 | 77.50 | 88.02 | >>100 | |
| D104 | Big Lakes Frontage | 190 | 4 | 0.18 | 4 | 6 | 4.0 | 0.030 | 336.1 | | 8.65 | 12.15 | 14.80 | 16.46 | 18.98 | 21.52 | >>100 | |
| D105 | Big Lakes Frontage | 225 | 4 | 0.12 | 4 | 4 | 2.0 | 0.030 | 45.9 | | 8.71 | 12.27 | 14.94 | 16.91 | 19.44 | 22.04 | >>100 | |
| D106 | Big Lakes Frontage | 135 | 4 | 1.90 | 4 | 4 | 1.5 | 0.030 | 96.9 | | 8.30 | 11.64 | 14.16 | 15.77 | 18.16 | 20.55 | >>100 | |
| D107 | KEC Frontage | 230 | 4 | -0.19 | 4 | 4 | 3.0 | 0.030 | 75.0 | | 5.35 | 7.65 | 9.27 | 9.84 | 11.54 | 12.93 | >>100 | |
| D108 | Pawnee Frontage | 160 | 4 | 0.76 | 4 | 4 | 2.0 | 0.030 | 115.5 | | 3.30 | 4.60 | 5.57 | 5.96 | 6.86 | 7.76 | >>100 | |
| D109 | Hawley Frontage | 160 | 4 | 1.14 | 5 | 5 | 2.0 | 0.030 | 162.8 | | 2.11 | 3.01 | 3.70 | 3.99 | 4.62 | 5.25 | >>100 | |
| D110 | Tri City Frontage | 190 | 1 | 0.38 | 4 | 4 | 2.3 | 0.030 | 80.0 | | 3.94 | 5.66 | 6.99 | 7.45 | 8.66 | 9.81 | >>100 | |
| D111 | Levy Trail Pkg. Frontage | 220 | 4 | 1.18 | 4 | 4 | 2.3 | 0.030 | 197.3 | | 3.23 | 4.93 | 6.28 | 7.04 | 8.31 | 9.60 | >>100 | |
| D112 | Parker Frontage | 440 | 8 | 0.14 | 4 | 4 | 4.0 | 0.030 | 314.7 | | 39..29 | 55.45 | 67.94 | 76.19 | 88.13 | 100.25 | >>100 | |
| D113 | Parker Pkg. Frontage | 440 | 9 | -0.02 | 4 | 4 | 4.5 | 0.030 | 257.4 | | 35.50 | 50.92 | 62.72 | 70.84 | 81.92 | 93.15 | >>100 | |
| D114 | Reservoir Stream | 640 | 8 | 0.10 | 3 | 3 | 2.0 | 0.028 | 57.7 | | 34.05 | 50.41 | 63.42 | 73.95 | 86.89 | 100.84 | <10 | |

Elements deficient under Existing (and Developed) Conditions
Additional Elements deficient under Developed Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P201 | 21" RCP | 24 | | 0.92 | | | | 0.013 | 17.1 | | 19.65 | 26.98 | 32.47 | 35.60 | 40.71 | 45.80 | <2 | |
| P202 | 24" RCP | 477 | | 0.60 | | | | 0.013 | 20.0 | | 31.56 | 43.14 | 51.77 | 55.74 | 63.74 | 71.70 | <2 | |
| P203 | 15" CMP | 41 | | 0.29 | | | | 0.024 | 4.7 | | 2.77 | 3.76 | 4.50 | 4.81 | 5.49 | 6.15 | >10 | |
| P204 | 24" CMP | 40 | | 0.40 | | | | 0.024 | 11.6 | 4.6 | 2.76 | 3.75 | 4.49 | 4.80 | 5.47 | 6.13 | >10 | 40% |
| P205 | 28"x20" CMAP | 41 | | 0.57 | | | | 0.025 | 15.9 | 6.4 | 5.90 | 8.02 | 9.61 | 10.49 | 11.96 | 13.43 | >2 | 40% |
| P206 | 28"x20" CMAP | 31 | | 0.77 | | | | 0.025 | 16.1 | 6.4 | 5.73 | 7.84 | 9.39 | 10.23 | 11.61 | 13.03 | >2 | 40% |
| P207 | 28"x20" CMAP | 31 | | 0.26 | | | | 0.025 | 16.3 | 6.5 | 9.26 | 12.60 | 15.08 | 16.05 | 18.40 | 20.56 | <2 | 40% |
| P208 | 28"x20" CMAP | 36 | | 0.47 | | | | 0.025 | 17.7 | 2.7 | 14.57 | 19.99 | 24.08 | 26.00 | 29.79 | 33.40 | <<2 | 15% |
| P209 | 28"x20" CMAP | 36 | | 0.87 | | | | 0.025 | 17.2 | 1.7 | 14.37 | 19.70 | 23.66 | 25.14 | 28.91 | 32.46 | <<2 | 10% |
| P210 | 28"x20" CMAP | 34 | | 1.13 | | | | 0.025 | 18.3 | 5.5 | 17.44 | 24.31 | 29.46 | 31.23 | 36.08 | 40.70 | <<2 | 30% |
| P211 | 30" CMP | 64 | | 0.28 | | | | 0.024 | 28.3 | 2.8 | 20.79 | 29.18 | 35.55 | 37.47 | 43.14 | 48.66 | <<2 | 10% |
| P212 | 30" CMP | 43 | | 0.05 | | | | 0.024 | 23.1 | | 19.84 | 28.00 | 34.31 | 36.16 | 41.74 | 47.09 | >2 | |
| P213 | 18" CMP | 37 | | 0.03 | | | | 0.024 | 8.4 | 5.0 | 9.12 | 12.51 | 15.05 | 15.98 | 18.32 | 20.64 | <2 | 60% |
| P214 | 23"x14" RCPHE | 50 | | 0.34 | | | | 0.013 | 10.9 | 4.4 | 16.49 | 22.54 | 27.07 | 28.86 | 33.10 | 37.31 | <<2 | 40% |
| P215 | 28"x20" CMAP | 29 | | 1.62 | | | | 0.025 | 19.1 | 3.8 | 18.11 | 25.27 | 30.67 | 32.50 | 37.48 | 42.46 | <<2 | 20%, Damaged |
| P216 | 28"x20" CMAP | 37 | | 1.63 | | | | 0.025 | 15.4 | 4.6 | 18.42 | 25.85 | 31.79 | 33.04 | 38.57 | 43.27 | <<2 | 30%, Damaged |
| P217 | 28"x20" CMAP | 60 | | 1.11 | | | | 0.025 | 17.3 | 5.2 | 23.44 | 32.97 | 40.25 | 43.34 | 49.88 | 56.64 | <<2 | 30%, Damaged |
| P218 | 28"x20" CMAP | 64 | | 0.31 | | | | 0.025 | 17.6 | 8.8 | 24.76 | 34.72 | 42.37 | 45.37 | 52.22 | 59.20 | <<2 | 50% |
| P219 | 35"x24" CMAP | 67 | | 0.24 | | | | 0.025 | 29.8 | 20.9 | 27.49 | 38.71 | 47.37 | 51.46 | 59.36 | 67.33 | <2 | 70% |
| P220 | 35"x24" CMAP | 25 | | 0.31 | | | | 0.025 | 45.2 | | 28.22 | 39.78 | 48.66 | 52.75 | 60.81 | 68.94 | <10 | |
| P221 | 12" CMP | 70 | | 0.00 | | | | 0.024 | 2.4 | | 6.68 | 9.14 | 10.93 | 11.33 | 12.98 | 14.63 | <2 | |
| P222 | 15" HDPE | 36 | | 1.04 | | | | 0.018 | 6.5 | 6.2 | 1.07 | 1.56 | 1.94 | 2.17 | 2.52 | 2.88 | >100 | 95% |
| P223 | 15" HDPE | 24 | | 0.72 | | | | 0.018 | 6.7 | 0.3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | N/A | 5%, Receives no flow |
| P224 | 2-28"x20" CMAP | 56 | | 0.30 | | | | 0.025 | 28.8 | | 11.66 | 15.23 | 17.92 | 18.42 | 20.91 | 23.25 | >100 | |
| P225 | 2-42"x29" CMAP | 60 | | 0.30 | | | | 0.025 | 89.5 | | 16.17 | 21.56 | 25.41 | 25.66 | 29.10 | 32.63 | >100 | |
| P226 | 42" CMP | 79 | | 0.93 | | | | 0.024 | 78.3 | | 47.35 | 65.21 | 78.45 | 82.98 | 95.00 | 107.16 | 10 | |
| P227 | 42" CMP | 53 | | 0.15 | | | | 0.024 | 62.6 | | 114.16 | 159.85 | 194.32 | 210.19 | 241.65 | 273.01 | <2 | |
| P228 | 48" CMP | 50 | | 0.04 | | | | 0.024 | 113.9 | | 114.85 | 161.29 | 196.27 | 211.92 | 243.95 | 275.57 | 2 | |
| P229 | 48" CMP | 250 | | 0.23 | | | | 0.024 | 80.9 | | 110.94 | 155.29 | 189.68 | 205.45 | 237.07 | 267.84 | <2 | |
| P230 | 48" RCP | 246 | | 0.04 | | | | 0.013 | 118.4 | | 139.86 | 196.57 | 239.65 | 256.88 | 296.15 | 334.55 | <2 | |
| P231 | 48" RCP | 280 | | 0.42 | | | | 0.013 | 119.0 | | 139.96 | 196.94 | 240.48 | 258.26 | 297.88 | 336.55 | <2 | |
| P232 | 15" RCP | 15 | | 3.00 | | | | 0.013 | 11.9 | | 2.02 | 3.02 | 3.79 | 4.32 | 5.06 | 5.79 | >100 | |
| P233 | 30" CMP | 85 | | 0.30 | | | | 0.025 | 39.3 | | 41.29 | 58.21 | 71.24 | 79.16 | 91.45 | 103.77 | 2 | |
| P234 | 15" RCP | 57 | | 0.30 | | | | 0.013 | 9.4 | | 1.89 | 2.69 | 3.30 | 3.69 | 4.26 | 4.82 | >100 | |
| P235 | 15" RCP | 197 | | 0.30 | | | | 0.013 | 5.8 | | 1.43 | 2.03 | 2.50 | 2.60 | 3.02 | 3.43 | >100 | |
| P236 | 30" RCP | 99 | | 0.65 | | | | 0.013 | 46.0 | | 39.28 | 55.09 | 67.25 | 74.52 | 85.95 | 97.43 | >2 | |
| P237 | 24" CMP | 62 | | 0.50 | | | | 0.024 | 21.3 | | 24.10 | 34.05 | 41.69 | 47.52 | 54.89 | 62.58 | 2 | |
| P238 | 24" CMP | 68 | | 0.15 | | | | 0.024 | 18.3 | | 23.64 | 33.30 | 40.75 | 46.50 | 53.82 | 60.98 | <2 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P239 | 24" CMP | 59 | | 0.21 | | | | 0.024 | 18.7 | | 16.90 | 23.51 | 28.45 | 31.71 | 36.51 | 41.01 | >2 | |
| P240 | 24"x18" CMAP | 56 | | 0.04 | | | | 0.025 | 12.9 | | 16.62 | 22.88 | 27.61 | 30.21 | 34.55 | 38.94 | <2 | |
| P241 | 24"x18" CMAP | 45 | | 0.45 | | | | 0.025 | 12.2 | | 16.82 | 23.10 | 27.80 | 30.43 | 34.79 | 39.19 | <2 | |
| P242 | 24"x18" CMAP | 45 | | 0.29 | | | | 0.025 | 11.9 | | 12.11 | 16.53 | 19.83 | 21.62 | 24.86 | 27.81 | 2 | |
| P243 | 10" HDPE | 50 | | 0.66 | | | | 0.018 | 3.2 | | 4.86 | 6.66 | 8.01 | 8.62 | 9.85 | 11.08 | <2 | |
| P244 | 24" RCP | 346 | | 0.46 | | | | 0.013 | 19.2 | | 8.62 | 12.51 | 15.49 | 17.78 | 20.66 | 23.54 | 50 | |
| P245 | 54"x34" RCPHE | 30 | | 3.90 | | | | 0.013 | 113.3 | | 16.18 | 22.21 | 26.75 | 28.26 | 32.46 | 36.61 | >100 | |
| P246 | 2-18" CMP | 59 | | 0.55 | | | | 0.024 | 14.6 | | 12.77 | 17.51 | 21.05 | 22.70 | 25.99 | 29.26 | >2 | |
| P247 | 2-18" CMP | 40 | | 0.03 | | | | 0.024 | 15.6 | | 9.69 | 13.35 | 16.09 | 17.48 | 20.01 | 22.51 | 10 | |
| P248 | 21" CMP | 49 | | 0.16 | | | | 0.024 | 9.4 | | 9.83 | 13.50 | 16.25 | 17.62 | 20.15 | 22.67 | 2 | |
| P249 | 23"x14" RCPHE | 53 | | 1.43 | | | | 0.013 | 10.0 | | 9.99 | 13.72 | 16.51 | 17.93 | 20.50 | 23.05 | 2 | |
| P250 | 18" RCP | 36 | | 1.00 | | | | 0.013 | 16.6 | | 3.03 | 4.35 | 5.33 | 5.59 | 6.49 | 7.37 | >100 | |
| P251 | 15" CMP | 83 | | 1.00 | | | | 0.024 | 6.6 | | 3.04 | 4.37 | 5.34 | 5.63 | 6.52 | 7.41 | 50 | |
| P252 | 15" RCP | 88 | | 0.40 | | | | 0.013 | 8.0 | | 0.75 | 1.11 | 1.38 | 1.51 | 1.76 | 2.01 | >>100 | |
| | | | | | | | | | | | | | | | | | | |
| D201 | Bryant Frontage | 83 | 0.5 | -0.43 | 4 | 4 | 2.4 | 0.030 | 27.0 | | 5.75 | 7.86 | 9.42 | 10.27 | 11.66 | 13.08 | >100 | |
| D202 | McKinzie Pest Frontage | 145 | 0.5 | 0.18 | 4 | 4 | 2.4 | 0.030 | 58.0 | | 9.30 | 12.68 | 15.17 | 16.20 | 18.57 | 20.74 | >100 | |
| D203 | Bob's Frontage | 75 | 0.5 | -0.04 | 4 | 4 | 2.0 | 0.030 | 21.0 | | 14.39 | 19.71 | 23.68 | 25.29 | 29.08 | 32.64 | <10 | |
| D204 | Gymnastics Frontage | 241 | 5 | 0.40 | 4 | 3 | 1.5 | 0.030 | 39.0 | | 17.20 | 23.85 | 28.95 | 29.96 | 34.38 | 38.72 | 100 | |
| D205 | Empty Lot on Hayes Dr. | 58 | 5 | -1.50 | 4 | 3 | 3.0 | 0.030 | 67.0 | | 20.13 | 28.34 | 34.68 | 36.60 | 42.22 | 47.59 | >100 | |
| D206 | Empty Lot on Hayes Dr. | 125 | 5 | 1.91 | 4 | 3 | 3.3 | 0.030 | 552.0 | | 28.26 | 39.63 | 48.52 | 50.48 | 58.36 | 66.04 | >>100 | |
| D207 | Hill and Co. Frontage | 190 | 4 | 0.90 | 4 | 4 | 2.0 | 0.030 | 126.0 | | 9.24 | 12.65 | 15.21 | 16.11 | 18.46 | 20.78 | >>100 | |
| D208 | Transportation Frontage | 46 | 4 | 1.74 | 4 | 4 | 2.0 | 0.030 | 175.0 | | 18.13 | 25.30 | 30.69 | 32.61 | 37.60 | 42.59 | >>100 | |
| D209 | Transportation Frontage | 127 | 4 | -0.56 | 4 | 4 | 2.0 | 0.030 | 26.0 | | 18.45 | 25.89 | 31.85 | 33.17 | 38.74 | 43.44 | 5 | |
| D210 | Transportation Frontage | 139 | 6 | 0.65 | 5 | 2 | 2.5 | 0.030 | 195.0 | | 23.50 | 33.03 | 40.30 | 43.44 | 49.98 | 56.77 | >>100 | |
| D211 | Transportation Frontage | 100 | 7 | 0.43 | 5 | 2 | 2.5 | 0.030 | 172.0 | | 25.07 | 35.18 | 42.95 | 45.89 | 52.83 | 59.91 | >>100 | |
| D212 | Storage Unit on Hayes Dr. | 63 | 7 | 0.60 | 5 | 2 | 3.0 | 0.030 | 300.0 | | 27.88 | 39.32 | 48.12 | 52.17 | 60.18 | 68.29 | >>100 | |
| D213 | Storage Unit on Hayes Dr. | 85 | 7 | 0.51 | 5 | 2 | 3.0 | 0.030 | 277.0 | | 28.34 | 39.96 | 48.88 | 52.95 | 61.04 | 69.21 | >>100 | |
| D214 | S. of Hill and Co. on Levee Dr. | 349 | 7 | 0.77 | 8 | 9 | 1.5 | 0.030 | 121.0 | | 6.78 | 9.26 | 11.17 | 11.69 | 13.38 | 15.07 | >>100 | |
| D215 | N. of Transportation on Levee | 480 | 6 | 0.03 | 8 | 6 | 1.5 | 0.030 | 20.0 | | 0.63 | 0.95 | 1.21 | 1.42 | 1.66 | 1.92 | >>100 | |
| D216 | Storage Unit on McCall Rd. | 200 | 0.5 | 0.30 | 5 | 13 | 2.3 | 0.030 | 138.0 | | 11.74 | 15.31 | 18.05 | 18.67 | 21.20 | 23.57 | >>100 | |
| D217 | Storage Unit on McCall Rd. | 230 | 0.5 | 0.30 | 4 | 6 | 2.8 | 0.030 | 132.0 | | 16.30 | 21.71 | 25.56 | 26.01 | 29.42 | 33.03 | >>100 | |
| D218 | Storage Unit on McCall Rd. | 270 | 0.5 | 0.30 | 4 | 6 | 3.3 | 0.030 | 204.0 | | 19.40 | 25.78 | 30.20 | 30.51 | 34.51 | 38.60 | >>100 | |
| D219 | Empty Lot on McCall Rd. | 123 | 6 | 0.11 | 4 | 4 | 4.0 | 0.030 | 249.0 | | 115.25 | 161.07 | 195.61 | 211.57 | 243.08 | 274.55 | >50 | |
| D220 | Waste Mgmt. Frontage | 101 | 6 | 0.62 | 4 | 4 | 4.3 | 0.030 | 682.0 | | 115.53 | 162.03 | 197.05 | 212.95 | 245.03 | 276.73 | >>100 | |
| D221 | Waste Mgmt. Frontage | 90 | 6 | 0.43 | 4 | 4 | 4.5 | 0.030 | 649.0 | | 115.85 | 162.81 | 198.46 | 213.82 | 246.46 | 278.19 | >>100 | |
| D222 | Wal-Mart on McCall Rd. | 287 | 8 | 0.36 | 6 | 4 | 2.0 | 0.030 | 126.0 | | 0.74 | 1.09 | 1.35 | 1.46 | 1.72 | 1.97 | >>100 | |
| D223 | Burnetts on Hayes Dr. | 170 | 4 | 0.48 | 4 | 4 | 2.0 | 0.030 | 92.0 | | 16.19 | 22.22 | 26.75 | 28.29 | 32.50 | 36.64 | >>100 | |
| D224 | Quiznos Frontage | 40 | 3 | 1.65 | 3 | 3 | 3.0 | 0.022 | 36.0 | | 12.81 | 17.56 | 21.12 | 22.94 | 26.26 | 29.56 | >100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D225 | Burnetts on McCall Rd. | 143 | 0.5 | -0.07 | 6 | 5 | 3.8 | 0.030 | 119.0 | | 24.13 | 34.16 | 41.84 | 47.66 | 55.25 | 63.02 | >100 | |
| D226 | Max. Performance Frontage | 111 | 0.5 | 0.12 | 6 | 5 | 3.5 | 0.030 | 47.0 | | 19.66 | 27.50 | 33.53 | 37.16 | 42.78 | 48.22 | 100 | |
| D227 | Abbott Aluminum Frontage | 81 | 1 | -0.11 | 5 | 7 | 2.5 | 0.030 | 52.0 | | 17.10 | 23.80 | 28.81 | 32.10 | 36.96 | 41.51 | >100 | |
| D228 | Willie's Car Wash Frontage | 178 | 1 | 0.13 | 5 | 7 | 2.5 | 0.030 | 84.0 | | 16.88 | 23.18 | 27.97 | 30.72 | 35.11 | 39.54 | >100 | |
| D229 | KSU Research Frontage | 311 | 5 | 0.13 | 8 | 6 | 2.0 | 0.030 | 74.0 | | 12.19 | 16.64 | 19.99 | 21.78 | 25.06 | 28.03 | >100 | |

Elements deficient under Existing (and Developed) Conditions
Additional Elements deficient under Developed Conditions

## Level of Service

**2006 Eastside Drainage Study**
**Levee Watershed (300)**
**Developed Conditions**

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P301 | 21" X 15" CMAP | 40 | | 0.15 | | | | 0.025 | 6.9 | | 14.67 | 20.50 | 24.89 | 27.06 | 31.15 | 35.24 | <2 | |
| P302 | 21" X 15" CMAP | 48 | | 0.33 | | | | 0.025 | 8.2 | | 18.51 | 26.04 | 31.72 | 33.47 | 38.57 | 43.72 | <2 | |
| P303 | 24" RCP | 78 | | 0.26 | | | | 0.013 | 33.5 | 30.2 | 5.59 | 9.32 | 12.34 | 14.73 | 17.89 | 20.91 | >100 | 90% |
| P304 | 18" CMP | 73 | | 2.21 | | | | 0.024 | 10.9 | | 3.89 | 5.52 | 6.77 | 7.56 | 8.71 | 9.82 | >100 | |
| P305 | 57"x38" CMAP | 310 | | 0.21 | | | | 0.013 | 59.3 | | 31.07 | 43.70 | 53.30 | 58.62 | 67.45 | 76.46 | 25 | |
| P306 | 30" RCP | 53 | | 0.53 | | | | 0.013 | 37.0 | | 5.32 | 7.39 | 8.97 | 9.67 | 11.03 | 12.52 | >>100 | |
| P307 | 12" RCP | 20 | | 6.20 | | | | 0.013 | 7.5 | | 2.85 | 4.18 | 5.19 | 5.83 | 6.79 | 7.74 | 100 | |
| P308 | 6'x2' RCB | 30 | | 0.23 | | | | 0.013 | 115.0 | | 25.05 | 35.48 | 43.49 | 46.49 | 53.68 | 60.86 | >100 | |
| P309 | 18" RCP | 52 | | 0.23 | | | | 0.013 | 16.4 | | 2.93 | 4.35 | 5.45 | 5.98 | 7.03 | 8.08 | >100 | |
| P310 | 57"x38" CMAP | 48 | | 0.54 | | | | 0.025 | 80.5 | | 18.49 | 26.37 | 32.56 | 35.57 | 41.20 | 46.73 | >100 | |
| P311 | 24" RCP | 56 | | 0.21 | | | | 0.013 | 30.6 | | 5.21 | 6.89 | 8.15 | 8.03 | 9.21 | 10.29 | >>100 | |
| P312 | 2 - 30" CMP | 20 | | 1.98 | | | | 0.024 | 42.1 | | 16.04 | 22.80 | 28.18 | 30.42 | 35.39 | 40.20 | >100 | |
| P313 | 2 - 24" X 18" CMAP | 80 | | 0.21 | | | | 0.025 | 16.2 | | 15.66 | 22.19 | 27.26 | 29.17 | 33.78 | 38.25 | 2 | 90 Deg. Bends |
| P314 | 2 - 21" X 15" CMAP | 41 | | 0.02 | | | | 0.025 | 12.6 | | 13.57 | 19.27 | 23.71 | 25.60 | 29.50 | 33.33 | <2 | |
| P315 | 24" RCP | 95 | | 6.00 | | | | 0.013 | 39.9 | | 26.15 | 30.87 | 32.88 | 34.93 | 37.05 | 39.24 | 100 | |
| D301 | Farrar Frontage | 330 | 8 | 0.10 | 13 | 4 | 1.5 | 0.030 | 45.3 | | 14.56 | 20.40 | 24.79 | 26.32 | 30.35 | 34.37 | >100 | |
| D302 | North roadside ditch | 90 | 4 | 0.14 | 16 | 4 | 3.0 | 0.030 | 257.4 | | 25.01 | 34.98 | 42.39 | 45.97 | 52.96 | 59.93 | >>100 | |
| D303 | South roadside ditch (by wells) | 134 | 4 | 0.11 | 4 | 3.5 | 3.0 | 0.030 | 107.1 | | 2.96 | 5.23 | 7.12 | 8.72 | 10.74 | 12.64 | >>100 | |
| D304 | W. of Animal Shelter | 450 | 8 | 0.37 | 3 | 3 | 6.0 | 0.080 | 401.0 | | 31.40 | 45.14 | 55.73 | 61.35 | 70.73 | 80.62 | >>100 | Lots of Brush |
| D305 | Quaker Frontage | 535 | 6 | 0.65 | 6 | 4 | 1.0 | 0.030 | 34.1 | | 3.89 | 5.53 | 6.77 | 7.56 | 8.72 | 9.82 | >>100 | |
| D306 | E. of Animal Shelter | 700 | 8 | 0.31 | 3 | 3 | 6.0 | 0.090 | 325.6 | | 40.14 | 56.78 | 69.97 | 78.03 | 90.18 | 103.14 | >>100 | Lots of Brush |
| D307 | W. side of RR tracks | 530 | 4 | 0.50 | 8 | 4 | 3.5 | 0.030 | 435.4 | | 5.32 | 7.41 | 8.99 | 9.70 | 11.06 | 12.54 | >>100 | |
| D308 | E. side of RR tracks | 530 | 2 | 0.50 | 4 | 5 | 3.5 | 0.030 | 292.6 | | 5.22 | 6.95 | 8.22 | 8.13 | 9.32 | 10.41 | >>100 | |
| D309 | TDM Frontage | 300 | 6 | 1.83 | 8 | 5 | 4.0 | 0.030 | 1447.1 | | 18.50 | 26.39 | 32.66 | 35.66 | 41.32 | 46.86 | >>100 | |
| D310 | TDM Frontage | 105 | 6 | 0.02 | 8 | 5 | 3.0 | 0.030 | 76.0 | | 16.05 | 20.84 | 28.19 | 30.45 | 35.42 | 40.24 | >100 | |
| D311 | Between TDM and 2-Wire | 154 | 6 | 0.27 | 30 | 6 | 2.0 | 0.030 | 227.4 | | 15.89 | 22.82 | 27.86 | 29.86 | 34.56 | 39.11 | >>100 | |
| D312 | Between TDM and 2-Wire | 230 | 6 | 0.21 | 30 | 6 | 2.1 | 0.030 | 226.4 | | 13.72 | 22.66 | 23.87 | 25.88 | 29.80 | 33.65 | >>100 | |

Elements deficient under Existing (and Developed) Conditions
Additional Elements deficient under Developed Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P401 | 23"x14" RCPHE | 57 | | 0.76 | | | | 0.013 | 9.2 | 4.6 | 1.67 | 2.43 | 3.02 | 3.33 | 3.88 | 4.43 | >100 | 50% |
| P402 | 24" CMP | 31 | | 0.20 | | | | 0.024 | 13.2 | 10.6 | 2.36 | 3.55 | 4.47 | 5.03 | 5.91 | 6.78 | >100 | 80% |
| P403 | 34"x22" RCPHE | 49 | | 0.16 | | | | 0.013 | 32.7 | | 16.63 | 23.18 | 28.08 | 30.23 | 34.76 | 39.26 | <50 | |
| P404 | 18" CMP | 33 | | 1.26 | | | | 0.024 | 10.4 | 1.0 | 19.27 | 26.85 | 32.51 | 34.89 | 40.11 | 45.28 | <<2 | 10% |
| P405 | 24" CMP | 39 | | 0.28 | | | | 0.024 | 15.6 | 9.4 | 21.05 | 29.39 | 35.55 | 38.29 | 44.03 | 49.71 | <2 | 60%, Damaged |
| P406 | 23"x14" RCPHE | 52 | | -0.57 | | | | 0.013 | 17.2 | | 12.95 | 17.18 | 20.26 | 20.97 | 23.78 | 26.59 | 5 | |
| P407 | 24" CMP | 62 | | 0.79 | | | | 0.024 | 20.7 | | 31.14 | 42.98 | 51.86 | 56.95 | 65.42 | 74.12 | <2 | |
| P408 | 18" CMP | 72 | | 3.61 | | | | 0.024 | 6.3 | | 7.48 | 10.18 | 12.20 | 13.02 | 14.84 | 16.76 | <2 | |
| P409 | 18" CMP | 29 | | 0.91 | | | | 0.024 | 8.3 | 0.0 | 5.22 | 7.14 | 8.58 | 9.25 | 10.57 | 11.88 | <<2 | Clogged |
| P410 | 21" RCP | 55 | | 0.98 | | | | 0.013 | 32.7 | | 38.49 | 53.05 | 63.93 | 69.76 | 80.02 | 90.60 | <2 | |
| P411 | 12" PVC | 40 | | 0.35 | | | | 0.012 | 6.2 | | 12.94 | 17.79 | 21.37 | 22.74 | 26.01 | 29.27 | <2 | |
| P412 | 12" HDPE | 20 | | 0.70 | | | | 0.018 | 4.5 | 2.7 | 7.44 | 10.21 | 12.29 | 13.08 | 14.95 | 16.80 | <2 | 60% |
| P413 | 12" CMP | 23 | | 0.78 | | | | 0.024 | 5.8 | 5.2 | 2.63 | 3.60 | 4.32 | 4.42 | 5.05 | 5.67 | 50 | 90% |
| P414 | 30"x19" RCPHE | 113 | | 0.68 | | | | 0.013 | 23.0 | | 7.51 | 9.75 | 11.43 | 11.79 | 13.27 | 14.78 | >100 | |
| P415 | 45"x29" RCPHE | 113 | | 0.00 | | | | 0.013 | 53.7 | | 10.24 | 13.37 | 15.66 | 15.84 | 17.95 | 20.06 | >100 | |
| P416 | 45"x29" RCPHE | 112 | | 0.26 | | | | 0.013 | 53.2 | | 12.97 | 16.89 | 19.81 | 20.96 | 23.73 | 26.48 | >100 | |
| P417 | 53"x34" RCPHE | 146 | | 0.35 | | | | 0.013 | 72.4 | | 16.40 | 21.32 | 25.03 | 26.43 | 29.90 | 33.35 | >100 | |
| P418 | 53"x34" RCPHE | 107 | | 1.01 | | | | 0.013 | 80.0 | | 22.71 | 29.61 | 34.80 | 37.01 | 41.86 | 46.70 | >100 | |
| P419 | 38"x24" RCPHE | 43 | | 2.56 | | | | 0.013 | 51.4 | | 1.65 | 2.34 | 2.86 | 3.20 | 3.70 | 4.19 | >>100 | |
| P420 | 68"x43" RCPHE | 266 | | 0.49 | | | | 0.013 | 137.0 | | 30.69 | 40.40 | 47.74 | 51.31 | 58.12 | 64.92 | >100 | |
| P421 | 18" RCP | 142 | | 0.65 | | | | 0.013 | 12.4 | | 7.99 | 10.36 | 12.14 | 12.81 | 14.44 | 16.09 | 10 | |
| P422 | 68"x43" RCPHE | 102 | | -0.03 | | | | 0.013 | 192.3 | | 56.30 | 74.84 | 88.78 | 94.97 | 107.85 | 120.73 | >100 | |
| P423 | 68"x43" RCPHE | 112 | | 0.16 | | | | 0.013 | 213.4 | | 93.72 | 126.54 | 151.03 | 162.74 | 185.57 | 208.71 | >100 | |
| P424 | 68"x43" RCPHE | 280 | | 0.16 | | | | 0.013 | 188.0 | | 93.71 | 126.08 | 149.62 | 160.92 | 183.45 | 206.24 | >50 | |
| P425 | 15" RCP | 48 | | 1.29 | | | | 0.013 | 10.8 | | 7.75 | 10.30 | 12.22 | 13.35 | 15.16 | 16.98 | <10 | |
| P426 | 15" RCP | 78 | | 1.15 | | | | 0.013 | 9.7 | | 4.02 | 5.21 | 6.09 | 6.31 | 7.10 | 7.90 | >100 | |
| P427 | 15" RCP | 27 | | 1.74 | | | | 0.013 | 11.6 | | 2.44 | 3.46 | 4.23 | 4.73 | 5.46 | 6.19 | >100 | |
| P428 | 68"x43" RCPHE | 203 | | 0.05 | | | | 0.013 | 212.3 | | 97.99 | 132.23 | 157.28 | 168.54 | 192.40 | 216.51 | <100 | |
| P429 | 68"x43" RCPHE | 174 | | 0.33 | | | | 0.013 | 201.6 | | 100.39 | 135.28 | 161.10 | 172.07 | 196.49 | 221.02 | >50 | |
| P430 | 68"x43" RCPHE | 125 | | 0.11 | | | | 0.013 | 197.5 | | 108.95 | 146.22 | 173.96 | 186.73 | 213.09 | 239.58 | >25 | |
| P431 | 15" RCP | 45 | | 1.27 | | | | 0.013 | 12.9 | | 10.13 | 13.24 | 15.59 | 16.95 | 19.15 | 21.35 | 5 | |
| P432 | 15" HDPE | 84 | | 3.10 | | | | 0.018 | 8.0 | | 1.27 | 1.81 | 2.23 | 2.41 | 2.79 | 3.17 | >100 | |
| P433 | 15" RCP | 20 | | 3.75 | | | | 0.013 | 7.2 | | 9.27 | 12.03 | 14.10 | 15.01 | 16.92 | 18.83 | <2 | |
| P434 | 18" RCP | 271 | | 0.32 | | | | 0.013 | 9.2 | | 5.77 | 7.58 | 8.92 | 9.60 | 10.84 | 12.09 | 10 | |
| P435 | 27" RCP | 125 | | 0.88 | | | | 0.013 | 32.6 | | 7.28 | 9.55 | 11.24 | 12.14 | 13.74 | 15.31 | >100 | |
| P436 | 24" RCP | 336 | | 0.37 | | | | 0.013 | 18.9 | | 3.55 | 4.67 | 5.51 | 5.61 | 6.36 | 7.11 | >100 | |
| P437 | 42"x32" RCPHE | 80 | | 0.76 | | | | 0.013 | 73.3 | | 15.17 | 19.84 | 23.33 | 25.23 | 28.52 | 31.77 | >100 | |
| P438 | 36" RCP | 495 | | 0.24 | | | | 0.013 | 39.2 | | 34.44 | 45.47 | 53.85 | 57.36 | 65.10 | 72.65 | >2 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P439 | 12" HDPE | 275 | | 0.28 | | | | 0.018 | 1.7 | 0.8 | 2.06 | 2.61 | 3.04 | 3.19 | 3.58 | 3.97 | <2 | 50% |
| P440 | 18" RCP | 39 | | 0.04 | | | | 0.013 | 15.3 | | 5.61 | 7.59 | 9.08 | 9.88 | 11.25 | 12.62 | >100 | |
| P441 | 24" RCP | 64 | | 0.04 | | | | 0.013 | 32.8 | | 6.23 | 8.39 | 10.02 | 11.21 | 12.77 | 14.32 | >100 | |
| P442 | 18" RCP | 39 | | 0.07 | | | | 0.013 | 14.8 | | 7.05 | 9.30 | 10.97 | 11.99 | 13.56 | 15.14 | 100 | |
| P443 | 24" RCP | 14 | | 12.82 | | | | 0.013 | 37.1 | | 7.82 | 10.29 | 12.13 | 13.54 | 15.32 | 17.09 | >100 | |
| P444 | 15" RCP | 40 | | 4.82 | | | | 0.013 | 10.5 | | 1.85 | 2.39 | 2.79 | 2.94 | 3.31 | 3.68 | >100 | |
| P445 | 15" RCP | 18 | | 10.14 | | | | 0.013 | 14.1 | | 3.26 | 4.21 | 4.92 | 5.18 | 5.83 | 6.49 | >100 | |
| P446 | 12" RCP | 72 | | 4.53 | | | | 0.013 | 5.1 | 0.0 | 9.14 | 11.89 | 13.94 | 14.87 | 16.77 | 18.67 | <<2 | Clogged |
| P447 | 18" RCP | 93 | | 2.29 | | | | 0.013 | 8.0 | | 14.28 | 18.54 | 21.72 | 23.10 | 26.05 | 28.97 | <2 | |
| P448 | 18" RCP | 48 | | 1.49 | | | | 0.013 | 21.7 | | 19.63 | 25.49 | 29.86 | 31.79 | 35.85 | 39.87 | >2 | |
| P449 | 18" RCP | 18 | | 0.33 | | | | 0.013 | 23.0 | | 21.94 | 28.49 | 33.38 | 35.54 | 40.07 | 44.58 | >2 | |
| P450 | 18" CMP | 30 | | 0.40 | | | | 0.024 | 7.4 | | 0.52 | 0.75 | 0.93 | 1.03 | 1.20 | 1.37 | >>100 | |
| P451 | 18" RCP | 496 | | 0.62 | | | | 0.013 | 9.3 | | 15.20 | 20.71 | 24.79 | 26.08 | 29.81 | 33.51 | <2 | |
| P452 | 18" RCP and 30"x19" RCPHE | 209 | | 0.18 | | | | 0.013 | 12.6 | | 12.52 | 17.16 | 20.56 | 22.18 | 25.32 | 28.45 | 2 | Transitions in middle |
| P453 | 30"x19" RCPHE | 115 | | 1.89 | | | | 0.013 | 33.2 | | 6.19 | 8.00 | 9.35 | 9.75 | 10.98 | 12.22 | >100 | |
| | | | | | | | | | | | | | | | | | | |
| D401 | Rear of Hobby Lobby/Staples | 508 | 4 | 0.50 | 0 | 0 | 2.5 | 0.014 | 80.7 | | 13.18 | 17.46 | 20.56 | 21.36 | 24.20 | 27.04 | >>100 | |
| D402 | Manko Frontage on Hayes Dr. | 57 | 4 | 1.71 | 6 | 6 | 1.5 | 0.030 | 116.0 | | 2.37 | 3.57 | 4.49 | 5.05 | 5.92 | 6.80 | >>100 | |
| D403 | Autocraft Frontage on Hayes | 175 | 6 | 0.67 | 6 | 7 | 2.3 | 0.030 | 225.1 | | 3.32 | 4.87 | 6.05 | 6.83 | 7.98 | 9.13 | >>100 | |
| D404 | Westgate Auto Frontage | 103 | 6 | 0.25 | 4 | 6 | 2.5 | 0.030 | 148.3 | | 21.22 | 29.64 | 35.85 | 38.53 | 44.32 | 50.04 | >>100 | |
| D405 | Goodson Auto Frontage | 184 | 6 | 1.36 | 4 | 4 | 2.5 | 0.030 | 304.0 | | 22.53 | 31.50 | 38.14 | 40.97 | 47.14 | 53.27 | >>100 | |
| D406 | N. ditch on Service Cir. | 136 | 3 | 0.82 | 7 | 6 | 2.0 | 0.030 | 152.6 | | 13.39 | 18.44 | 22.19 | 23.53 | 26.95 | 30.33 | >>100 | |
| D407 | N. ditch on Service Cir. | 106 | 2 | -0.30 | 6 | 5 | 1.7 | 0.030 | 47.5 | | 12.98 | 17.86 | 21.45 | 22.83 | 26.13 | 29.40 | >100 | |
| D408 | S. ditch on Service Cir. | 188 | 3 | -0.02 | 4 | 6 | 1.8 | 0.030 | 14.3 | | 3.00 | 4.23 | 5.12 | 5.39 | 6.32 | 7.46 | >>100 | |
| D409 | Ekart Frontage on Sarber Ln. | 56 | 2 | 0.16 | 6 | 8 | 2.0 | 0.030 | 65.9 | | 7.50 | 10.20 | 12.22 | 13.07 | 14.89 | 16.82 | >>100 | |
| D410 | Near Sirloin Stock. on Sarber | 212 | 5 | 0.40 | 4 | 6 | 2.0 | 0.030 | 105.3 | | 5.50 | 7.21 | 8.47 | 9.27 | 10.48 | 11.67 | >>100 | |

Elements deficient under Existing (and Developed) Conditions
Additional Elements deficient under Developed Conditions

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P501 | 24" CMP | 20 | | 1.98 | | | | 0.024 | 2.1 | 0.8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | N/A | 40%, Receives no flow |
| P502 | 21"x15" CMAP | 29 | | 0.35 | | | | 0.025 | 7.3 | | 0.51 | 0.79 | 1.01 | 1.11 | 1.32 | 1.53 | >>100 | |
| P503 | 38"x24" RCPHE | 57 | | -0.37 | | | | 0.013 | 38.0 | | 5.84 | 8.00 | 9.61 | 10.19 | 11.58 | 13.05 | >>100 | |
| P504 | 35"x24" CMAP | 65 | | 0.28 | | | | 0.025 | 28.0 | | 8.62 | 11.50 | 13.64 | 14.55 | 16.55 | 18.54 | >100 | |
| P505 | 24"x18" CMAP | 61 | | -0.99 | | | | 0.025 | 9.1 | | 4.39 | 5.73 | 6.73 | 6.96 | 7.86 | 8.76 | 100 | |
| P506 | 38"x24" RCPHE | 93 | | 0.81 | | | | 0.013 | 43.3 | | 16.91 | 22.78 | 27.09 | 28.69 | 32.59 | 36.68 | >100 | |
| P507 | 2-24" CMP | 49 | | 0.16 | | | | 0.024 | 32.0 | | 23.33 | 31.62 | 37.81 | 40.58 | 46.30 | 52.22 | 5 | |
| P508 | 21"x15" CMAP | 36 | | 0.50 | | | | 0.025 | 11.0 | | 16.43 | 22.10 | 26.32 | 28.22 | 32.12 | 36.01 | <2 | Privately owned |
| P509 | 24" RCP | 65 | | 1.27 | | | | 0.013 | 24.9 | | 7.77 | 10.62 | 12.74 | 13.24 | 15.10 | 16.95 | >100 | |
| P510 | 24" CMP | 77 | | 0.96 | | | | 0.024 | 17.3 | | 19.43 | 26.19 | 31.27 | 33.93 | 38.64 | 43.33 | <2 | |
| P511 | 2-35"x24" CMAP | 43 | | 0.86 | | | | 0.025 | 67.6 | | 32.73 | 44.69 | 53.56 | 57.17 | 65.39 | 73.80 | 50 | |
| P512 | 53"x34" RCPHE | 41 | | -0.02 | | | | 0.013 | 75.6 | | 32.09 | 44.58 | 53.96 | 57.80 | 65.83 | 75.39 | 100 | |
| P513 | 60"x42" RCPHE | 295 | | 0.37 | | | | 0.013 | 109.2 | | 34.41 | 48.11 | 58.41 | 62.39 | 71.22 | 81.53 | >100 | |
| P514 | 24" CMP | 56 | | 2.21 | | | | 0.024 | 21.8 | | 2.47 | 3.64 | 4.54 | 5.06 | 5.90 | 6.74 | >>100 | |
| P515 | 42" CMP | 63 | | -1.21 | | | | 0.024 | 55.5 | | 67.88 | 93.67 | 113.08 | 125.30 | 143.13 | 161.13 | <2 | |
| P516 | 24" CMP | 76 | | 0.08 | | | | 0.024 | 16.0 | | 7.45 | 10.05 | 11.99 | 12.99 | 14.83 | 16.66 | 100 | |
| P517 | 30" RCP | 59 | | 0.73 | | | | 0.013 | 45.2 | | 44.17 | 59.37 | 71.06 | 75.65 | 85.02 | 96.29 | 2 | |
| P518 | 18" CMP | 34 | | 1.57 | | | | 0.024 | 7.8 | | 1.38 | 1.99 | 2.45 | 2.75 | 3.19 | 3.62 | >100 | |
| P519 | 18" CMP | 35 | | 0.55 | | | | 0.024 | 8.2 | | 3.16 | 4.34 | 5.20 | 5.66 | 6.41 | 7.24 | >100 | |
| P520 | 24" CMP | 54 | | 0.22 | | | | 0.024 | 17.6 | | 5.04 | 7.27 | 8.97 | 10.39 | 12.07 | 13.76 | >100 | |
| P521 | 42"x29" CMAP | 40 | | 0.17 | | | | 0.025 | 47.7 | | 72.16 | 100.13 | 121.15 | 134.35 | 153.65 | 173.02 | <2 | |
| P522 | 2-36" CMP | 40 | | 0.33 | | | | 0.024 | 102.4 | | 74.46 | 102.96 | 124.48 | 138.11 | 157.92 | 177.85 | 5 | |
| P523 | 24" CMP | 42 | | 0.87 | | | | 0.024 | 12.8 | | 1.89 | 2.72 | 3.36 | 3.79 | 4.40 | 5.00 | >100 | |
| P524 | 18" HDPE | 41 | | 0.51 | | | | 0.018 | 9.1 | | 3.22 | 4.69 | 5.81 | 6.27 | 7.30 | 8.33 | >100 | |
| P525 | 18" HDPE | 41 | | 0.66 | | | | 0.018 | 8.6 | 1.7 | 3.77 | 5.55 | 6.91 | 7.41 | 8.70 | 9.99 | <2 | 20% |
| P526 | 24" CMP | 52 | | 0.21 | | | | 0.024 | 14.7 | | 10.93 | 15.32 | 18.70 | 20.14 | 23.28 | 26.03 | 5 | |
| P527 | 24" CMP | 40 | | 0.79 | | | | 0.024 | 13.9 | | 9.35 | 14.51 | 18.55 | 22.09 | 26.18 | 30.30 | <5 | |
| P528 | 30" CMP | 100 | | 0.25 | | | | 0.024 | 25.1 | 12.6 | 11.73 | 16.44 | 20.03 | 21.77 | 25.12 | 28.14 | >2 | 50%, Damaged |
| P529 | 18" CMP | 140 | | 0.23 | | | | 0.024 | 15.1 | | 9.76 | 15.00 | 19.08 | 22.71 | 26.84 | 30.97 | 5 | |
| P530 | 24" CMP | 40 | | 0.42 | | | | 0.024 | 21.7 | 10.9 | 12.07 | 17.02 | 20.81 | 22.68 | 26.32 | 29.65 | <2 | 50% |
| P531 | 23"x14" RCPHE | 60 | | 1.42 | | | | 0.013 | 14.8 | | 4.17 | 6.11 | 7.59 | 8.40 | 9.79 | 11.18 | >100 | |
| P532 | 34"x22" RCPHE | 45 | | 1.01 | | | | 0.013 | 40.9 | | 15.15 | 22.70 | 28.52 | 33.70 | 39.63 | 45.50 | >50 | |
| P533 | 24"x18" CMAP | 30 | | 0.50 | | | | 0.025 | 7.1 | | 3.11 | 5.44 | 7.34 | 8.96 | 10.94 | 12.98 | 10 | |
| P534 | 23"x14" RCPHE | 60 | | 1.42 | | | | 0.013 | 14.8 | | 2.00 | 2.91 | 3.61 | 3.98 | 4.63 | 5.28 | >100 | |
| P535 | 3'x2' RCB | 120 | | 0.21 | | | | 0.013 | 30.6 | | 36.99 | 53.42 | 65.96 | 74.33 | 86.49 | 98.17 | <2 | |
| P536 | 23"x14" RCPHE | 53 | | 4.04 | | | | 0.013 | 12.8 | | 10.01 | 14.10 | 17.19 | 18.85 | 21.76 | 24.67 | >2 | |
| P537 | 54"x38" CMAP | 70 | | 0.32 | | | | 0.025 | 95.4 | | 42.38 | 61.37 | 80.75 | 92.38 | 109.91 | 125.72 | >25 | |
| P538 | 23"x14" RCPHE | 61 | | 1.95 | | | | 0.013 | 19.8 | | 7.80 | 10.90 | 13.24 | 14.46 | 16.65 | 18.85 | >100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P539 | 42" CMP | 86 | | 0.76 | | | | 0.024 | 96.7 | | 43.29 | 65.36 | 82.48 | 94.08 | 111.84 | 127.94 | >25 | |
| P540 | 23"x14" RCPHE | 66 | | 3.45 | | | | 0.013 | 15.0 | | 3.26 | 4.28 | 5.04 | 5.40 | 6.11 | 6.81 | >>100 | |
| P541 | 5'x3' RCB | 62 | | 0.39 | | | | 0.013 | 125.3 | | 139.23 | 193.04 | 233.63 | 258.65 | 296.27 | 336.29 | <2 | |
| P542 | 24" CMP | 36 | | 6.87 | | | | 0.024 | 7.5 | | 5.02 | 6.89 | 8.26 | 8.58 | 9.80 | 11.00 | >5 | |
| P543 | 6'x4' RCB | 180 | | 0.16 | | | | 0.013 | 176.1 | | 220.46 | 308.82 | 376.14 | 416.27 | 478.54 | 544.73 | <2 | |
| P544 | 96" CMP | 72 | | 0.03 | | | | 0.024 | 610.1 | | 220.69 | 309.70 | 379.91 | 428.55 | 494.47 | 562.10 | >100 | |
| P545 | 34"x22" RCPHE | 42 | | -0.21 | | | | 0.013 | 34.2 | | 76.35 | 108.60 | 133.39 | 148.16 | 171.04 | 194.27 | <2 | |
| P546 | 18"x11" RCAP | 61 | | 3.70 | | | | 0.013 | 9.1 | | 2.67 | 3.88 | 4.79 | 5.28 | 6.15 | 7.02 | >100 | |
| P547 | 30"x24" RCPHE | 74 | | 0.03 | | | | 0.013 | 32.4 | | 67.58 | 96.53 | 118.55 | 132.18 | 152.42 | 173.37 | <2 | |
| P548 | 23"x14" RCPHE | 57 | | 3.04 | | | | 0.013 | 13.5 | | 2.42 | 3.50 | 4.33 | 4.81 | 5.59 | 6.38 | >100 | |
| P549 | 12" CMP | 31 | | 1.17 | | | | 0.024 | 2.8 | | 2.29 | 3.34 | 4.14 | 4.59 | 5.35 | 6.11 | >2 | |
| P550 | 12" CMP | 32 | | 0.31 | | | | 0.024 | 2.8 | | 15.34 | 22.08 | 27.24 | 30.77 | 35.70 | 40.62 | <2 | |
| P551 | 34"x22" RCPHE | 64 | | 0.67 | | | | 0.013 | 26.7 | | 24.38 | 34.87 | 42.99 | 47.23 | 54.78 | 63.00 | >2 | |
| P552 | 23"x14" RCPHE | 57 | | 1.54 | | | | 0.013 | 16.1 | | 2.67 | 3.88 | 4.79 | 5.28 | 6.14 | 7.01 | >100 | |
| P553 | 23"x14" RCPHE | 56 | | 1.08 | | | | 0.013 | 23.4 | | 10.00 | 13.16 | 15.51 | 16.70 | 18.88 | 21.06 | >100 | |
| P554 | 38"x24" RCPHE | 42 | | 7.17 | | | | 0.013 | 39.9 | 8.0 | 10.86 | 16.20 | 20.37 | 23.09 | 26.95 | 30.95 | <2 | 20% |
| P555 | 23"x14" RCPHE | 61 | | 1.24 | | | | 0.013 | 16.9 | | 2.83 | 4.00 | 4.89 | 5.43 | 6.27 | 7.11 | >100 | |
| P556 | 34"x22" RCPHE | 42 | | 0.39 | | | | 0.013 | 26.6 | | 10.45 | 15.26 | 18.90 | 20.35 | 23.27 | 27.15 | 100 | |
| P557 | 23"x14" RCPHE | 63 | | 1.24 | | | | 0.013 | 17.8 | | 4.42 | 6.22 | 7.59 | 7.91 | 9.09 | 10.28 | >100 | |
| P558 | 23"x14" RCPHE | 37 | | 0.50 | | | | 0.013 | 8.3 | | 3.45 | 5.56 | 7.23 | 8.03 | 9.64 | 11.27 | 25 | |
| P559 | 34"x22" RCPHE | 42 | | 0.07 | | | | 0.013 | 31.8 | 19.1 | 5.46 | 7.64 | 9.29 | 10.16 | 11.67 | 13.21 | >100 | 60% |
| P560 | 12" RCP | 55 | | 0.54 | | | | 0.013 | 5.7 | | 3.14 | 4.38 | 5.30 | 5.78 | 6.64 | 7.50 | 25 | |
| P561 | 18" CMP | 21 | | 0.54 | | | | 0.024 | 5.4 | | 1.67 | 2.42 | 2.99 | 3.34 | 3.88 | 4.42 | >100 | |
| P562 | 4-49"x33" & 1-28"x20" CMAP | 90 | | 0.39 | | | | 0.025 | 220.6 | 178.8 | 111.50 | 153.86 | 187.04 | 219.46 | 251.29 | 277.85 | <10 | Composite Values, 81% |
| P563 | 84" RCP | 120 | | 1.73 | | | | 0.013 | 807.0 | | 156.45 | 211.56 | 251.92 | 294.21 | 305.31 | 313.27 | >100 | |
| P564 | 24" CMP | 41 | | 0.93 | | | | 0.024 | 19.8 | | 5.75 | 7.90 | 9.51 | 10.11 | 11.57 | 13.03 | >100 | |
| P565 | 24" RCP | 197 | | 0.87 | | | | 0.013 | 21.1 | | 8.07 | 11.00 | 13.19 | 13.84 | 15.83 | 17.82 | <100 | |
| P566 | 24" CMP | 18 | | 0.16 | | | | 0.024 | 23.9 | | 75.70 | 107.89 | 132.64 | 147.69 | 170.33 | 193.93 | <<2 | |
| P567 | 2-28"x20" CMAP & 1-24" CMP | 56 | | 0.33 | | | | 0.024 | 67.8 | 66.4 | 6.74 | 12.19 | 16.74 | 21.10 | 26.00 | 31.03 | >100 | Composite Values, 98% |
| | | | | | | | | | | | | | | | | | | |
| D501 | Quaker Ditch on Kretschmer | 173 | 4.5 | 0.93 | 4 | 4 | 2.2 | 0.030 | 161.3 | | 4.62 | 6.25 | 7.47 | 7.81 | 8.92 | 10.04 | >>100 | |
| D502 | Kretschmer Dr. | 190 | 5 | 0.83 | 5.5 | 4 | 3.0 | 0.030 | 371.0 | | 5.98 | 8.16 | 9.81 | 10.36 | 11.84 | 13.30 | >>100 | |
| D503 | Manhattan Wrecker Frontage | 142 | 6 | 0.21 | 5 | 4 | 4.0 | 0.030 | 249.3 | | 16.95 | 22.80 | 27.13 | 28.87 | 32.77 | 36.88 | >>100 | |
| D504 | Kretschmer Dr. | 349 | 4 | 0.52 | 4 | 3.5 | 3.0 | 0.045 | 231.2 | | 23.70 | 32.05 | 38.27 | 41.16 | 46.93 | 52.90 | >>100 | Brush |
| D505 | Kretschmer Dr. | 450 | 5.25 | 0.46 | 3 | 4 | 2.5 | 0.030 | 153.9 | | 7.78 | 10.63 | 12.75 | 13.26 | 15.12 | 16.97 | >>100 | |
| D506 | Farm Bureau Frontage | 130 | 7 | 0.61 | 4 | 4 | 4.0 | 0.030 | 622.0 | | 32.78 | 44.72 | 53.61 | 57.32 | 65.58 | 74.02 | >>100 | |
| D507 | McCall Ditch on Kretschmer | 763 | 9 | 0.26 | 2 | 5 | 2.5 | 0.030 | 155.2 | | 38.44 | 51.55 | 61.56 | 65.60 | 73.44 | 83.16 | >>100 | |
| D508 | Kretschmer Dr. | 421 | 10 | 0.05 | 4 | 5.5 | 2.0 | 0.030 | 52.3 | | 32.36 | 44.94 | 54.36 | 58.16 | 66.21 | 75.81 | 10 | |
| D509 | Orcheln Frontage on McCall | 162 | 5 | 0.07 | 4.5 | 4 | 2.0 | 0.030 | 40.1 | | 3.16 | 4.34 | 5.21 | 5.70 | 6.45 | 7.28 | >>100 | |

## Level of Service

| Reach ID | Description | Length (ft) | Bottom Width(ft) | Pipe or Ditch Slope (%) | L. Side Slope xH:1V | R. Side Slope xH:1V | Ditch Depth | Manning's n | Theoretical $Q_{MAX}$ (CFS) | Adjusted $Q_{MAX}$ (CFS) | Q2 (CFS) | Q5 (CFS) | Q10 (CFS) | Q25 (CFS) | Q50 (CFS) | Q100 (CFS) | LOS (Years) | Comments (Percentages indicate the effective area available for flow) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D510 | McCall Rd. | 830 | 6 | 0.14 | 3 | 3 | 3.0 | 0.030 | 123.8 | | 68.43 | 94.26 | 113.71 | 126.09 | 143.96 | 162.02 | 25 | |
| D511 | McCall Pattern Frontage | 495 | 4 | 0.38 | 5.3 | 3.8 | 2.0 | 0.030 | 88.4 | | 7.67 | 10.33 | 12.30 | 13.26 | 15.13 | 16.99 | >>100 | |
| D512 | McCall Rd. | 174 | 4 | 0.33 | 2.5 | 2.5 | 3.5 | 0.020 | 198.9 | | 72.35 | 100.27 | 121.25 | 134.38 | 153.70 | 173.44 | >100 | Brush in Cracks |
| D513 | Jon Murdock along McCall Rd. | 271 | 6 | 0.21 | 2.5 | 2.5 | 4.5 | 0.020 | 331.3 | | 74.53 | 103.15 | 124.70 | 138.26 | 158.10 | 178.06 | >100 | Brush in Cracks |
| D514 | Jon Murdock along McCall Rd. | 116 | 6 | 0.07 | 2.5 | 2.5 | 4.5 | 0.020 | 191.3 | | 73.76 | 102.01 | 123.25 | 137.07 | 156.99 | 176.71 | >100 | Brush in Cracks |
| D515 | McCall Rd. | 92 | 6 | 0.31 | 2.5 | 2.5 | 4.5 | 0.014 | 862.5 | | 36.13 | 50.78 | 61.80 | 65.92 | 75.40 | 86.35 | >>100 | |
| D516 | East side of Jon Murdock | 221 | 6 | 0.64 | 2.5 | 2.5 | 5.0 | 0.014 | 1568.1 | | 139.34 | 193.12 | 233.71 | 259.16 | 296.81 | 336.85 | >>100 | |
| D517 | Bailey Storage Frontage | 87 | 6 | -0.12 | 4.5 | 3.5 | 2.0 | 0.045 | 22.8 | | 3.78 | 5.55 | 6.91 | 7.42 | 8.71 | 10.01 | >100 | Trees |
| D518 | FedEx Frontage | 644 | 7 | 0.31 | 3 | 8 | 2.0 | 0.035 | 74.3 | | 11.03 | 15.54 | 18.96 | 20.37 | 23.55 | 26.34 | >>100 | Low Areas |
| D519 | Levee Dr. | 290 | 5 | 0.20 | 5 | 4 | 2.0 | 0.030 | 70.0 | | 9.35 | 14.51 | 18.56 | 22.10 | 26.19 | 30.31 | >100 | |
| D520 | Griffith Lumber Frontage | 89 | 6 | 0.71 | 6 | 4 | 2.0 | 0.030 | 152.2 | | 9.82 | 15.14 | 19.29 | 23.00 | 27.23 | 31.46 | >>100 | |
| D521 | Flint Hills Bev. on Levee Dr. | 67 | 8 | 0.00 | 3.7 | 3.3 | 2.8 | 0.030 | 69.4 | | 12.11 | 17.05 | 20.88 | 22.74 | 26.38 | 29.72 | >100 | |
| D522 | Flint Hills Bev. on Hwy 24 | 372 | 7 | 0.27 | 3 | 3 | 3.9 | 0.030 | 328.2 | | 29.58 | 42.90 | 53.19 | 60.72 | 70.98 | 80.85 | >>100 | |
| D523 | East Hwy 24 | 350 | 5 | 0.50 | 4 | 4.5 | 2.0 | 0.035 | 91.9 | | 5.04 | 8.73 | 11.78 | 14.17 | 17.32 | 20.50 | >>100 | Taller Grass |
| D524 | East Hwy 24 | 364 | 6 | -0.01 | 5.3 | 4 | 2.0 | 0.035 | 29.7 | | 35.74 | 53.77 | 67.69 | 77.44 | 92.47 | 105.84 | <2 | Taller Grass |
| D525 | McCall Rd.& Hwy 24 | 329 | 8 | 0.22 | 3 | 4 | 3.0 | 0.030 | 195.5 | | 5.02 | 6.89 | 8.26 | 8.58 | 9.80 | 11.00 | >>100 | |
| D526 | Jon Murdock on Hwy 24 | 173 | 5 | 0.19 | 5 | 4 | 3.6 | 0.030 | 262.1 | | 75.97 | 108.22 | 133.00 | 148.08 | 170.75 | 194.37 | >100 | |
| D527 | Jon Murdock on Frontage Rd. | 175 | 8 | 0.50 | 5 | 4 | 2.0 | 0.025 | 169.4 | | 5.78 | 7.93 | 9.54 | 10.16 | 11.63 | 13.09 | >>100 | |
| D528 | West Hwy 24 | 632 | 7 | 0.12 | 3.4 | 4 | 3.9 | 0.030 | 248.0 | | 75.72 | 107.60 | 131.78 | 146.71 | 169.34 | 192.30 | >100 | |
| D529 | East Hwy 24 | 3000 | 4.5 | 0.20 | 2.7 | 2.3 | 5.0 | 0.030 | 363.7 | | 10.40 | 18.11 | 24.45 | 30.14 | 36.76 | 43.50 | >>100 | |
| D530 | Best Western Frontage | 228 | 6 | 0.41 | 3.5 | 3.5 | 3.5 | 0.035 | 279.1 | | 68.13 | 97.21 | 119.27 | 133.10 | 153.40 | 174.42 | >100 | Taller Grass |
| D531 | Hampton Inn/Linweld | 502 | 6 | 0.09 | 3.5 | 3.5 | 3.0 | 0.035 | 92.8 | | 28.17 | 40.19 | 49.61 | 55.20 | 63.13 | 71.64 | >100 | Taller Grass |
| D532 | Town West Frontage | 659 | 4 | 0.19 | 3.5 | 3.5 | 3.0 | 0.035 | 114.2 | | 22.68 | 32.24 | 39.74 | 43.80 | 50.35 | 57.03 | >25 | Taller Grass |
| D533 | Sirloin Stock/K-Mart | 510 | 6 | 0.09 | 3.5 | 3 | 4.0 | 0.030 | 131.1 | | 10.86 | 16.20 | 20.38 | 23.10 | 26.96 | 30.96 | >>100 | |
| D534 | Ampride Frontage | 566 | 4 | 0.16 | 4.7 | 4.3 | 2.0 | 0.030 | 7.8 | | 10.46 | 15.26 | 18.96 | 20.45 | 23.36 | 27.26 | <2 | |

Elements deficient under Existing (and Developed) Conditions
Additional Elements deficient under Developed Conditions

| No. | Description | Quantity Estimated | Units | Price Unit | Price Total |
|---|---|---|---|---|---|
| **WWTP Channels (I-15)** | | | | | |
| 1. | Mobilization | | Lump Sum | $ 15,000.00 | $ 15,000.00 |
| 2. | Clearing and Grubbing | | Lump Sum | $ 10,000.00 | $ 10,000.00 |
| 3. | Double 5'x3' RCB | 90 | Lin. Ft. | $ 750.00 | $ 67,500.00 |
| 4. | Gravel Road Replacement | 165 | Sq. Yds | $ 15.00 | $ 2,475.00 |
| 5. | Channel Construction (4,750 LF) | 32,740 | Cu. Yds. | $ 8.00 | $ 261,920.00 |
| 6. | Concrete Ditch Lining | 15,790 | Sy | $ 41.17 | $ 650,074.30 |
| 7. | Seeding | 3.7 | Acre | $ 1,000.00 | $ 3,700.00 |
| 8. | Easement | 8.13 | Acre | $ 5,000.00 | $ 40,650.00 |
| 9. | Surveying (3-Man Crew) | 24 | Hr | $ 130.00 | $ 3,120.00 |
| | | | Total Estimated Construction Cost | | $ 1,054,439.30 |
| | | | 20% Construction Contingencies | | $ 210,887.86 |
| | | | Subtotal | | $ 1,265,327.16 |
| | | | 15% Engineering, Administration, Legal | | $ 189,799.07 |
| | | | **Total Estimated Project Cost** | | **$ 1,455,126.23** |
| **Carlson Street (I-11 & I-5)** | | | | | |
| 1. | Mobilization | | Lump Sum | $ 10,000.00 | $ 10,000.00 |
| 2. | Clearing and Grubbing | | Lump Sum | $ 6,000.00 | $ 6,000.00 |
| 3. | 23"x14" RCPHE | 96 | Lin. Ft. | $ 60.00 | $ 5,760.00 |
| 4. | 15" RCP | 31 | Lin. Ft. | $ 32.89 | $ 1,019.59 |
| 5. | 49"x32" RCPHE | 40 | Lin. Ft. | $ 100.00 | $ 4,000.00 |
| 6. | 23"x14" RCPHE End Section | 6 | Each | $ 550.00 | $ 3,300.00 |
| 7. | 15" RCP End Section | 2 | Each | $ 550.00 | $ 1,100.00 |
| 8. | 49"x32" RCPHE End Section | 2 | Each | $ 590.00 | $ 1,180.00 |
| 9. | Replace Driveways (2) | 57 | Sq. Yds | $ 25.00 | $ 1,425.00 |
| 10. | Street Replacement (Frontage Rd) | 26.7 | Sq. Yds | $ 35.00 | $ 934.50 |
| 11. | Concrete Ditch Lining (1.5' D) | 6,548 | Sy | $ 41.17 | $ 269,581.16 |
| 12. | Channel Construction (3,500 LF) | 3,391 | Cu. Yds. | $ 8.00 | $ 27,128.00 |
| 13. | Seeding | 2.0 | Acre | $ 1,000.00 | $ 2,000.00 |
| 14. | Easement | 2.0 | Acre | $ 60,000.00 | $ 120,000.00 |
| 15. | Surveying (2-Man Crew) | 24 | Hr | $ 100.00 | $ 2,400.00 |
| | | | Total Estimated Construction Cost | | $ 455,828.25 |
| | | | 20% Construction Contingencies | | $ 91,165.65 |
| | | | Subtotal | | $ 546,993.90 |
| | | | 15% Engineering, Administration, Legal | | $ 82,049.09 |
| | | | **Total Estimated Project Cost** | | **$ 629,042.99** |

| No. | Description | Quantity Estimated | Units | | Price Unit | | Price Total |
|---|---|---|---|---|---|---|---|
| **Enoch Lane (I-12)** | | | | | | | |
| 1. | Mobilization | | Lump Sum | $ | 8,000.00 | $ | 8,000.00 |
| 2. | Clearing and Grubbing | | Lump Sum | $ | 3,000.00 | $ | 3,000.00 |
| 3. | 15" RCP | 90 | Lin. Ft. | $ | 32.89 | $ | 2,960.10 |
| 4. | 18" RCP | 60 | Lin. Ft. | $ | 35.00 | $ | 2,100.00 |
| 5. | 30"x19" RCP | 60 | Lin. Ft. | $ | 65.00 | $ | 3,900.00 |
| 6. | 15" RCP End Section | 6 | Each | $ | 550.00 | $ | 3,300.00 |
| 7. | 18" RCP End Section | 2 | Each | $ | 616.69 | $ | 1,233.38 |
| 8. | 30"x19" RCP End Section | 2 | Each | $ | 570.00 | $ | 1,140.00 |
| 9. | Replace Driveways (3) | 90 | Sq. Yds | $ | 25.00 | $ | 2,250.00 |
| 10. | Street Replacement (Frontage Rd) | 80 | Sq. Yds | $ | 35.00 | $ | 2,800.00 |
| 11. | Concrete Ditch Lining (1.25' D) | 2,703 | Sy | $ | 41.17 | $ | 111,282.51 |
| 12. | Channel Construction (1,700 LF) | 708 | Cu. Yds. | $ | 8.00 | $ | 5,664.00 |
| 13. | Seeding | 0.4 | Acre | $ | 1,000.00 | $ | 400.00 |
| 14. | Easement | 0.6 | Acre | $ | 60,000.00 | $ | 36,000.00 |
| 15. | Surveying (2-Man Crew) | 16 | Hr | $ | 100.00 | $ | 1,600.00 |
| | | | Total Estimated Construction Cost | | | **$** | **185,629.99** |
| | | | 20% Construction Contingencies | | | $ | 37,126.00 |
| | | | | | Subtotal | $ | 222,755.99 |
| | | | 15% Engineering, Administration, Legal | | | $ | 33,413.40 |
| | | | **Total Estimated Project Cost** | | | **$** | **256,169.39** |
| **3-3'x2' RCB** | | | | | | | |
| 1. | Mobilization | | Lump Sum | $ | 10,000.00 | $ | 10,000.00 |
| 2. | Clearing and Grubbing | | Lump Sum | $ | 5,000.00 | $ | 5,000.00 |
| 3. | Traffic Control | | Lump Sum | $ | 30,000.00 | $ | 30,000.00 |
| 4. | Double 3'x2' RCB | 120 | Lin. Ft. | $ | 450.00 | $ | 54,000.00 |
| 5. | Street Replacement | 382 | Sq. Yds | $ | 35.00 | $ | 13,370.00 |
| 6. | Surveying (2-Man Crew) | 24 | Hr | $ | 100.00 | $ | 2,400.00 |
| | | | Total Estimated Construction Cost | | | **$** | **114,770.00** |
| | | | 20% Construction Contingencies | | | $ | 22,954.00 |
| | | | | | Subtotal | $ | 137,724.00 |
| | | | 15% Engineering, Administration, Legal | | | $ | 20,658.60 |
| | | | **Total Estimated Project Cost** | | | **$** | **158,382.60** |

| No. | Description | Quantity Estimated | Units | | Price Unit | | Price Total |
|---|---|---|---|---|---|---|---|
| **3-6'x4' RCB Combination** | | | | | | | |
| 1. | Mobilization | | Lump Sum | $ | 10,000.00 | $ | 10,000.00 |
| 2. | Clearing and Grubbing | | Lump Sum | $ | 7,000.00 | $ | 7,000.00 |
| 3. | Traffic Control | | Lump Sum | $ | 40,000.00 | $ | 40,000.00 |
| 4. | Double 6'x4' RCB | 180 | Lin. Ft. | $ | 800.00 | $ | 144,000.00 |
| 5. | 7'x3' RCB | 60 | Lin. Ft. | $ | 500.00 | $ | 30,000.00 |
| 6. | 6'x3' RCB | 74 | Lin. Ft. | $ | 500.00 | $ | 37,000.00 |
| 7. | 5'x3' RCB | 62 | Lin. Ft. | $ | 480.00 | $ | 29,760.00 |
| 8. | 24" RCP | 63 | Lin. Ft. | $ | 38.74 | $ | 2,440.62 |
| 9. | 24" RCP End Section | 2 | Each | $ | 670.00 | $ | 1,340.00 |
| 10. | 34"x22" RCPHE | 64 | Each | $ | 70.00 | $ | 4,480.00 |
| 11. | 34"x22" RCPHE End Section | 2 | Each | $ | 640.00 | $ | 1,280.00 |
| 12. | Replace Driveway | 388 | Sq. Yds | $ | 25.00 | $ | 9,700.00 |
| 13. | Street Replacement | 713 | Sq. Yds | $ | 35.00 | $ | 24,955.00 |
| 14. | Street Replacement | 24 | Hr | $ | 100.00 | $ | 2,400.00 |
| | | | Total Estimated Construction Cost | | | **$** | **344,355.62** |
| | | | 20% Construction Contingencies | | | $ | 68,871.12 |
| | | | | | Subtotal | $ | 413,226.74 |
| | | | 15% Engineering, Administration, Legal | | | $ | 61,984.01 |
| | | | **Total Estimated Project Cost** | | | **$** | **475,210.76** |
| **North Hayes Group** | | | | | | | |
| 1. | 15" RCP | 120 | Lin. Ft. | $ | 32.89 | $ | 3,946.80 |
| 2. | 18" RCP | 38 | Lin. Ft. | $ | 35.00 | $ | 1,330.00 |
| 3. | 15" RCP End Section | 4 | Each | $ | 550.00 | $ | 2,200.00 |
| 4. | 18" RCP End Section | 2 | Each | $ | 616.69 | $ | 1,233.38 |
| 5. | 18" CMP Discharge end Repair | 5 | Lin. Ft. | | $50 | $ | 250.00 |
| 6. | Replace Driveway | 65 | Sq. Yds | $ | 25.00 | $ | 1,625.00 |
| 7. | Street Replacement | 16 | Sq. Yds | $ | 35.00 | $ | 560.00 |
| 8. | Pipe Cleaning | 3 | Each | $ | 200.00 | $ | 600.00 |
| 9. | Channel Cleaning | Lump Sum | | $ | 18,500.00 | $ | 18,500.00 |
| 10. | Channel Construction | 2,400 | Cu. Yds. | $ | 5.00 | $ | 12,000.00 |
| 11. | Seeding | 2.4 | Acre | $ | 1,000.00 | $ | 2,400.00 |
| 12. | Easement | 0.61 | Acre | $ | 5,000.00 | $ | 3,050.00 |
| 13. | Surveying | 24 | Hr | $ | 100.00 | $ | 2,400.00 |
| | | | Total Estimated Construction Cost | | | **$** | **50,095.18** |
| | | | 20% Construction Contingencies | | | $ | 10,019.04 |
| | | | | | Subtotal | $ | 60,114.22 |
| | | | 15% Engineering, Administration, Legal | | | $ | 9,017.13 |
| | | | **Total Estimated Project Cost** | | | **$** | **69,131.35** |

| No. | Description | Quantity Estimated | Units | Price Unit | Price Total |
|---|---|---|---|---|---|
| **West McCall Group** | | | | | |
| 1. | 15" RCP | 153 | Lin. Ft. | $ 32.89 | $ 5,032.17 |
| 2. | 18" RCP | 118 | Lin. Ft. | $ 35.00 | $ 4,130.00 |
| 3. | 21" RCP | 31 | Lin. Ft. | $ 37.00 | $ 1,147.00 |
| 4. | 24" RCP | 72 | Lin. Ft. | $ 38.74 | $ 2,789.28 |
| 5. | 30" RCP | 107 | Lin. Ft. | $ 50.53 | $ 5,406.71 |
| 6. | 23"x14" RCPHE | 106 | Lin. Ft. | $ 60.00 | $ 6,360.00 |
| 7. | 30"x19" RCPHE | 149 | Lin. Ft. | $ 65.00 | $ 9,685.00 |
| 8. | 34"x22" RCPHE | 100 | Lin. Ft. | $ 70.00 | $ 7,000.00 |
| 9. | 38"x24" RCPHE | 216 | Lin. Ft. | $ 75.00 | $ 16,200.00 |
| 10. | 15" RCP End Section | 8 | Each | $ 550.00 | $ 4,400.00 |
| 11. | 18" RCP End Section | 4 | Each | $ 616.69 | $ 2,466.76 |
| 12. | 21" RCP End Section | 2 | Each | $ 660.00 | $ 1,320.00 |
| 13. | 24" RCP End Section | 4 | Each | $ 670.00 | $ 2,680.00 |
| 14. | 30" RCP End Section | 4 | Each | $ 770.11 | $ 3,080.44 |
| 15. | 23"x14" RCPHE End Section | 4 | Each | $ 550.00 | $ 2,200.00 |
| 16. | 30"x19" RCPHE End Section | 6 | Each | $ 570.00 | $ 3,420.00 |
| 17. | 34"x22" RCPHE End Section | 6 | Each | $ 640.00 | $ 3,840.00 |
| 18. | 38"x24" RCPHE End Section | 8 | Each | $ 705.00 | $ 5,640.00 |
| 19. | Replace Driveway | 329 | Sq. Yds | $ 25.00 | $ 8,225.00 |
| 20. | Street Replacement | 21 | Sq. Yds | $ 35.00 | $ 735.00 |
| 21. | Pipe Cleaning | 5 | Each | $ 200.00 | $ 1,000.00 |
| 22. | Channel Cleaning | Lump Sum | | $ 9,500.00 | $ 9,500.00 |
| 23. | Seeding | 0.5 | Acre | $ 1,000.00 | $ 500.00 |
| | | | Total Estimated Construction Cost | | **$ 106,757.36** |
| | | | 20% Construction Contingencies | | $ 21,351.47 |
| | | | Subtotal | | $ 128,108.83 |
| | | | 15% Engineering, Administration, Legal | | $ 19,216.32 |
| | | | **Total Estimated Project Cost** | | **$ 147,325.16** |

| No. | Description | Quantity Estimated | Units | | Price Unit | | Price Total |
|---|---|---|---|---|---|---|---|
| **Sarber Watershed (400)** | | | | | | | |
| 1. | 15" RCP | 40 | Lin. Ft. | $ | 32.89 | $ | 1,315.60 |
| 2. | 18" RCP | 146 | Lin. Ft. | $ | 35.00 | $ | 5,110.00 |
| 3. | 21" RCP | 52 | Lin. Ft. | $ | 37.00 | $ | 1,924.00 |
| 4. | 24" RCP | 40 | Lin. Ft. | $ | 38.74 | $ | 1,549.60 |
| 5. | 36" RCP | 117 | Lin. Ft. | $ | 71.41 | $ | 8,354.97 |
| 6. | 30"x19" RCPHE | 92 | Lin. Ft. | $ | 65.00 | $ | 5,980.00 |
| 7. | 38"x24" RCPHE | 73 | Lin. Ft. | $ | 75.00 | $ | 5,475.00 |
| 8. | 15" RCP End Section | 4 | Each | $ | 550.00 | $ | 2,200.00 |
| 9. | 18" RCP End Section | 6 | Each | $ | 616.69 | $ | 3,700.14 |
| 10. | 21" RCP End Section | 2 | Each | $ | 660.00 | $ | 1,320.00 |
| 11. | 24" RCP End Section | 2 | Each | $ | 670.00 | $ | 1,340.00 |
| 12. | 36" RCP End Section | 4 | Each | $ | 983.95 | $ | 3,935.80 |
| 13. | 30"x19" RCPHE End Section | 4 | Each | $ | 570.00 | $ | 2,280.00 |
| 14. | 38"x24" RCPHE End Section | 4 | Each | $ | 705.00 | $ | 2,820.00 |
| 15. | Replace Driveway | 112 | Sq. Yds | $ | 25.00 | $ | 2,800.00 |
| 16. | Street Replacement | 68 | Sq. Yds | $ | 35.00 | $ | 2,380.00 |
| 17. | Channel Cleaning | Lump Sum | | $ | 6,500.00 | $ | 6,500.00 |
| 18. | Seeding | 0.3 | Acre | $ | 1,000.00 | $ | 300.00 |
| | | | Total Estimated Construction Cost | | | **$** | **59,285.11** |
| | | | 20% Construction Contingencies | | | $ | 11,857.02 |
| | | | | | Subtotal | $ | 71,142.13 |
| | | | 15% Engineering, Administration, Legal | | | $ | 10,671.32 |
| | | | **Total Estimated Project Cost** | | | **$** | **81,813.45** |
| **Hwy 24 Watershed (500)** | | | | | | | |
| 1. | 18" RCP | 181 | Lin. Ft. | $ | 35.00 | $ | 6,335.00 |
| 2. | 24" RCP | 252 | Lin. Ft. | $ | 38.74 | $ | 9,762.48 |
| 3. | 42" RCP | 59 | Lin. Ft. | $ | 99.10 | $ | 5,846.90 |
| 4. | 18" RCP End Section | 4 | Each | $ | 616.69 | $ | 2,466.76 |
| 5. | 24" RCP End Section | 10 | Each | $ | 670.00 | $ | 6,700.00 |
| 6. | 42" RCP End Section | 2 | Each | $ | 1,124.00 | $ | 2,248.00 |
| 7. | Replace Driveway | 178 | Sq. Yds | $ | 25.00 | $ | 4,450.00 |
| 8. | Street Replacement | 67 | Sq. Yds | $ | 35.00 | $ | 2,345.00 |
| 9. | Pipe Cleaning | 2 | Each | $ | 200.00 | $ | 400.00 |
| 10. | Channel Cleaning | Lump Sum | | $ | 24,000.00 | $ | 24,000.00 |
| 11. | Seeding | 3.1 | Acre | $ | 1,000.00 | $ | 3,100.00 |
| | | | Total Estimated Construction Cost | | | **$** | **67,654.14** |
| | | | 20% Construction Contingencies | | | $ | 13,530.83 |
| | | | | | Subtotal | $ | 81,184.97 |
| | | | 15% Engineering, Administration, Legal | | | $ | 12,177.75 |
| | | | **Total Estimated Project Cost** | | | **$** | **93,362.71** |

| No. | Description | Quantity Estimated | Units | Price Unit | Price Total |
|---|---|---|---|---|---|
| **McCall Road Improvements** | | | | | |
| ***West Portion*** | | | | | |
| 1. | 8'x4' RCB | 1230 | Lin. Ft. | $ 500.00 | $ 615,000.00 |
| 2. | 42" RCP | 80 | Lin. Ft. | $ 99.10 | $ 7,928.00 |
| 3. | 36" RCP | 585 | Lin. Ft. | $ 71.41 | $ 41,774.85 |
| 4. | 30" RCP | 650 | Lin. Ft. | $ 65.00 | $ 42,250.00 |
| 5. | 24" RCP | 250 | Lin. Ft. | $ 38.74 | $ 9,685.00 |
| 6. | 30"x19" RCPHE | 400 | Lin. Ft. | $ 65.00 | $ 26,000.00 |
| 7. | 23"x14" RCPHE | 300 | Lin. Ft. | $ 60.00 | $ 18,000.00 |
| 8. | Replace Driveway | 150 | Sq. Yds | $ 35.00 | $ 5,250.00 |
| 9. | 18" slotted drain | 620 | Lin. Ft. | $ 60.00 | $ 37,200.00 |
| 10. | Junction Box | 12 | Each | $ 5,000.00 | $ 60,000.00 |
| | | | | Subtotal West | $ 863,087.85 |
| ***East Portion*** | | | | | |
| 1. | 5'x3.5' RCB | 1190 | Lin. Ft. | $ 485.00 | $ 577,150.00 |
| 2. | 4'x3' RCB | 1000 | Lin. Ft. | $ 420.00 | $ 420,000.00 |
| 3. | 42" RCP | 60 | Lin. Ft. | $ 99.10 | $ 5,946.00 |
| 4. | 24" RCP | 60 | Lin. Ft. | $ 38.74 | $ 2,324.40 |
| 5. | Replace Driveway | 135 | Sq. Yds. | $ 35.00 | $ 4,725.00 |
| 6. | Junction Box | 10 | Each | $ 5,000.00 | $ 50,000.00 |
| | | | | Subtotal East | $ 1,060,145.40 |
| | | | | Total Estimated Construction Cost | **$ 1,923,233.25** |
| | | | | 20% Construction Contingencies | $ 384,646.65 |
| | | | | Subtotal | $ 2,307,879.90 |
| | | | | 15% Engineering, Administration, Legal | $ 346,181.99 |
| | | | | **Total Estimated Project Cost** | **$ 2,654,061.89** |