Sioux Falls, South Dakota

Water Reclamation Collection System

Planning Study – Sioux Falls Water Reclamation Collection System Evaluation: Brandon Road Pump Station, Equalization, and Outfall Sewer & Brandon Road Force Main Alignments

City of Sioux Falls Project No. 13-3254
HDR Project No. 211184

Prepared for:

CITY OF SIOUX FALLS
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Sioux Falls Department of Public Works
& Water Reclamation

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****Appendix H added June 2014**
****Appendix I added August 2014**

1.0 Project Background

The following sanitary sewer collection system improvements were recommended in the City of Sioux Falls Water Reclamation Facility Master Plan completed in 2009:

- Expansion of the Equalization (EQ) Basins (located between East Chambers Street and the Big Sioux River Spillway, just west of Lien Park),
- Replacement of the 66-inch outfall sewer from the EQ Basin to Brandon Road Pump Station,
- Improvements to the Brandon Road Pump Station (BRPS), and
- A new parallel forcemain from the BRPS to the Water Reclamation Facility (WRF).

The purpose of this memorandum is to review and recommend alignment alternatives for both the Outfall Sewer from the EQ basins to the BRPS and the forcemain from BRPS to WRF as well as recommend and refine facility upgrades for the EQ basins, and the BRPS. The objective is to provide recommendations for the sequence of construction for the resulting capital improvement projects as well as outline the capital, operational, and constructability issues for each project.

2.0 Approach

The approach to performing this analysis included the following steps:

1. Gather information about the project area including topographic mapping, suspected rock protrusion elevations, sewer inverts, storm sewer structures and utilities based on the City of Sioux Falls GIS system, as recorded drawings, and previously provided soil borings.
2. Outline constructability, accessibility, and operational and maintenance issues for each of the facility upgrades and alternatives.
3. Update planning level construction cost estimates for each capital improvement project.

3.0 Outfall Sewer

3.1 Sewer Modeling

Sewer modeling was completed using the City of Sioux Falls Sanitary Sewer Model in XPSWMM. The flows modeled were based on predicted flows for 2030. The sewer model for the City sewer system explicitly models wet weather conditions referencing a 25-year return period precipitation event. The assumptions made for this model are as follows:

- Assumed infiltration was 100 gallons/day/acre
- Wet weather modeling 25-year 24 hour rainfall depth with a SCS type II distribution
- Inflow factor of 0.4% and also at a more conservative inflow factor of 0.8% divided equally into each of the nodes(manholes)
- Model was executed with previous methodologies regarding dry and wet weather flow generation, with sanitary sewer geometry based primarily on the database provided by the City of Sioux Falls on November 11, 2010.

The sewer model was run using the existing alignment with a 66-inch diameter pipe as well as a 72-inch diameter pipe. In both models, the existing siphon was assumed to be left in place and both models show that the siphon carries the predicted flows without backing up the sewer upstream of the siphon. The peak flow summary for each scenario can be found in Table 1 and full model results can be found in Appendix A. The existing siphon can meet the capacity requirements of the 2030 predicted flows. The maximum flow estimated through the existing siphon without surcharging an upstream manhole is approximately 80 MGD as shown in Appendix A (A.6-A.9). Four scenarios were run in the sewer model to compare maximum flow and determine the flow restrictions of the outfall sewer between the EQ basins and the BRPS.

Table 1 - Sewer Model Summary

SEWER MODEL SUMMARY				
	Inflow Factor of 0.4%	Inflow Factor of 0.4%	Inflow Factor of 0.8%	Inflow Factor of 0.8%
Pipe Size	66 - Inches	72 - Inches	66 - Inches	72 - Inches
Peak Flow (cfs)	55	55	70	70
Peak Flow (gpm)	24,684	24,684	31,416	31,416
Peak Flow (MGD)	36	36	45	45
Max d/D (depth/dia)	0.71	0.62	0.82	0.73

A 72-inch pipe will be assumed for the proposed outfall sewer based on the sanitary sewer modeling results. A d/D of 0.75 was used for the purpose of this planning study. When costs were evaluated for pipe size the cost difference was negligible between 66-inch pipe and 72-inch pipe. Through planning meetings it was determined that if the sewer is being replaced the opportunity to increase the pipe size should be utilized. Pipe larger then 72-inches increased the cost per foot significantly when compared to 66-inch pipe.

3.2 Existing Siphon and Siphon Boxes

The existing pipe is believed to be HDPE pipe and was confirmed by video inspection and Engineer of Record. For the cost estimated within, it was assumed that the existing siphon could be left in place and utilized for the new outfall sewer and by using the existing siphon, there would be fewer impacts to the Big Sioux River and levee system. The existing siphon box locations then dictate the west portion of the alignment as it will be required to connect to these points at the river.

The west siphon box (Figure 1) has most of the liner intact but it is no longer attached to the wall in all places. In areas where the concrete is exposed, aggregate can be seen. The majority of the liner in the east siphon box (Figure 2) has detached from the wall and has exposed aggregate. In some areas, the steel reinforcement can also be seen. The siphon boxes should be repaired or replaced during construction. The boxes could be cleaned, built up to reinforce the existing structure and lined or they could be completely replaced with a new lined structure. Sluice gates could be installed in order to have better control over the siphon for maintenance and if sluice gates are desired, the structure should be replaced for proper installation of the gates.

Figure 1: West Siphon Box

Figure 2: East Siphon Box

3.2.1 Cost Assessment

The cost to replace the existing siphon boxes is estimated to be in the range of $95,000 to $135,000 each. In addition, the cost of the 24-inch, 30-inch, and 36-inch sluice gates is $18,800, $19,900, and $21,400 respectively. Sluice Gates would only be feasible if a new siphon box was constructed.

The cost to rehabilitate the existing structures by using a form and pour method to increase the wall thickness and install an HDPE stud liner is estimated to be in the range of $60,000 to $75,000 each. The cost to rehabilitate the existing structures by using a grout to increase the wall thickness and installing a spray on epoxy liner is estimated to be in the range of $35,000 to $45,000 each. There would also be some cost savings in engineering fees for a rehabilitation option due to less permitting requirements and coordination with the U.S. Army Corps of Engineers (USACE). Installation of a new structure will require additional engineering analysis and permitting with the USACE. For the purpose of this memo it was assumed that the manholes would be rehabilitated with an HDPE stud liner, during design it should be re-evaluated to determine if a grout and epoxy liner is more feasible.

3.3 Outfall Sewer Design

Design Criteria that were considered for this report were:

- Roadways crossed that have questionable soils to support a successful trenchless installation or minor roadways should be crossed by open cut method. Major roadways such as interstates should be crossed by trenchless construction whenever possible.
- Pipe installed will be HOBAS pipe similar to recent construction of major sanitary sewer trunk lines. Concrete was not considered.
- All pipes including lateral connections that are extended to the outfall sewer shall meet or exceed the minimum 10 State Standards slope for the appropriate pipe size.
- Capacity of the sewer should be increased or sufficient for the pipes d/D to be less than 0.75 when using the sewer modeling data from the City of Sioux Falls Sanitary Sewer Model in XPSWMM based on the following assumptions.
    - Assumed infiltration was 100 gallons/day/acre
    - Wet weather modeling 25-year 24 hour rainfall depth with a SCS type II distribution
    - Inflow factor of 0.4% and also at a more conservative inflow factor of 0.8% divided equally into each of the nodes(manholes)
    - Model was executed with previous methodologies regarding dry and wet weather flow generation, with sanitary sewer geometry based primarily on the database provided by the City of Sioux Falls on November 11, 2010.

During the collection system review, design parameters based on the needs of Water Reclamation were identified that should be taken into consideration regardless of the alignment.

- Equalization Flow Metering: The EQ basins do not currently have an accurate way of measuring the flow into and out of the basins. During the outfall sewer sanitary sewer installation Flo-Dar^{tm} flow meters could be installed in order to track the flow in and out of the EQ basins more accurately.
- Lime Lagoon Drain: The water lime sludge lagoons are located north of the existing siphon box on the west side of the Big Sioux River. The current procedure for draining these lagoons is to bypass pump the water from the lagoons across the ground using a lay flat hose to the siphon box. This operation has a risk of spilling, takes extra set up time, and provides no way to monitor the flow. During the sanitary sewer replacement, a sanitary sewer line and manhole could be installed to the north of the siphon box with a Flo-Dar flow meter. This would allow accurate tracking of the flow from the lagoons and reduce the risk of spilling the water from the lagoons into the river.
- EQ & BRPS Communication: A fiber optic line could be installed along the sanitary sewer alignment from the EQ basins to the BRPS to improve communications.

The cost estimates for each alignment include costs to address the above including: Flow-Dar flow meters, a new sanitary sewer to the lime sludge lagoons, and installation of a fiber optic line.

- Watermain Size/Conflicts: The existing watermain located on the west side of North Cliff Avenue needs to be upsized where it crosses under the Big Sioux River. The pipe crosses all three of the proposed sanitary sewer alignments and is potentially in conflict with the profile. Subsurface utility explorations should be conducted to determine if the watermain will require adjustment. The pipe may be replaced with the outfall sewer depending on funding and schedule. During design of the outfall sewer replacement there should be coordination with the City Water Department to determine if the watermain should be replaced with the outfall sewer.

Due to the uncertainty of when the work on the outfall sewer and work on the watermain may occur, no costs were included in the cost estimate for replacement of the watermain.

Before design begins on the outfall sewer, evaluation of the storm sewer drainage area should be completed to determine the storm sewer size downstream of the BMP. The drainage study will include an extensive area that drains into these storm sewers including the over land drainage area near the existing basins. By installing storm sewer pipe large enough to convey future flows if the EQ basin is located to the east the levee impacts can be included with this project with the other levee impacts associated with the outfall sewer replacement. This will reduce the total impact of costs to the City associated with these CIP projects and the levee system. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design

During the study utilizing the existing outfall sewer as storage and backup to a new alignment was discussed. The existing sewer would need to be CIPP lined or slip lined in order to stop infiltration and the sewer would need to be connected to the new sewer pipe and lift station with isolation valves. The estimated storage in the existing pipe is approximately 1.72 MG, the estimated cost to line the existing sewer would be a minimum of $4,000,000 which equates to approximately $2.33/gal of EQ. The estimated cost of EQ for the east basin option is approximately $1.55/gal. If left in place the existing sanitary sewer would require a separate easement from a new alignment. The feasibility and cost of utilizing the existing sanitary sewer should be re-evaluated during design.

3.4 Existing Sanitary Sewer

The existing alignment for the outfall sewer has some operation and maintenance issues that have become apparent since it was installed in 1980-1981. The alignment stretches across an open field within the floodplain and along the Big Sioux River. The condition of the outfall sewer is known from CCTV recordings from 2010. Liner deterioration is visible along with some deterioration in the concrete. CCTV is being conducted at the time of this memorandum. The CCTV records that are being completed in winter 2013/2014 will be compared to the records from 2010 to aid in the determination of the priority to replace the outfall sewer.

- Accessibility and Inflow & Infiltration (I/I) Issues: The area is difficult to access due to its location since the field is often wet or flooded, occupied by crops, or full of snow. The alignment is not only a concern for maintenance of the sewer but for I/I issues at the manhole locations.
- Bank Erosion Issues: There is an area along the Big Sioux River where the RCP sewer was exposed to the river, a bank stabilization project was completed in the fall of 2012 to attempt to protect the pipe. However, the City indicated that the bank stabilization was not a fully engineered system and it is not known how long it will stay in place. Any alignment that would require protection from this bank stabilization should include an evaluation of the bank stabilization project to determine if additional measures will need to be taken during construction to further stabilize the area. The alignment also crosses drainage channels that hinder access and are possible locations that could expose the pipe.
- Easement Issues: Land access can also be an issue for maintenance. Although there is a sanitary sewer easement over the pipe; additional permission is required from land owners due to structures, roads, and landmarks that are obstructing access down the easement.
- United States Army Corps of Engineers: Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design.

The topography of the area is flat and alternate alignments will be required to shift to the south in order to get closer to the 100 year flood elevation and provide better access for maintenance. Three proposed alternate alignments were developed and are evaluated in the following sections to address the above issues; refer to exhibits in Appendix B. They are named based on relative geographic locations of north, middle and south.

All three alignments were compared using criteria established by the City as desired improvements and items that would significantly vary the project cost. The criteria included:

1. Right of Way and easement constraints
2. Big Sioux River Floodplain
3. Trenchless Construction
4. Existing utility coordination
5. Rock interface
6. Operation and Maintenance Implications
7. Bypass Pumping
8. Impacts to traffic
9. Impacts to Park System
10. Connections to existing sewers
11. Environmental impacts

CIPP lining was not evaluated during this planning study based on the concerns for access, maintenance, and erosion from the Big Sioux River. The existing 66-inch pipe has a d/D of 0.82 which is greater than the 0.75 that was used as a design parameter, CIPP lining would increase this value. Although CIPP lining can be a good form of rehabilitation in some situations it would not increase the capacity of the outfall sewer and would not address any of the operations and maintenance issues identified in this memo therefore it was not considered.

3.5 North Alignment

The existing alignment is the cause of the operations and maintenance issues listed in section 3.4, it was not considered an option for this planning study because it would not address any of the issues identified in this memo. The North alignment is the existing alignment modified to address some of the operation and maintenance concerns to the best extent possible. The existing alignment was not considered because the pipe was exposed to the river and an emergency bank stabilization project had to be constructed. It was not desired to replace a pipe in a location that is known to be susceptible to failure.

3.5.1 Right-of-Way/Easement Constraints

Required Permit(s): A permit from the SDDOT will be required for the crossing of I-229.

New Easements: New easements will be required on three separate parcels with three different landowners. Discussions have not started with effected landowners; therefore, the level of difficulty to obtain these easements is not yet known. The parcel on the west side of I-229 is currently used as an outdoor archery shooting course. There will be major impacts to this parcel with the re-alignment of the sanitary sewer and coordination with this landowner will likely dictate the location of the I-229 crossing.

3.5.2 Big Sioux River Constraints and Floodplain

Bank Erosion Issues: As noted previously, the existing sewer borders the Big Sioux River for approximately 1,200 feet and was recently exposed to the river due to erosion of the river bank but was temporarily rehabilitated in 2012. A bank stabilization project was completed in the fall of 2012 to re-establish the river bank and protect it from future erosion. The City indicated that the bank stabilization was not a fully engineered system and it is not known how long it will stay in place. If the north alignment is selected an evaluation of the bank stabilization should be conducted and if required it should be re-built as part of the sanitary sewer installation project to protect the pipe.

Floodplain Issues: The north alignment does not raise any of the manholes closer to the 100 year flood elevation and the majority of the pipe and manholes along this alignment will remain in the floodplain. A floodplain permit will be required for construction in the floodplain. First, in order to determine how high the manholes could be raised, a No Rise Impact Study would be required to obtain a Floodplain Permit. Second, raising the manholes would need to be coordinated with landowners as mounds would be built on their property. Some areas may not be well suited for manholes with increased ground elevations due to current land uses. Second, construction in the floodplain can add risk and cost to the sewer replacement during construction. While it is unknown if manholes would be raised along this alignment, the extra depth for manholes and associated grading work are not deemed as significant cost impacts, so no variation in the sanitary sewer pipe installation price has been estimated.

3.5.3 Trenchless Construction

Trenchless construction methods will need to be evaluated for the crossing of I-229. The trenchless installation for this alignment would be approximately 440 feet on an approximately 35 foot deep crossing. Soil borings have been completed and show a layer of sand and cobbles near the invert of the casing pipe. Therefore, trenchless construction methods will need to be evaluated further during design to determine the most feasible option for completing the installation successfully.

3.5.4 Existing Utility Coordination

At North Cliff Avenue there will be numerous utilities to cross including a 12-inch watermain, electrical lines, 48-inch RCP and 30-inch RCP storm sewers, and multiple drainage channels.

Storm Sewers: The storm sewer crossing on the north side of the storm water detention pond, west of North Cliff Avenue, has a junction box which conflicts with the sanitary sewer alignment. The storm sewer drops quickly in elevation after this junction box and would intersect the sanitary sewer pipe. The junction box will need to be moved to the south in order to allow the sanitary sewer pipe to cross under the existing storm sewer.

Watermain to Great Bear: The existing 8-inch sludge pipe that parallels the existing outfall sewer is currently used for supplying raw water from the Water Treatment Plant to Great Bear Recreation Park for making snow. The water is used to make snow because it is cheaper to use the raw water than the treated water and the untreated water seems to make better snow. The pipe would be damaged during construction along this alignment and would need to be replaced during construction in order to continue the water service to the park. The cost to install a new watermain is estimated at approximately $600,000 and would likely require a directional drill to cross the Big Sioux River if a connection cannot be made to the existing 8-inch pipe under the river. The average water usage from this pipe at Great Bear Recreation Park is approximately 8.7 MG per year at a rate of $1.12/1000 gal. The average cost to buy raw water using this pipe is approximately $10,000 per year. If a new watermain was not installed and Great Bear Recreation Park is required to buy treated water at the existing commercial rate the average cost would be approximately $60,000 per year. The average savings that Great Bear Recreation Park sees from the ability to use the raw water is approximately $50,000 per year, it would take approximately 12 years for Great Bear Recreation Park to recover the cost of installing a new watermain, after approximately 12 years Great Bear Recreation Park would start to see a savings in their water usage again. A determination of the responsible party for the cost to replace the watermain would need to be made.

Power: There is an existing power line that is adjacent to the sewer alignment. At the east siphon box there are two adjacent power poles that may need to be supported during construction. At this point, the power line continues underground and parallels the alignment to the BRPS. The City Light and Power Department has no use for this wire and has stated that the power line may be at the end of its life cycle within the next 10 years at which point it would be abandoned. There are no current plans to upgrade the power line in the future. Sioux Falls Water Reclamation expressed interest in leaving the wire in place or replacing it as necessary to provide back up power to the BRPS. Replacing the power line also provides the option in the future to buy power from the City rather than Xcel Energy if there is ever a cost savings. By installing a new wire the City is not bound to buy power from Xcel Energy.

Cost to install a new power line within the sanitary sewer easement has been included in the cost estimate. Feasibility and requirements for having the power line reinstalled during construction should be re-evaluated during design. This power line could be taken out of service during construction without impact to the BRPS because of other power supplies that are available.

Drainage Crossings: Three drainage way crossings along this alignment need to be addressed with regard to elevation and Stormwater Pollution Prevention Plan (SWPPP) requirements.

3.5.5 Rock Interface

Based on previous soil borings, the invert of the outfall sewer appears to be above the bedrock interface. Additional soil borings have been completed for crossings of I-229 and North Cliff Avenue to confirm the location of bedrock where trenchless installation may be required. One soil boring in the I-229 median showed a layer of cobbles at the invert with boulders below and ultimately the boring hit an obstruction at five feet below the invert. The other two soil borings across I-229 showed fine to medium grained sand near the invert of the pipe with no obstructions. The soil borings across North Cliff Avenue showed sandy lean clay with no obstructions. The soil boring logs can be found in Appendix G. Additional soil borings should be conducted during design to confirm bedrock locations along the remainder of the alignment.

3.5.6 Operation and Maintenance Implications

Access for the City’s sewer jet and vactor truck to the majority of the manholes along the outfall sewer is difficult and often impossible. Most of the manholes are located in fields that are inaccessible in the spring due to flooding and wet ground. In the summer these areas are planted for crops, and in the winter the fields can be difficult to access depending on the amount of snow cover. If access during the winter is required permission must be granted by the landowners for a road to be plowed out to the manholes. Typically, the only time that crews can access the manholes is in the late fall after crops are out and before it starts to snow. The sewer will be located in the floodplain and access would not be possible during flood events. The 100 year flood level is approximately 1320 based on FEMA floodplain maps. In order to raise the manholes above the 100 year flood level, an impact study would need to be conducted, see Table 2 for manhole elevations. This alignment does not address any of these operation and maintenance concerns. However, the alignment does move the pipe further from the river at the location where the pipe was exposed in the river.

FRPM pipe is much lighter than RCP and requires floatation protection if adequate soil cover is not available. This alignment crosses the Water Reclamation property from the EQ Basins to North Cliff Avenue in a low area. The ground cover in this area is not adequate to prevent floatation in all areas and in some areas does not cover the pipe. This area is currently being used as a storage area for trees, mulch, and snow. The area recieves heavy loads from the large equipment and the ground elevation changes with each use as the items get moved on and off the site. Installation of a berm over the pipe alignment would protect the pipe from floating, traffic loads, and would serve as a reminder that there is a sanitary sewer pipe in place so that the ground is not excavated in this area. Installing a berm along this alignment would minimize the effective area that can be used for storage and would divide the property in half. Coordination with Water Reclamation and City Street Department will be important during planning for future land uses in this area.

Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee. Early coordination will be important for incorporating their requirements and concerns into the design.

3.5.7 Bypass Pumping

Bypass pumping would be required for the duration of the project due to the alignment being in the same location as the existing sewer. The bypass would need to cross North Cliff Avenue, the Big Sioux River, I-229, and Bahnson Avenue. The bypass west of North Cliff Avenue would need to be laid along the levee and cross under the Cliff Avenue Bridge near the river in order to avoid impacts to traffic. The bypass pipe could then be run along the levee up to the existing siphon box to limit the impacts in the Lien Dog Park. Another option for crossing the Big Sioux River would be to attach the bypass pipe to the North Cliff Avenue Bridge and run the pipe along the south levee. This would lower the risk of a sanitary sewer overflow because the pipe would not be floating in the river. The pipe could be laid under the I-229 ramps and would need to cross Glenwood Circle and Bahnson Avenue. For the crossing of Glenwood Circle and Bahnson Avenue the use of ramps or installation of a culvert will need to be considered due to the length of time the bypass pipe would be in place. Bypass set ups that are longer in length require larger pumps and have increased pressure in the temporary pipes therefore increasing the risk of a failure. Recent bypass setups have been limited to less than 1 mile in length of bypass pipe in order to help mitigate this risk. Therefore a minimum of two bypass set ups would be required with the possibility of 3 set ups being required depending on the route. Bypass pumping will also need to be considered when obtaining temporary construction easements as often times the best bypass route is not adjacent to the sewer installation.

3.5.8 Impacts to Traffic

Trenchless installation methods have proved difficult on similar projects and can be costly when compared to open cut installation. The impact to traffic needs to be compared to the cost and risk of trenchless installation across North Cliff Avenue. Recent preference has been to open cut major roadways such as North Cliff Avenue when installing major sewer lines, the road would be temporarily closed to all traffic during this time. Time restrictions for the closure could be considered during design and the use of incentives and disincentives could be utilized to help the closure to occur as planned. Consideration could also be made during the design phase to maintain traffic and have a phased closure. For the purpose of this cost estimate a complete closure for open cut installation was assumed. The crossing of I-229 should be evaluated for trenchless methods of installation due to the depth of this sewer being approximately 35 feet deep. If a trenchless method can be utilized there would not be any large impacts to traffic along I-229. The crossing of Bahnson Avenue is currently planned to be by open cut method and a full closure would require a detour for traffic. There would also be a crossing of the dead end road Glenwood Circle.

3.5.9 Impacts to the Park system

The Park system will be impacted at Lien Dog Park as the sewer will cross through the north portion of the park. The parking lot for this park is located to the north and will be impacted by the sewer installation. Due to the steep grade from North Cliff Avenue down to the parking lot it would be difficult to provide a temporary access for use during pipe installation. Closing the parking lot and including this as part of the North Cliff Avenue closure could be considered. The pipe could be installed to a point where the traffic could come into the parking lot and a temporary parking lot could be provided while the remaining pipe is installed along the north side of the park. The bike trail system may be impacted by the bypass pipes if they are laid next to the trail. The bike trail currently dead ends at the north side of Lien Park, therefore the number of users impacted should be limited. If the bike trail is extended before construction the impact to the bike trail would be greater. No other impacts to the Park system are seen at this time.

3.5.10 Connections to Existing Sewers

There will be several connections to existing sewer laterals along this alignment, most of these sewer lines will be connected at their current locations. Due to the realignment of the sewer for the I-229 crossing, the 8-inch and 10-inch (dual siphons under the river connecting to a 12-inch pipe) from the north will need to be extended. The extension of the 12-inch sewer from the north should be laid along the DOT ROW for easy access and to limit impact to the property. The existing siphon currently has a higher end invert than a starting invert. Based on the GIS data supplied by the City of Sioux Falls and the proposed outfall sewer inverts proposed in this memo the siphon could be fixed so that the downstream elevation is lower than the upstream. The extension of the pipe to the proposed outfall sewer would still meet 10 State Standards for minimum slope requirements based on the information provided for this memo. The need to replace the siphon and the feasibility of meeting 10 State Standards should be re-evaluated during design after a formal Topographic Survey has been completed and the final design of the proposed outfall sewer has been completed. Other sewer laterals will be easily connected to the new outfall sewer where needed.

3.5.11 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along the Big Sioux River. Much of the land in this area has been previously undisturbed and the location of certain cultural resources is not known. In addition it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be effected by the project additional constraints or permits may be required for the project. The majority of the north alignment is located in previously disturbed areas.

3.6 Middle Alignment

3.6.1 Right-of-Way/Easement Constraints

Required Permit(s): A permit from the SDDOT will be required for the crossing of I-229.

New Easements: New easements will be required on nine separate parcels with five different landowners. Discussions have not started with effected landowners; therefore, the level of difficulty to obtain these easements is not yet known. The parcel on the west side of I-229 is currently used as an outdoor archery shooting course. There will be major impacts to this parcel with the re-alignment of the sanitary sewer and coordination with this landowner will likely dictate the location of the crossing for I-229.

3.6.2 Big Sioux River Constraints and Floodplain

The majority of the pipe and manholes along this alignment will remain in the floodplain. The middle alignment adds four manholes to the outfall sewer, three of which are below the 100 year flood elevation and one manhole that would be above the 100 year flood elevation. Five manholes would be lowered 1.5 to 7.5 feet below the existing alignment profile, five manholes would be raised 1 to 5 feet, and seven would remain at about the same elevation as shown in Table 2. Although some manholes will be higher than the existing alignment the majority of manholes are still 2 to 12 feet below the 100 year flood elevation. A floodplain permit will be required for construction in the floodplain. First, in order to determine how high the manholes could be raised, a No Rise Impact Study would be required for a Floodplain Permit to determine if any of the manholes could be raised to the 100 year flood elevation or how close they could get. Also associated with raising the manholes would be coordination with landowners for the mounds that would be built on their property. Some areas may not be well suited for manholes with increased ground elevations due to current land uses. Second, construction in the floodplain can add risk and cost to the sewer replacement. While it is unknown if manholes would be raised along this alignment, the extra depth for manholes and associated grading work are not deemed as significant cost impacts, so no variation in the sanitary sewer pipe installation price has been estimated.

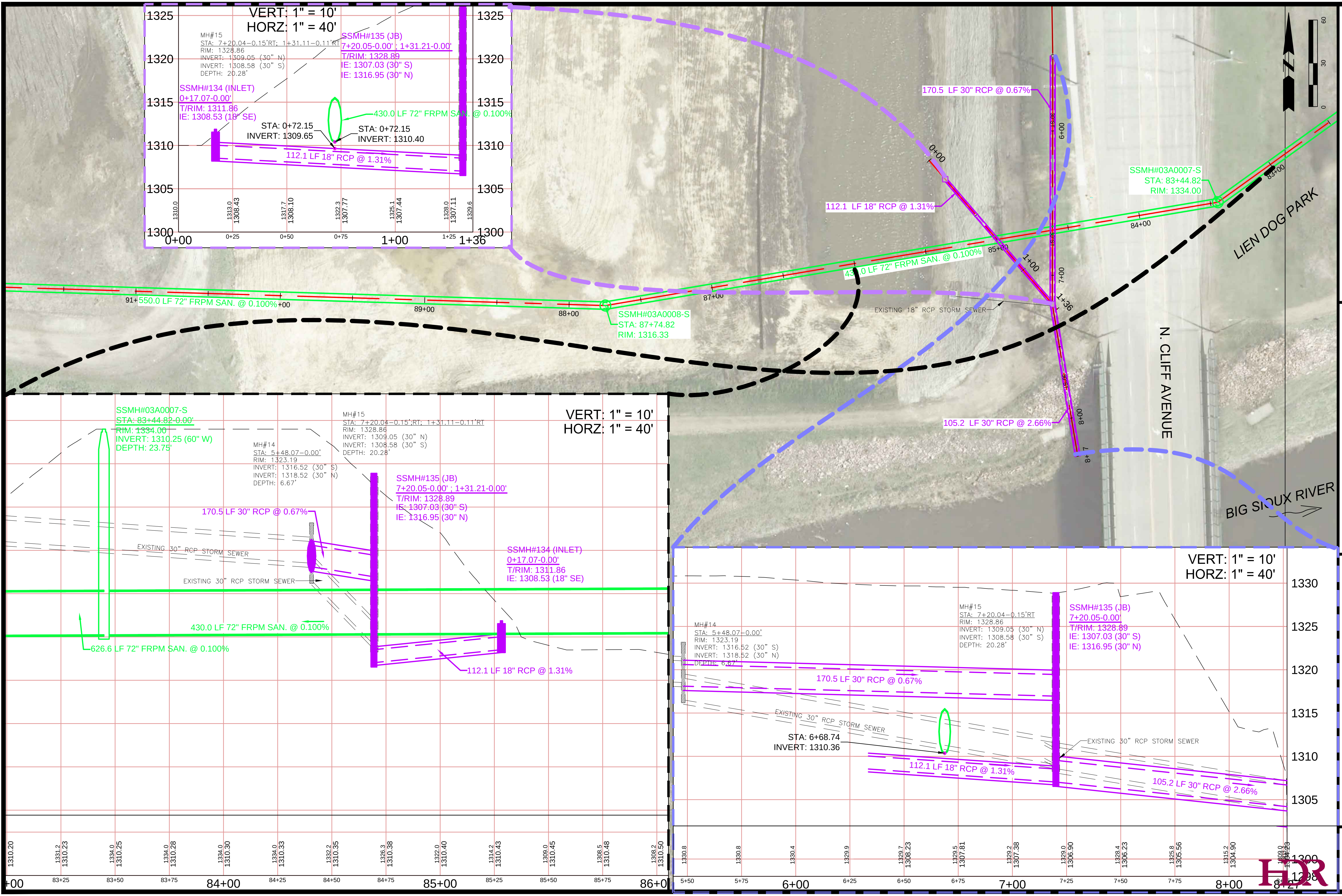
3.6.3 Trenchless Construction

Trenchless construction methods will need to be evaluated for the crossing of I-229. Soil borings have been completed and show a layer of sand and cobbles near the invert of the casing pipe. Trenchless construction methods will need to be evaluated during design to determine the best feasible option for completing the installation successfully. The trenchless installation for this alignment would be approximately 450 feet on an approximately 35 foot deep crossing.

3.6.4 Existing Utilities

At North Cliff Avenue there will be several utilities to cross including a 12-inch watermain, electrical lines, and a 30-inch RCP storm sewer.

Storm Sewers: This alignment crosses through the existing storm water detention pond west of North Cliff Avenue. The bottom elevation of the pond is lower than the invert of the proposed sanitary sewer. The pond would need to be shortened and widened to the west in order to allow the sanitary sewer pipe to cross at the proposed location. This would impact the area to the west that is currently used for storage of trees, mulch, snow and other various maintenance items by the City Street Department. By shortening the pond to the north the storm sewer outlet will also need to be extended to the north, this would cause a conflict with the proposed sanitary sewer. In order to cross the sanitary sewer alignment with a minimum of six inches of clearance the 18-inch storm sewer must be lowered from its original grade and the inlet structure will need to be installed at the existing elevation so that flow does not enter the pipe and drain the pond. Figure 3, located after section 3.6.4, shows the concept of lowering the storm sewer and extending it to the north. The existing storm sewer that parallels North Cliff Avenue on the west side is also in conflict with the proposed sanitary sewer alignment. The storm pipe would need to be raised above the sanitary sewer and a new junction box would need to be installed downstream to accommodate the new storm sewer connections, Figure 3, located after section 3.6.4, shows the concept of raising this storm sewer pipe. Before design of this alignment, a drainage study for the area should be completed in order to determine the future size of these storm sewer pipes downstream of the pond as discussed in the "Upgrades to Equalization Basins" section. By installing storm sewer pipe large enough to convey future flows if the EQ basin is located to the east the levee impacts can be included with this project with the other levee impacts associated with the outfall sewer replacement. This will reduce the total impact of costs to the City associated with these CIP projects and the levee system. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design.



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PLOT DATE: 1/23/2014 10:23 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FIGURE 3

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

CITY OF SIOUX FALLS
PUBLIC WORKS
Providing a Better Quality of Life for You!

SHEET NO.
FIG.
3

Watermain to Great Bear: The existing 8-inch sludge pipe that parallels the existing outfall sewer is currently used for supplying raw water from the Water Treatment Plant to Great Bear Recreation Park for making snow. The water is used to make snow because it is cheaper to use the raw water than the treated water and the untreated water seems to make better snow. The pipe would need to be replaced during construction in order to continue the water service to the park if the existing easement will not remain in place. The pipe could be left in place along the old outfall alignment but would require the existing easement to remain in place which would mean there are two City easements on each property. The cost to install a new watermain is estimated at approximately $600,000 and may require a directional drill to cross the Big Sioux River if a connection cannot be made to the existing 8-inch pipe under the river. The average water usage from this pipe at Great Bear Recreation Park is approximately 8.7 MG per year at a rate of $1.12/1000 gal. The average cost per year to buy raw water using this pipe is approximately $10,000. If a new watermain was not installed and Great Bear Recreation Park is required to buy treated water at the existing commercial rate the average cost per year would be approximately $60,000. The average savings that Great Bear Recreation Park sees from the ability to use the raw water is approximately $50,000 per year, it would take approximately 12 years for Great Bear Recreation park to recover the cost of installing a new watermain, after approximately 12 years Great Bear Recreation would start to see a savings in their water usage again. A determination of the responsible party for this cost would also need to be made.

Power: There is an existing power line that is adjacent to the sewer alignment. At the east siphon box there are two adjacent power poles that may need to be supported during construction. The middle alignment would not impact the power line after the east siphon box therefore minimizing the disturbance to this power line. The City Light and Power Department has no use for this wire and has stated that the power line may be at the end of its life cycle within the next 10 years at which point it would be abandoned. There are no current plans to upgrade the power line in the future. Sioux Falls Water Reclamation expressed interest in leaving the wire in place or replacing it as necessary to provide back up power to the BRPS. Replacing the power line also provides the option in the future to buy power from the City rather than Xcel Energy if there is ever a cost savings. Due to new easements being required for this alignment a new wire would need to be installed within the new sanitary sewer easement so that there are not two easements encumbering the same property. By installing a new wire the City is not bound to always buy power from Xcel Energy. Cost to install a new power line within the sanitary sewer easement has been included in the cost estimate. Feasibility and requirements for having the power line reinstalled during construction should be re-evaluated during design. This power line could be taken out of service during construction without impact to the BRPS because of other power supplies that are available.

Drainage Crossings: Three drainage way crossings along this alignment need to be addressed with regard to elevation and SWPP requirements.

3.6.5 Rock Interface

Based on previous soil borings the invert of the outfall sewer appears to be above the bedrock interface. Additional soil borings have been completed for crossings of I-229 and North Cliff Avenue to confirm the location of bedrock where trenchless installation may be required. One soil boring in the I-229 median showed a layer of cobbles at the invert with boulders below that and the boring hit an obstruction at six feet below the invert. The other two soil borings across I-229 showed fine to medium grained sand near the invert of the pipe with no obstructions. The soil borings across North Cliff Avenue showed sandy lean clay with no obstructions. The soil boring logs can be found in Appendix G. Additional soil borings should be conducted during design to confirm bedrock locations along the remainder of the alignment.

3.6.6 Operation and Maintenance Implications

Access for the City's Sewer jet and vactor truck to the majority of the manholes along the outfall sewer is difficult and often impossible due to the locations. Most of the manholes are located in fields that are inaccessible in the spring due to flooding and wet ground. In the summer these areas are planted for crops, and in the winter the fields can be difficult to access depending on the amount of snow cover. If access during the winter is required permission must be granted by the landowners for a road to be plowed out to the manholes. Most often the only time that crews can access the manholes is in the late fall after crops are out and before it starts to snow. The sewer will be located in the floodplain and access would not be possible during flood events. The 100 year flood level is approximately 1320 based on FEMA floodplain maps. In order to raise the manholes above the 100 year flood level, an impact study would need to be conducted, see Table 2 for a list of manhole elevations. This alignment does not address any of these operation and maintenance concerns. The middle alignment does move the pipe further from the river at the location where the pipe was exposed in the river.

FRPM pipe is much lighter than RCP and requires floatation protection if adequate soil cover is not available. This alignment crosses the Water Reclamation property from the EQ Basins to North Cliff Avenue in a low area. The ground cover in this area is not adequate to prevent floatation in all areas and in some areas does not cover the pipe. This area is currently being used as a storage area for trees, mulch, and snow. The area recieves heavy loads from the large equipment and the ground elevation changes with each use as the items get moved on and off the site. Extending the toe of the levee over the pipe alignment would protect the pipe from floating, traffic loads, and would serve as a reminder that there is a sanitary sewer pipe in place so that the ground is not excavated in this area. By extending the toe of the levee over top of the sanitary sewer pipe the effective area that can be used for storage is reduced. Coordination with Water Reclamation and City Street Department will be important during planning for future land uses in this area. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee and extension of the toe of the levee. Early coordination will be important for incorporating their requirements and concerns into the design.

3.6.7 Bypass Pumping

Bypass pumping would be required for the tie in locations at the EQ basins, siphon boxes at the Big Sioux River, and at the BRPS. The shorter bypass set up reduces the risks and cost to the project associated with long term and long range bypass set ups.

3.6.8 Impacts to Traffic

Trenchless installation methods have proved difficult on similar projects and can be costly when compared to open cut installation. The impact to traffic needs to be compared to the cost and risk of trenchless installation across North Cliff Avenue. Recent preference has been to open cut major roadways such as North Cliff Avenue when installing major sewer lines, the road would be temporarily closed to all traffic during this time. Time restrictions for the closure could be considered during design and the use of incentives and disincentives could be utilized to help the closure to occur as planned. Consideration could also be made during the design phase to maintain traffic and have a phased closure. For the purpose of this cost estimate a complete closure for open cut installation was assumed. The crossing of I-229 should be evaluated for trenchless methods of installation due to the depth of this sewer being approximately 35 feet deep. If a trenchless method can be utilized there would not be any large impacts to traffic along I-229. The crossing of Bahnson Avenue is currently planned to be by open cut method and a full closure would require a detour for traffic. There would also be a crossing of the dead end road, Glenwood Circle.

3.6.9 Impacts to the Park system

The Park system will be impacted at Lien Dog Park as the sewer will cross through the south half of the park. Safety fence can be installed along the work limits to allow safe access to the north half of the park which includes the parking lot. The bike trail system may be impacted by the bypass pipes if they are laid next to the trail. The bike trail currently dead ends at the north side of Lien Park, therefore the number of users impacted should be limited. If the bike trail is extended before construction the impact to the bike trail would be greater. No other impacts to the Park system are seen at this time.

3.6.10 Connections to Existing Sewers

There will be several connections to existing sewer laterals along this alignment, most of these sewer lines will be connected at their current locations. Due to the realignment of the sewer for the I-229 crossing, the 21-inch connection from the south will need to be shortened and the 8-inch and 10-inch (dual siphons under the river connecting to a 12-inch pipe) from the north will need to be extended. The 21-inch sewer from the south will require a manhole to be placed in the middle of the property. The manhole would provide difficult access for maintenance. The extension of the 12-inch sewer from the north should be laid along the DOT ROW for easy access and to limit impact to the property. The existing siphon currently has a higher end invert than a starting invert. Based on the GIS data supplied by the City of Sioux Falls and the proposed outfall sewer inverts proposed in this memo the siphon could be fixed so that the downstream elevation is lower than the upstream. The extension of the pipe to the proposed outfall sewer would still meet 10 State Standards for minimum slope requirements based on the information provided for this memo. The need to replace the siphon and the feasibility of meeting 10 State Standards should be re-evaluated during design after a formal Topographic Survey has been completed and the final design of the proposed outfall sewer has been completed.

3.6.11 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along the Big Sioux River. Much of the land in this area has been previously undisturbed and the location of certain cultural resources is not known. In addition it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be effected by the project additional constraints or permits may be required for the project. The alignment to the west of the Big Sioux River is located in previously disturbed areas. The alignment to the east of the Big Sioux River is located in areas considered to be previously undisturbed and may require additional information before design.

3.7 South Alignment

3.7.1 Right-of-Way/Easement Constraints

A permit from the SDDOT will be required for the crossing of I-229. New easements will be required on eleven separate parcels with six different landowners. Discussions have not started with effected landowners therefore the level of difficulty to obtain these easements is not yet known. The parcel on the west side of I-229 is currently used as an outdoor shooting course for bow and arrows. There will be major impacts to this parcel with the re-alignment of the sanitary sewer and coordination with this landowner will likely dictate the location of the crossing for I-229.

3.7.2 Big Sioux River Constraints and Floodplain

The majority of the pipe and manholes along this alignment will remain in the floodplain. The south alignment adds three additional manholes three of which are below the 100 year flood elevation and one that is above the 100 year flood elevation. Six manholes remain at approximately the same elevation, six manholes are 1.5 to 6 feet higher, and three manholes are 2.5 to 7.5 feet lower than the existing alignment profile. Although some manholes will be higher than the existing alignment the majority of manholes are still 2 to 12 feet below the 100 year flood elevation. A floodplain permit will be required for construction in the floodplain. First, in order to determine how high the manholes could be raised, a No Rise Impact Study would be required for a Floodplain Permit to determine if any of the manholes could be raised to the 100 year flood elevation or how close they could get. Also associated with raising the manholes would be coordination with landowners for the mounds that would be built on their property. Some areas may not be well suited for manholes with increased ground elevations due to current land uses. This alignment moves the sewer pipe the furthest from the Big Sioux Riverbanks. Second, construction in the floodplain can add risk and cost to the sewer replacement. While it is unknown if manholes would be raised along this alignment, the extra depth for manholes and associated grading work are not deemed as significant cost impacts, so no variation in the sanitary sewer pipe installation price has been estimated.

3.7.3 Trenchless Construction

Trenchless construction methods will need to be evaluated for the crossing of I-229. Soil borings have been completed and show a layer of sand and cobbles near the invert of the casing pipe. Trenchless construction methods will need to be evaluated during design to determine the best feasible option for completing the installation successfully. The trenchless installation for this alignment would be approximately 470 feet on an approximately 35 foot deep crossing.

3.7.4 Existing Utilities

At North Cliff Avenue there will be many utilities to cross including a 12-inch watermain, electrical lines, and a 30-inch RCP storm sewer.

Storm Sewers: This alignment crosses through the existing storm water detention pond west of North Cliff Avenue. The bottom elevation of the pond is lower than the invert of the proposed sanitary sewer. The pond would need to be shortened and widened to the west in order to allow the sanitary sewer pipe to cross at the proposed location. This would impact the area to the west that is currently used for storage of trees, mulch, snow and other various maintenance items by the City Street Department. By shortening the pond to the north the storm sewer outlet will also need to be extended to the north, this would cause a conflict with the proposed sanitary sewer. In order to cross the sanitary sewer alignment with a minimum of six inches of clearance the 18-inch storm sewer must be lowered from its original grade and the inlet structure will need to be installed at the existing elevation so that flow does not enter the pipe and drain the pond. Figure 3, located after section 3.6.4, shows the concept of lowering the storm sewer and extending it to the north. The existing storm sewer that parallels North Cliff Avenue on the west side is also in conflict with the proposed sanitary sewer alignment. The storm pipe would need to be raised above the sanitary sewer and a new junction box would need to be installed downstream to accommodate the new storm sewer connections, Figure 3, located after section 3.6.4, shows the concept of raising this storm sewer pipe. Before design of this alignment, a drainage study for the area should be completed in order to determine the future size of these storm sewer pipes downstream of the pond as discussed in the "Upgrades to Equalization Basins" section. By installing storm sewer pipe large enough to convey future flows if the EQ basin is located to the east the levee impacts can be included with this project with the other levee impacts associated with the outfall sewer replacement. This will reduce the total impact of costs to the City associated with these CIP projects and the levee system. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design.

Watermain to Great Bear: The existing 8-inch sludge pipe that parallels the existing outfall sewer is currently used for supplying raw water from the Water Treatment Plant to Great Bear Recreation Park for making snow. The water is used to make snow because it is cheaper to use the raw water than the treated water and the untreated water seems to make better snow. The pipe would need to be replaced during construction in order to continue the water service to the park if the existing easement will not remain in place. The pipe could be left in place along the old outfall alignment but would require the existing easement to remain in place which would mean there are two City easements on each property. The cost to install a new watermain is estimated at approximately $600,000 and may require a directional drill to cross the Big Sioux River if a connection cannot be made to the existing 8-inch pipe under the river. The average water usage from this pipe at Great Bear Recreation Park is approximately 8.7 MG per year at a rate of $1.12/1000 gal. The average cost per year to buy raw water using this pipe is approximately $10,000. If a new watermain was not installed and Great Bear Recreation Park is required to buy treated water at the existing commercial rate the average cost per year would be approximately $60,000. The average savings that Great Bear Recreation Park sees from the ability to use the raw water is approximately $50,000 per year, it would take approximately 12 years for Great Bear Recreation park to recover the cost of installing a new watermain, after approximately 12 years Great Bear Recreation would start to see a savings in their water usage again. A determination of the responsible party for this cost would also need to be made.

Power: There is an existing power line that is adjacent to the sewer alignment. At the east siphon box there are two adjacent power poles that may need to be supported during construction. The south alignment would not impact the power line after the east siphon box therefore minimizing the disturbance to this power line. The City Light and Power Department has no use for this wire and has stated that the power line may be at the end of its life cycle within the next 10 years at which point it would be abandoned. There are no current plans to upgrade the power line in the future. Sioux Falls Water Reclamation expressed interest in leaving the wire in place or replacing it as necessary to provide back up power to the BRPS. Replacing the power line also provides the option in the future to buy power from the City rather than Xcel Energy if there is ever a cost savings. Due to new easements being required for this alignment a new wire would need to be installed within the new sanitary sewer easement so that there are not two easements encumbering the same property. By installing a new wire the City is not bound to always buy power from Xcel Energy. Cost to install a new power line within the sanitary sewer easement has been included in the cost estimate. Feasibility and requirements for having the power line reinstalled during construction should be re-evaluated during design. This power line could be taken out of service during construction without impact to the BRPS because of other power supplies that are available.

Drainage Crossings: Three drainage way crossings along this alignment need to be addressed with regard to elevation and SWPP requirements.

3.7.5 Rock Interface

Based on previous soil borings the invert of the outfall sewer appears to be above the bedrock interface. Additional soil borings have been completed for crossings of I-229 and North Cliff Avenue to confirm the location of bedrock where trenchless installation may be required. One soil boring on the east side of I-229 showed a layer of cobbles at the invert with boulders below that. The other two soil borings across I-229 showed fine to medium grained sand near the invert of the pipe with no obstructions. The soil borings across North Cliff Avenue showed sandy lean clay with no obstructions. The soil boring logs can be found in Appendix G. Additional soil borings should be conducted during design to confirm bedrock locations along the remainder of the alignment.

3.7.6 Operation and Maintenance Implications

Access for the City’s Sewer jet and vactor truck to the majority of the manholes along the outfall sewer is difficult and often impossible due to the locations. Most of the manholes are located in fields that are inaccessible in the spring due to flooding and wet ground. In the summer these areas are planted for crops, and in the winter the fields can be difficult to access depending on the amount of snow cover. If access during the winter is required permission must be granted by the landowners for a road to be plowed out to the manholes. Most often the only time that crews can access the manholes is in the late fall after crops are out and before it starts to snow. The sewer will be located in the floodplain and access would not be possible during flood events. The 100 year flood level is approximately 1320 based on FEMA floodplain maps. In order to raise the manholes above the 100 year flood level, an impact study would need to be conducted, see Table 2 for approximate manhole elevations. This alignment best adresses some of these operation and maintenance concerns by moving the alignment the furthest away from the Big Sioux River and raising the manhole elevations as much as possible based on adjacent terrain. Better maintenance access may be possible by installing an access road along the south property lines following close to the alignment but outside of the crop fields. Additional easements would be required if this option is pursued. A temporary access road would require additional tree removal and portions of the road may encroach slightly on the adjacent crop areas. Landowner coordination would need to include that the area not be tilled in order to preserve the integrity of the road.

FRPM pipe is much lighter than RCP and requires floatation protection if adequate soil cover is not available. This alignment crosses the Water Reclamation property from the EQ Basins to North Cliff Avenue in a low area. The ground cover in this area is not adequate to prevent floatation in all areas and in some areas does not cover the pipe. This area is currently being used as a storage area for trees, mulch, and snow. The area recieves heavy loads from the large equipment and the ground elevation changes with each use as the items get moved on and off the site. Extending the toe of the levee over the pipe alignment would protect the pipe from floating, traffic loads, and would serve as a reminder that there is a sanitary sewer pipe in place so that the ground is not excavated in this area. By extending the toe of the levee over top of the sanitary sewer pipe the effective area that can be used for storage is reduced. Coordination with Water Reclamation and City Street Department will be important during planning for future land uses in this area. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee and extension of the toe of the levee. Early coordination will be important for incorporating their requirements and concerns into the design.

3.7.7 Bypass Pumping

Bypass pumping would be required for the tie in locations at the EQ basins, siphon boxes at the Big Sioux River, and at the BRPS. The shorter bypass set up reduces the risks and cost to the project associated with long term and long range bypass set ups.

3.7.8 Impacts to Traffic

Trenchless installation methods have proved difficult on similar projects and can be costly when compared to open cut installation. The impact to traffic needs to be compared to the cost and risk of trenchless installation across North Cliff Avenue. Recent preference has been to open cut major roadways such as North Cliff Avenue when installing major sewer lines, the road would be temporarily closed to all traffic during this time. Time restrictions for the closure could be considered during design and the use of incentives and disincentives could be utilized to help the closure to occur as planned. Consideration could also be made during the design phase to maintain traffic and have a phased closure. For the purpose of this cost estimate a complete closure for open cut installation was assumed. The crossing of I-229 should be evaluated for trenchless methods of installation due to the depth of this sewer being approximately 35 feet deep. If a trenchless method can be utilized there would not be any large impacts to traffic along I-229. The crossing of Bahnson Avenue is currently planned to be by open cut method and a full closure would require a detour for traffic. There would also be a crossing of the dead end road, Glenwood Circle.

3.7.9 Impacts to the Park system

The Park system will be impacted at Lien Dog Park as the sewer will cross through the south half of the park. Safety fence can be installed along the work limits to allow safe access to the north half of the park which includes the parking lot. The bike trail system may be impacted by the bypass pipes if they are laid next to the trail. The bike trail currently dead ends at the north side of Lien Park, therefore the number of users impacted should be limited. If the bike trail is extended before construction the impact to the bike trail would be greater. No other impacts to the Park system are seen at this time.

3.7.10 Connections to Existing Sewers

There will be several connections to existing sewer laterals along this alignment, most of these sewer lines will be connected at their current locations. Due to the realignment of the sewer for the I-229 crossing, the 21-inch connection from the south will need to be shortened and the 8-inch and 10-inch (dual siphons under the river connecting to a 12-inch pipe) from the north will need to be extended.   The 21-inch sewer from the south will require a manhole to be placed in the middle of the property. The manhole would provide difficult access for maintenance. The extension of the 12-inch sewer from the north should be laid along the DOT ROW for easy access and to limit impact to the property. The existing siphon currently has a higher end invert than a starting invert. Based on the GIS data supplied by the City of Sioux Falls and the proposed outfall sewer inverts proposed in this memo the siphon could be fixed so that the downstream elevation is lower than the upstream. The extension of the pipe to the proposed outfall sewer would still meet 10 State Standards for minimum slope requirements based on the information provided for this memo. The need to replace the siphon and the feasibility of meeting 10 State Standards should be re-evaluated during design after a formal Topographic Survey has been completed and the final design of the proposed outfall sewer has been completed.

3.7.11 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along the Big Sioux River. Much of the land in this area has been previously undisturbed and the location of certain cultural resources is not known. In addition it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be effected by the project additional constraints or permits may be required for the project. The alignment to the west of the Big Sioux River is located in previously disturbed areas. The alignment to the east of the Big Sioux River is located in areas considered to be previously undisturbed and may require additional information before design.

3.8 Comparison of Advantages and Disadvantages

3.8.1 Summary

All three of the alignments examined in this study meet the design criteria of increasing capacity in the outfall sewer. However, none of the alignments truly meet the design parameters of providing better access along the outfall sewer and moving the manholes out of the 100 year floodplain. The south alignment is the alignment that most closely approaches meeting these requirements by utilizing existing ground elevations to bring the rims 1.5 to 6 feet higher than the other alignments as shown in Table 2**.** The south alignment could also provide the best access at more times of the year by moving manholes to the edges of crop fields. An access road could also be installed along the edge of property boundaries if additional easements are acquired to allow for access at manhole locations. The north and middle alignments would not allow for the construction of an access road because of their location through the crop fields. At this time no cost associated with providing separate access has been included in the cost estimate.

Both the middle and south alignment will require the same amount of bypass pumping and would minimize the bypass pumping required for pipe installation. The north alignment would require 2 bypass setups that would run for the duration of the project while the south and middle alignments would require only 3 short duration bypass setups for connection to the existing locations at the EQ basins, the siphon boxes at the Big Sioux River, and at the BRPS.

Sewer laterals may only need to be re-routed if made a requirement by landowner agreement to obtain an easement. All laterals should easily be shortened or extended straight to the outfall sewer as needed.

All three alignments will require construction within the floodplain and floodway of the Big Sioux River. The south alignment is the furthest from the river and at the highest elevation which offers the lowest risk during construction however the elevation difference is minimal. As shown in Table 2 the south alignment partially addresses the design parameter of raising the manholes above the 100 year flood elevation by raising a few manholes above the elevation of 1320 and raising a few manholes to be closer to 1320 but does not meet this parameter for every manhole.

All three alignments will require the same number of utility crossings and conflicts with the exception of the detention pond west of Cliff Avenue. The detention pond will require re-grading approximately 24,000 sqft, a new outlet structure, and installation of three new storm sewers. The installation of the storm sewers will breach the levee system and require additional coordination with the USACE.

Landowner coordination will be required for all sewer alignments. The affects of each alignment and landowner will not be fully established until landowner meetings begin.

The future bike trail alignment would not be significantly affected by any of the proposed alignments. The largest impact would be if the bike trail was extended before the construction began for the outfall sewer replacement. Communication with the Parks Department between now and design will be very important to keep track of schedules and possible impacts.

Cultural resources, threatened or endangered species and wetland impacts would be affected more significantly by the middle and south alignment because these are considered previously undisturbed areas. The north alignment would offer the least impacts to these areas and permits associated with the work may not be as stringent due to the majority of the alignment utilizing previously disturbed areas.

3.8.2 Results

Table 3 shows a matrix that was established based on the criteria that was important to the City in determining a final alignment. Each item was ranked on a scale of 1-10, 10 being the best, for the importance of the item to the City. If the item was extremely important to the City to meet it received a 10. The scores were then weighted by 100% if the item was fully satisfied by the alignment, 50% if the item was only partially satisfied by the alignment or 0% if the item was not satisfied at all by the alignment. Based on the scores entered by the City during one of the planning meetings, the South alignment was preferred over the north and middle alignments. The estimated cost for each alignment option is approximately north – $19,900,000, middle – $18,300,000, and south – $18,500,000, a detailed cost estimate can be found in Appendix F on F.1.

Table 2: Manhole Elevation Comparison

Green = Highest elevation, Yellow = Middle elevation, Red = Lowest elevation, Blue = Same elevations

Note: 100 Year Flood Elevation is approximately 1320

North Alignment					Middle Alignment					South Alignment			
Manhole Number	Station	Rim Elevation	Invert Elevation		Manhole Number	Station	Rim Elevation	Invert Elevation		Manhole Number	Station	Rim Elevation	Invert Elevation
SSMH#02A0001-N	100+00	1318.00	1291.86		SSMH#02A0001-M	200+00	1318.00	1291.72		SSMH#02A0001-S	0+00	1318.00	1291.72
SSMH#02A0002-N	101+25	1308.00	1291.98		SSMH#02A0002-M	200+60.88	1308.00	1291.78		SSMH#02A0002-S	0+60.88	1308.00	1291.78
SSMH#02A0003-N	108+01.64	1313.87	1292.66		SSMH#02A0003-M	207+40.88	1314.33	1292.48		SSMH#02A0003-S	7+40.88	1314.33	1292.47
SSMH#02A0004-N	116+51.07	1310.00	1293.51		SSMH#02A0004-M	210+48	1315.26	1292.80		SSMH#02A0004-S	11+67.96	1314.02	1292.88
SSMH#02A0005-N	123+47.66	1310.00	1294.21		SSMH#02A0005-M	216+02.29	1310.00	1293.47		SSMH#02A0005-S	16+78.51	1310.10	1293.39
SSMH#02A0006-N	131+32.66	1310.45	1294.90		SSMH#02A0006-M	220+03	1310.00	1293.83		SSMH#02A0006-S	21+52.66	1313.89	1293.87
SSMH#02A0007-N	135+68.66	1311.53	1295.43		SSMH#02A0007-M	224+48	1308.69	1294.24		SSMH#02A0007-S	25+52.66	1315.94	1294.27
SSMH#03A0001-N	140+04.05	1314.00	1295.86		SSMH#02A0008-M	230+48	1308.11	1294.86		SSMH#02A0008-S	31+77.66	1309.25	1294.89
SSMH#03A0002-N	145+67.1	1312.00	1296.43		SSMH#02A0009-M	234+98	1312.33	1295.32		SSMH#02A0009-S	36+49.63	1308.25	1295.36
SSMH#03A0003-N	151+42.12	1308.00	1297.00		SSMH#02A0010-M	239+14.23	1312.00	1295.84		SSMH#02A0010-S	40+66.33	1317.64	1295.78
SSMH#03A0004-N	157+17.11	1310.00	1297.55		SSMH#02A0011-M	243+73.84	1308.79	1296.38		SSMH#03A0001-S	45+80.07	1316.56	1296.30
SSMH#03A0005-N	162+92.11	1314.00	1298.13		SSMH#03A0001-M	248+23.84	1312.00	1296.94		SSMH#03A0002-S	49+80.07	1312.12	1296.70
SSMH#03A0006-N	169+14.11	1316.97	1298.75		SSMH#03A0002-M	253+43.84	1314.83	1297.51		SSMH#03A0003-S	55+30.07	1314.83	1297.25
SSMH#03A0007-N	176+07.44	1319.85	1309.62		SSMH#03A0003-M	261+62.09	1323.14	1298.08		SSMH#03A0004-S	63+48.32	1323.14	1298.04
SSMH#03A0008-N	183+72.44	1323.73	1310.39		SSMH#03A0004-M	268+38.97	1316.97	1298.72		SSMH#03A0005-S	70+25.19	1316.97	1298.72
SSMH#03A0009-N	190+32.74	1316.69	1311.04		SSMH#03A0005-M	275+32.29	1319.85	1309.62		SSMH#03A0006-S	77+18.19	1319.87	1309.62
SSMH#03A0010-N	196+93.03	1320.05	1311.69		SSMH#03A0006-M	276+15.33	1318.86	1309.73		SSMH#03A0007-S	83+44.82	1334.00	1310.25
					SSMH#03A0007-M	281+65.33	1334.00	1310.02		SSMH#03A0008-S	87+74.82	1316.33	1310.68
					SSMH#03A0008-M	285+95.33	1316.04	1310.38		SSMH#03A0009-S	93+24.82	1318.10	1311.23
					SSMH#03A0009-M	291+45.33	1318.10	1311.04		SSMH#03A0010-S	98+74.82	1320.05	1311.78
					SSMH#03A0010-M	296+95.33	1320.05	1311.77					

Table 3 - Alignment Comparison Matrix

	Construction Impacts		Operations and Maintenance		Property Impacts	Potential Environmental Impacts	Cost	Construction Cost	Total Points
Point Value	**10**	**4**	**9**	**9**	**8**	**3**	**8**		
Alignment	**Minimize Bypass Pumping**	**Minimize Re-routing of Sewer Laterals and Service lines, length of project**	**Manhole elevations above the 100 year flood elevation**	**Improved Access/Move Sewer off of Difficult property**	**Minimize number of new easements required**	**Previously Disturbed Area**	**Minimize Cost**	**Total Cost** **$**	
North	0	4	0	0	8	3	8	$ 19,866,185.82	23
Middle	10	0	0	0	0	0	8	$ 18,286,503.30	18
South	10	0	5	5	0	0	8	$ 18,533,326.50	27

4.0 Brandon Road Forcemain

The existing forcemain connects the outfall sewer to the WRF. The condition of the forcemain is unknown at this time due to the difficulty of assessing the pipe condition under flow. If a failure occurs in the forcemain the repairs would need to be contracted out and the set up of a bypass system would be extensive and require long installation time. In the meantime, the sewage would have no where to be pumped and a system would need to be installed to allow pumping to the river in order to relieve system backups. In addition to providing a dual forcemain system for protection against a failure, a dual forcemain would increase the capacity of the lift station to approximately 58MGD. The additional pumping capacity gained by installing a second forcemain would alleviate the need to make immediate upgrades to the BRPS or increase equalization capacity upstream of the BRPS. The requirements discussed in the 2009 Water Reclamation Facility Master Plan for additional 6 MG to the east of the existing basins could be temporarily alleviated if upgrades to the BRPS are made or a dual forcemain is installed in the near future to increase the pumping capacity to 50 MGD. If upgrades are not made at the BRPS or a dual forcemain is not installed and pumping capacity remains the same the additional EQ will be required upstream of the BRPS within the next 5-10 years, as recommended in the 2009 Water Reclamation Facility Master Plan.

The existing forcemain alignment parallels East Rice Street up to the BNSF Railroad ROW, then parallels the BNSF ROW to the location just east of the WRF where it turns west to cross the Big Sioux River. The air release valves along the existing alignment are difficult to access and are currently not being maintained. A portion of the alignment is located in the floodplain and within crop land where it is often wet, flooded, covered by crops, or covered in snow. Three alignments were developed for further evaluation, west, middle, and east as shown in Appendix C. The west alignment crosses the Big Sioux River behind the BRPS and follows the end of the river north to North Sycamore Avenue where it turns to follow the ROW up to the WRF. The middle alignment parallels the existing forcemain up to the ROW for North Sycamore Avenue where it turns to follow the ROW north to the WRF. The east alignment parallels the existing alignment from the BRPS to the WRF. For each alignment a cost has been included to install a fiber optic line within the sanitary sewer easement to provide better communication between the WRF and BRPS.

The three alignments were evaluated for the purpose of this memo. They are named based on relative geographic locations of east, middle and west. All three were compared using criteria established by the City as desired improvements and items that would significantly vary the project cost. The criteria included:

1. Right of Way and easement constraints
2. Big Sioux River Floodplain
3. Existing utility coordination
4. Rock interface
5. Operation and Maintenance Implications
6. Bypass Pumping
7. Impacts to traffic
8. Impacts to Park System
9. Adjacent construction projects
10. Environmental impacts

4.1 West Alignment

4.1.1 Right-of-Way/Easement Constraints

New easements will be required on three separate parcels with three different landowners. Discussions have not started with effected landowners therefore the level of difficulty to obtain these easements is not yet known. One parcel on the west side of the Big Sioux River is City property that was obtained for a future bike trail, coordination with the Sioux Falls Parks Department will be necessary to determine the feasibility of utilizing this area based on their planned use in the future. The alignment will also utilize existing ROW for North Sycamore Avenue to minimize the number of new easements that would need to be acquired. Although a permanent sanitary sewer easement would not be required in this ROW, temporary easements may be required to perform the work. The alignment has been offset to the east side of the ROW to allow for any future roads that may be constructed.

4.1.2 Big Sioux River Constraints and Floodplain

One river crossing will be required with this alignment. Over half of the pipe along this alignment will be placed in the floodplain. As the alignment moves away from the river and north along the ROW of North Sycamore Avenue, it rises out of the floodplain. Protection of air release valves in this area should be considered. Construction in the floodplain can add risk and cost to the sewer replacement.

4.1.3 Existing Utilities

The majority of the west alignment is located in previously undisturbed areas and there are a limited number of utility crossings. The forcemain would parallel a water service line in the ROW of North Sycamore Avenue, parallel a 6-inch watermain on the opposite side of North Sycamore Avenue, cross a 10-inch watermain on the southwest side of the sludge lagoons at the WRF, and cross a 6-inch watermain near the trickling filters. There may be other various utilities within the WRF that were not shown in the existing plans. The forcemain will also cross Xcel Energy overhead power lines just north of the corner of East Benson Road and North Sycamore Avenue.

4.1.4 Rock Interface

There were no previous soil borings for the forcemain that could be located on the as recorded drawings provided by the City. Soil borings should be conducted during design of the forcemain after a final alignment has been chosen. Any impacts and costs associated with unknown soil conditions are considered equal for all alignments and therefore no separate item has been provided in the cost estimate.

4.1.5 Operation and Maintenance Implications

Access for the City maintenance crews to the air release valves would be limited without the installation of an access path. A path could be installed in the ROW of North Sycamore Avenue and along the alignment within the City property planned for the future bike trail. Coordination with the Parks department could allow for a separate access path for the maintenance vehicles or could allow for the gravel maintenance access to be paved in the future by the Parks department for the bike trail. There would be approximately 1,000 feet of the 12,340 foot forcemain that would be on private property on the west side of the Big Sioux River and additional easement in this area would be required to install the access path along the forcemain alignment. The alignment for this forcemain could be installed to allow for a continuous rise in the pipe profile with no dips if the pipe is installed 15 to 25 feet deep in some areas, approximately 3,200 feet of the 12,340 feet of pipe would be installed at 20 to 25 feet deep. Installing the pipe deeper at these locations rather than having high spots in the pipe profile will require fewer air release valves and will also reduce the total head required for the pumps at the BRPS. If the forcemain is installed to a set depth below existing grade there would be approximately 15 to 20 feet of static head added to the pumping requirements.

4.1.6 Bypass Pumping

This forcemain would be installed along a new alignment located away from the existing forcemain which would allow for the existing forcemain to remain in service therefore no major bypass pumping would be required for this project. Bypass pumping will be required for the tie in points at the lift station and the headworks of the WRF. There is an existing bypass set up for the BRPS discharge header, it may be possible to utilize this for the connection of the second forcemain. The cost for bypass was considered to be equal for each alignment and was included in the price for furnishing and installing the forcemain pipe.

4.1.7 Impacts to Traffic

Impacts to traffic would be limited for this alignment as the majority of the alignment is located in undisturbed areas. There would be construction adjacent to North Sycamore Avenue but would not require a full closure of the road. The alignment is offset from the road to allow for minimum disturbance, construction staging and activities should occur to the east to minimize impacts to traffic. There will be a crossing at the service road to the sludge lagoons at WRF which may require a temporary access road to be installed for access to these lagoons during construction. This alignment has the least impacts to traffic.

4.1.8 Impacts to the Park system

There are no existing parks or trails located within the project area and impacts to park users during this project would not occur with the existing conditions. One parcel along the west side of the Big Sioux River is owned by the City of Sioux Falls and is currently planned for use of a future bike trail. This project would set the ground work for a bike trail to be installed by clearing a path through the trees located on the parcel. The trees would need to be cleared for the installation of the pipe as well as to provide access for City maintenance crews. Impacts to the trail users would occur if this project was constructed after a bike trail is installed. Therefore coordination with the Parks Department will be critical for proposed construction dates as well as establishing an alignment that will be best suited for both the future trail and the forcemain.

4.1.9 Adjacent Construction Projects

There are currently two construction projects that could possibly impact the construction of the forcemain; they are the Railroad Relocation Project and South Dakota Highway 100. The final alignment and construction dates of these projects has not been determined, however, the study area associated with them is in the vicinity of the existing forcemain and therefore, could impact construction. The west alignment will cross the Big Sioux River just to the northeast of the BRPS and will not be impacted by the construction of either project. The existing forcemain is located adjacent to the existing railroad ROW. The current plans for the railroad relocation include adding additional tracks to parallel the existing tracks. If new ROW is acquired to the west of the existing tracks and new tracks are installed near the forcemain this may have impacts to the existing pipe as well as the middle and east alignments. The railroad may request that the pipe get relocated or additional loading over the pipe may cause damage as this pipe was not designed for rail traffic.

Future expansion of Benson Road across Rice Street has also been projected. The Benson Road project is not expected to begin in the near future but could impact this alignment when it is constructed. The most recent study on the expansion of Benson Road showed a bridge constructed just to the east of North Sycamore Avenue across Rice Street. The actual location of the structure is not known. Before design begins on the forcemain installation a Bridge Study should be conducted to determine if the location of the bridge would impact the proposed forcemain alignment in the future. After a location for the bridge is determined the forcemain alignment can be finalized for design.

4.1.10 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along Rice Street. Much of the land in this area is considered to be previously undisturbed and the location of certain cultural resources is not known. In addition, it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be affected by the project additional constraints or permits may be required for the project. The west alignment is located in previously undisturbed areas until it reaches North Sycamore Avenue and may require additional investigation before design.

4.2 Middle Alignment

4.2.1 Right-of-Way/Easement Constraints

New easements will be required on five separate parcels with three different landowners. Discussions have not started with affected landowners therefore the level of difficulty to obtain these easements is not yet known. The middle alignment will parallel the existing forcemain along East Rice Street until the ROW for North Sycamore Avenue. The alignment along East Rice Street will impact the frontage of two businesses and additional easements will be required. The actual easements required will need to be determined during design in coordination with Xcel Energy due to the close proximity to the power poles. The alignment will also utilize existing ROW for North Sycamore Avenue to minimize the number of new easements that would need to be acquired. Although a permanent sanitary sewer easement would not be required in this ROW temporary easements may be required to perform the work. The alignment has been offset to the east side of the ROW to allow for any future roads that may be constructed.

4.2.2 Big Sioux River Constraints and Floodplain

One river crossing will be required with this alignment. The majority of the alignment would be located out of the floodplain as East Rice Street is on the edge and partially in the floodplain. The alignment then crosses the Big Sioux River and comes back out of the floodplain as it follows the ROW for North Sycamore Avenue. Protection of air release valves in this area should be considered. Construction in the floodplain can add risk and cost to the sewer replacement.

4.2.3 Existing Utilities

The middle alignment has many utility conflicts along East Rice Street. It will parallel the existing forcemain, a 10-inch steel gas line, overhead power lines, and two fiber optic cables. Utility crossings include the following: two water service lines, two sanitary sewer services, one 132-inch storm sewer culvert end, three 36-inch storm sewer culvert ends, and one 6-inch watermain. The forcemain would parallel the existing power lines along Rice Street. The alignment will need to be finalized during design to limit the impact to the power lines and 10-inch gas line in order to determine the actual easement requirements. A cost has been included in the estimate for relocation and supporting of the existing Xcel power poles as necessary. The forcemain would parallel a water service line in the ROW of North Sycamore Avenue, parallel a 6-inch watermain on the opposite side of North Sycamore Avenue, cross a 10-inch watermain on the southwest side of the sludge lagoons at the Water Reclamation Facility (WRF), and cross a 6-inch watermain near the trickling filters. There may be other various utilities within the WRF that were not shown in the existing plans. The forcemain will also cross Xcel Energy overhead power lines just north of the corner of East Benson Road and North Sycamore Avenue.

4.2.4 Rock Interface

There were no previous soil borings for the forcemain that could be located on the as recorded drawings provided by the City. Soil borings should be conducted during design of the forcemain after a final alignment has been chosen. Any impacts and costs associated with unknown soil conditions are considered equal for all alignments and therefore no separate item has been provided in the cost estimate.

4.2.5 Operation and Maintenance Implications

Access along Rice Street would be similar to the existing forcemain access. Access for the City maintenance crews to the air release valves north of East Rice Street would be limited without the installation of an access path. A path could be installed in the ROW of North Sycamore Avenue. The alignment for this forcemain could be installed to allow for a continuous rise in the pipe profile with no dips if the pipe is installed 15 to 25 feet deep in some areas, approximately 3,200 feet of the 12,570 feet of pipe would be installed at 20 to 25 feet deep. Installing the pipe deeper at these locations rather than having high spots in the pipe profile will require fewer air release valves and will also reduce the total head required for the pumps at the BRPS. If the forcemain is installed to a set depth below existing grade there would be approximately 15 to 20 feet of unnecessary head added to the pumping requirements.

4.2.6 Bypass Pumping

The majority of this forcemain would be installed along a new alignment located away from the existing forcemain which would allow for the existing forcemain to remain in service therefore no major bypass pumping would be required for this project. A portion of this alignment would be installed near the existing forcemain, and although this alignment does not directly impact the existing forcemain there is increased risk of damaging the existing forcemain when excavating next to it. Consideration of setting up a temporary bypass system before construction begins may be appropriate. In the event of a failure the set up could quickly be turned on and limit the amount of backups and flow into the Big Sioux River. Bypass pumping will be required for the tie in points at the lift station and the headworks of the WRF. There is an existing bypass set up for the BRPS discharge header, it may be possible to utilize this for the connection of the second forcemain. The cost for bypass was considered to be equal for each alignment and was included in the price for furnishing and installing the forcemain pipe.

4.2.7 Impacts to Traffic

Construction adjacent to East Rice Street would require that one lane of traffic be closed. The alignment is on the west side of the existing alignment and should not require that any surfacing be removed and replaced but rather it would only be closed for safe use during construction. There will be one railroad crossing adjacent to Rice Street, coordination with the owner of this rail will be necessary to determine the method of installation as trenchless construction may be required. An encroachment agreement and permit may be required for this railroad crossing which may include railroad insurance. A price has been included in the cost estimate for railroad insurance. There would also be construction adjacent to North Sycamore Avenue but would not require a full closure of the road. The alignment is offset from the road to allow for minimum disturbance to the road, construction staging and activities should occur to the east to minimize impacts to traffic. There will be a crossing at the service road to the sludge lagoons at WRF which may require a temporary access road to be installed for access to these lagoons during construction.

4.2.8 Impacts to the Park system

There are no existing parks or trails located within the project area and impacts to park users during this project would not occur with the existing conditions. One parcel along the west side of the Big Sioux River is owned by the City of Sioux Falls and is currently planned for use of a future bike trail. Impacts to the trail users would occur if this project was constructed after a bike trail is installed. Therefore coordination with the Parks Department will be critical for proposed construction dates as well as establishing an alignment that will be best suited for both the future trail and the forcemain.

4.2.9 Adjacent construction projects

There are currently two construction projects that could possibly impact the construction of the forcemain, they are the Railroad Relocation Project and South Dakota Highway 100. The final alignment and construction dates of these projects has not been determined, however the study area associated with them is in the vicinity of the existing forcemain therefore could impact construction. The middle alignment would not be significantly affected by the railroad relocation as the alignment is currently located at the south edge of the study area which is subject to change as the project progresses. The existing forcemain is located adjacent to the existing railroad ROW. The current plans for the railroad relocation include adding additional tracks to parallel the existing tracks. If new ROW is acquired to the west of the existing tracks and new tracks are installed near the forcemain this may have impacts to the existing pipe. The railroad may request that the pipe get relocated or additional loading over the pipe may cause damage as this pipe was not designed for rail traffic. The middle alignment is also located on the south edge of the SD Highway 100 Project but will likely not be affected.

Future expansion of Benson Road across Rice Street has also been projected. The Benson Road project is not expected to begin in the near future but could impact this alignment when it is constructed. The most recent study on the expansion of Benson Road showed a bridge constructed just to the east of North Sycamore Avenue across Rice Street. The actual location of the structure is not known. Before design begins on the forcemain installation a Bridge Study should be conducted to determine if the location of the bridge would impact the proposed forcemain alignment in the future. After a location for the bridge is determined the forcemain alignment can be finalized for design.

4.2.10 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along Rice Street. Much of the land in this area is considered to be previously undisturbed and the location of certain cultural resources is not known. In addition it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be affected by the project additional constraints or permits may be required for the project. The middle alignment is located in previously disturbed areas along East Rice Street and North Sycamore Avenue. There is approximately 3,000 feet of the 12,570 feet of pipe located in previously undisturbed area along the middle alignment at the Big Sioux River Crossing which may require additional investigation before design.

4.3 East Alignment

4.3.1 Right-of-Way/Easement Constraints

New easements will be required on thirteen separate parcels with six different landowners. Discussions have not started with affected landowners therefore the level of difficulty to obtain these easements is not yet known. The east alignment will parallel the existing forcemain along East Rice Street until the ROW for the BNSF Railroad tracks. The alignment along East Rice Street will impact the frontage of two businesses and additional easements will be required. The actual easements required will need to be determined during design in coordination with Xcel Energy due to the close proximity to the power poles. The alignment would be installed to the west of the existing forcemain due to the future railroad plans to expand the rails, this will require additional easements from the adjacent property owners that would be affected during construction. An encroachment agreement will be required for the BNSF railroad for work within their ROW and a minimum of six months should be allotted during design in order to obtain the required agreements with BNSF. Due to the future railroad expansion in this area the forcemain would be installed closer to the Xcel Energy Substation and additional easements may be difficult to acquire.

4.3.2 Big Sioux River Constraints and Floodplain

One river crossing will be required with this alignment. The majority of the alignment along East Rice Street would be located out of the floodplain as East Rice Street is on the edge and partially in the floodplain. The alignment then crosses into fields and across the Big Sioux River in the floodplain the forcemain would come back out of the floodplain as it approaches the WRF. Protection of air release valves in this area should be considered. Construction in the floodplain can add risk and cost to the sewer replacement.

4.3.3 Existing Utilities

The east alignment has many utility conflicts along East Rice Street. It will parallel the existing forcemain, a 10-inch steel gas line, overhead power lines, and two fiber optic cables. Utility crossings include the following: two water service lines, two sanitary sewer services, one 132-inch storm sewer culvert end, three 36-inch storm sewer culvert ends, one 6-inch watermain, one 54-inch storm sewer culvert end, and two fiber optic crossings. The forcemain alignment also parallels the existing forcemain to the west to avoid ever having to cross it. The forcemain would parallel the existing power lines along Rice Street. The alignment will need to be finalized during design to limit the impact to the power lines and 10-inch gas line in order to determine the actual easement requirements. A cost has been included in the estimate for relocation and supporting of the existing Xcel power poles as necessary.

4.3.4 Rock Interface

There were no previous soil borings for the forcemain that could be located on the as recorded drawings provided by the City. Soil borings should be conducted during design of the forcemain after a final alignment has been chosen. Any impacts and costs associated with unknown soil conditions are considered equal for all alignments and therefore no separate item has been provided in the cost estimate.

4.3.5 Operation and Maintenance Implications

Access along the east alignment would be similar to the current conditions. Access roads may be difficult to install due to crop fields and the need for additional easements.

4.3.6 Bypass Pumping

This forcemain would be installed along a new alignment located away from the existing forcemain which would allow for the existing forcemain to remain in service therefore no bypass pumping would be required for this project. Although this alignment does not directly impact the existing forcemain there is increased risk of damaging the existing forcemain when excavating next to it. Consideration of setting up a temporary bypass system before construction begins may be appropriate. In the event of a failure the set up could quickly be turned on and limit the amount of backups and flow into the Big Sioux River.

4.3.7 Impacts to Traffic

Construction adjacent to East Rice Street would require that one lane of traffic be closed. The alignment is on the west side of the existing alignment and should not require that one lane of traffic be removed and replaced rather it would only be closed for safe use during construction. There will be one railroad crossing adjacent to Rice Street, coordination with the owner of this rail will be necessary to determine the method of installation as trenchless construction may be required. An encroachment agreement and permit may be required for this railroad crossing which may include railroad insurance. A price has been included in the cost estimate for railroad insurance. This will also impact traffic in and out of businesses and homes along East Rice Street and into the Xcel Energy Substation. This alignment is considered to have largest impact to traffic.

4.3.8 Impacts to the Park system

There are no existing parks or trails located within the project area and impacts to park users during this project would not occur with the existing conditions.

4.3.9 Adjacent construction projects

There are currently two construction projects that could possibly impact the construction of the forcemain, they are the Railroad Relocation Project and South Dakota Highway 100. The final alignment and construction dates of these projects has not been determined, however the study area associated with them is in the vicinity of the existing forcemain therefore could impact construction. The east alignment could be significantly affected by the railroad relocation. The alignment is currently located along the west boundary of the study area which is subject to change as the project progresses. The railroad re-alignment could also impact the existing forcemain depending on the final alignment. The existing forcemain is located adjacent to the existing railroad ROW. The current plans for the railroad relocation include adding additional tracks to parallel the existing tracks. If new ROW is acquired to the west of the existing tracks and new tracks are installed near the forcemain this may have impacts to the existing pipe. The railroad may request that the pipe get relocated or additional loading over the pipe may cause damage as this pipe was not designed for rail traffic. The east alignment is also located on the south edge of the SD Highway 100 Project but will likely not be affected.

4.3.10 Environmental Impacts

The existing sewer alignment is located on the north side of Sioux Falls and along Rice Street. Much of the land in this area is considered to be previously undisturbed and the location of certain cultural resources is not known. In addition it is possible that a Threatened or Endangered Species could be affected by the construction. Work in a previously undisturbed area will require additional survey to determine possible impacts as required for State or Federally funded projects. If Cultural Resources, or a Threatened or Endangered species is found to be affected by the project additional constraints or permits may be required for the project. The east alignment is in previously disturbed areas due to paralleling the existing alignment; however, environmental impacts will still need to be evaluated.

4.4 Comparison of Advantages and Disadvantages

4.4.1 Summary

All three of the alignments examined in this study meet the design criteria of increasing capacity from the BRPS to WRF and providing a dual forcemain for backup, cleaning, and inspection. All three alternatives can be installed without providing a sanitary sewer bypass due to being installed off of the existing alignment.

All three alignments will require construction within the floodplain and floodway of the Big Sioux River, the east alignment is the furthest from the river and at the highest elevation which offers the lowest risk during construction and protection of air release valves.

The west alignment has significantly less utility crossings due to its location in undisturbed areas. It would, however, require a large amount of tree clearing. There are some major utility crossings along East Rice Street as well as paralleling the existing railroad tracks that have plans for expansion which will increase the cost and risks associated with the middle and east alignments.

Landowner coordination will be required for all sewer alignments. The affects of each alignment on each landowner will not be fully established until landowner meetings begin. The west alignment requires the least number of easements followed by the middle alignment. The east alignment has significantly more easements that would be required.

The future bike trail alignment would not be significantly affected by the middle and east alignments. The west alignment would clear a path that could be utilized for the future construction of the bike trail. The largest impact would be if the bike trail was extended before the construction began for the forcemain installation. Coordination with the Park Department will be critical if the west alignment is chosen.

Cultural resources, threatened or endangered species and wetland impacts would be affected more significantly by the west and middle alignments because these are considered to be in previously undisturbed areas. The east alignment would offer the least impacts to these areas and permits associated with the work may not be as stringent due to the majority of the alignment utilizing previously disturbed areas.

Proper operation and maintenance procedures for pump schedules and operating the dual forcemain should be addressed during design to limit the detention time and amount of additional H2S produced from wastewater remaining in one forcemain.

4.4.2 Results

Table 4 shows a matrix that was established based on the criteria that was important the City in determining a final alignment. Each item was ranked on a scale of 1-10, 10 being the best, for the importance of the item to the City. If the item was extremely important to the City to meet it received a 10. The scores were then weighted by 100% if the item was fully satisfied by the alignment, 50% if the item was only partially satisfied by the alignment or 0% if the item was not satisfied at all by the alignment. Based on the scores entered by the City during one of the planning meetings, the west alignment was preferred over the middle and east alignments. The estimated cost for each alignment option is approximately west – $11,400,000, middle – $11,400,000, and east – $12,300,000, a detailed cost estimate can be found in Appendix F on F.2.

Table 4: Alignment Comparison Matrix

	Adjacent Projects		Construction Impacts		Operations and Maintenance	Property Impacts		Environmental Impacts		Cost	Construction Cost	Total Points
Point Value	**10**	**5**	**8**	**10**	**7**	**8**	**9**	**7**	**3**	**8**		
Alignment	**Not affected by Railroad Re-Alignment**	**Not affected by SD-100**	**Minimize Major Utility Crossings**	**Reduce Risk by not installing next to existing Force main**	**Provide good Access**	**Minimize number of new easements required**	**Minimize impacts to traffic**	**Future Bike Trail Alignment Access**	**Previously Disturbed Area**	**Minimize Cost**	**Total Cost** **$**	
West	10	3	8	10	7	8	9	0	0	8	$ 11,400,058.80	63
Middle	5	3	0	5	7	4	5	7	2	8	$ 11,357,026.20	45
East	0	0	0	0	4	0	0	7	3	8	$ 12,318,239.70	22

5.0 Facility Upgrades to the Equalization Basins

The existing equalization basins are located to the west of North Cliff Avenue along the south side of Chambers Street. The EQ basins were constructed in 1994 and the condition of the structures was not evaluated as part of this study.

The 2009 Water Reclamation Facility Master Plan calls for an additional 18 MG of equalization storage, 6 MG to the east of the existing basins sharing a common wall to be built as soon as possible and 12 MG at the WRF site to be built by the year 2020. For this memo, Water Reclamation expressed interest in locating the 18MG of equalization in different combinations of size at both the WRF and the existing EQ site. There are some options that Water Reclamation would like to explore for additional EQ at the WRF before determining how much EQ would be located at each site. For estimating purposes it was assumed that 9 MG would be placed at each location.

The location of the additional basins at the existing EQ location was evaluated for the east and the west sides of the existing basins. For planning purposes, Appendix D shows options of installing a 9 MG EQ basin to the east or to the west of the existing basins along with typical cross sections for each location. The size and location would be finalized during design.

5.1 Site Assessment West of Existing EQ

The land to the west of the existing basins was the site for the previous municipal wastewater treatment plant. During demolition of the previous wastewater treatment plant, the floors of the existing structures were only removed from the area where the existing EQ basins are located in preparation of the construction; the remaining structures on the site were not completely removed. As shown in the cross sections of the proposed basin located in Appendix D, there would be significantly more excavation required for the west location when compared to the east which would also require a retaining wall or a higher wall in the EQ basin. If the basins were constructed on the west they would need to be placed further away from the existing basins due to the location of the grit unit. Depending on the size of the new basins, the existing access road along the west side of the property may need to be relocated to allow enough space between the new basins and the existing sanitary sewer.

5.2 Site Assessment East of Existing EQ

The east location allows for the design of the basins to share a common wall with the existing basin. Locating the basins to the east of the existing basins would offer a common wall construction, less excavation, and space for additional EQ to the east if ever required in the future and would not conflict with the existing grit unit. There is an existing 36-inch storm sewer and overhead electric lines to the east of the existing EQ basins. If additional EQ is built to the east of the existing structure utilizing a common wall to the existing structure both of these utilities would need to be relocated. The storm sewer section that would need to be replaced, including a section through the levee, is shown in Appendix D. The additional EQ could also be moved further to the east to avoid these utilities. However, moving further to the east would occupy more land that is currently used for other operations by the City Street Department.

It was determined that the power lines are owned by the City Light and Power Department and that they could be relocated to the west of the existing structures if needed. It was estimated that the cost to move these poles would be approximately $5,000 -$10,000 for materials if relocated by the City crews.

The storm sewer could be re-routed around the new EQ basin and back to the existing junction structure, routed east down Chambers Street, or behind the Hazardous Waste Facility. The distances of storm sewer replacement for each of these routes are approximately 1,400 feet plus or minus 100 feet. The area that drains into this storm sewer is used by the City Street Department for their maintenance equipment and salt storage. Routing this storm sewer through a BMP would improve the quality of water that is discharged to the Big Sioux River. Routing the storm sewer to the existing BMP would eliminate one levee crossing during construction. The additional excavation to the BMP could be made part of the contract for the excavation of the EQ basin to reduce costs.

Before design begins on the outfall sewer, evaluation of the storm sewer drainage area should be completed to determine the storm sewer size downstream of the BMP. The drainage study will include an extensive area that drains into these storm sewers including the over land drainage area near the existing basins. By installing storm sewer pipe large enough to convey future flows if the EQ basin is located to the east the levee impacts can be included with this project with the other levee impacts associated with the outfall sewer replacement. This will reduce the total impact of costs to the City associated with these CIP projects and the levee system. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design.

In addition to the storm sewer re-routing, there is a large area to the west and north of the existing basins that drains across the surface to a catch basin at the southeast corner of the EQ basins. During design a significant effort will be required in determining the sizing and routing of the storm sewer, sizing an additional BMP or increasing the volume of the existing BMP adjacent to Cliff Avenue.

5.3 Conclusion

For the purpose of this memo a cost estimate located in Appendix F on F.18 and F.19, was established for 9 MG of EQ to the west of the exiting basins and 9 MG to be constructed to the east of the existing basins or at WRF. Each cost estimate includes approximately $2 Million for a pump station to increase the flow capacity into the EQ during a storm event. The approximate cost for the 9 MG of EQ to the west of the existing basins is approximately $16,300,000 and the approximate cost for the 9 MG to be constructed to the east of existing basins or at WRF is approximately$14,00,000. The approximate cost estimated for both the east and west options included approximately $2,000,000 for a 10 MGD pump station. Additional information is required to properly size the pump station. Additional monitoring should be completed to track the amount of flow into the EQ basins and the flow that bypasses the EQ basins in order to aid during design.

Due to the uncertainty of upcoming requirements at the WRF and the possibility for other EQ options at the WRF it is difficult to determine a location for the future EQ basins. The requirements discussed in the 2009 Water Reclamation Facility Master Plan for additional 6 MG to the east of the existing basins could be temporarily alleviated if upgrades to the BRPS are made or a dual forcemain is installed in the near future to increase the pumping capacity to 50 MGD. If upgrades are not made at the BRPS or a dual forcemain is not installed and pumping capacity remains the same the additional EQ will be required upstream of the BRPS within the next 5-10 years, as recommended in the 2009 Water Reclamation Facility Master Plan.

By increasing the pumping capacity at BRPS the requirement for additional equalization is pushed out to WRF. It is recommended that if upgrades are made to increase the pumping capacity of the BRPS that the need for equalization be re-evaluated after the improvements have been implemented. By waiting until after the improvements have been in operation for a period of time it will be easier to determine the affects that were made on the system and determine a more accurate volume required for the equalization.

6.0 Facility upgrades to the Brandon Road Pump Station

6.1 Existing Conditions

The existing condition of the BRPS is similar to that of other 35 year old lift stations. The lift station is serving its purpose and functioning with minimal disturbances and moderate maintenance. However, there were several items identified as risks and operations concerns either due to the age of the facility or the ability to perform proper and safe maintenance on the equipment.

The BRPS is a dry-pit/wetwell type of arrangement complete with mechanically cleaned bar screens installed in the influent channel. Four (4) pumps are arranged with spacing between pumps at 10 feet. Three (3) pumps are driven by 500 Hp magnetic style variable speed drives while the fourth (4th) pump is a diesel driven pump. Emergency backup consists of a truck-mounted emergency generator. The truck-mounted emergency generator will operate two pumps. In order to run three pumps during a power outage the diesel driven pump would need to be operated in conjunction with the two pumps powered by the truck mounted emergency generator. The diesel pump has 24-hours of fuel storage.

The existing pump curves can be found on E.1 in Appendix E. The curves show that the maximum flow that could be pumped with the existing pumps is approximately 40 MGD. The curves also show that at low flows the pumps will run far to the right of the curves. Also shown on this graph is the additional flow capacity that could be achieved by adding a second forcemain.

The wetwell dimensions of 53-feet 2-inches long by 11 feet 10 inches wide by 13 feet 6 inches deep. Figure 4 shows the configuration of the existing wetwell and the arrangement of the pumps and piping in the existing Pump Station.

The Pump Station has a dry pit type arrangement, with no baffle walls separating the pumps. With this open-type arrangement, the pumps are susceptible to the following adverse flow conditions:

- Submerged vortex formation,
- Free-surface vortex formation,
- Excessive pre-swirl of flow approaching the pump impeller,
- Entrained air or gas bubbles, and
- Turbulence in the approach flow to pumps.

These adverse flow conditions can create the following:

- Cavitation,
- Loss of pump capacity, and
- Decreased efficiency.

These are conditions that can cause premature wear on the pump impellers and bearings.

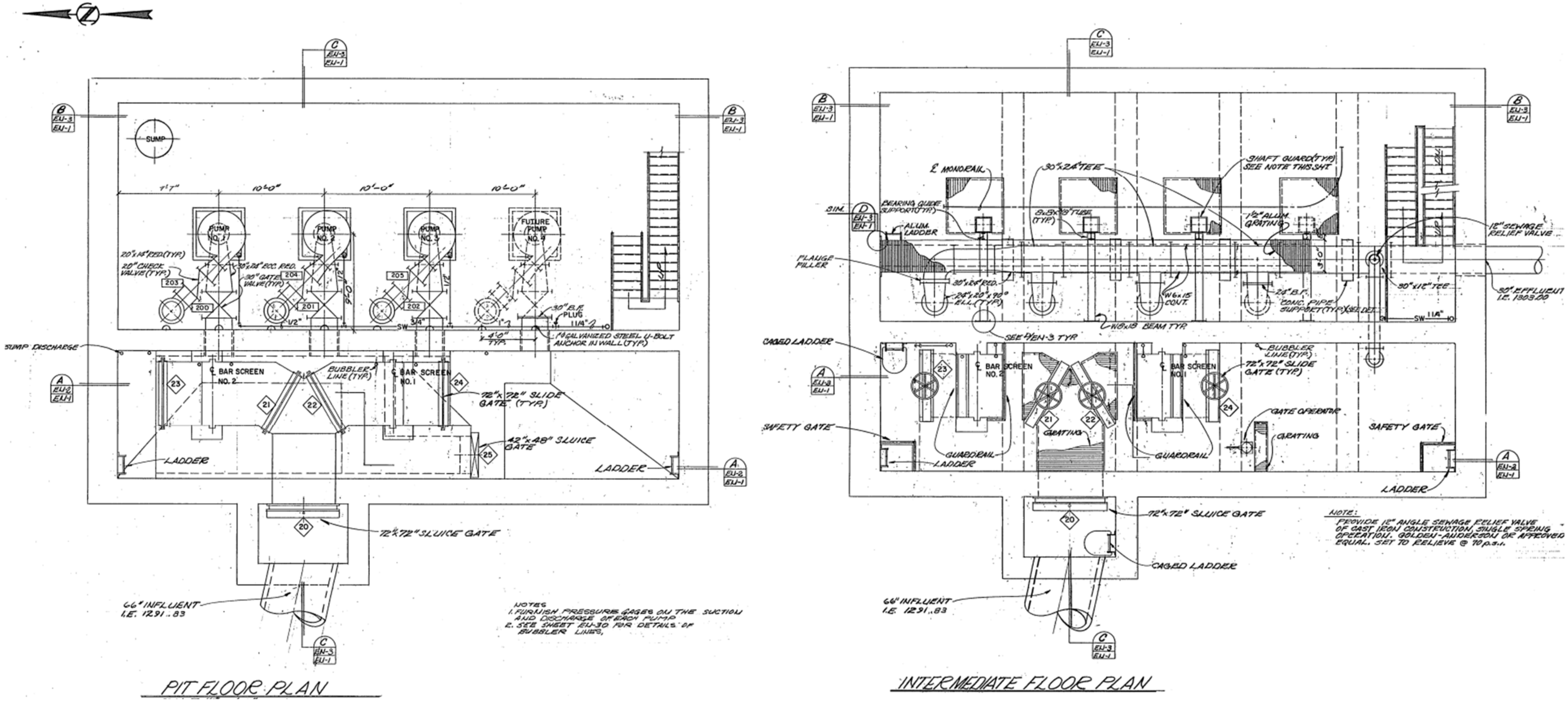


Figure 4 - Existing Pump Station Layout

The design team identified the following major risks for failure and operations concerns which stem from both age of the facility and the ability to perform proper and safe maintenance on the equipment.

1. **Electrical Equipment**
    1. Life expectancy/serviceability: 35 years old, well past typical life expectancy of electrical equipment.
    2. Main Switch Gear/Breakers: Failure would cause significant down time due to the age and size of equipment (not readily available).
    3. Electromagnetic drives: difficult to find parts for and repair.
2. **Health, Safety and Accessibility**
    1. Wetwell: Accessing the wetwell is unsafe for workers during required cleaning operation due to confined space requirements and temporary piping for the Vactor truck.
3. **Flood Protection and Accessibility**
    1. Transformers/ATS and pad mounted service enclosures: At the 100-year flood elevation. The station would lose power if flooded.
    2. Pump station elevation/entry is 0.5-feet below the 500-year flood elevation.
    3. Fuel tank for the diesel engine driven pump: Fuel tank is below the 100-year flood elevation, access to fill the tank is 0.5-feet above the 100-year flood elevation. Could run out of fuel and site would not be accessible.
4. **Standby Power**
    1. Standby power can only operate two pumps. Not fully redundant standby pumping if unable to fuel and service the diesel engine which is used as the third pump when standby power is required.
5. **Pumping Capacity**
    1. Flow Capacity: There is approximately 40 MGD existing max capacity and approximately 50 MGD will be required if no additional equalization capacity is constructed upstream. Pump curves for the existing and proposed pumps are included in Appendix E.
6. **Influent Screening**
    1. Reached the expected service life for mechanical equipment
    2. Causes flushing effect during low flows
    3. Difficult to maintain in the wetwell
    4. Screenings are a mess and difficult to load out
7. **Pumps**
    1. Issues with cavitation at low levels during cleaning cycles for influent screening
    2. Pumps run right (or off) of the published pump curves which reduces pump efficiency and bearing life.

Many options for addressing these risks and operation concerns were examined. A series of projects were identified for potential phasing to individually address existing issues and concerns in a systematic order. Due to the capacity and horsepower involved the majority of the phased projects carry significant costs; however there are a few projects that could be constructed with moderate associated costs.

6.1.1 Evaluation of Existing Arrangement/Layout

The existing Pump Station wetwell is an open type arrangement, with no walls separating each pump. This is a less than ideal arrangement, especially considering the size and capacity of the pumps. If a new lift station is built different wetwell configurations will be evaluated during design.

The HI Standard states that for pumps over 5,000 gpm, in a single intake structure with no dividing walls, pre-swirl could occur and strong submerged vortices can be formed. Submerged vortices entering the pump, even without air entrainment, will impose a fluctuating load on the pump impeller capable of causing vibration, accelerated bearing wear, and in extreme cases, impeller fatigue.

6.1.2 Evaluation of Existing Submergence

Adequate submergence over a pump intake is required to limit velocities which reduces the potential for free surface vortex formation. Strong surface vortices that extend from the water surface down to a pump intake are an unacceptable condition that can cause air to be entrained in the pump. The result could be potential loss of prime and loss of pump capacity.

The maximum original design water surface in the existing wetwell is 1299.0. The existing pump intakes are set 3 inches above the wetwell floor which puts the centerline elevation of the intakes at 1284.5. At the maximum water surface elevation there is 174 inches of submergence over the centerline of the pump intakes.

According to the HI Standards, the minimum submergence required to prevent strong vortices is calculated as follows:

Minimum Submergence, S = D(1+2.3FD) =
Where:
FD = Froude number = V/(gD)0.5
D = Outside diameter of bell or pipe inlet
V = Velocity at Suction Inlet = Flow/Area, based on D
g = Gravitational acceleration

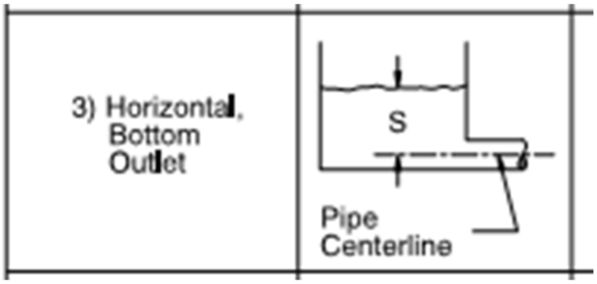


Figure 5 - Recommended Datum for Calculating Submergence *(Courtesy of the Hydraulic Institute's Pump Intake Design Manual)*

The minimum submergence is 67 inches or elevation of 1290.08 for the 11,600 gpm pumps.

The velocity is limited to between 2 and 8 ft/s. The recommended maximum suction velocity is 5.5 ft/s. At 50 MGD, with three (3) pumps operating, the suction velocity is approximately 4.8 ft/s.

6.2 Future Flow Requirements and Conditions

The estimated 2035 peak flow at the BRPS is approximately 50 MGD when considering an additional flow of 2.5 MGD for future regional connection(s) i.e. Tea, SD.

The existing pumps do not have the capability to meet 50 MGD and would need to be replaced to meet the future flow requirements with the current forcemain arrangement. If a second forcemain is constructed the pumping capacity of the existing pumps increases to approximately 58 MGD as shown in Appendix E.

Four (4) new pumps complete with new variable frequency drives (VFD's) would have firm capacity to meet both minimum requirements and peak flow requirements. The following action items would need to be addressed in design:

- 50 MGD -Increase Discharge Pipe Sizes: At the 50 MGD flow, velocities in the individual pump discharge and the main discharge header to the forcemain exceed recommended design velocities at 10.66 ft/sec. It is recommended to increase the pipe size of the discharge piping. The installation of a second forcemain could reduce the velocities in the discharge header if the connection is made properly, but does not address individual pump discharge losses.
- 45 MGD with Additional Equalization: The maximum recommended capacity to maintain less than 10 ft/sec in the individual pump discharges is 45 MGD which would require additional upstream equalization before year 2025.

Project implementation includes costs for phasing the work into several projects or constructing as a single project. It should be noted that the most significant single cost for the 50 MGD station is bypass pumping. Significant savings would be likely by combining projects as the number of bypass setups would be reduced.

An option of building a new pump station adjacent to the existing station was also examined. The new pump station is estimated to be approximately $20,940,000.

The option to construct key refurbishment projects in order to maintain the existing pump station until the new pump station could financially be built was considered. Due to the significant project costs associated with many of the refurbishment projects it is recommended to choose to completely refurbish the existing pump station or build a new pump station. The majority of money that could be invested in refurbishing the existing station to provide the required capacity while the financing was acquired to build the new station would essentially be lost after the station is built. The smaller projects that address the issues with the aging electrical equipment and back up power generation would be feasible if planning for a new pump station; however installing new pumps and drives would create significant costs that could not be recovered.

6.3 Refurbish Existing Pump Station

In order to refurbish the existing station to address all of the risks and operations concerns; the following projects would need to be completed:

1. Refurbish Existing Switch Gear
2. Raise outside electrical equipment, transformers, ATS, and pad mounted systems, above the 500 year flood level.
3. Construct a New Emergency Generator
    i. If Refurbish Existing Switch Gear is already complete there would be a deduction to the emergency generator project cost as completely new switch gear was included.
4. Replace Pumps and Drives
    i. Additional options **not included** in the pumps and drives project cost require bypass pumping:
        a) Replace discharge header
        b) Line/Coat Wetwell
5. Construct Access for Wetwell Cleaning
6. Replace Influent Screening
7. Construct 500-Year Flood Protection
8. Replace HVAC, Doors, Roof and Repaint Facilities

The projects total approximately $17,600,000 which would be constructed over the course of 10 to 20 years. A detailed cost estimate for each of the following projects can be found in Appendix F. At the completion of all of the projects, the risks and operations concerns will have been addressed.

The advantages of this option are:

- All of the risks and concerns will have been addressed and
- Cost would be spread out over the course of 10 to 20 years rather than pay the full price up front.

The disadvantages are as follows:

- Not all of the risks and concerns will be addressed at the same time leaving the pump station vulnerable until the individual projects are complete and
- The pump station will not physically be changed so items such as the wetwell and pump intake arrangement will not be changed.
- Limited minimum operating level in wetwell due to suction arrangement.
- The structural components are 35 years old and would need to continue to be maintained.

6.3.1 Refurbish Existing Electrical

The Brandon Road Pump Station is served by dual utility transformers with secondary voltages of 4160V. Based on exterior markings, the transformers appear to be two (2) units at 1000kVA (one of the 13.8kV/4160V transformers has a “1000” label). At the current size, the individual transformers can feed a maximum of two (2) pumps.

Based on the configuration of the service the size could be increased to be able to feed at least three pumps. Upsizing the transformer would allow at least three pumps to operate if one of the utility transformers or one of the utility mains failed. This would be accomplished by opening one of the utility mains and closing the tie switch. The utility mains and tie fuses appear to be sized adequately to run three pumps (need pump nameplate FLC to confirm). Therefore, a single-point failure on the upsized utility transformer or utility would reduce the pumping capacity to a worst case capacity of three pumps. A single failure of a single pump drive would provide a reduction in pump capacity to three pumps, *assuming the engine driven unit is operational*.

A review of the critical electrical components is as follows: *Reference Figure 6 – Brandon Road PS one-line diagram below.*

1. A failure on the switchgear bus could cause a reduction in pumping capacity to two pumps. However, bus failures are uncommon events.
2. Transformer Replacement: The Utility can likely obtain a replacement from the utility fairly quickly, so a preventative replacement of these transformers is probably not necessary. However, as noted, upsizing the transformer would allow at least three pumps to operate if one of the utility transformers or one of the utility mains failed. Some preventive maintenance on the transformer and testing of the transformer oil may be warranted. The budgetary cost for replacing the utility transformers is:
    - $50,000 each, or $100,000 total. This price includes removing and replacing the transformer. The price included for the transformers is estimated; an actual cost for moving the transformers from Xcel Energy has been requested but has not been provided for this cost estimate.
    - $50, 0000 for ATS and utility primary feed.
3. Replacement of the utility main and tie load interrupter switches and fuses: May be warranted if new emergency generator is not planned. The budgetary cost for installed replacement:
    - $35,000 each or $105,000 total

    OR
4. Convert to electrically operated circuit breakers: It would be prudent to convert the existing utility main and tie load interrupter switches and fuses to electrically operated circuit breakers if the plan is to accommodate the installation of a future automatically controlled generator. The budgetary installed cost:
    - $50,000 per breaker plus $75,000 for control upgrades, for a total of $225,000.
5. Complete Switchgear Replacement: Replacement of the switchgear busses is not really feasible unless the entire switchgear is replaced for an installed cost of:
    - $800,000.
6. Refurbish Individual motor starters and MCC Feeders:
    - $25,000 each or $150,000 total.

Electrical Recommendations:

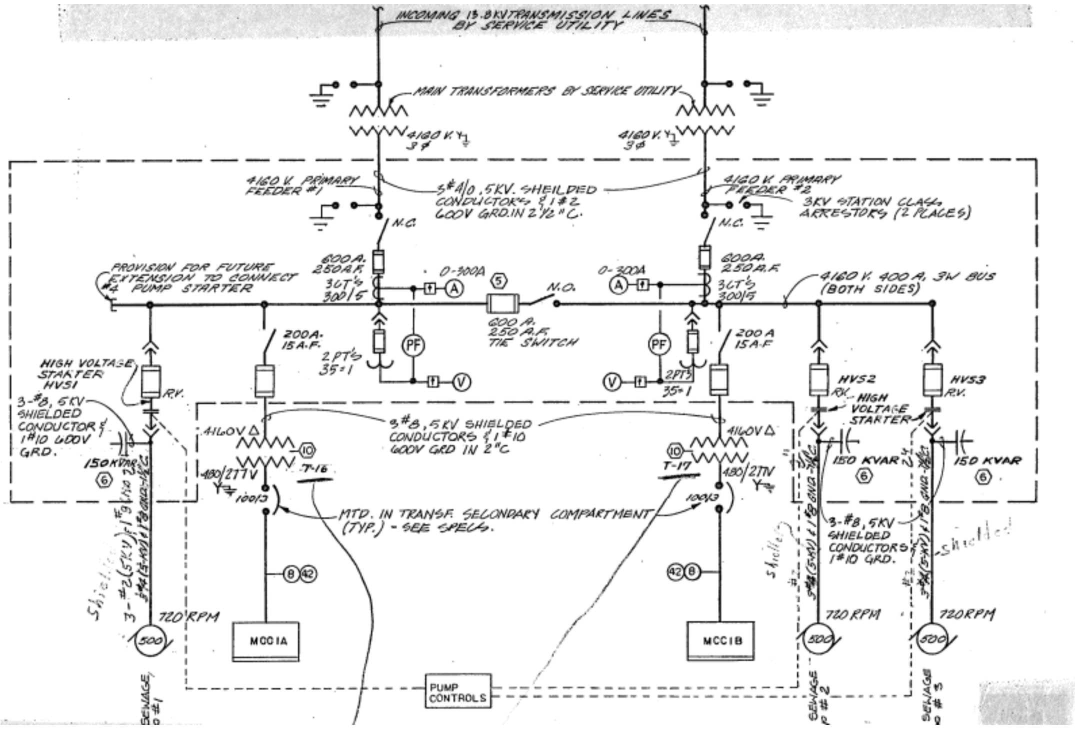
- Item 3: At a minimum, replace the load interrupter switches and fuses for the utility mains and tie.

OR

- Item 4: Convert to electrically operated circuit breakers if planning for a permanent generator with automatic controls in the near future.
- Utility should perform preventative maintenance and testing on the utility transformer(s).

This project will refurbish the existing switch gear but is not a full replacement. It includes costs for converting to electrically operated circuit breakers assuming that a future permanent generator would be installed in the near future and would have automatic controls.

Figure 6 – Brandon Road PS one-line Diagram



6.3.2 Raise outside electrical equipment, transformers, ATS, and pad mounted systems, above the 500 year flood level.

This project will raise the outside electrical equipment including the transformers, transfer switch and pad mounted systems above the 500-year flood elevation. The price included for the transformers is estimated; an actual cost for moving the transformers from Xcel Energy has been requested but has not been provided for this cost estimate. The work included in this cost estimate also includes grading the area to the north of the pump station above the 500-year flood elevation and installing a retaining wall to avoid grading outside of the existing property boundaries. See Figure 7 for the proposed retaining wall location.

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SHEET NO.

FIGURE 7

CITY OF SIOUX FALLS
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RETAINING WALL AROUND BUILDING

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: LIFT STATION FLOOD PROTECTION_2013_12_4.DWG
CHECKED BY: D. GRABER DATE: 12/30/2013
REVISIONS: BY: DATE:
BY: DATE:

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

6.3.3 Emergency Generator

This project will install a Tier 2 emergency standby/emergency generator. The generator costs can be greatly reduced if the switch gear has already been refurbished. If the switch gear has not been refurbished it could be refurbished with this project or replaced. This project would address the concerns with the backup power not being a fully redundant standby pumping system because it would run 3 pumps rather than 2.

6.3.4 Replace Pumps and Drives

This project includes removing the existing pumps, installing 4 new pumps; one of which replaces the diesel engine pump, and install new variable frequency drives (VFD's).

The project does not include replacing the discharge header or individual pump discharge pipes as this additional work would require extensive bypass and add a cost of approximately $3 Million. The project also does not include lining the wetwell. The wetwell lining would require some bypass pumping and could be paired with the project to replace the discharge header. Replacing the pumps and drives would address the issues with pump cavitation at low levels and the proposed pumps are able to run at lower speeds in order to operate on the manufacturer’s pump curves.

6.3.5 Improve Access for Wetwell Cleaning

This project would provide outside access to the intermediate floor above the wetwell to allow better confined space entry and air flow to the outside. The project would also include coring holes in the intermediate floor to install hard piping down into the wetwell. The hard pipes would be installed to an elevation in the wetwell that would allow for a flex hose to be connected for vactoring out the wetwell. The pipes would be connected to the walls and piped outside for connection to the Vactor truck. This would make cleaning the wetwell safer by allowing unrestricted access into the wetwell through the intermediate floor and the hard pipes connect to the walls would provide safe use for vacuuming out the wetwell because the pipes are locked in place.

6.3.6 Replace Influent Screening

This project will replace the existing screens in the same location. The current screens are difficult to maintain due to the equipment located in the wetwell. The screens included in the cost estimate from this project would include screens that do not have any bearings located in the wetwell which would improve maintenance of the screens. The screens included in this cost estimate provide tighter rake spacing which would lower the flushing effect of the screens as they are cleaned. The project does not include the cost of lining the wetwell. Lining the wetwell would require some bypass and it may be possible to pair lining the wetwell with screen replacement. It was not recommended to install a new screening building due to the cost associated with the excavation and dewatering for a screening building almost 40 feet deep. The cost associated with excavating and constructing a building for the screens would make it more feasible to also build a new pump station rather than just the screening building.

6.3.7 Site – 500-year Flood Protection

This project will provide flood protection for the existing pump station up to the 500-year flood elevation. There are three options which would provide flood protection to the existing station.

The first option is to build a retaining wall around the building as close to the building perimeter as possible. The cost estimate for this project includes raising the outside electrical equipment above the 500-year flood elevation if it has not already been done previously. The retaining wall would need to be designed to allow access to the stairs and loading dock. The openings in the wall would be prefabricated to allow for the installation of a temporary flood gate in the event of a predicted flood. The project would not provide access from Rice Street to the lift station during a flood; however the pump station and electrical equipment would be protected. Figure 8 shows the proposed location of the retaining wall.

The second option is to build up the road from Rice Street to the lift station site. As the road approaches the lift station and is brought back to grade for easy access to the parking area a retaining wall would be built and surround the lift station area. This would allow complete access to the lift station without the use of temporary gates. The retaining wall would allow the flood protection without the need to acquire additional property. The road and retaining wall could be built to stay within the existing site; however some temporary construction easements may be required due to the existing steep slopes of the lift station property. Figure 9 shows the proposed location of the road and retaining wall.

The third option is to build up the road from Rice Street out to the lift station and build a berm around the entire site. This option would provide the same protection as the retaining wall but would require acquisition of the adjacent properties due to the required slopes of the berm. Figure 10 shows the proposed location of the road and flood protection berm, it also shows areas that would require additional land acquisitions.

All three of the proposed options would address the flood concerns to the 500-year flood elevation. The first option would be the only option that does not allow access to the site during a flood.

6.3.8 Replace HVAC, Doors, Roof Repairs, Painting

This project will update the existing HVAC, doors, roof repairs, painting, and miscellaneous items that have not been repaired or improved with the previous projects.

New HVAC equipment would be installed in the new pump station building. The new HVAC system would be designed to provide air changes of outside air to meet the requirements of NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

RETAINING WALL AROUND BUILDING

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: LIFT STATION FLOOD PROTECTION_2013_12_4.DWG
CHECKED BY: D. GRABER DATE: 12/30/2013
REVISIONS: BY: DATE:
BY: DATE:

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FIGURE 8

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WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

RET. WALL AROUND SITE & RAISE ROAD

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: LIFT STATION FLOOD PROTECTION_2013_12_4.DWG
CHECKED BY: D. GRABER DATE: 12/30/2013
REVISIONS: BY: DATE:
BY: DATE:

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HDR

SHEET NO.
FIGURE 9

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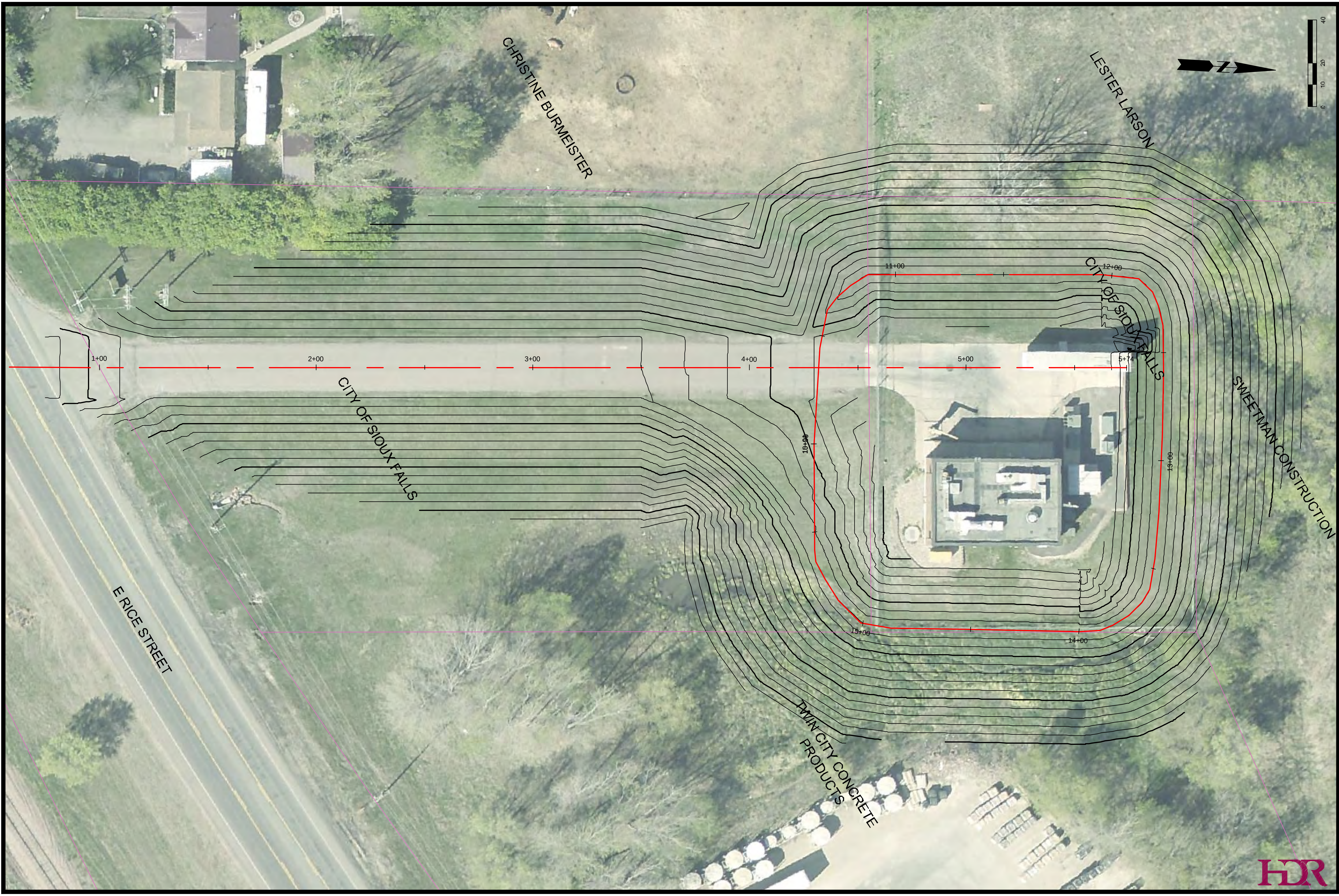

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

BUILD BERM AROUND SITE & RAISE ROAD

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: LIFT STATION FLOOD PROTECTION_2013_12_4.DWG
DATE: 12/30/2013
REVISIONS:
BY: DATE:
BY: DATE:

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SHEET NO.
FIGURE 10

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PLOT DATE: 12/30/2013 4:11 PM VanWyhe, Nick

6.4 Building a New Pump Station

A new pump station could be built on the existing site if planned for during construction of the outfall sewer and the dual forcemain. The construction of a new pump station would allow a pump station to be built to today's design standards and incorporate specific requests for the layout of the lift station. It would include a new screening building located outside of the wetwell and the wetwell could be constructed to improve the intake conditions of the pumps. The new lift station could address all of the risks and operating concerns associated with the existing pump station. The advantage to constructing a new lift station is that it addresses all of the concerns and risks within 1-2 years rather than spanning them out over the course of 10-20 years. The disadvantage to constructing a new lift station is that the project cost of almost $21 Million is required to be spent in 1-2 years rather than being able to spread the costs out over the course of 10-20 years.

6.4.1 New Pump Station

The pump station would include four pumps with space for a fifth, separate below-grade wetwell and dry pit areas, and an above-grade building for housing the discharge piping and valves and electrical equipment. The approximate plan dimensions of the pump station are 90 feet long by 50 feet wide by 46 feet deep (assumed ground elevation of 1323.00 to get above 500 year flood elevation). The layout of the wetwell is shown as recommended in the Hydraulic Institute’s American National Standard for Pump Intake Design as follows:

- Divided wetwell with an influent box and sluice gates for control of flow between each intake. A divided wetwell would allow one side of the pump station to be taken down for cleaning and maintenance while the other side is in use along with each pump intake.
- Wall to separate the pumps into bays and prevent interference between pumps
- Vortex breakers (as required).
- Wetwell depth to allow operation of the pumps at minimum submergence based on the Hydraulic Institute’s standards and manufacturer’s recommendations to prevent surface and submerged vortices.
- Coating of wetwell and influent chamber.
- Metering is proposed on the individual pump discharge lines.

The new pump station layout would improve maintenance access for pump removal, and the current station’s wetwell cleaning limitations would be eliminated. The building height and bridge crane height would allow the pumps to be completely pulled from the wetwell. In the new building, the bridge crane would be set high enough to allow room to completely remove the pumps. Pump curves for the existing pumps as well as two pump alternatives can be found in Appendix E. The estimated cost for a new pump station is approximately $21,000,000, a detailed cost estimate can be found on F.3 in Appendix F.

6.4.2 Screenings facilities

The best choice for this application is a coarse traveling-rake bar screen. The existing screen has 1-inch bar spacing, however since fine screen facilities have been added at the WRF Pretreatment Unit this spacing could be up to 2-inch. This type of screen reduces the “flushing” effect that is currently occurring at the existing pump station. Traveling-rake screens utilize a bar screen that is capable of being continuously cleaned by multiple rakes mounted on a chain. The technology is well suited for general wastewater applications and is considered to be robust and reliable. Bar screens have lower head loss than other fine screens.

Traveling-rake screens are similar to climber-screens but have multiple cleaning rakes and do not require as much head space. A traveling-rake screen is capable of keeping the bar rack clean during times of heavy loading. A traveling-rake screen is well suited for both the new and existing pump station applications and will not require significant building or channel modifications.

A screw conveyor or trough can be used to convey screenings. A sloped trough with a steady supply of non-potable water has proven to be effective for conveying screenings to a washer press. If the washer press is located near the screens a screw conveyor will be used to convey screening to the dumpster area for drive-through style pickup.

7.0 Implementation

The construction sequencing of these projects will be essential in preparing for the future projects. The location of the proposed outfall sewer and forcemain will be important based on the location of a new pump station or the refurbishment of the existing pump station. The order of precedence for these projects was determined based on condition, expected service life and risk for failure.

The forcemain and outfall sewer have been given top priority based on both condition and risk. Final priority will be determined based on further assessment of the outfall sewer CCTV currently being conducted.

7.1 Outfall Sewer

If a failure occurs in the outfall sewer, the repairs would need to be contracted out; however the bypass system set up would not be as extensive and time consuming as the forcemain. Easement acquisitions for the outfall sewer are estimated to take over one year due to the number of easements required. It may be possible to begin design and construction on the forcemain while design and easement acquisition occur for the outfall sewer.

The condition of the outfall sewer is known from CCTV recordings from 2010. Liner deterioration is visible along with some deterioration in the concrete. CCTV is being conducted at the time of this memorandum. The CCTV records that are being completed in winter 2013/2014 will be compared to the records from 2010 to aid in the decision of precedence between the forcemain and the outfall sewer.

7.2 Parallel Forcemain

The condition of the forcemain is unknown at this time due to the difficulty of assessing the pipe condition under flow. If a failure occurs in the forcemain the repairs would need to be contracted out and the set up of a bypass system would be extensive and require long installation time. In the meantime, the sewage would have no where to be pumped and a system would need to be installed to allow pumping to the river in order to relieve system backups. The easements for the proposed forcemain are estimated to take less time than the outfall sewer due to the low number of easements required.

The existing concrete pressure pipe portion of the forcemain from the lift station to Rice Street is planned for replacement along a new alignment based on refurbishing of the existing lift station or the location of a future lift station. Before design begins for the forcemain it should be determined which option is preferred for the lift station so that this can be planned into the location of the new forcemain and the location of the replacement pipe for the existing concrete pressure pipe.

7.3 Brandon Road Pump Station

The third project would be the refurbishment of the existing pump station or a new pump station depending on preference, schedule, and available funding. The location of the lift station needs to be addressed in the final design alignment of the forcemain and outfall sewer to allow for minimization of bypass pumping during the proposed future BRPS station improvements.

7.4 Equalization Facilities

The fourth project construction of the required additional equalization basins. The volume of equalization at the existing EQ site will be based on site constraints and requirements for BRPS capacity and the remainder is planned at the Water Reclamation Facility. Note that if only the pumps and drives are replaced at the BRPS, additional equalization will be required at the existing EQ site.

The EQ requirements and location should be re-evaluated as work progresses on the BRPS preliminary design and future nutrient requirements at WRF are being implemented. There are several design considerations listed in the equalization basin discussion that need to be considered when determining the location of any EQ at the existing site.

8.0 Summary of Projects

The recommended improvements are planned to be combined in four projects phased over the next 5 to 15 years. The projects have been identified as Outfall Sewer Replacement Project, Parallel Forcemain Installation Project, Brandon Road Pump Station Improvements (New Brandon Road Pump Station Project or Refurbish Brandon Road Pump Station Projects), and Equalization Facilities Project. The information for the Refurbish Brandon Road Pump Station Projects has been included for informational purposes as it was evaluated during this study. After review and comparing the cost to refurbish the existing lift station vs. building a new one the City is currently planning to build a new lift station however the option to retrofit is included for reference. The Outfall Sewer Replacement Project and Parallel Forcemain Installation Project may be re-ordered based on the CCTV reports completed in the winter of 2013/2014. Brandon Road Pump Station Improvements Project contains two separate projects one is a list of projects to provide for phasing improvements to the BRPS and one is a new pump station, one or the other of these projects will be completed not both. These four projects are described in the following paragraphs. Table 5 shows the estimated time from the date of this memo that it is estimated the project should be constructed.

The first project should include work to finalize alignments for the outfall sewer and forcemain to acquire the appropriate easements for both projects, facility planning for the forcemain, design of the forcemain, an EQ splitter box at WRF, planning for the future location of a new lift station, and connection of the outfall sewer to a new lift station.

Table 5 – Estimated years to complete project from time of memo

Description	Estimated Total Project Cost	Located in Appendix F	Completion Window
Outfall Sewer Replacement Project	$18,500,000	F.1	1-3 Years
Parallel Forcemain Installation Project	$11,400,000	F.2	1-3 Years
New Pump Station Project –OR–	$21,000,000	F.3	5-10 Years
Refurbish Brandon Road Pump Station Projects	$17,600,000	F.4 – F.17	5-10 years
Equalization Facilities Project	$14,000,000	F.18 –F.19	5-15 Years

8.1 Outfall Sewer Replacement Project

The Outfall Sewer Replacement Project will include the replacement of the existing outfall sewer with a 72-inch diameter Fiberglass Reinforced Polymer Mortar Pipe with all associated fittings and appurtenances, road crossings, levee and river crossings, utility crossings, installation of EQ flow meters, and the installation of a lime lagoon drain and flow meter. A 72-inch pipe will be assumed for the proposed outfall sewer based on the sanitary sewer modeling results. A d/D of 0.75 was used for the purpose of this planning study. When costs were evaluated for pipe size the cost difference was negligible between 66-inch pipe and 72-inch pipe. Through planning meetings it was determined that if the sewer is being replaced the opportunity to increase the pipe size should be utilized.

During the final meetings for this project it was identified that the City Street Department is beginning to use the site to the east of the existing EQ basins more frequently with heavy vehicles. The existing outfall sewer is located across the middle of this property and is buried less under less then 3-5 feet soil in some locations. There is concern that they heavy vehicle traffic may cause a sewer collapse and efforts to stop the traffic in this area have not been successful. It is desired that the portion of the outfall sewer between the EQ basins the Big Sioux River be replaced in the near future along the south alignment. The alignment would move the pipe to the south of the property and would eliminate the risk of failure due to heavy vehicle traffic. The project would include rehabilitation of the existing siphon boxes on both sides of the Big Sioux River. Early planning meetings should be held with the USACE to discuss placement of the sanitary sewer next to the levee, extension of the toe of the levee, and other work adjacent to the levee system. Early coordination will be important for incorporating their requirements and concerns into the design. This portion of the outfall sewer is located on City property and within ROW so land owner coordination would only be required with the appropriate City Departments.

A summary of the entire Outfall Sewer Replacement Project costs are shown in Appendix F on F.1 and are estimated to be approximately $18,500,000 based on the proposed South Alignment.

A proposed implementation schedule for the Outfall Sewer Replacement Project is shown in Table 6. Construction permitting and the submittal to the SDDENR are included as part of the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

Table 6 – Proposed Implementation Schedule for Outfall Sewer Replacement Project

Description	Completion Date
Facility Plan	February, 2015
Design	
Design Contract Award	May, 2015
Predesign Services	June, 2015
Land/Easement Acquisition	September,2015
Final Design Submittal	February, 2016
Bid	
Request Bids	March, 2016
Contract Award	April, 2016
Construction	
Shop Drawing Submittal Approvals	June, 2016
Project Completion	December, 2016

8.2 Parallel Forcemain Project

The Parallel Forcemain Project includes the installation of a dual 36-inch forcemain including all associated river crossings, and utility crossings as described in the forcemain discussion of this memo. A summary of The Parallel Forcemain Project costs are shown in Appendix F on F.2 and are estimated to be approximately $11,400,000 based on the proposed West Alignment:

A proposed implementation schedule for The Parallel Forcemain Project is shown in Table 7.

Table 7 - Proposed Implementation Schedule for Parallel Forcemain Installation Project

Description	Completion Date
Facility Plan	February, 2014
Design	
Design Contract Award	May, 2014
Predesign Services	June, 2014
Land/Easement Acquisition	January, 2015
Final Design Submittal	February, 2015
Bid	
Request Bids	April, 2015
Contract Award	May, 2015
Construction	
Shop Drawing Submittal Approvals	July, 2015
Project Completion	December, 2015

8.3 New Brandon Road Pump Station Project

The New Brandon Road Pump Station Project will be a new pump station as described in the new pump station discussion of this memo. A breakdown of The New Brandon Road Pump Station Project costs is shown in Appendix F on F.3.

A proposed implementation schedule for The New Brandon Road Pump Station Project is shown in Appendix F on F.3 and are estimated to be approximately $21,000,000. Construction permitting and the submittal to the SDDENR are included in the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

A proposed implementation schedule for The New Brandon Road Pump Station Project is shown in Table 8.

Table 8 - Proposed Implementation Schedule for New Brandon Road Pump Station Project

Description	Completion Date
Facility Plan	February, 2019
Design	
Design Contract Award	May, 2019
Predesign Services	July, 2019
Final Design Submittal	January, 2020
Bid	
Request Bids	March, 2020
Contract Award	April, 2020
Construction	
Shop Drawing Submittal Approvals	September, 2020
Project Completion	May, 2020

8.4 Refurbish Brandon Road Pump Station Improvements Projects

The refurbish Brandon Road Pump Station Improvements Projects includes the interim pump station improvements as described in the pump station refurbishment discussion of this memo. This project has been divided into smaller phased projects so serviceability and reliability concerns can be addressed as funds become available. After review and comparing the cost to refurbish the existing lift station vs. building a new one the City is currently planning to build a new lift station however the option to retrofit is included for reference. A summary of the Refurbish Brandon Road Pump Station Improvements Projects costs are shown in Appendix F on F.4 – F.17 and are estimated to be a total approximate cost of $17,600,000:

A proposed implementation schedule for The Refurbish Brandon Road Pump Station Improvements Projects typical for one refurbishment project of the 7 refurbishment projects proposed is shown in Table 9. Subsequent projects and dates will be dependent on priority and funding but would follow a similar time schedule.

Table 9 – Proposed Implementation Schedule for Refurbish Brandon Road Pump Station Improvements Projects

Description	Completion Date
Facility Plan	February, 2018
Design	
Design Contract Award	May, 2018
Predesign Services	July, 2018
Final Design Submittal	December, 2018
Bid	
Request Bids	January, 2019
Contract Award	February, 2019
Construction	
Shop Drawing Submittal Approvals	May, 2019
Project Completion	December, 2019

8.5 Equalization Facilities Project

The Equalization Facilities Project will be increasing the existing equalization capacity as discussed in the equalization discussion of this memo. A breakdown of the Equalization Facilities Project costs is shown in Appendix F on F.18 and F.19 and are estimated to be approximately $14,000,000 based on the east option for 9 MG.

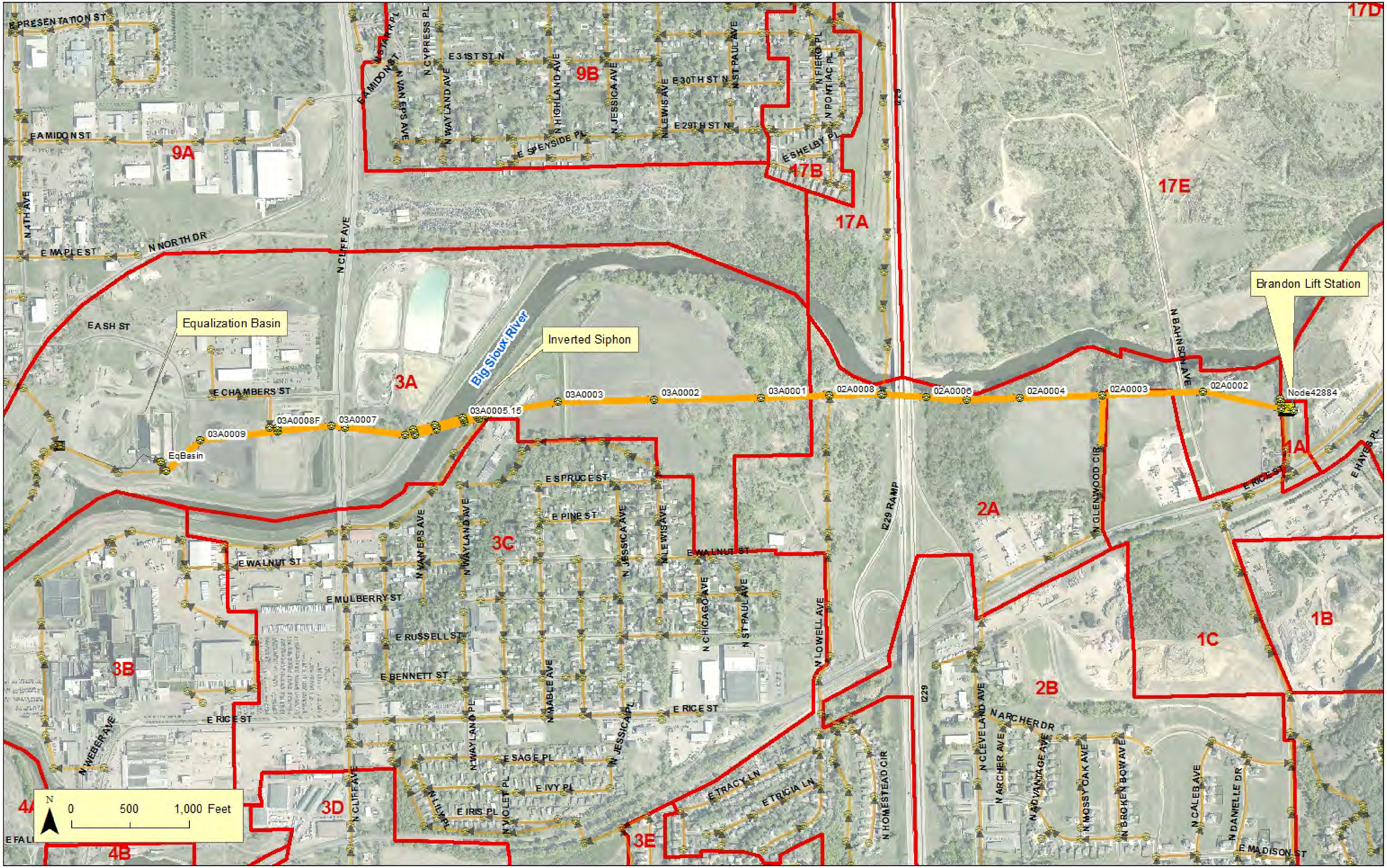
The City is currently planning to construct additional equalization in two phases one in 2021 and the other in 2023. A proposed implementation schedule for the Equalization Facilities Project is shown in Table 10. Construction permitting and the submittal to the SDDENR are included in the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

Table 10. Proposed Implementation Schedule for Equalization Facilities Project

Description	Completion Date
Facility Plan	February, 2021
Design	
Design Contract Award	May, 2021
Predesign Services	July, 2021
Final Design Submittal	January, 2022
Bid	
Request Bids	March, 2022
Contract Award	April, 2022
Construction	
Shop Drawing Submittal Approvals	July, 2022
Project Completion	December, 2022

Appendix A

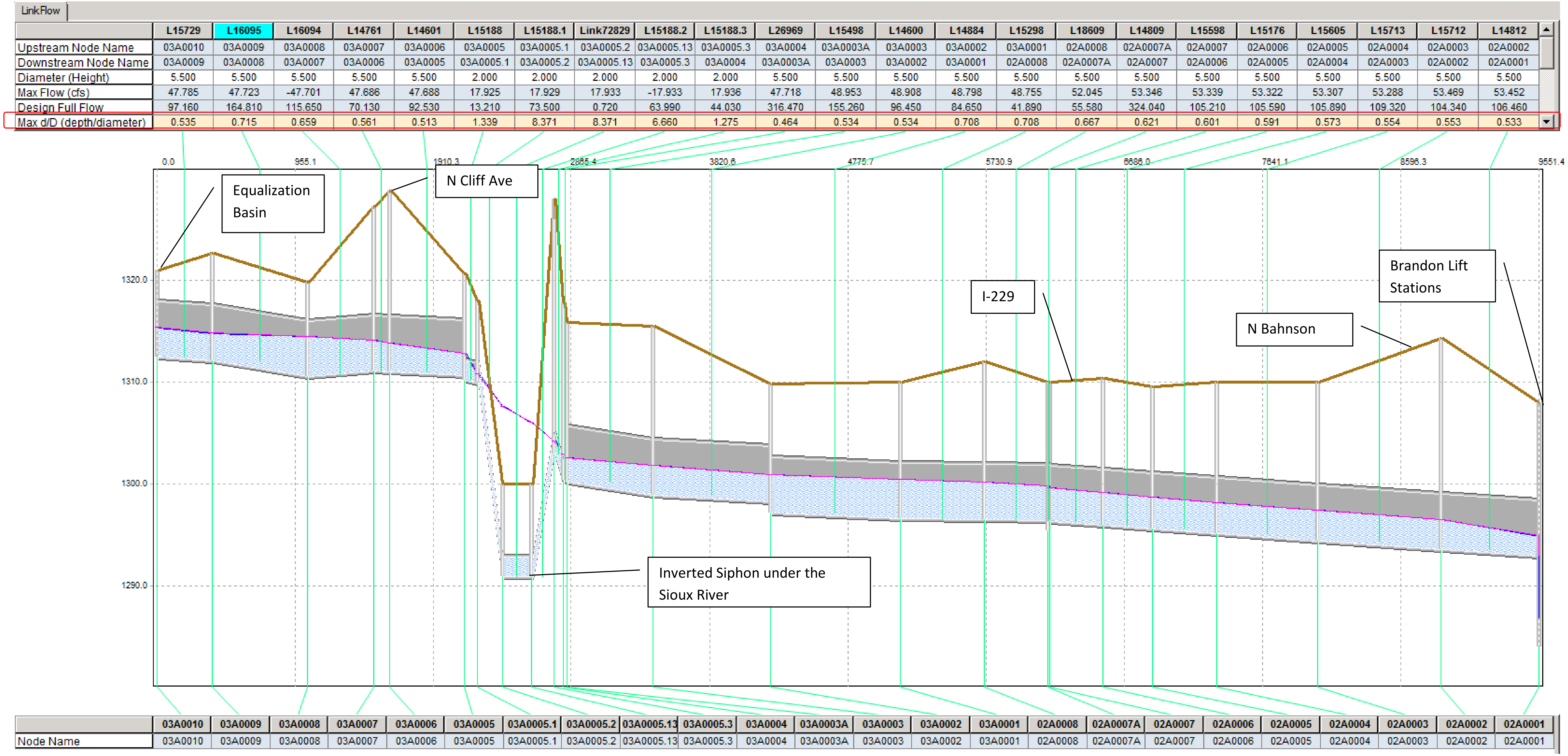
Sanitary Sewer XPSWMM Results



Model Alignment

Existing Conditions: Modeling profile for the existing conditions 66-inch diameter Outfall trunk: Equalization Basin to the Brandon Lift Station

25-year wet-weather flow with an inflow factor (K) of 0.4% plus dry-weather flow and infiltration (*sf-wwf004_073013_trimmed.xp*)



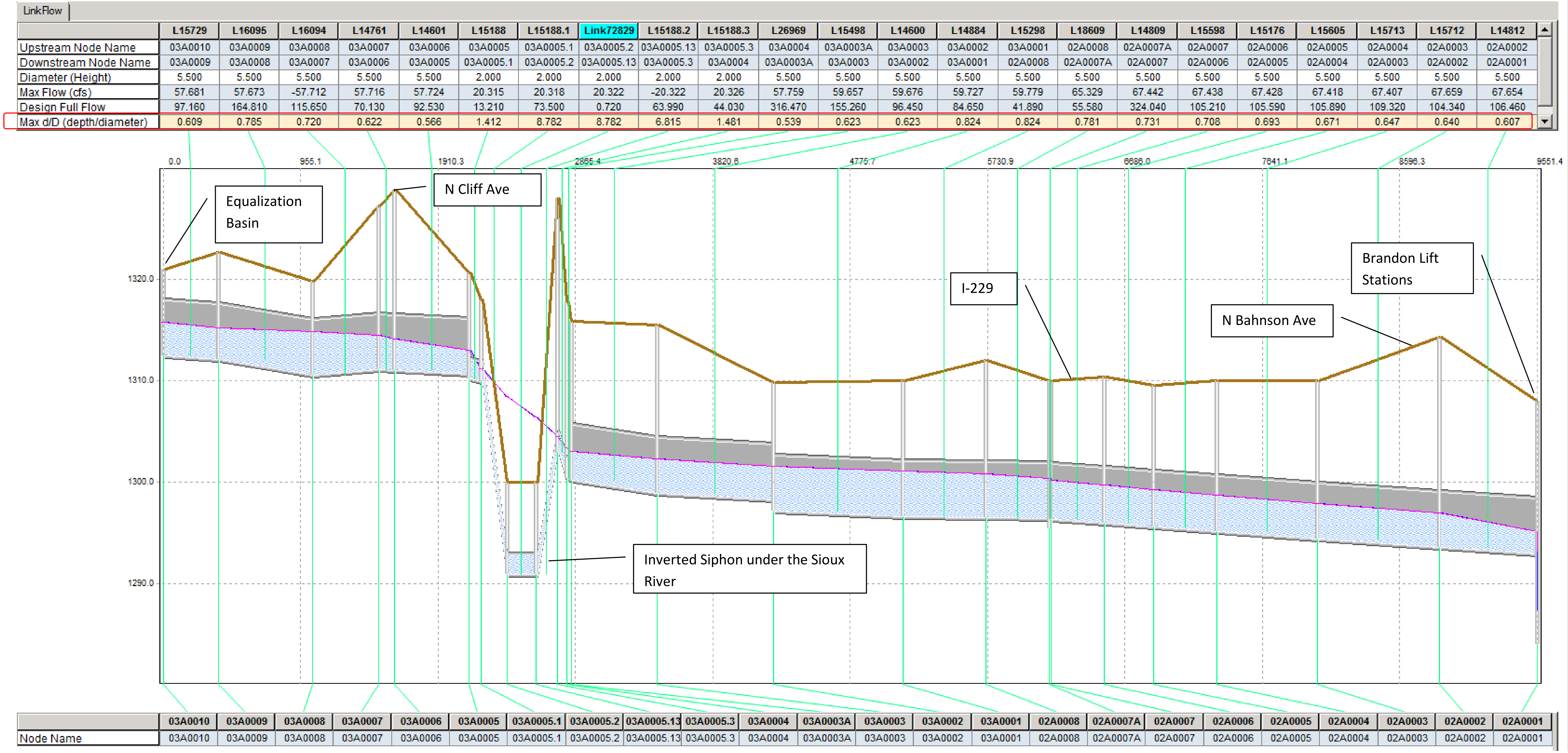
	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969	L15498	L14600	L14884	L15298	L18609	L14809	L15598	L15176	L15605	L15713	L15712	L14812
Upstream Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002
Downstream Node Name	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Diameter (Height)	5.500	5.500	5.500	5.500	5.500	2.000	2.000	2.000	2.000	2.000	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500
Max Flow (cfs)	47.785	47.723	-47.701	47.686	47.688	17.925	17.929	17.933	-17.933	17.936	47.718	48.953	48.908	48.798	48.755	52.045	53.346	53.339	53.322	53.307	53.288	53.469	53.452
Design Full Flow	97.160	164.810	115.650	70.130	92.530	13.210	73.500	0.720	63.990	44.030	316.470	155.260	96.450	84.650	41.890	55.580	324.040	105.210	105.590	105.890	109.320	104.340	106.460
Max d/D (depth/diameter)	0.535	0.715	0.659	0.561	0.513	1.339	8.371	8.371	6.660	1.275	0.464	0.534	0.534	0.708	0.708	0.667	0.621	0.601	0.591	0.573	0.554	0.553	0.533

	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001

This scenario was run to show the flow in a 66-inch sewer pipe with a 0.4% K factor for inflow/infiltration.

Existing Conditions: Modeling profile for the existing conditions 66-inch diameter Outfall trunk: Equalization Basin to the Brandon Lift Station

25-year wet-weather flow with an inflow factor (K) of 0.8% plus dry-weather flow and infiltration (*sf-wwf008_073013_trimmed.xp*)



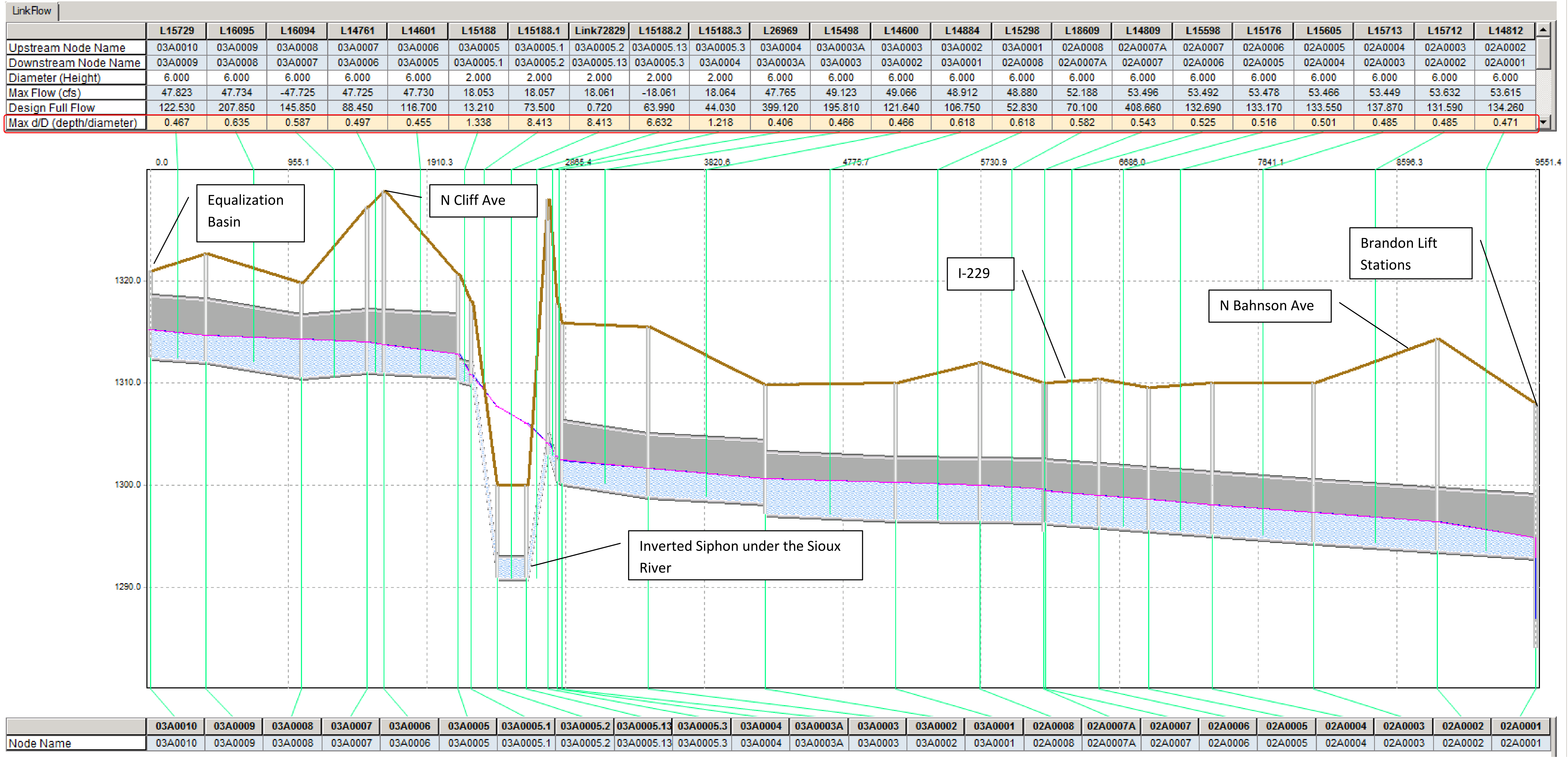
	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969	L15498	L14600	L14884	L15298	L18609	L14809	L15598	L15176	L15605	L15713	L15712	L14812
Upstream Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002
Downstream Node Name	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Diameter (Height)	5.500	5.500	5.500	5.500	5.500	2.000	2.000	2.000	2.000	2.000	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500	5.500
Max Flow (cfs)	57.681	57.673	-57.712	57.716	57.724	20.315	20.318	20.322	-20.322	20.326	57.759	59.657	59.676	59.727	59.779	65.329	67.442	67.438	67.428	67.418	67.407	67.659	67.654
Design Full Flow	97.160	164.810	115.650	70.130	92.530	13.210	73.500	0.720	63.990	44.030	316.470	155.260	96.450	84.650	41.890	55.580	324.040	105.210	105.590	105.890	109.320	104.340	106.460
Max d/D (depth/diameter)	0.609	0.785	0.720	0.622	0.566	1.412	8.782	8.782	6.815	1.481	0.539	0.623	0.623	0.824	0.824	0.781	0.731	0.708	0.693	0.671	0.647	0.640	0.607

	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001

This scenario was run to show the flow in a 66-inch sewer pipe with a 0.8% K factor for inflow/infiltration.

Future Conditions: Modeling profile for the future conditions 72-inch diameter Outfall trunk: Equalization Basin to the Brandon Lift Station

25-year wet-weather flow with an inflow factor (K) of 0.4% plus dry-weather flow and infiltration (*sf-wwf004_073013_trim_72in.xp*)



LinkFlow

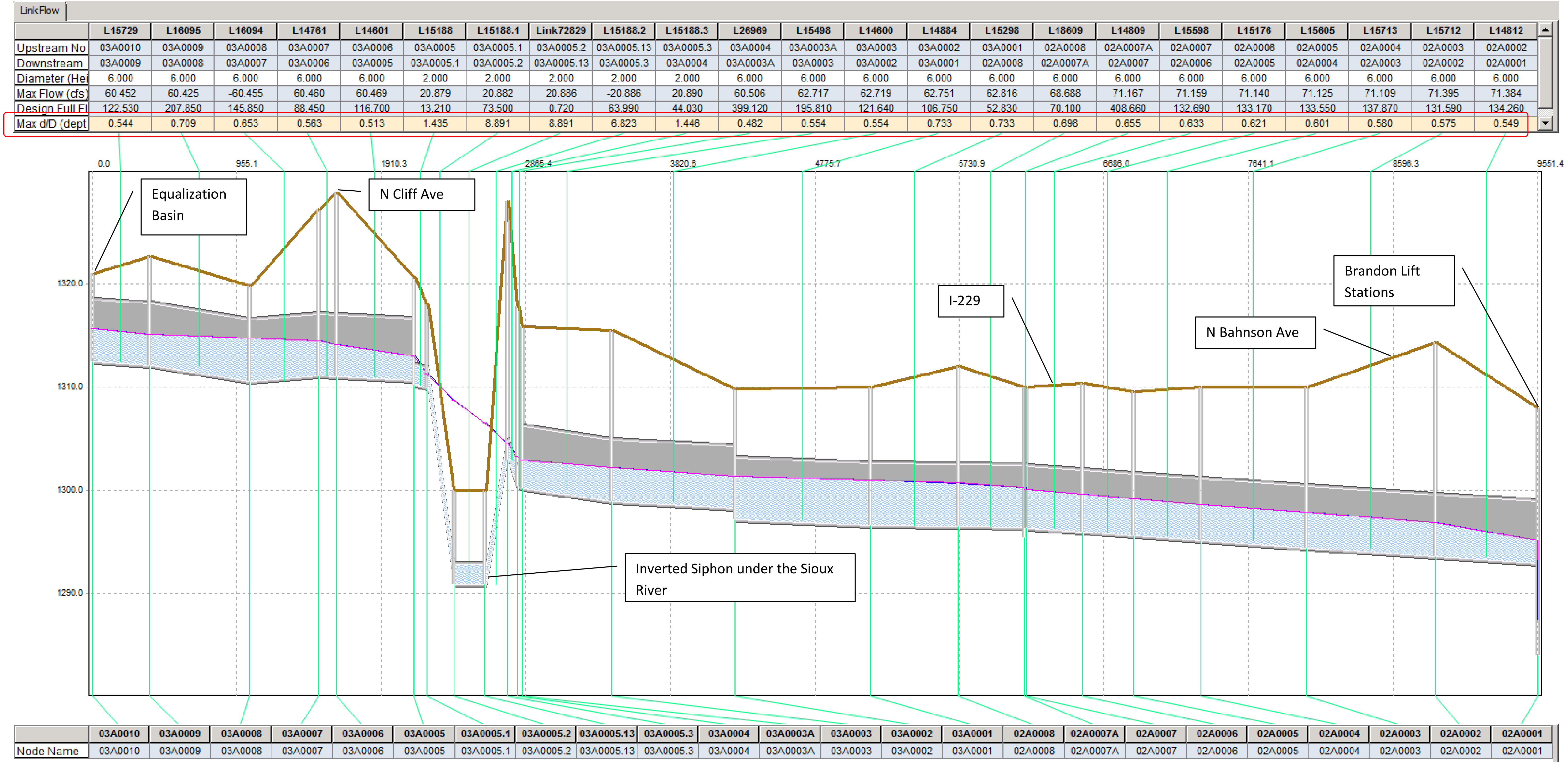
	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969	L15498	L14600	L14884	L15298	L18609	L14809	L15598	L15176	L15605	L15713	L15712	L14812
Upstream Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002
Downstream Node Name	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Diameter (Height)	6.000	6.000	6.000	6.000	6.000	2.000	2.000	2.000	2.000	2.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Max Flow (cfs)	47.823	47.734	-47.725	47.725	47.730	18.053	18.057	18.061	-18.061	18.064	47.765	49.123	49.066	48.912	48.880	52.188	53.496	53.492	53.478	53.466	53.449	53.632	53.615
Design Full Flow	122.530	207.850	145.850	88.450	116.700	13.210	73.500	0.720	63.990	44.030	399.120	195.810	121.640	106.750	52.830	70.100	408.660	132.690	133.170	133.550	137.870	131.590	134.260
Max d/D (depth/diameter)	0.467	0.635	0.587	0.497	0.455	1.338	8.413	8.413	6.632	1.218	0.406	0.466	0.466	0.618	0.618	0.582	0.543	0.525	0.516	0.501	0.485	0.485	0.471

	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001

This scenario was run to show the flow in a 72-inch sewer pipe with a 0.4% K factor for inflow/infiltration.

Future Conditions: Modeling profile for the future conditions 72-inch diameter Outfall trunk: Equalization Basin to the Brandon Lift Station

25-year wet-weather flow with an inflow factor (K) of 0.8% plus dry-weather flow and infiltration (*sf-wwf008_073013_trim_72in.xp*)



	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969
Upstream No	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004
Downstream	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A
Diameter (Hei	6.000	6.000	6.000	6.000	6.000	2.000	2.000	2.000	2.000	2.000	6.000
Max Flow (cfs)	60.452	60.425	-60.455	60.460	60.469	20.879	20.882	20.886	-20.886	20.890	60.506
Design Full Fl	122.530	207.850	145.850	88.450	116.700	13.210	73.500	0.720	63.990	44.030	399.120
Max d/D (dept	0.544	0.709	0.653	0.563	0.513	1.435	8.891	8.891	6.823	1.446	0.482

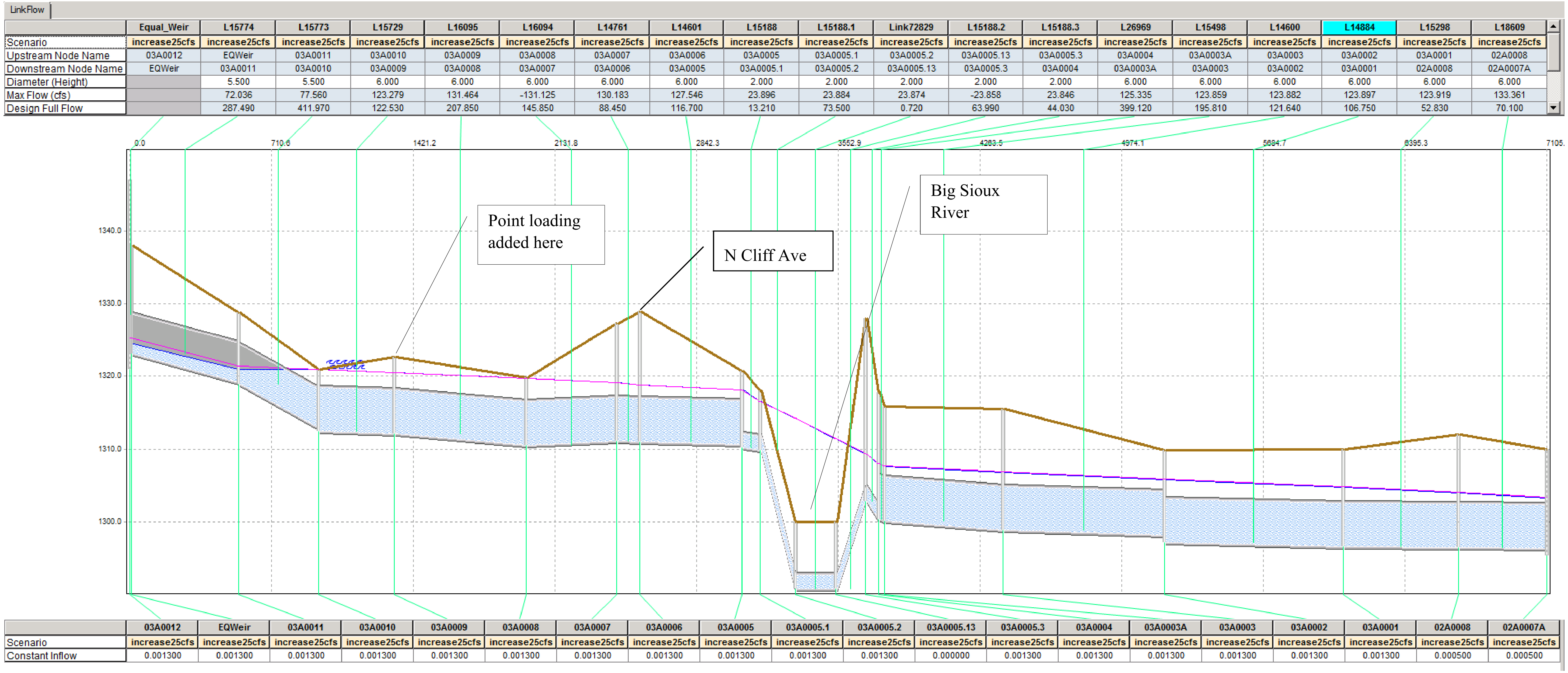
	L15498	L14600	L14884	L15298	L18609	L14809	L15598	L15176	L15605	L15713	L15712	L14812
Upstream No	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002
Downstream	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Diameter (Hei	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Max Flow (cfs)	62.717	62.719	62.751	62.816	68.688	71.167	71.159	71.140	71.125	71.109	71.395	71.384
Design Full Fl	195.810	121.640	106.750	52.830	70.100	408.660	132.690	133.170	133.550	137.870	131.590	134.260
Max d/D (dept	0.554	0.554	0.733	0.733	0.698	0.655	0.633	0.621	0.601	0.580	0.575	0.549

	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001
Node Name	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007	02A0006	02A0005	02A0004	02A0003	02A0002	02A0001

This scenario was run to show the flow in a 72-inch sewer pipe with a 0.8% K factor for inflow/infiltration.

Outfall trunk sized at 72-inch, max flow 125-130 cfs, (Ignore flow through siphon, only one of the three parallel lines are represented)

Model: sf-wwf008_073013_trimmed_SiphonCapacity.xp



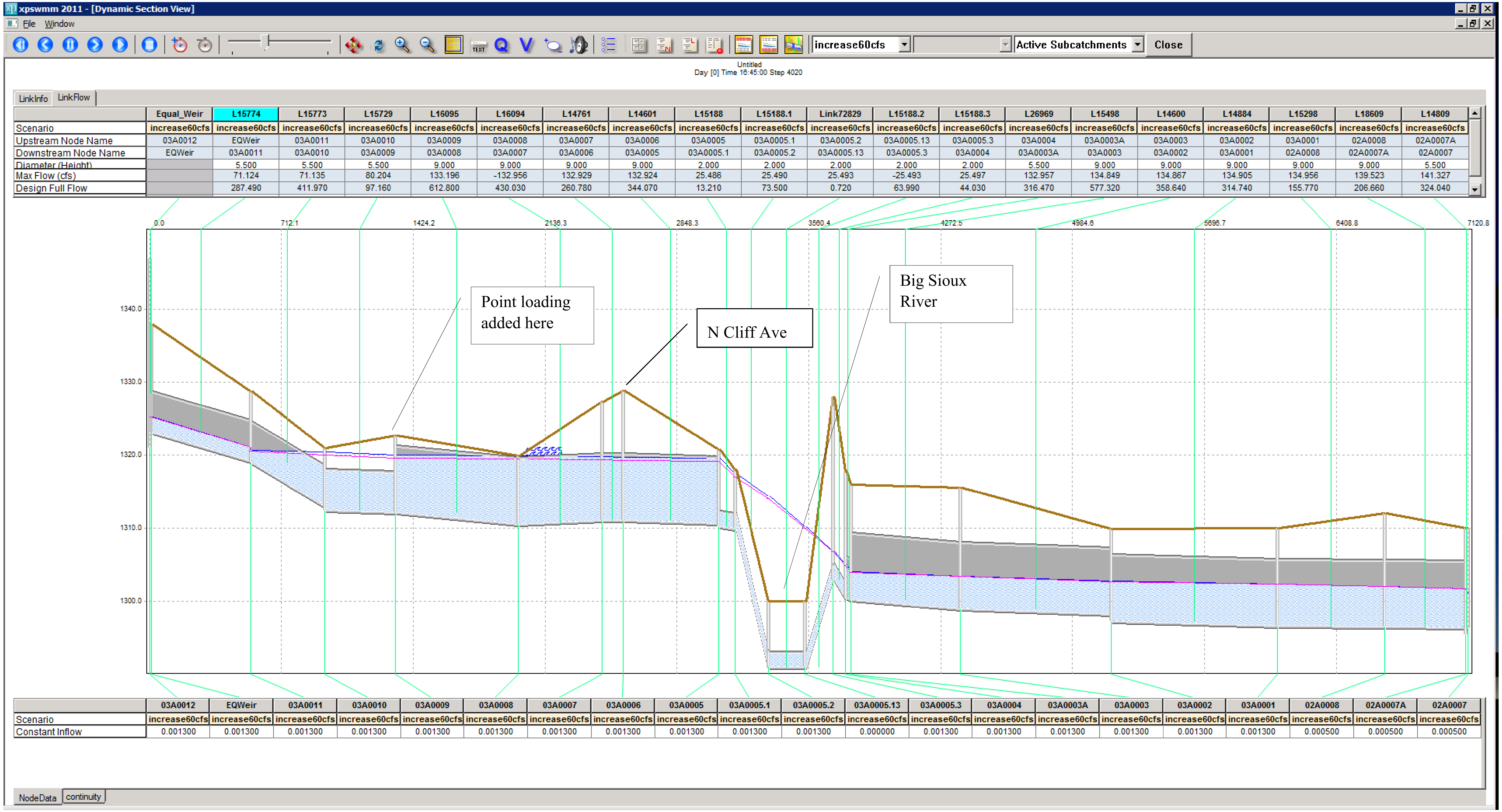
	Equal_Weir	L15774	L15773	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969	L15498	L14600	L14884	L15298	L18609
Scenario	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs
Upstream Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008
Downstream Node Name	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Diameter (Height)		5.500	5.500	6.000	6.000	6.000	6.000	6.000	2.000	2.000	2.000	2.000	2.000	6.000	6.000	6.000	6.000	6.000	6.000
Max Flow (cfs)		72.036	77.560	123.279	131.464	-131.125	130.183	127.546	23.896	23.884	23.874	-23.858	23.846	125.335	123.859	123.882	123.897	123.919	133.361
Design Full Flow		287.490	411.970	122.530	207.850	145.850	88.450	116.700	13.210	73.500	0.720	63.990	44.030	399.120	195.810	121.640	106.750	52.830	70.100

	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Scenario	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs	increase25cfs
Constant Inflow	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.000000	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.000500	0.000500

This scenario was run to determine how much flow could be conveyed through the outfall sewer from EQ to BRPS without creating a sanitary sewer overflow. In this scenario an overflow occurs to the west of the siphon and shows that the siphon can convey approximately 125 cfs without casing and overflow.

Outfall trunk sized at 108-inch, max flow 130-140 cfs, (Ignore flow through siphon, only one of the three parallel lines are represented)

Model: sf-wwf008_073013_trimmed_SiphonCapacity2.xp



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N Cliff Ave

Big Sioux River

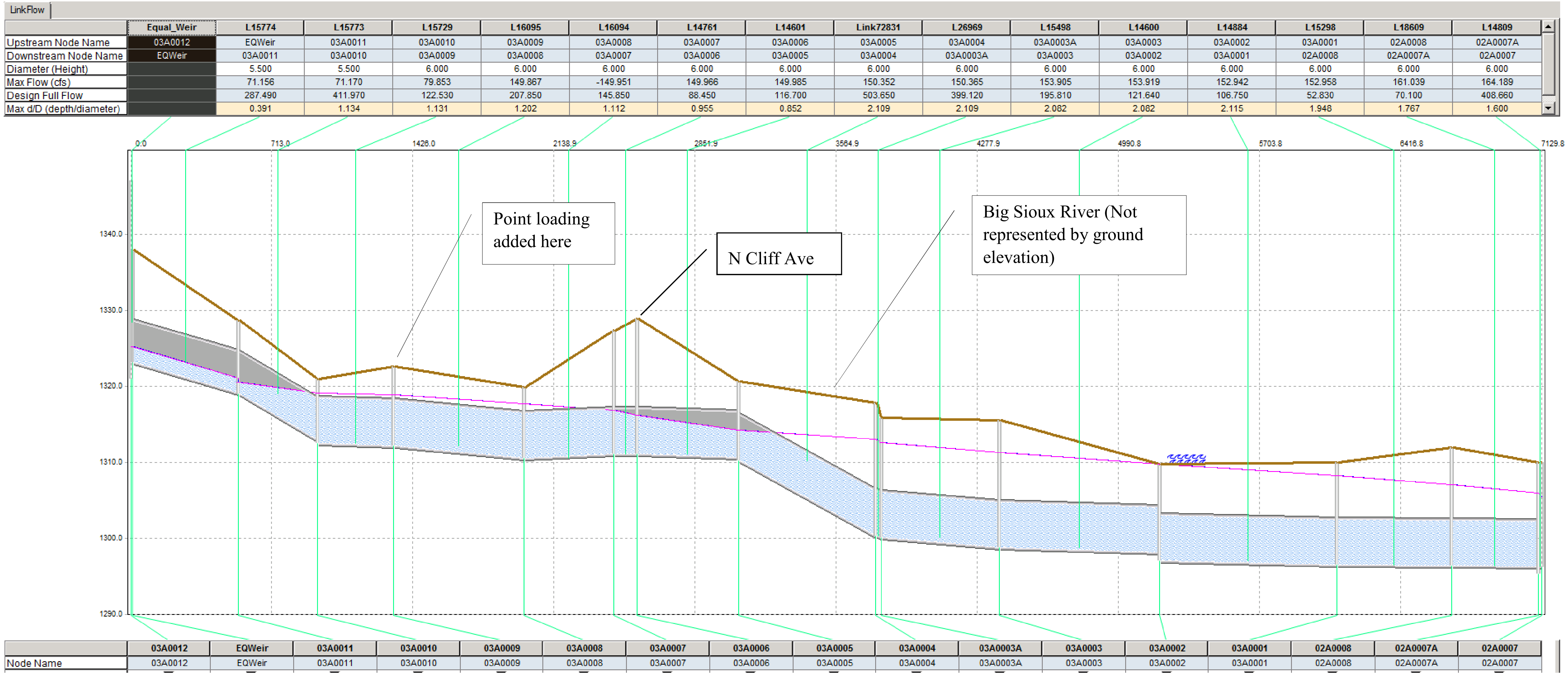
	Equal_Weir	L15774	L15773	L15729	L16095	L16094	L14761	L14601	L15188	L15188.1	Link72829	L15188.2	L15188.3	L26969	L15498	L14600	L14884	L15298	L18609	L14809
Scenario	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs
Upstream Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Downstream Node Name	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007
Diameter (Height)		5.500	5.500	5.500	9.000	9.000	9.000	9.000	2.000	2.000	2.000	2.000	2.000	5.500	9.000	9.000	9.000	9.000	9.000	5.500
Max Flow (cfs)		71.124	71.135	80.204	133.196	-132.956	132.929	132.924	25.486	25.490	25.493	-25.493	25.497	132.957	134.849	134.867	134.905	134.956	139.523	141.327
Design Full Flow		287.490	411.970	97.160	612.800	430.030	260.780	344.070	13.210	73.500	0.720	63.990	44.030	316.470	577.320	358.640	314.740	155.770	206.660	324.040

	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0005.1	03A0005.2	03A0005.13	03A0005.3	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007
Scenario	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs	increase60cfs
Constant Inflow	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.000000	0.001300	0.001300	0.001300	0.001300	0.001300	0.001300	0.000500	0.000500	0.000500

This scenario was run to determine how much flow could be conveyed through the outfall sewer siphon if the pipe was not the restriction. It shows that a 108-inch pipe is the largest pipe that could be installed underground and approximately 125 cfs is the maximum flow that could be conveyed through the siphon without causing a sanitary sewer overflow if the pipe was not the restriction.

Outfall trunk sized at 72-inch modeled without the siphon, max flow 150 cfs to create an SSO (the SSO occurs east of the Sioux River)

Model: sf-wwf008_073013_trim_72inNOSIPHON2.xp



LinkFlow

	Equal_Weir	L15774	L15773	L15729	L16095	L16094	L14761	L14601	Link72831	L26969	L15498	L14600	L14884	L15298	L18609	L14809
Upstream Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Downstream Node Name	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007
Diameter (Height)		5.500	5.500	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Max Flow (cfs)		71.156	71.170	79.853	149.867	-149.951	149.966	149.985	150.352	150.365	153.905	153.919	152.942	152.958	161.039	164.189
Design Full Flow		287.490	411.970	122.530	207.850	145.850	88.450	116.700	503.650	399.120	195.810	121.640	106.750	52.830	70.100	408.660
Max d/D (depth/diameter)		0.391	1.134	1.131	1.202	1.112	0.955	0.852	2.109	2.109	2.082	2.082	2.115	1.948	1.767	1.600

Point loading added here

N Cliff Ave

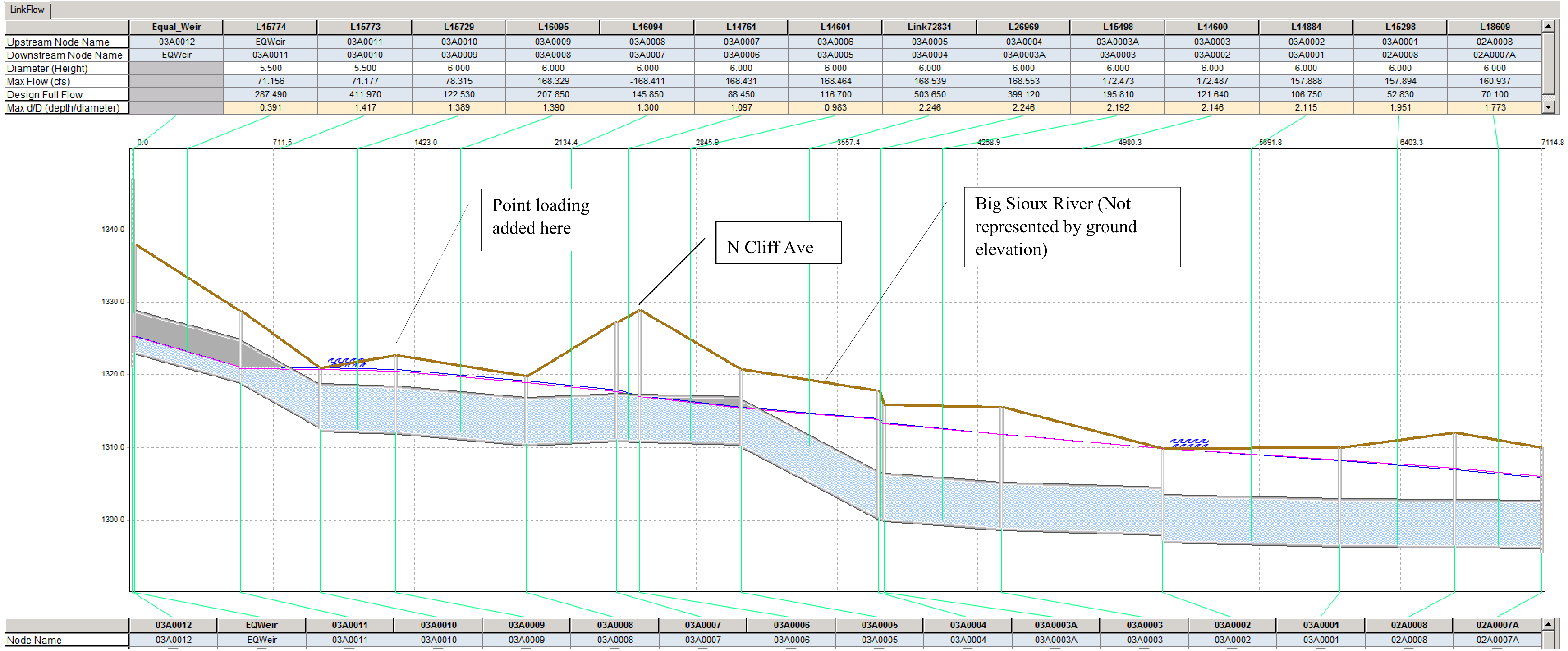
Big Sioux River (Not represented by ground elevation)

	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007
Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A	02A0007

This scenario was run to determine how much flow could be conveyed through the outfall sewer from EQ to BRPS if the siphon was straight graded as a 72-inch pipe in order to show that the siphon is the restriction in the system. In this scenario the 72-inch pipe could convey approximately 150 cfs which is about 20 cfs more than the siphon capacity of 125 cfs.

Outfall trunk sized at 72-inch modeled without the siphon, max flow 170 cfs to create an SSO west of the Sioux River

Model: sf-wwf008_073013_trim_72inNOSIPHON.xp



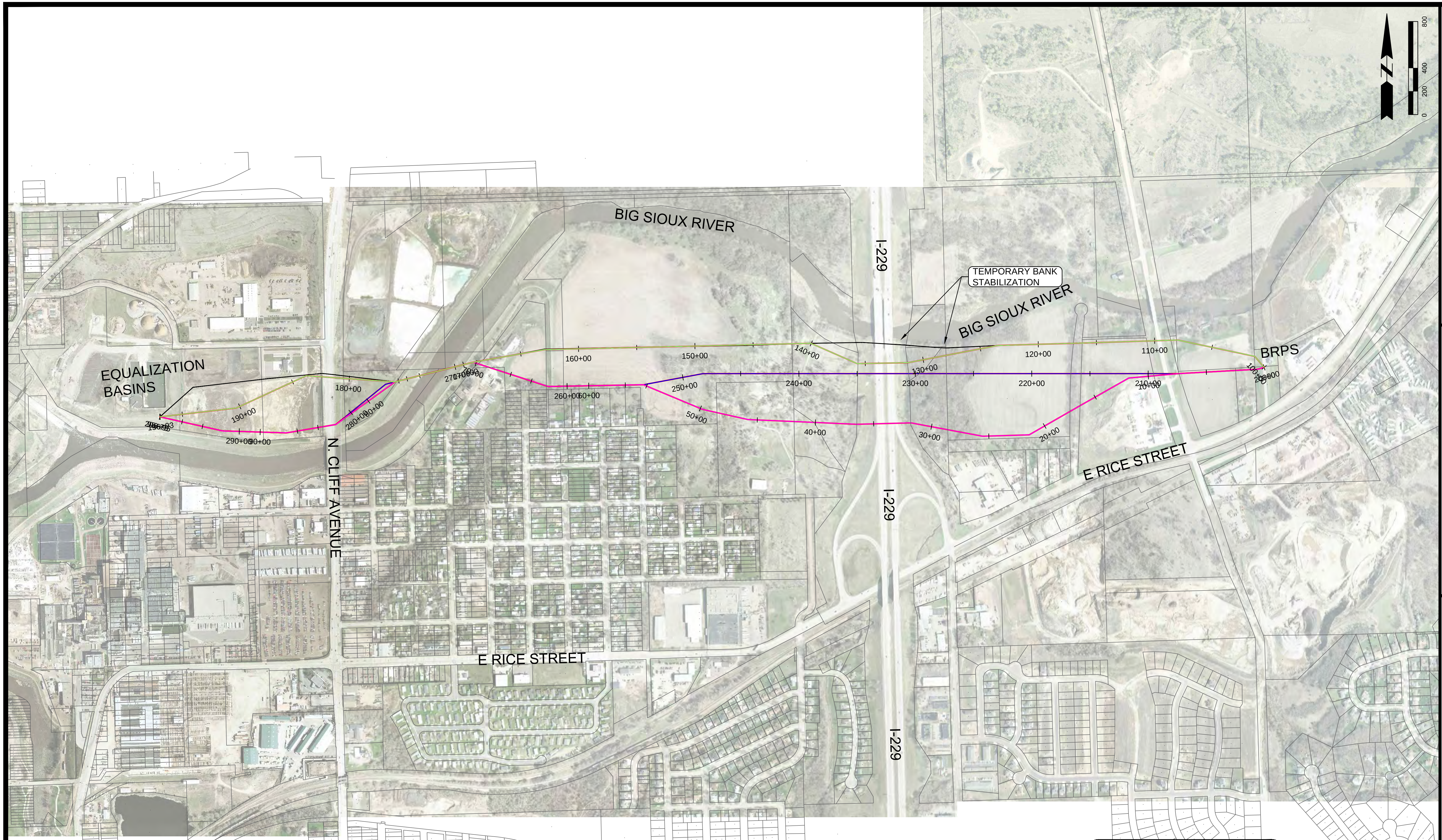
	Equal_Weir	L15774	L15773	L15729	L16095	L16094	L14761	L14601	Link72831	L26969	L15498	L14600	L14884	L15298	L18609
Upstream Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008
Downstream Node Name	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Diameter (Height)		5.500	5.500	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Max Flow (cfs)		71.156	71.177	78.315	168.329	-168.411	168.431	168.464	168.539	168.553	172.473	172.487	157.888	157.894	160.937
Design Full Flow		287.490	411.970	122.530	207.850	145.850	88.450	116.700	503.650	399.120	195.810	121.640	106.750	52.830	70.100
Max d/D (depth/diameter)		0.391	1.417	1.389	1.390	1.300	1.097	0.983	2.246	2.246	2.192	2.146	2.115	1.951	1.773

	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A
Node Name	03A0012	EQWeir	03A0011	03A0010	03A0009	03A0008	03A0007	03A0006	03A0005	03A0004	03A0003A	03A0003	03A0002	03A0001	02A0008	02A0007A

This scenario was run to determine the flow that it would take to cause a sanitary sewer overflow on the west side of the river with no siphon in place. This value was to compare to the 125 cfs that was modeled in the first siphon scenario on A.6

Appendix B

Outfall Sewer Alignments



LEGEND

🟩	NORTH ALIGNMENT
🟦	MIDDLE ALIGNMENT
🟪	SOUTH ALIGNMENT
⬛	EXISTING ALIGNMENT
⬜	PROPERTY LINE

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER ALIGNMENTS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
REVISIONS:
BY:
DATE:
BY:
DATE:

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SHEET NO.
B.1

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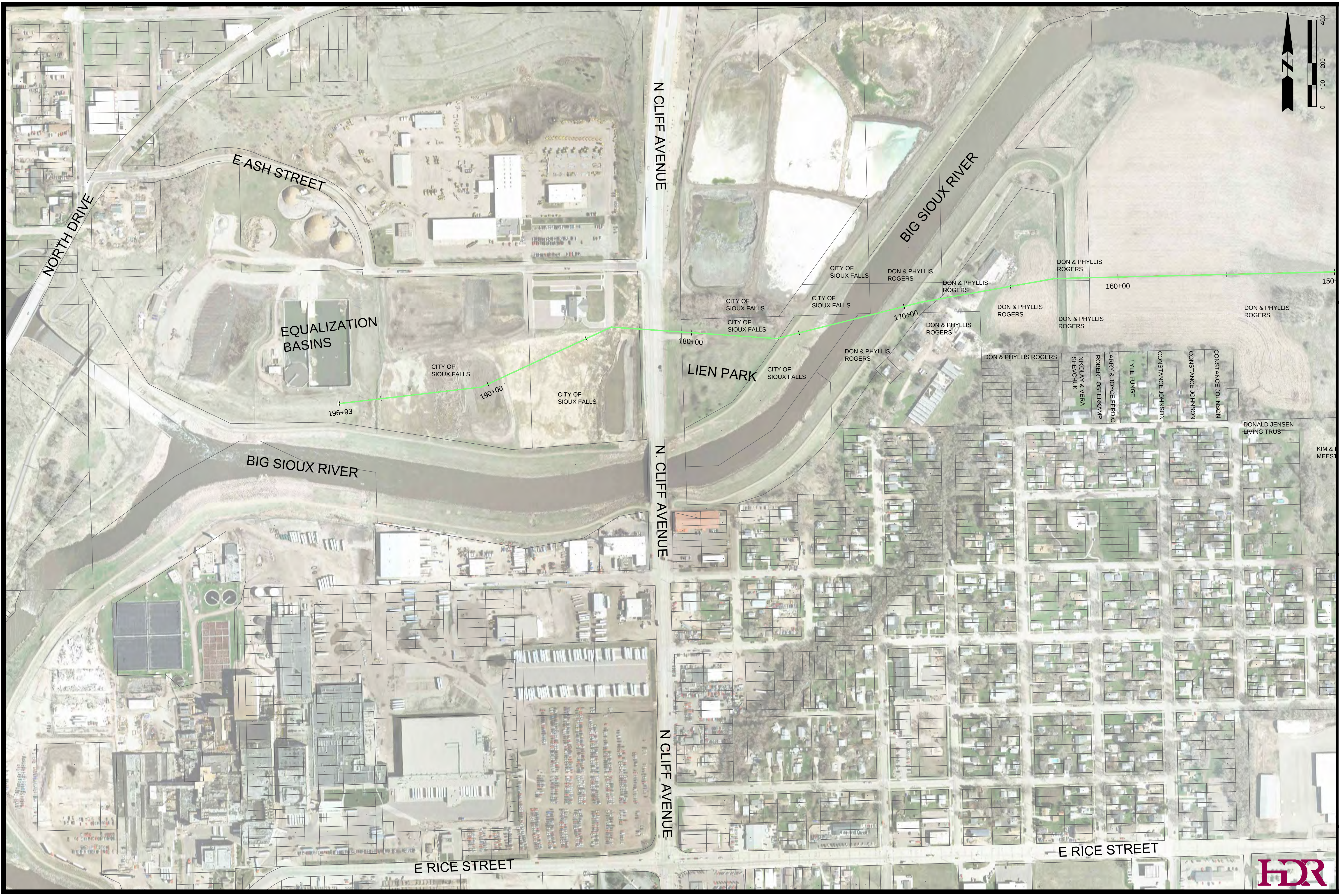
PLOT DATE: 3/6/2014 8:13 AM VanWyhe, Nick



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER NORTH

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014

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B.2

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PLOT DATE: 3/6/2014 8:13 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER NORTH

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
CHECKED BY: D. GRABER DATE: 3/6/2014
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B.3

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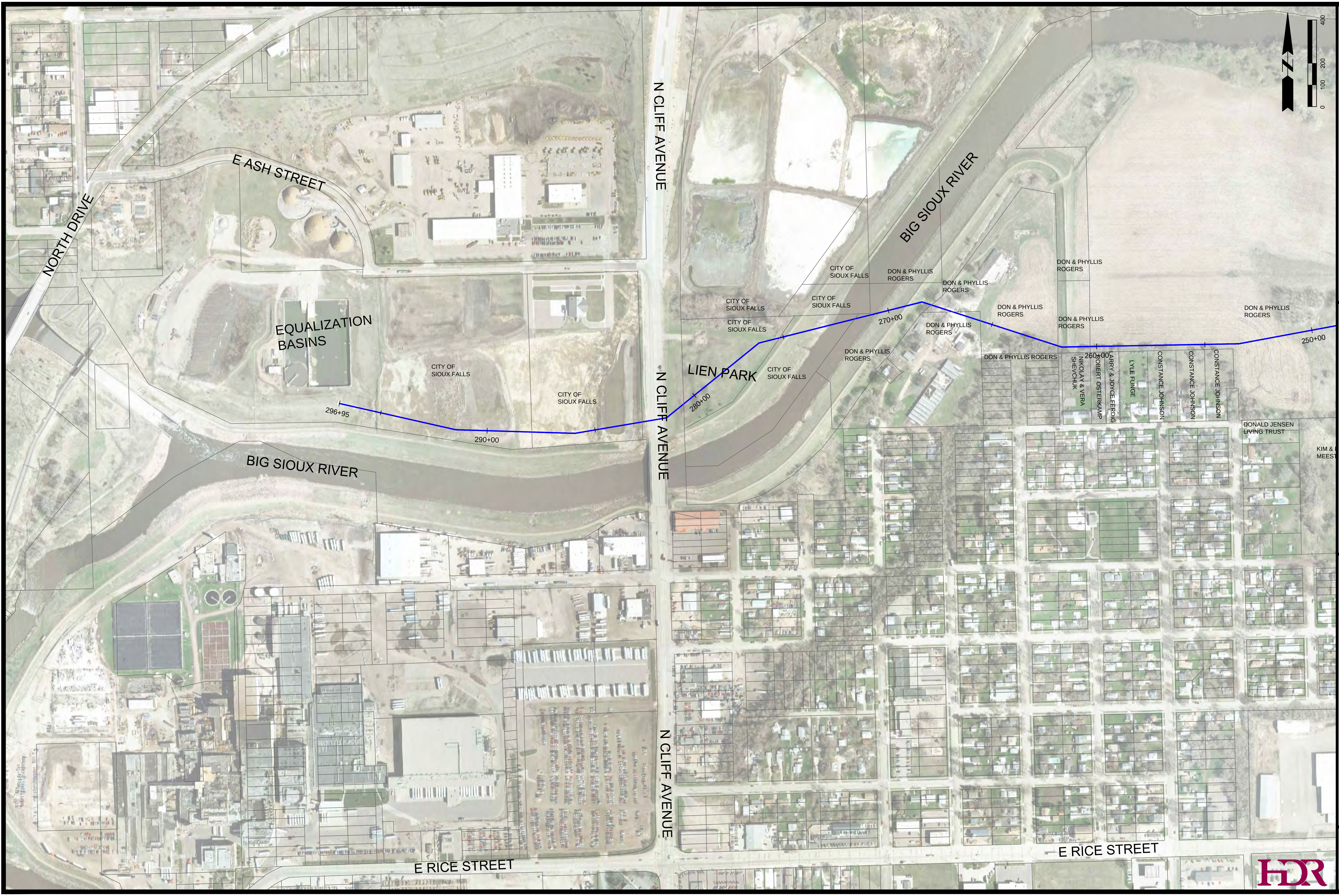

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER MIDDLE

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
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SHEET NO.
B.4

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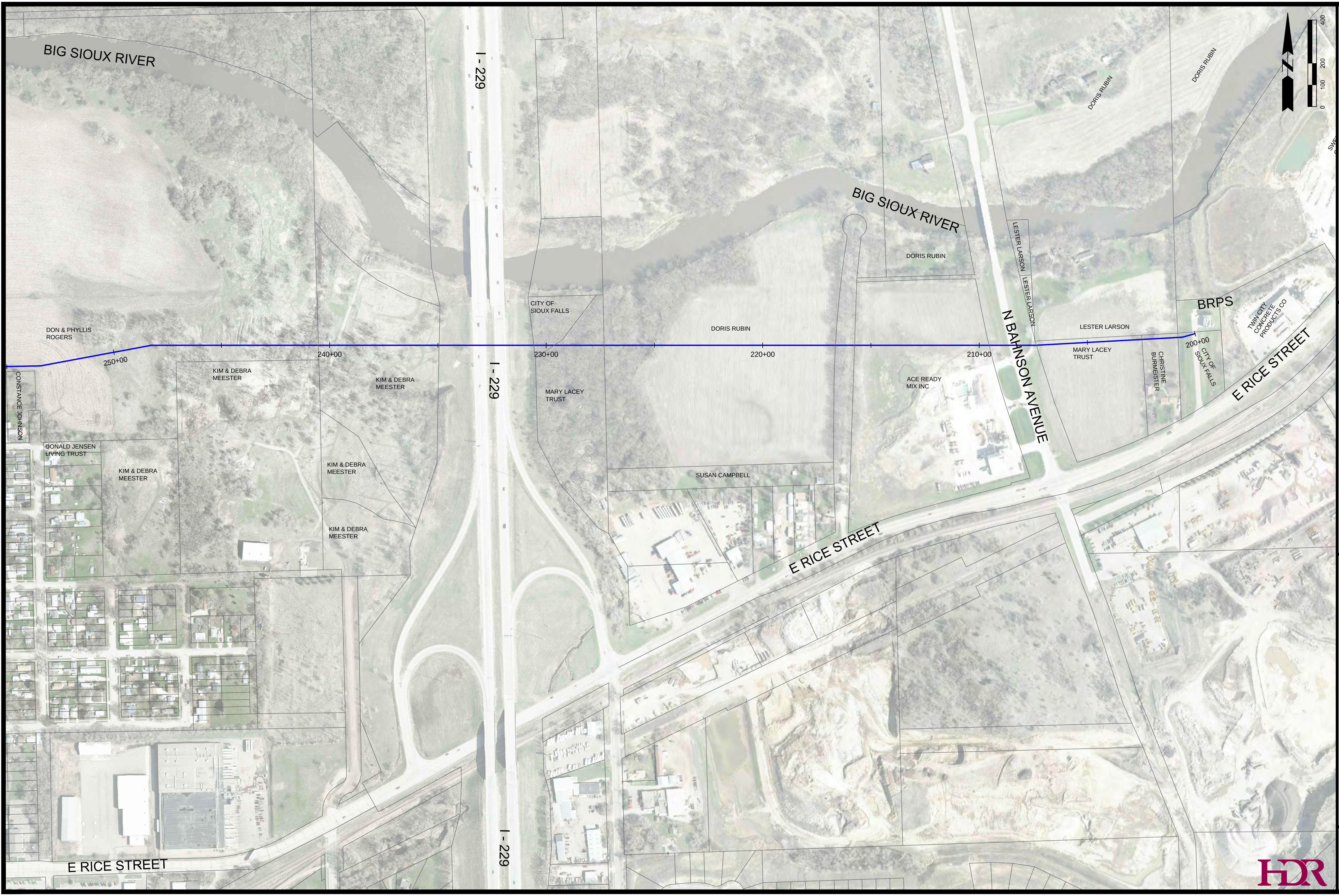
PLOT DATE: 3/6/2014 8:14 AM VanWyhe, Nick



WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER MIDDLE
DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
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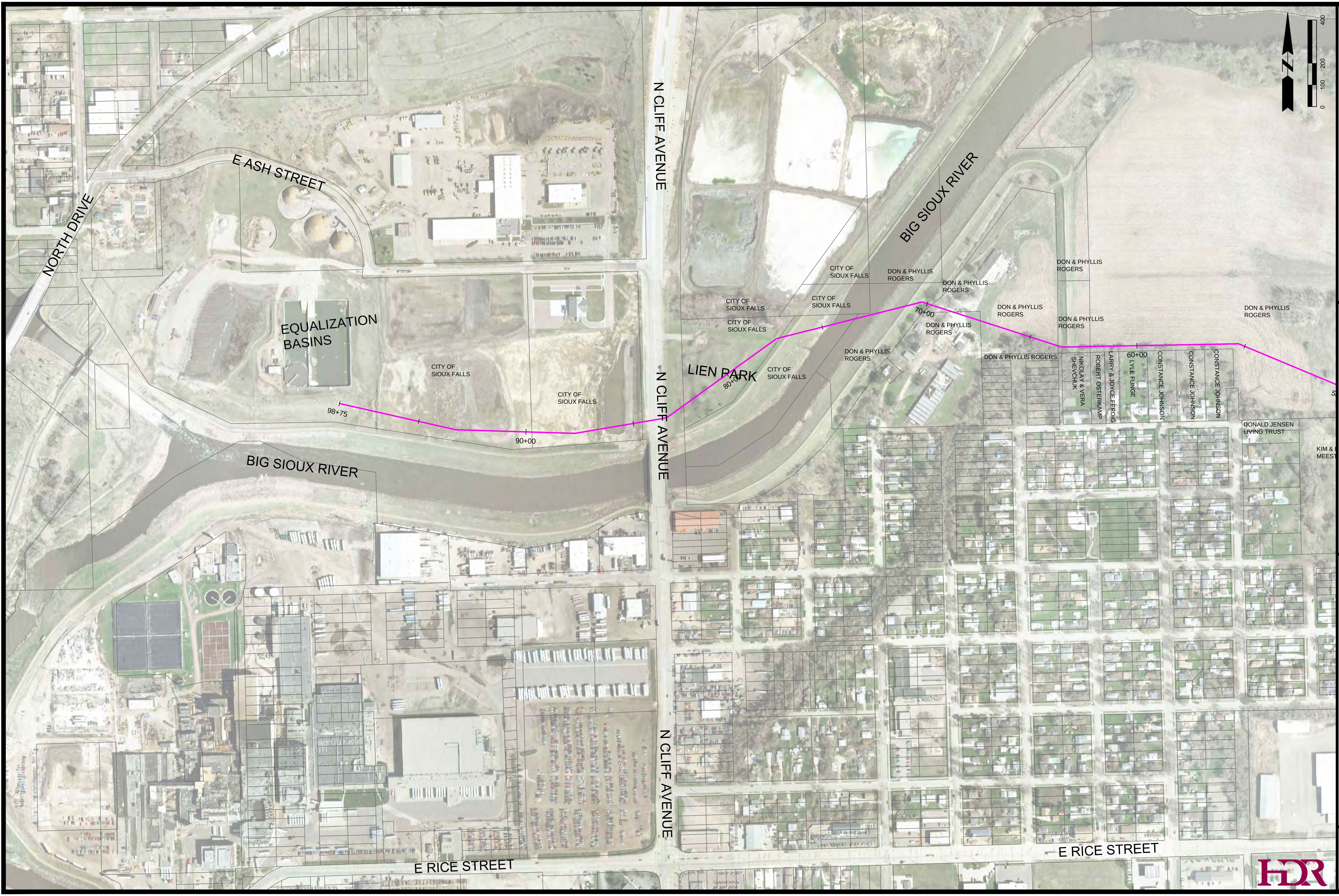
SHEET NO.
B.5



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER SOUTH

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
REVISIONS:

ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
BY: DATE:
BY: DATE:

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B.6

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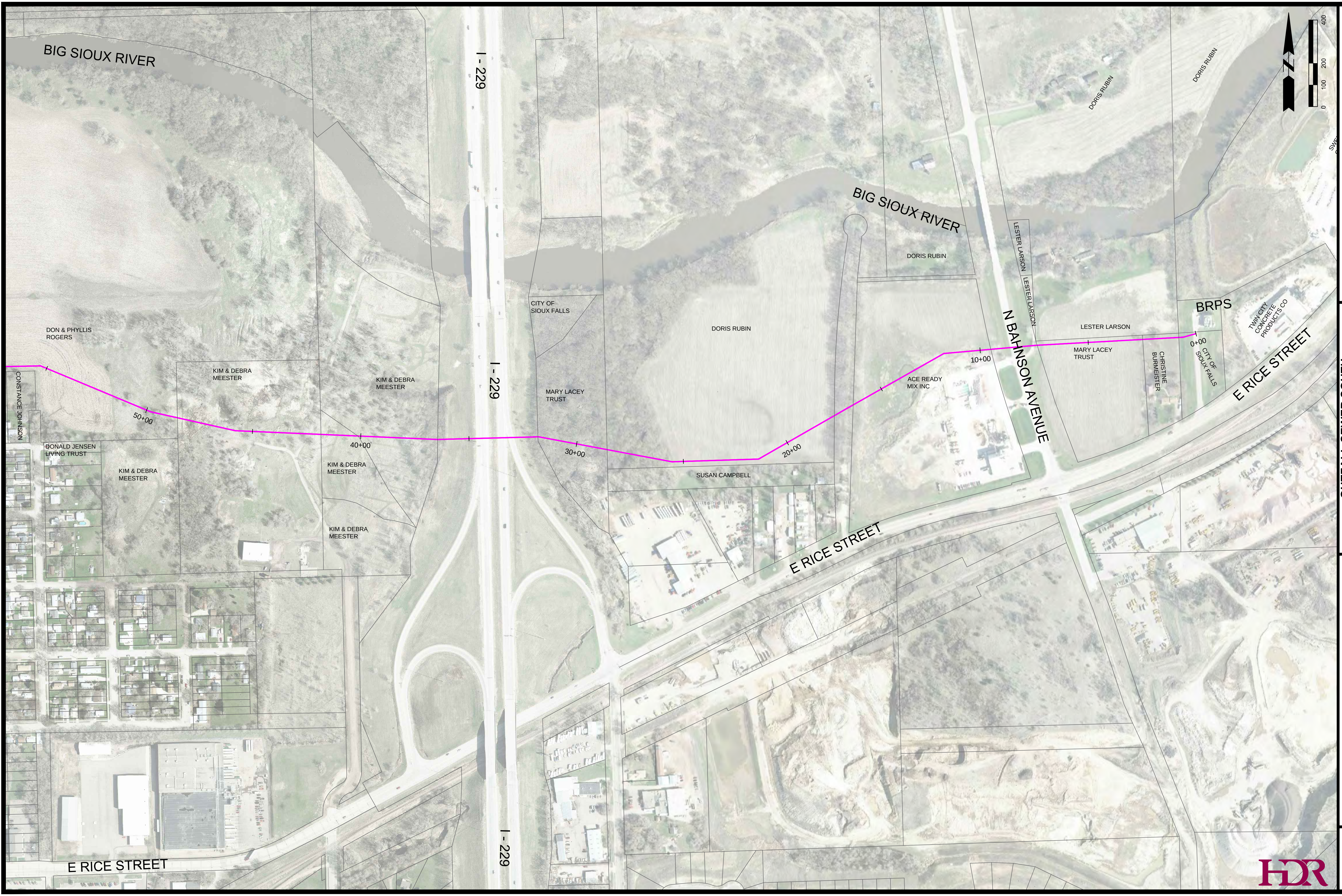

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PLOT DATE: 3/6/2014 8:15 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER SOUTH

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014

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BY: DATE:

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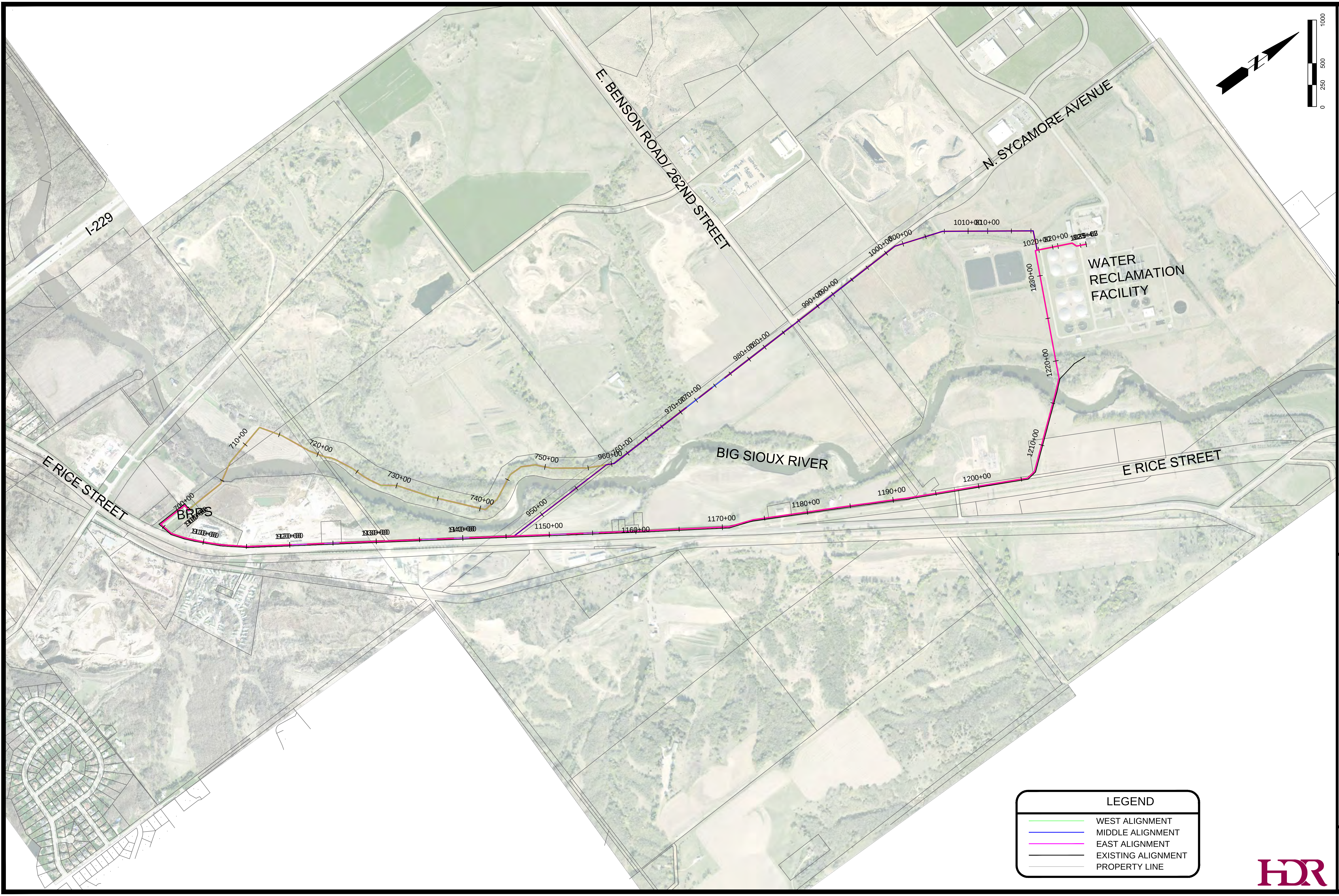
SHEET NO.
B.7

Appendix C

Forcemain Sewer Alignments



LEGEND

🟩	WEST ALIGNMENT
🟦	MIDDLE ALIGNMENT
🟪	EAST ALIGNMENT
⬛	EXISTING ALIGNMENT
⬜	PROPERTY LINE

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PLOT DATE: 3/6/2014 8:15 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN ALIGNMENTS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
REVISIONS: BY: DATE:
BY: DATE:

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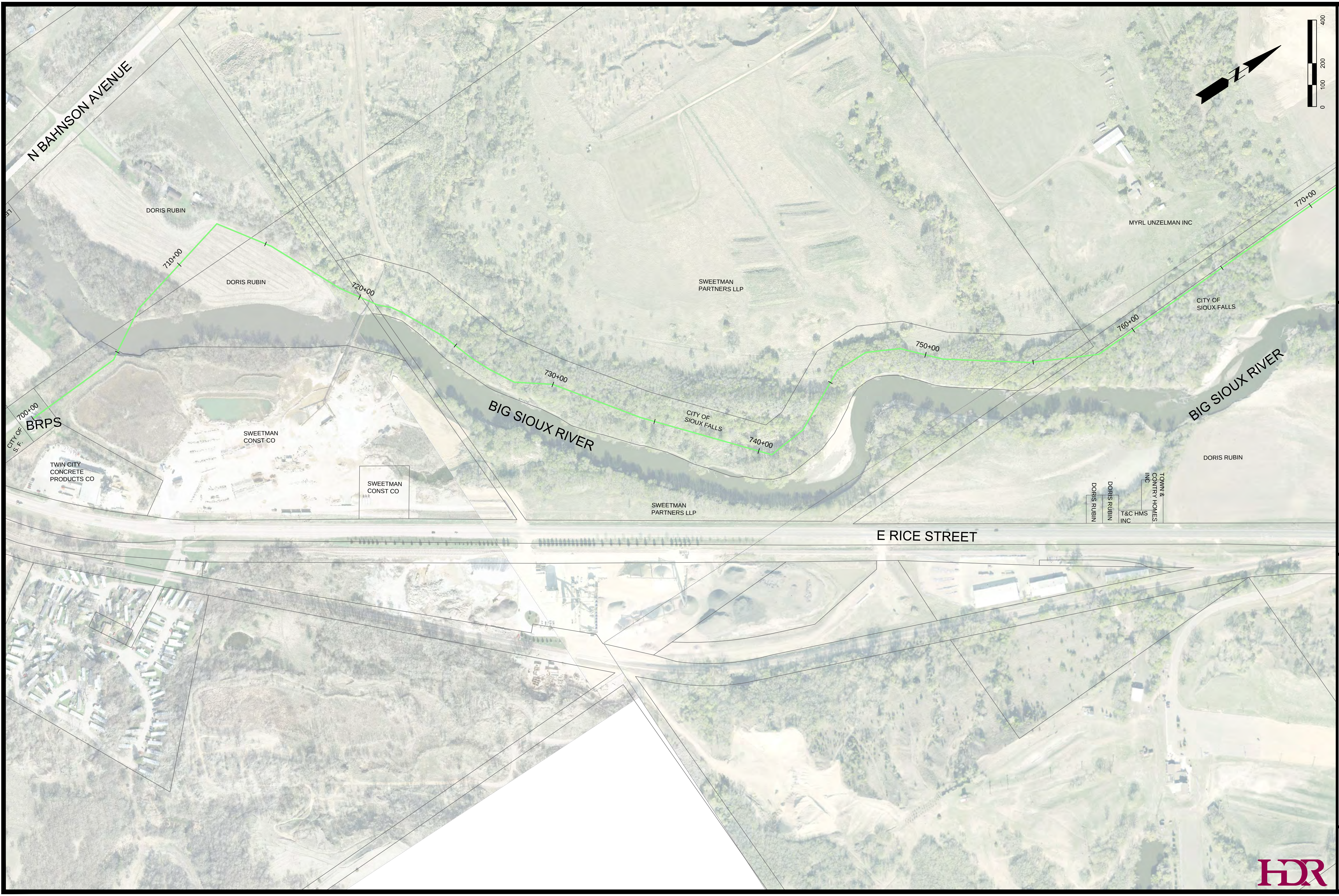
SHEET NO.
C.1



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN WEST

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
CHECKED BY: D. GRABER DATE: 3/6/2014
REVISIONS: BY: DATE:
BY: DATE:

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SHEET NO.

C.2

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 3/6/2014 8:15 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN WEST

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
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SHEET NO.
C.3

HDR

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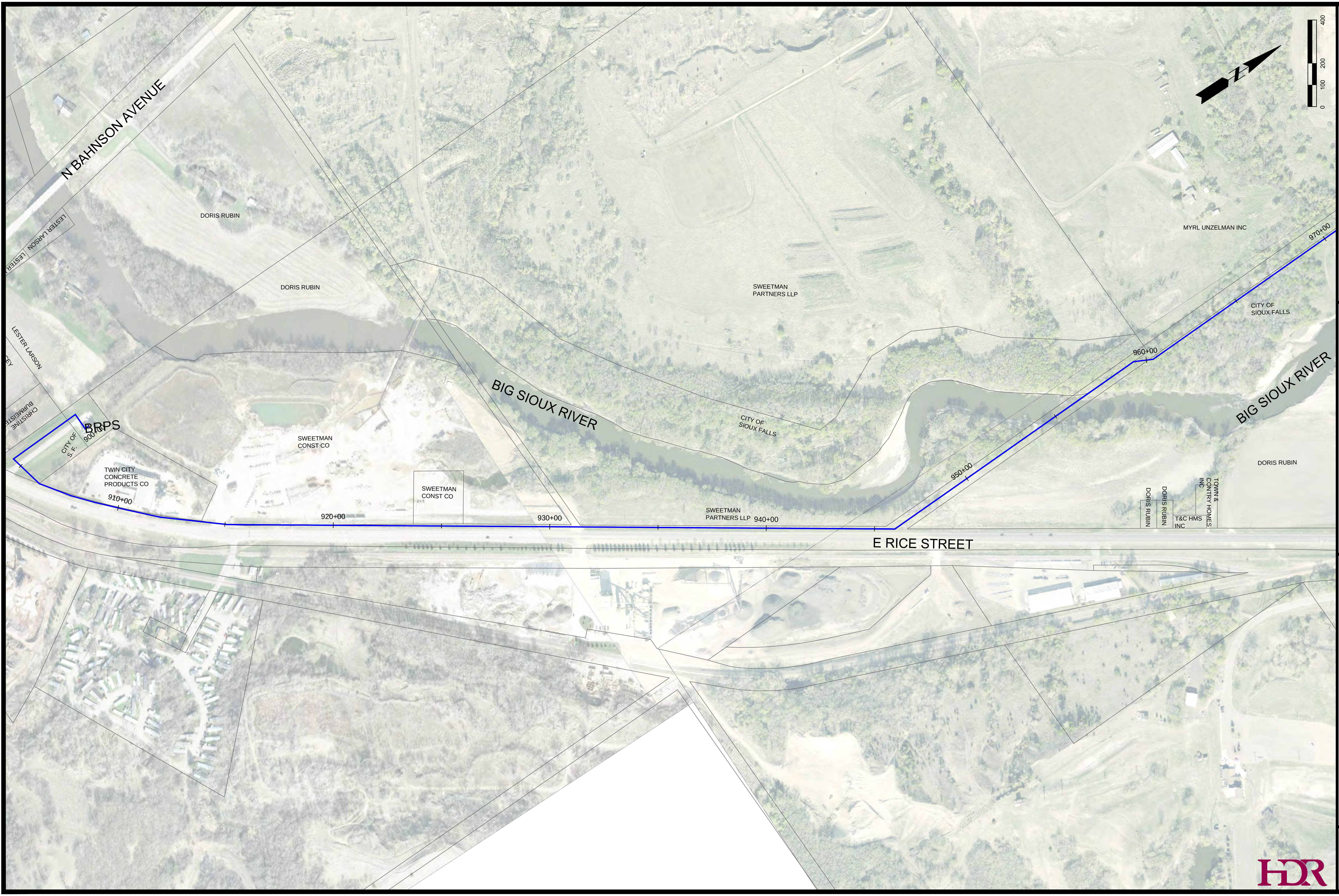
PLOT DATE: 3/6/2014 8:16 AM VanWyhe, Nick



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN MIDDLE

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014

REVISIONS:
BY: DATE:
BY: DATE:

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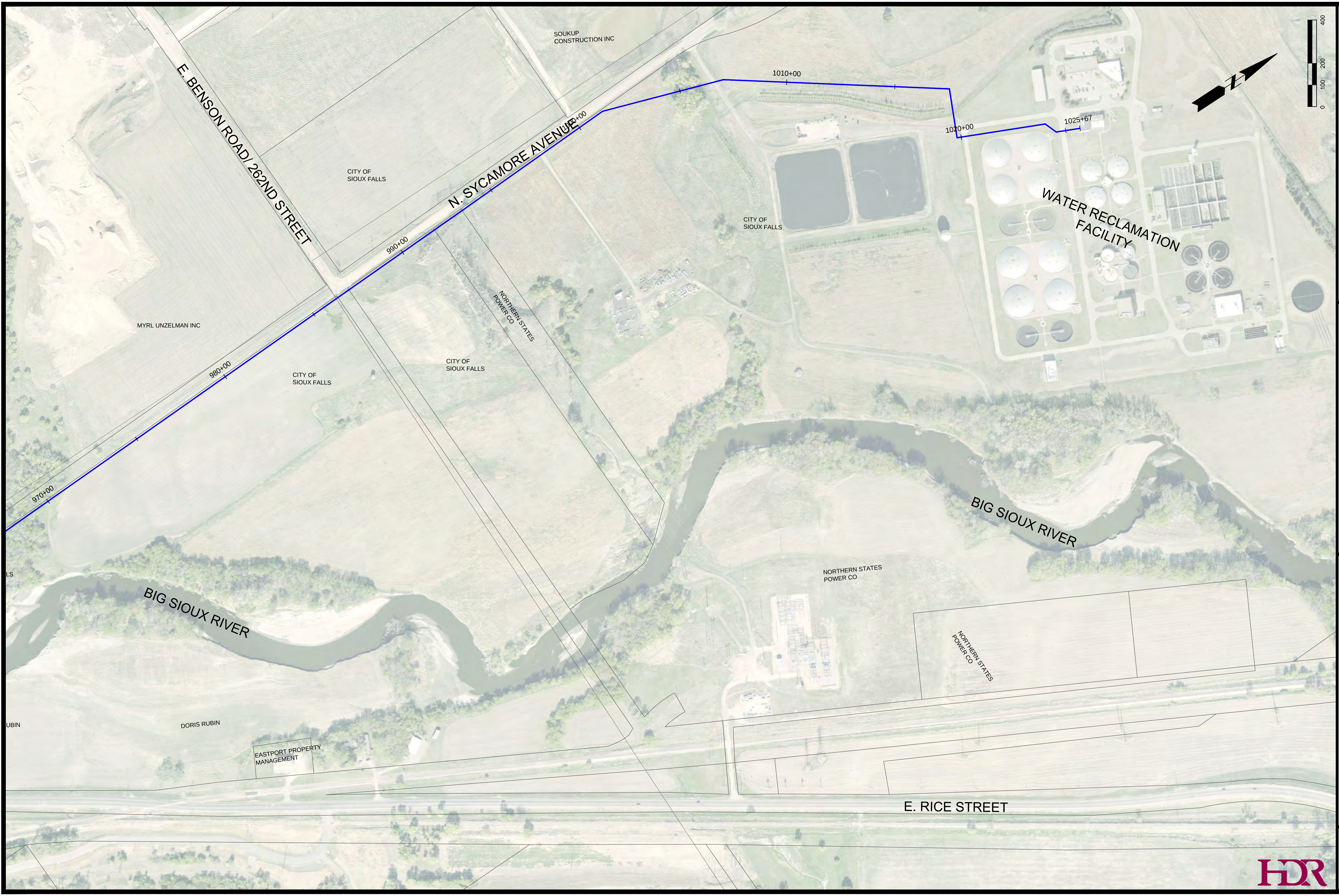
HDR

SHEET NO.
C.4

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 3/6/2014 8:16 AM VanWyhe, Nick



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN MIDDLE

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014

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C.5

HDR

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 3/6/2014 8:16 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN EAST

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014
REVISIONS: BY: DATE:
BY: DATE:

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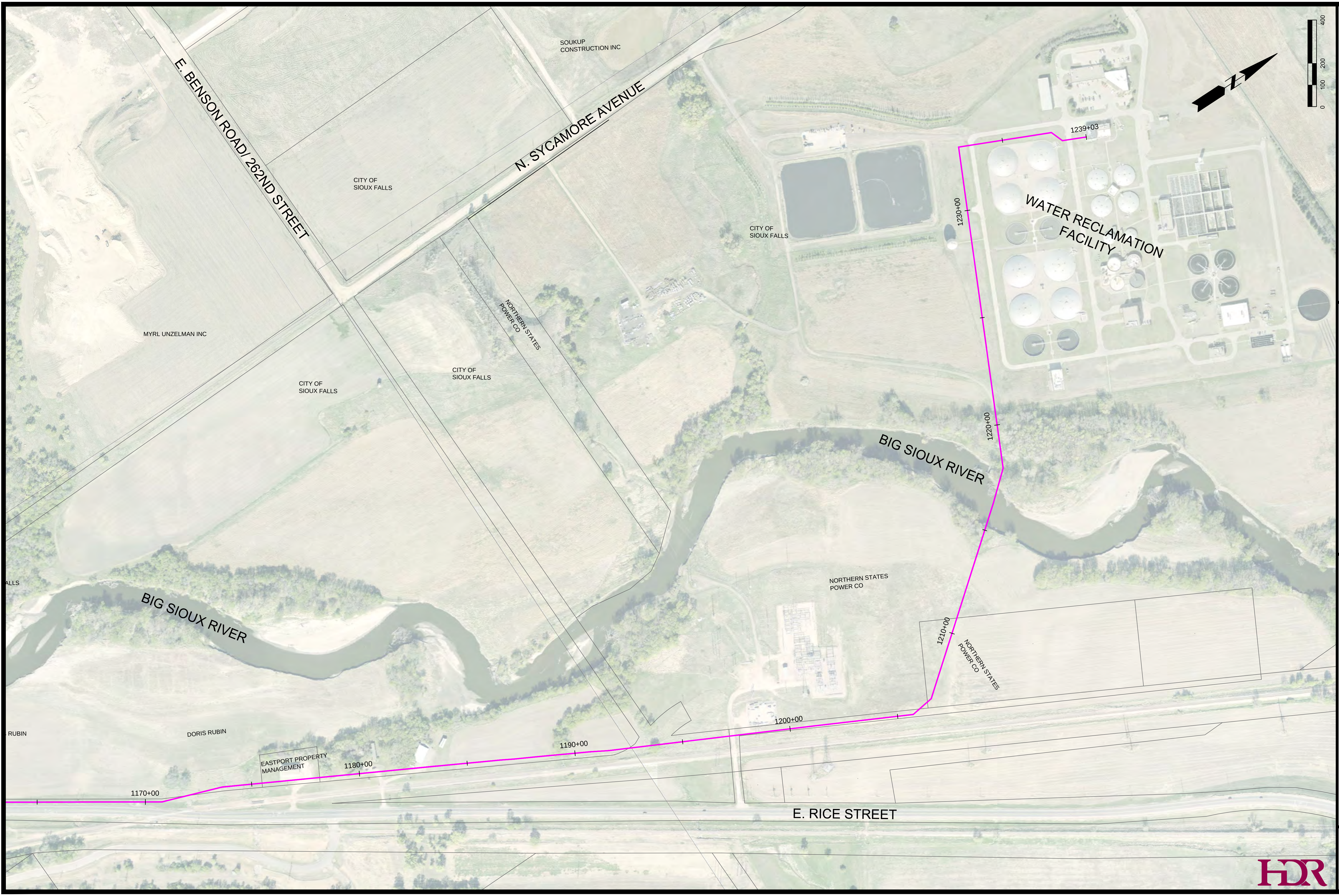
SHEET NO.
C.6

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 3/6/2014 8:17 AM VanWyhe, Nick



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

FORCE MAIN EAST

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 3/6/2014

REVISIONS: BY: DATE:
BY: DATE:

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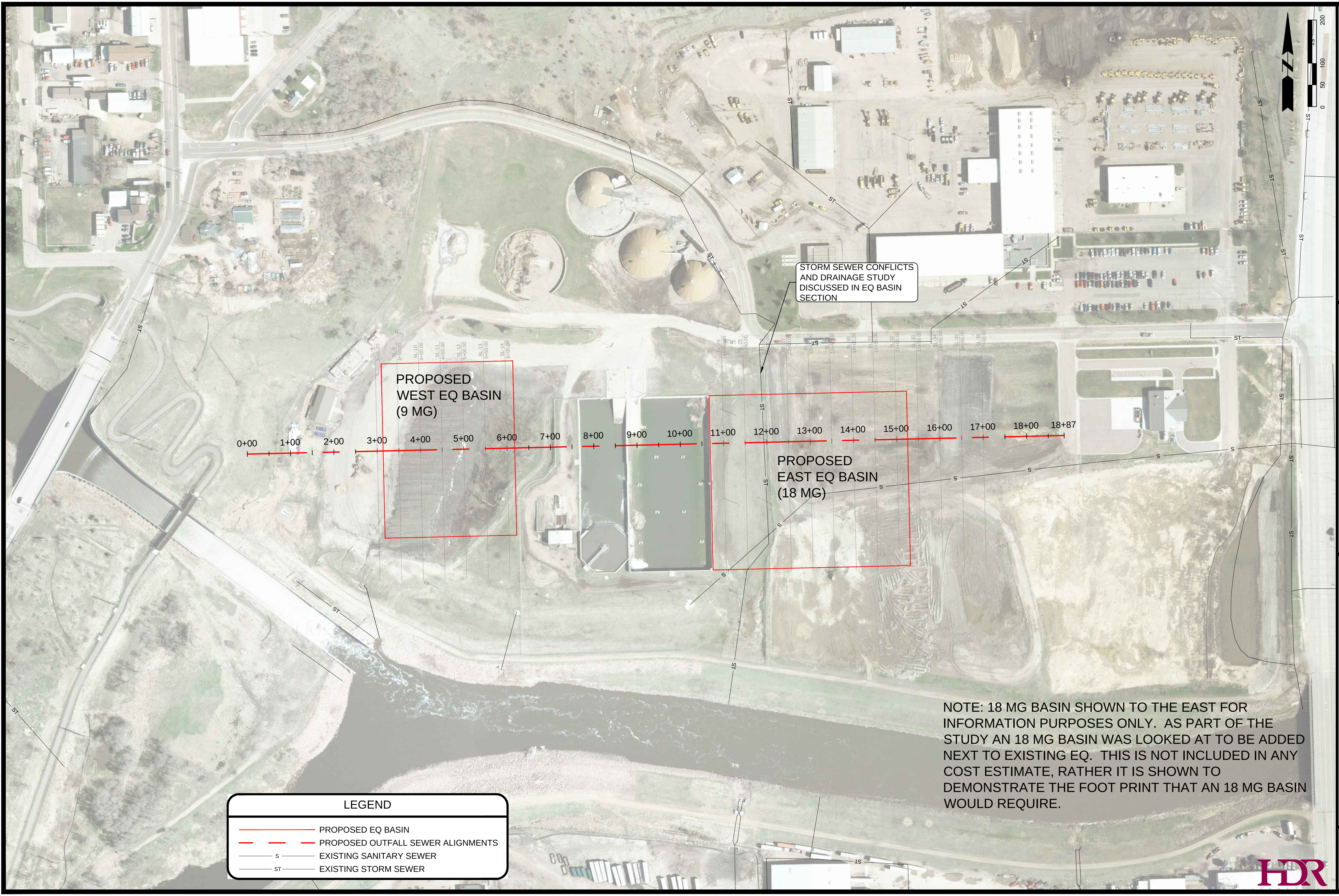
SHEET NO.
C.7

HDR

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 3/6/2014 8:17 AM VanWyhe, Nick

Appendix D

Equalization Basin Cross Sections



NOTE: 18 MG BASIN SHOWN TO THE EAST FOR INFORMATION PURPOSES ONLY. AS PART OF THE STUDY AN 18 MG BASIN WAS LOOKED AT TO BE ADDED NEXT TO EXISTING EQ. THIS IS NOT INCLUDED IN ANY COST ESTIMATE, RATHER IT IS SHOWN TO DEMONSTRATE THE FOOT PRINT THAT AN 18 MG BASIN WOULD REQUIRE.

LEGEND

🟥	PROPOSED EQ BASIN
— — —	PROPOSED OUTFALL SEWER ALIGNMENTS
—— S ——	EXISTING SANITARY SEWER
—— ST ——	EXISTING STORM SEWER

HDR

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 2/14/2014
REVISIONS: BY: DATE:
BY: DATE:

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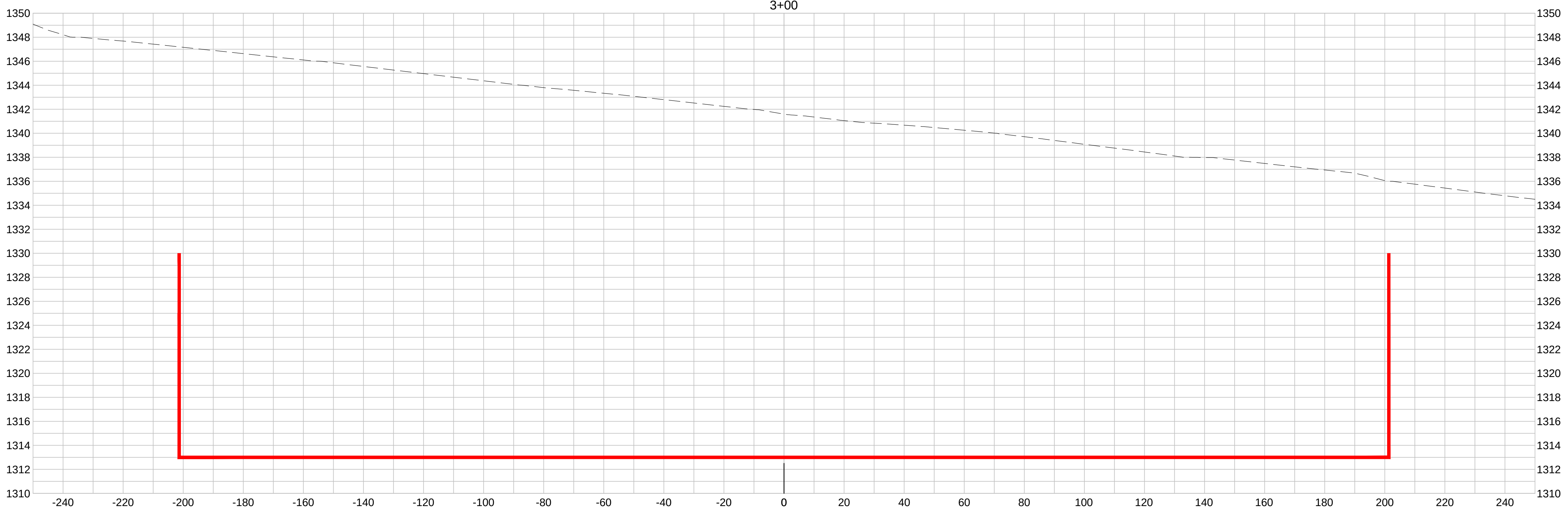
SHEET NO.
D.1

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 2/14/2014 3:28 PM VanWyhe, Nick

PROPOSED WEST EQ BASIN

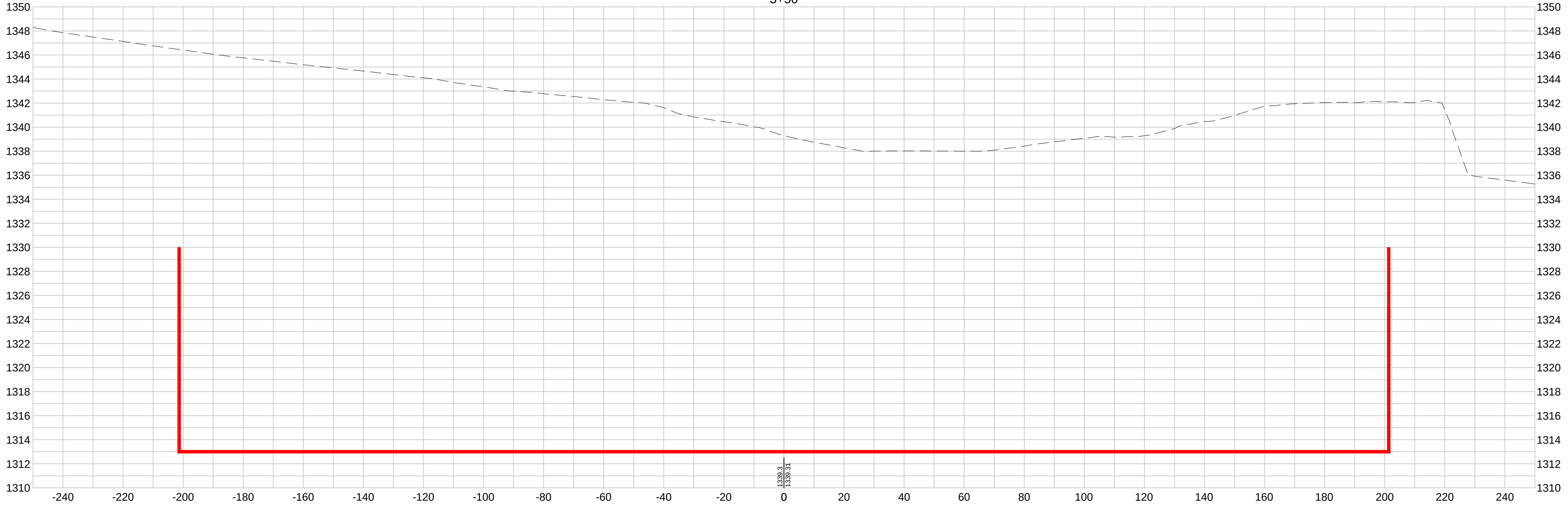
3+00



LEGEND

- – – – – – EXISTING GRADE
- 🟥 PROPOSED EQ BASIN

3+50



WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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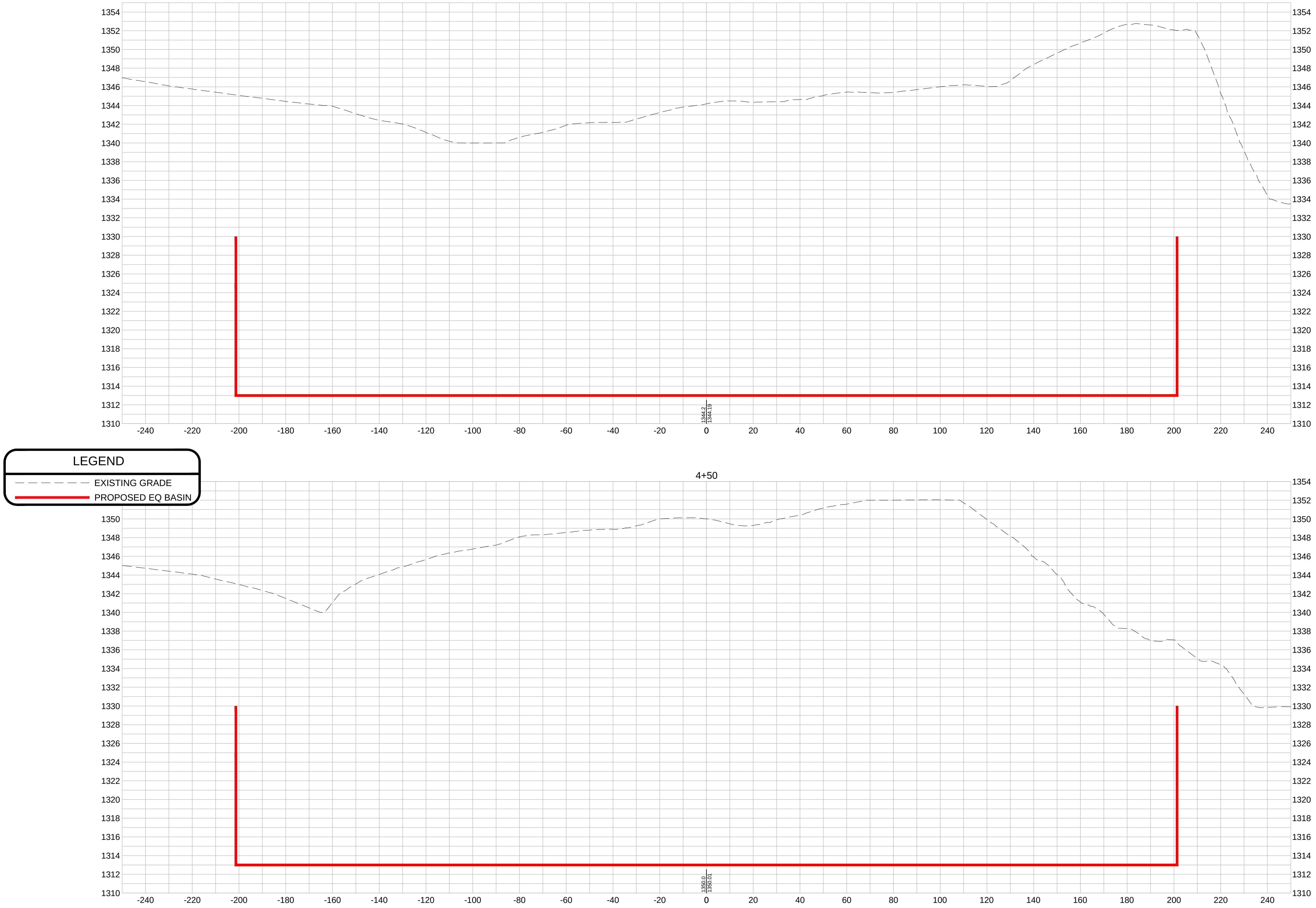
SHEET NO.
D.2

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:30 AM VanWyhe, Nick

PROPOSED WEST EQ BASIN



WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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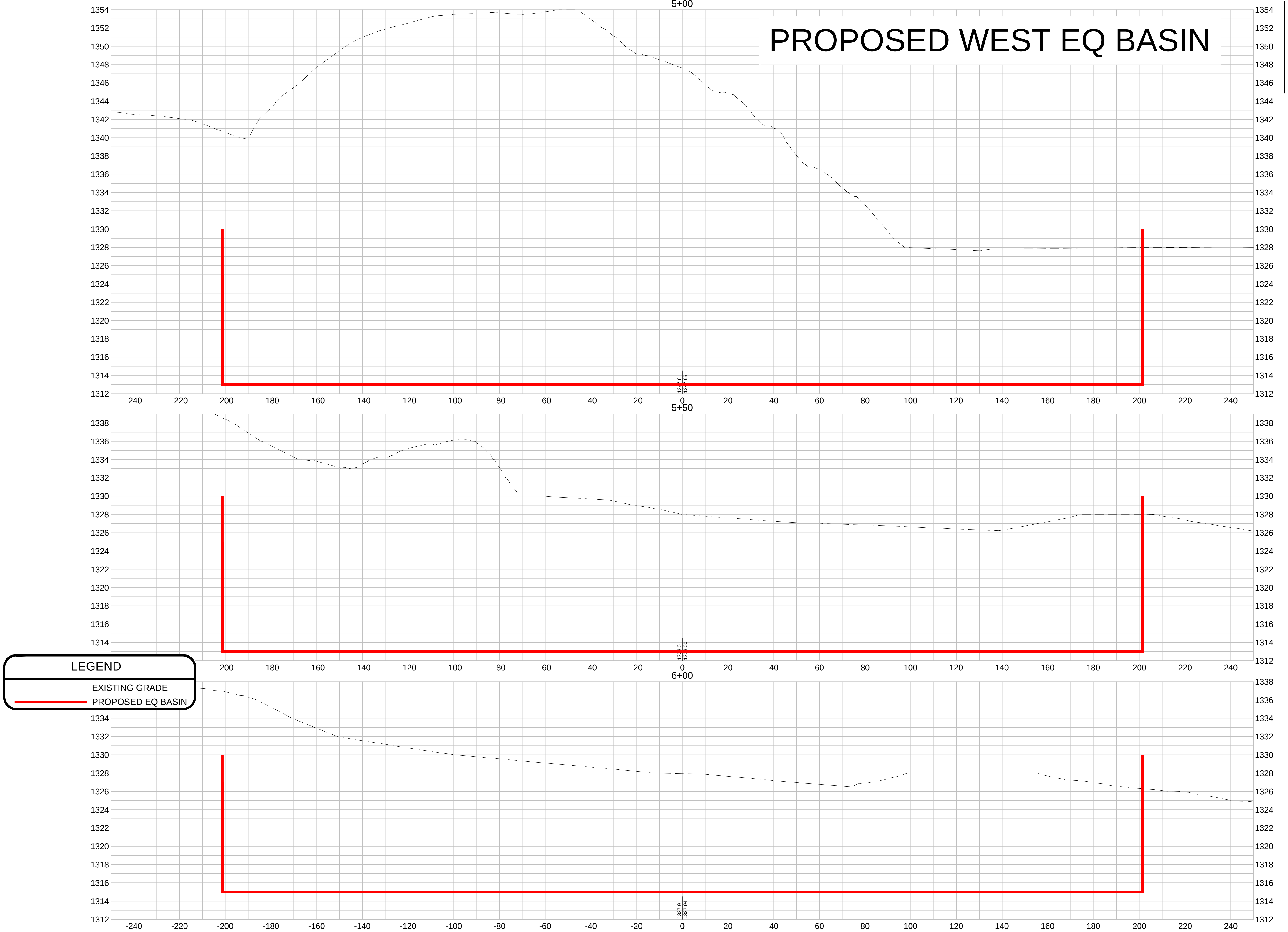
SHEET NO.
D.3

HDR

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:30 AM VanWyhe, Nick

PROPOSED WEST EQ BASIN



C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:30 AM VanWyhe, Nick

WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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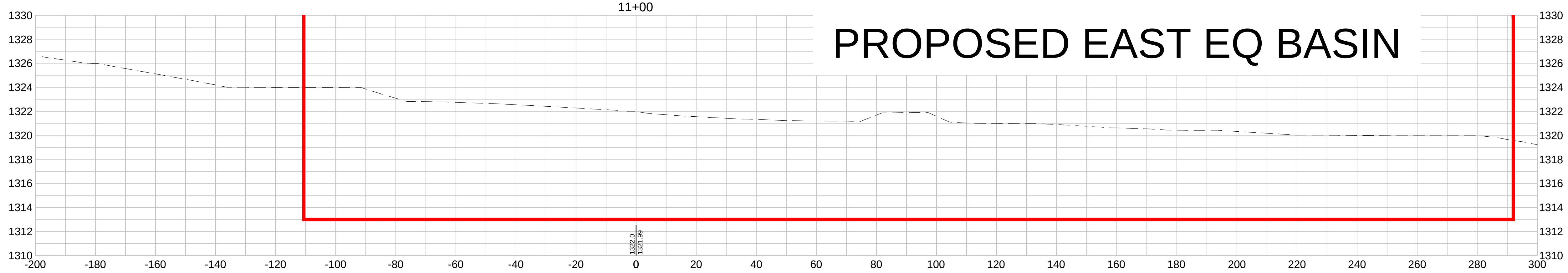
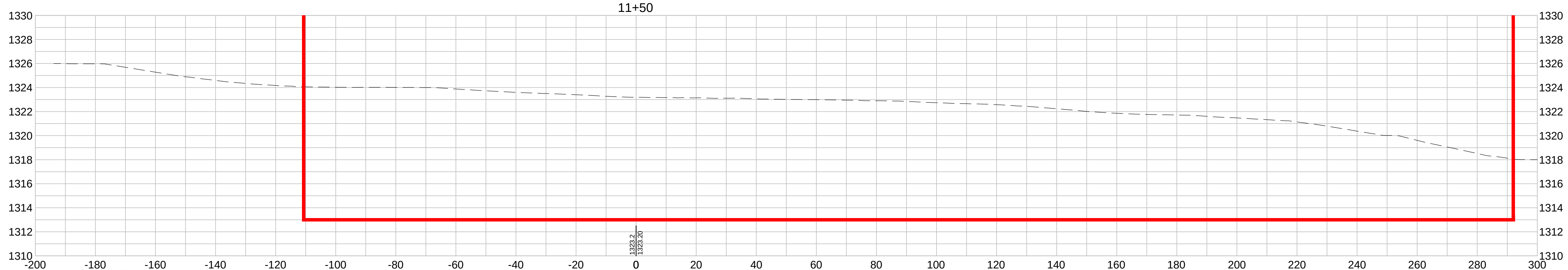
SHEET NO.
D.4

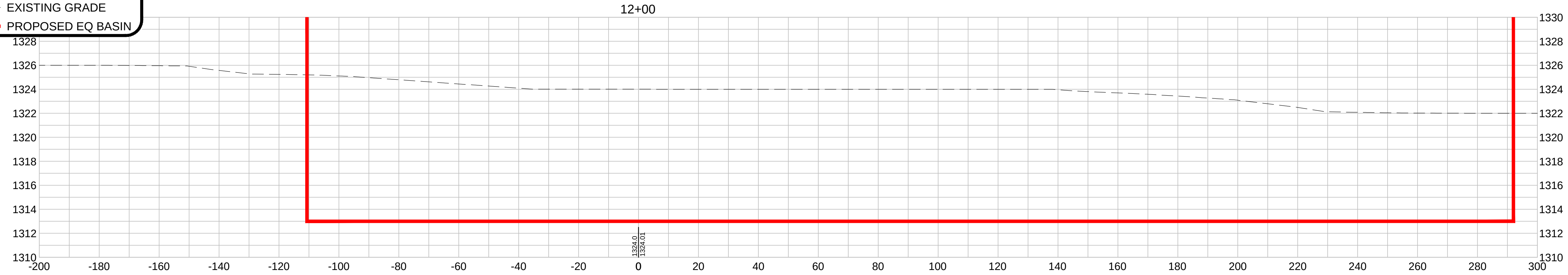
PROPOSED EAST EQ BASIN


11+00


11+50

LEGEND

— — — — —	EXISTING GRADE
🟥	PROPOSED EQ BASIN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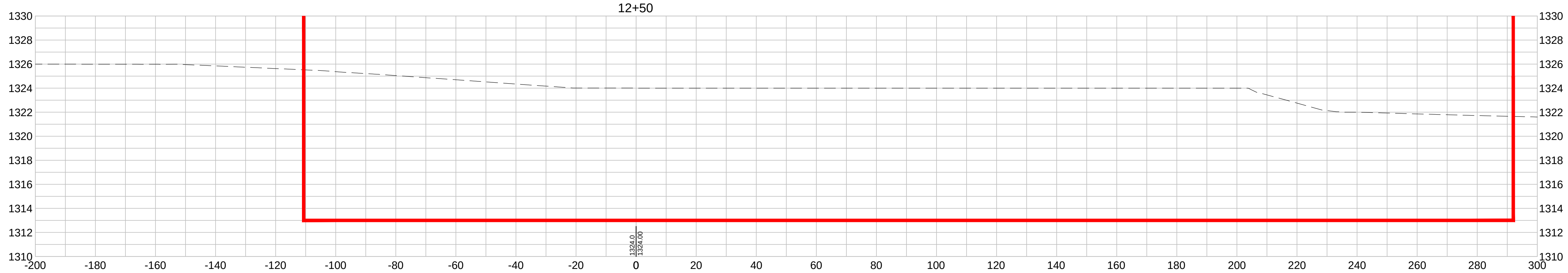
12+50

WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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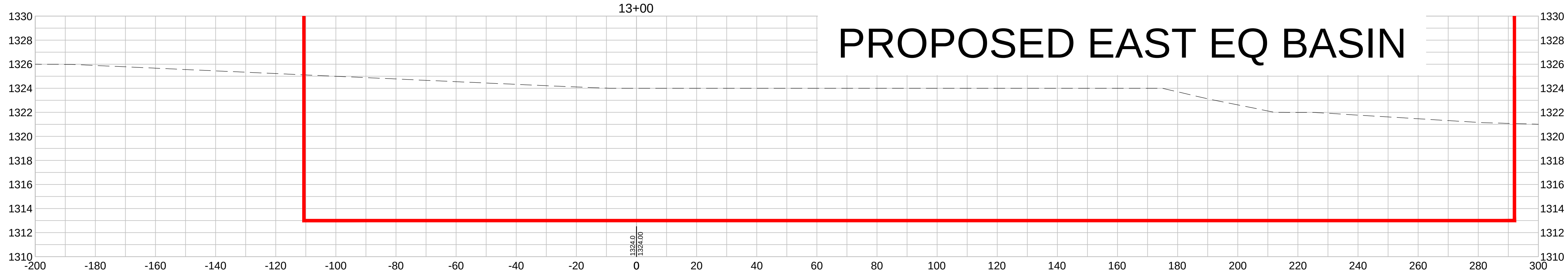
SHEET NO.
D.5

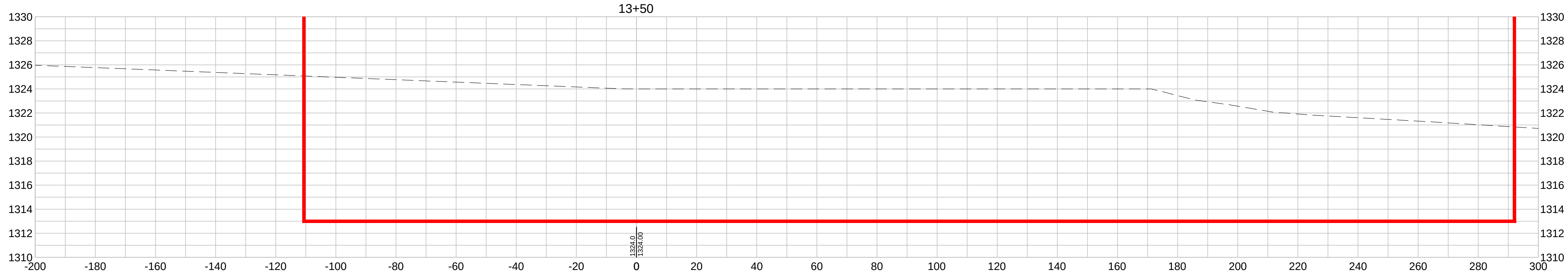
C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:31 AM VanWyhe, Nick

PROPOSED EAST EQ BASIN

13+00



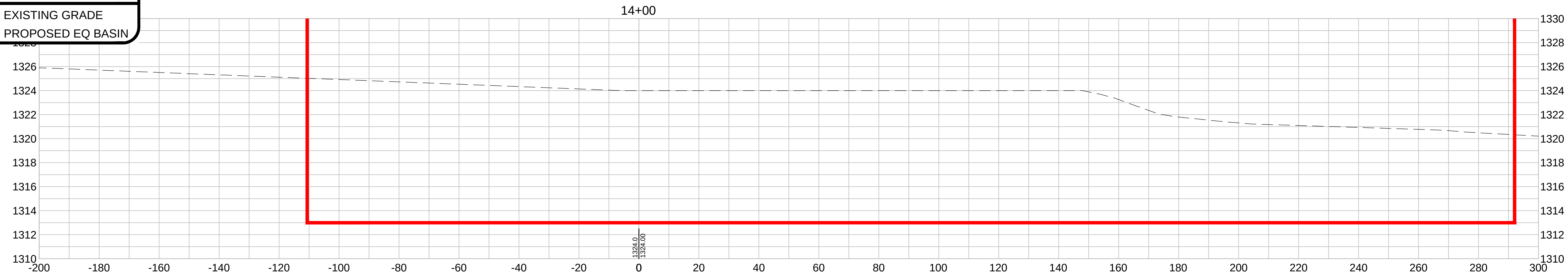
13+50



LEGEND

— — — —	EXISTING GRADE
━━━━	PROPOSED EQ BASIN

14+00



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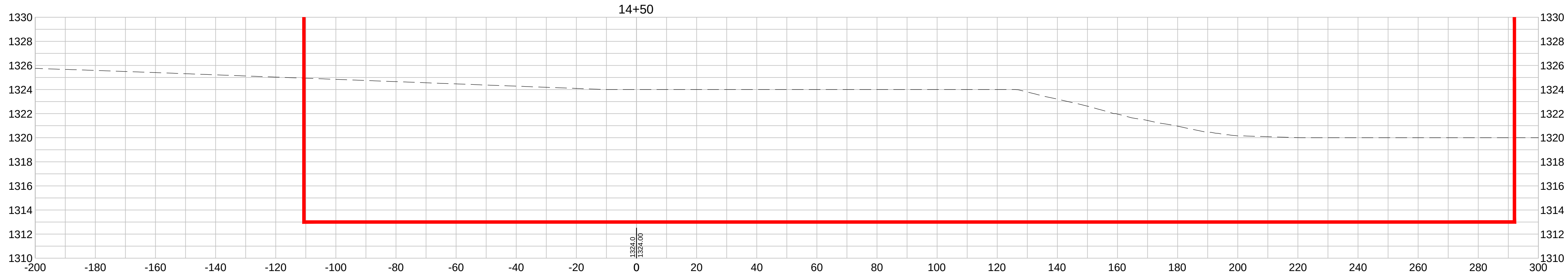

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:31 AM VanWyhe, Nick

HDR

WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS
DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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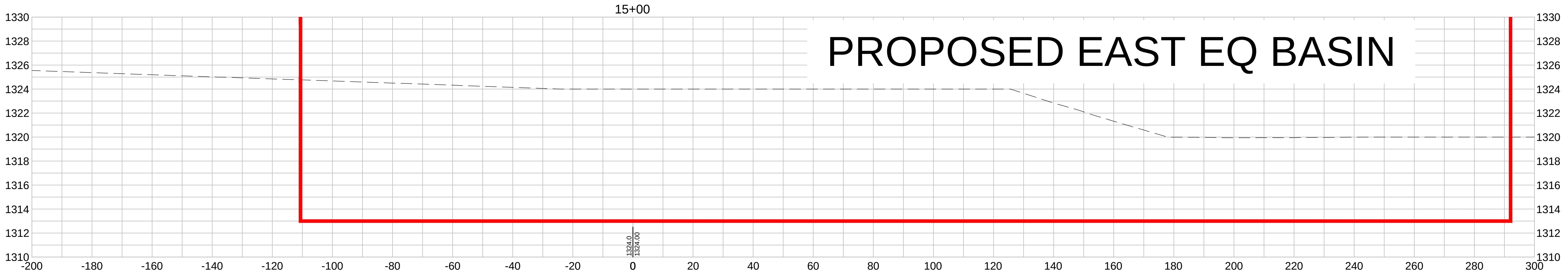
SHEET NO.
D.6

PROPOSED EAST EQ BASIN

15+00



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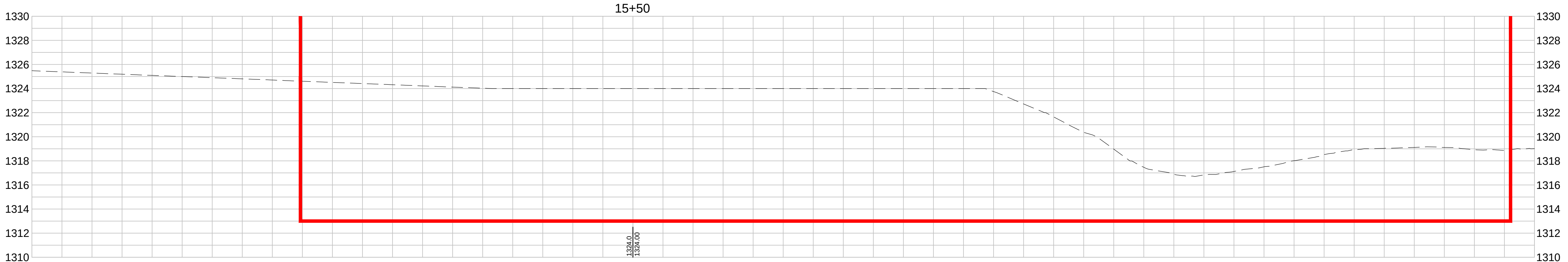
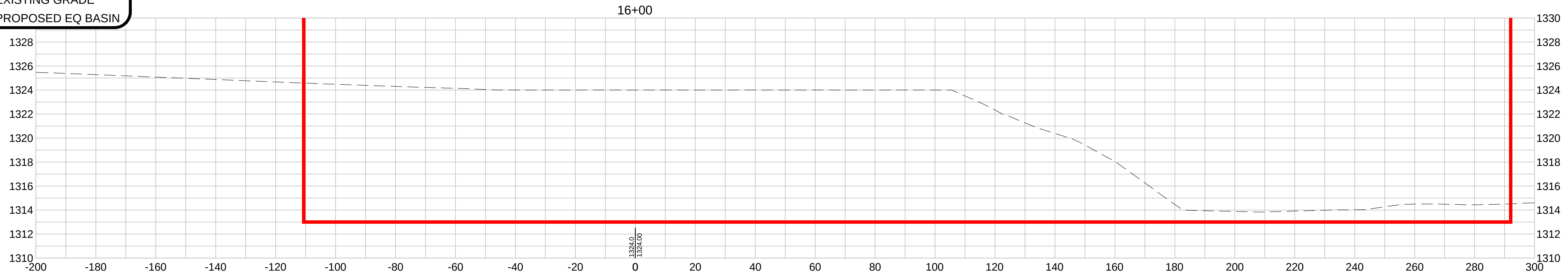


LEGEND

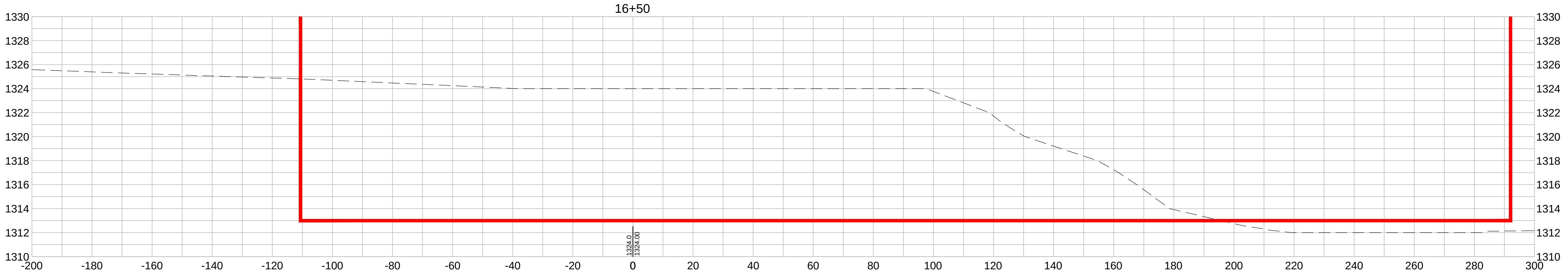
— — — — — EXISTING GRADE

▬▬▬ PROPOSED EQ BASIN

16+00



16+50



HDR

WATER RECLAMATION COLLECTION SYSTEM PLANNING
SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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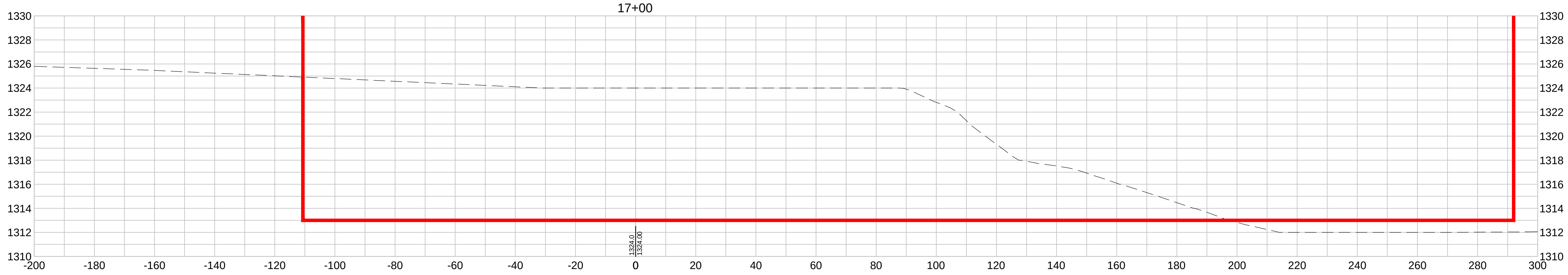
SHEET NO.
D.7

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:31 AM VanWyhe, Nick

PROPOSED EAST EQ BASIN



LEGEND

— — — — —	EXISTING GRADE
🟥	PROPOSED EQ BASIN

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

EQ BASIN CROSS SECTIONS

DESIGNED BY:
DRAWN BY: ACAD FILE:
CHECKED BY: DATE: 1/23/2014
REVISIONS: BY: DATE:
BY: DATE:

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SHEET NO.

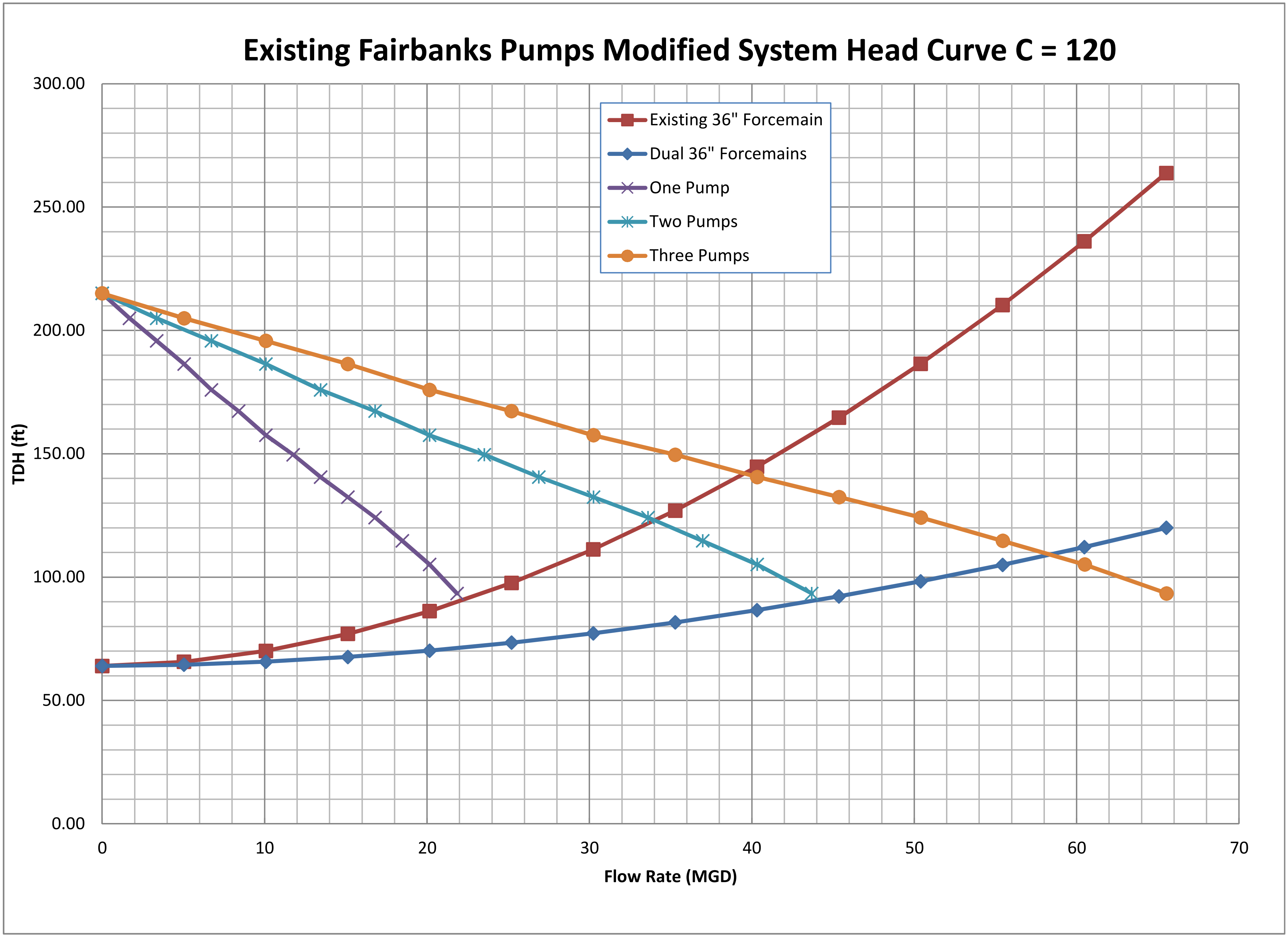
D.8

HDR

C:\pwworking\oma\d1154814\EQ_XSECTIONS.dwg
PLOT DATE: 1/23/2014 10:31 AM VanWyhe, Nick

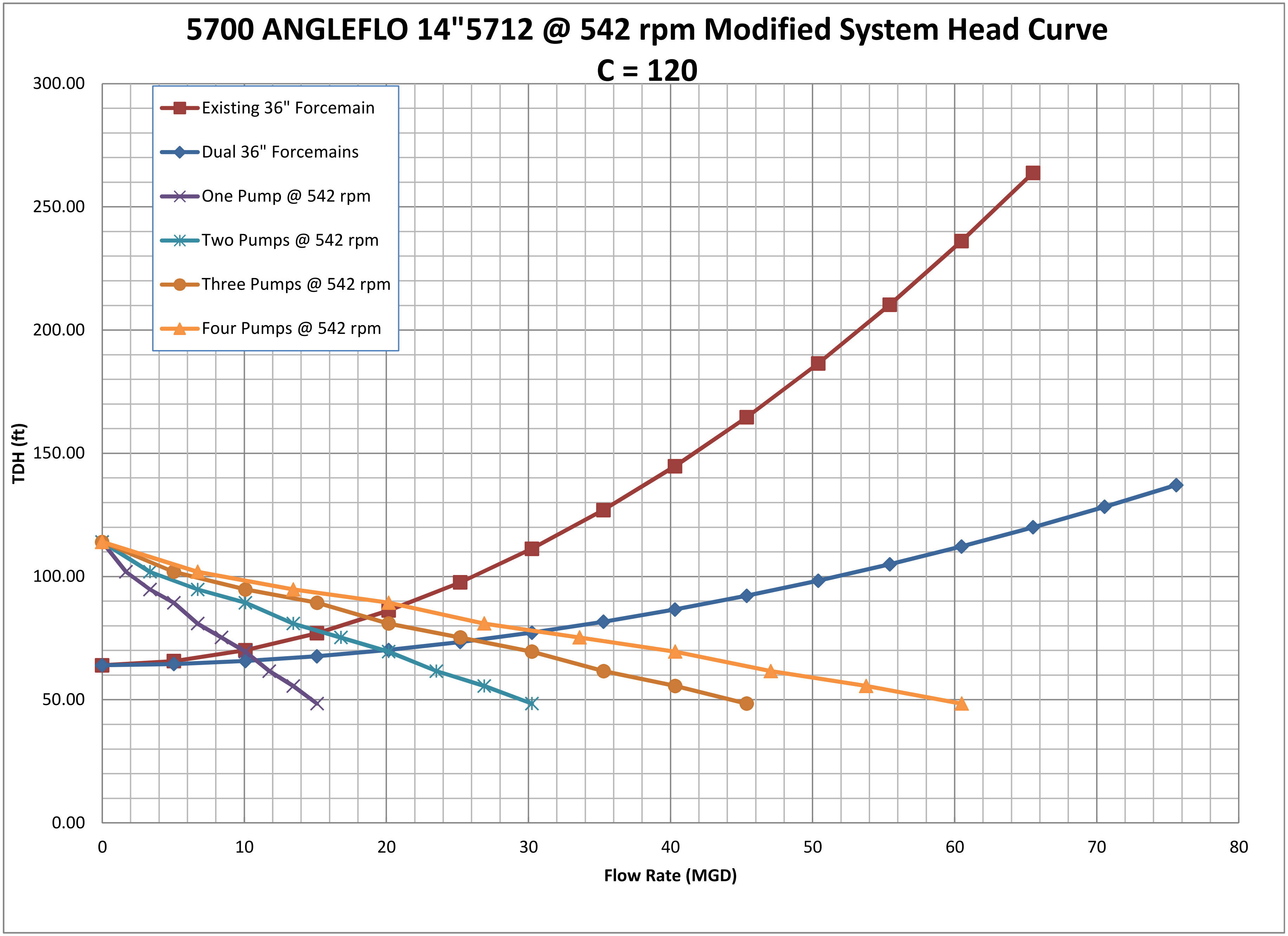
Appendix E

Brandon Road Pump Station - Existing and Proposed Pump Curves

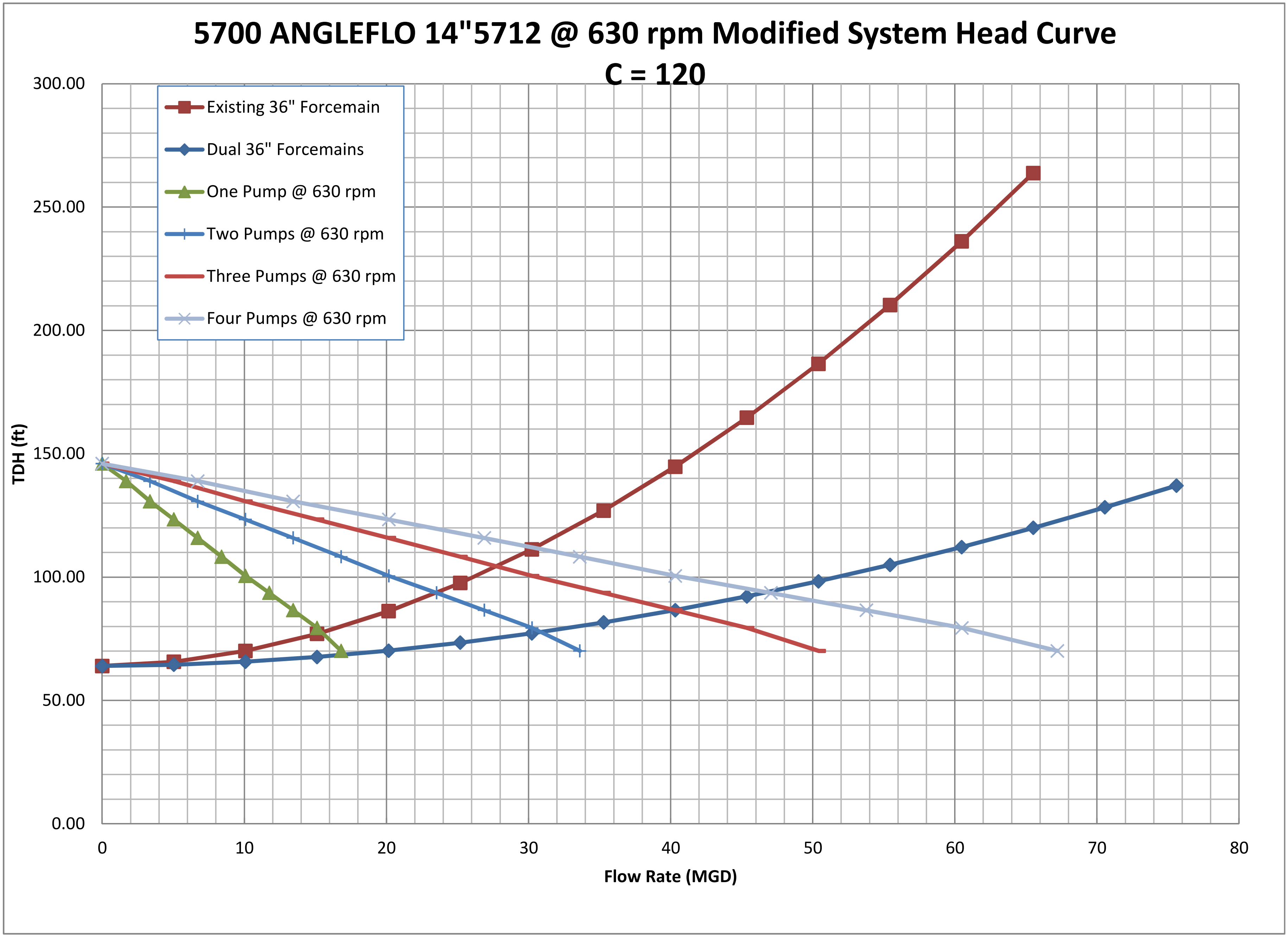


Existing Fairbanks Pumps Modified System Head Curve C = 120
300.00
250.00
200.00
150.00
100.00
50.00
0.00
TDH (ft)
0
10
20
30
40
50
60
70
Flow Rate (MGD)
Existing 36" Forcemain
Dual 36" Forcemains
One Pump
Two Pumps
Three Pumps

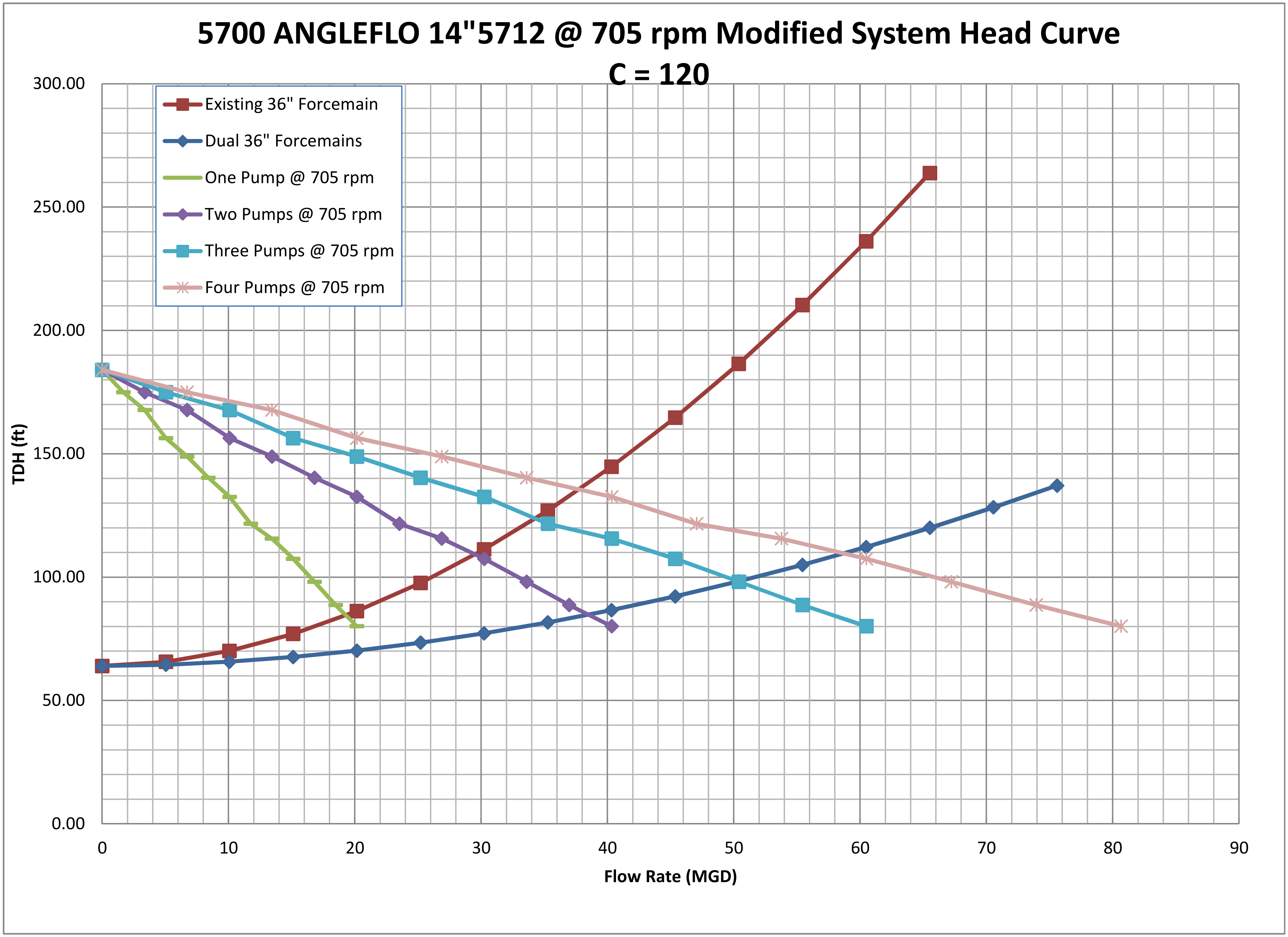
E.1

5700 ANGLEFLO 14"5712 @ 542 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 542 rpm
Two Pumps @ 542 rpm
Three Pumps @ 542 rpm
Four Pumps @ 542 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
Flow Rate (MGD)

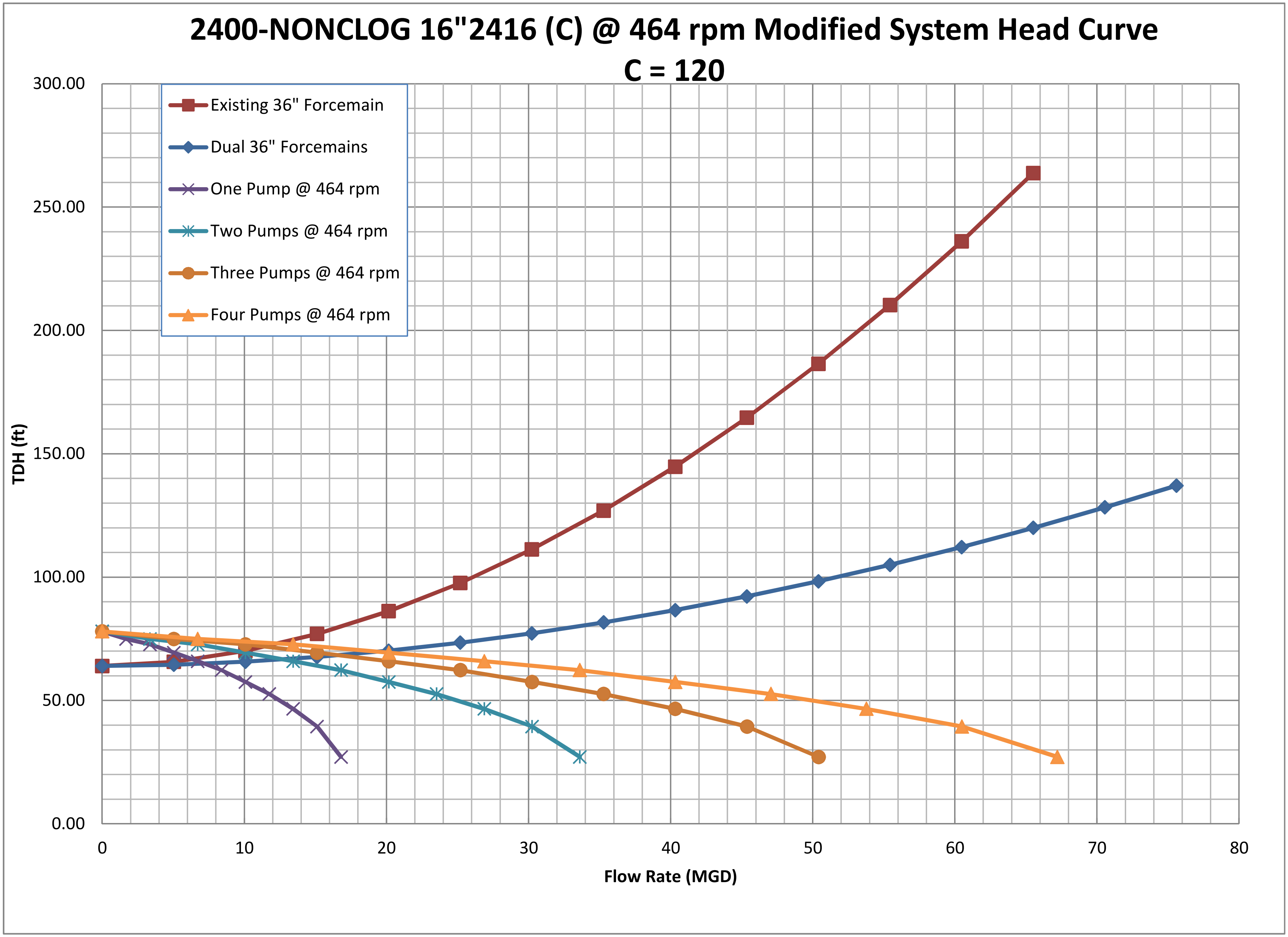
E.2


5700 ANGLEFLO 14"5712 @ 630 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 630 rpm
Two Pumps @ 630 rpm
Three Pumps @ 630 rpm
Four Pumps @ 630 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
Flow Rate (MGD)

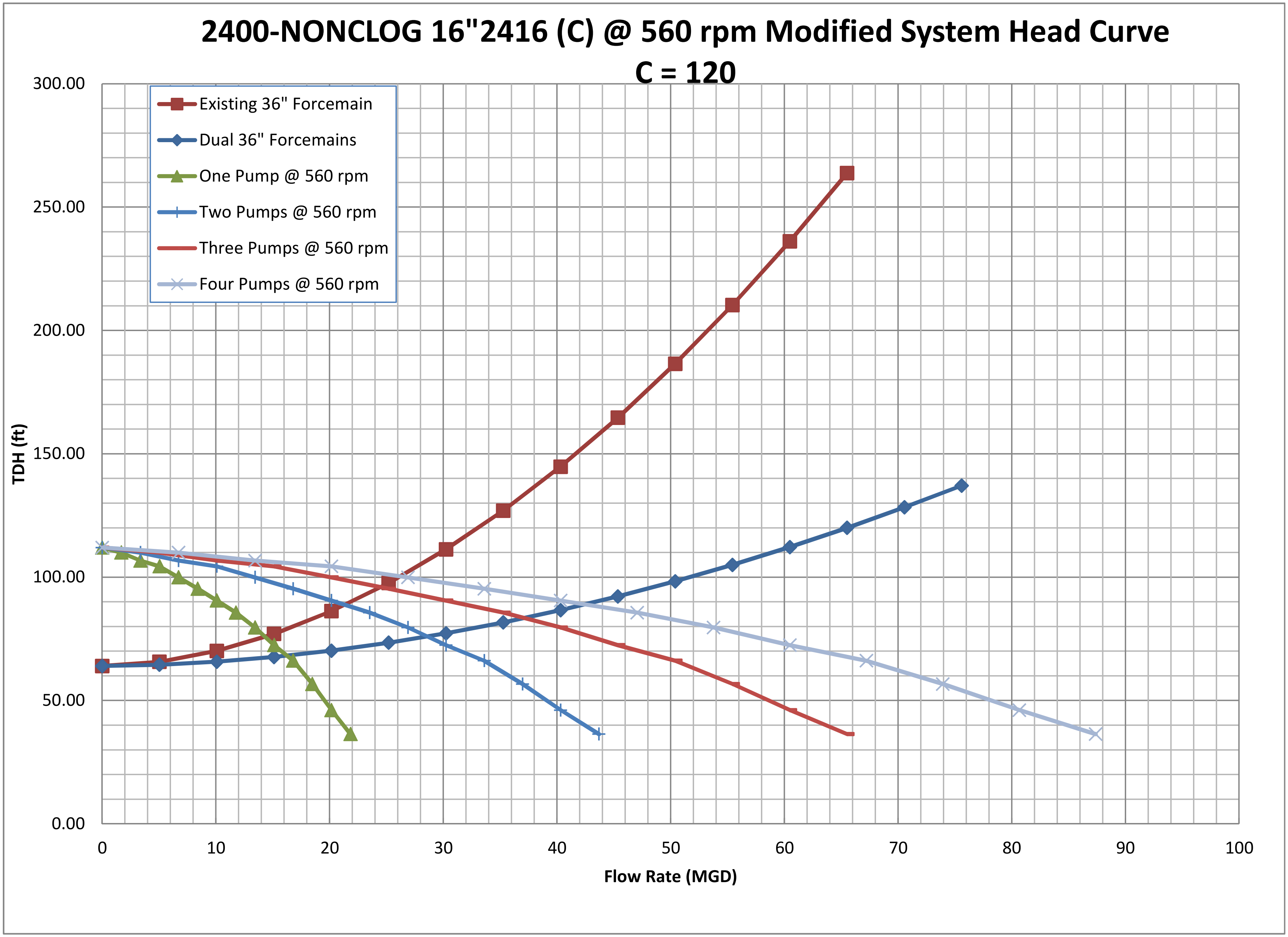
E.3


5700 ANGLEFLO 14"5712 @ 705 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 705 rpm
Two Pumps @ 705 rpm
Three Pumps @ 705 rpm
Four Pumps @ 705 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
90
Flow Rate (MGD)

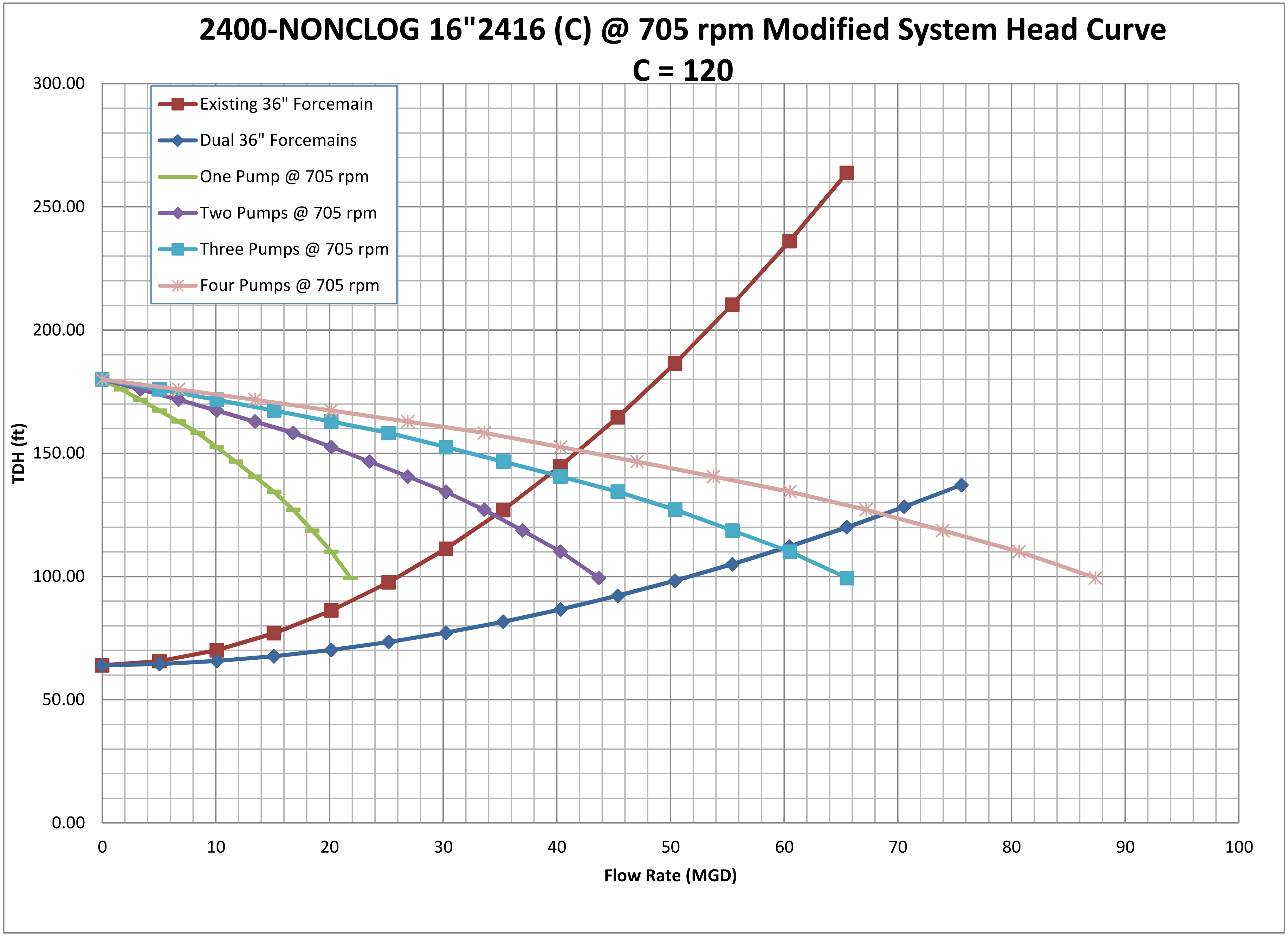
E.4


2400-NONCLOG 16"2416 (C) @ 464 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 464 rpm
Two Pumps @ 464 rpm
Three Pumps @ 464 rpm
Four Pumps @ 464 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
Flow Rate (MGD)

E.5


2400-NONCLOG 16"2416 (C) @ 560 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 560 rpm
Two Pumps @ 560 rpm
Three Pumps @ 560 rpm
Four Pumps @ 560 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
90
100
Flow Rate (MGD)

E.6


2400-NONCLOG 16"2416 (C) @ 705 rpm Modified System Head Curve
C = 120
Existing 36" Forcemain
Dual 36" Forcemains
One Pump @ 705 rpm
Two Pumps @ 705 rpm
Three Pumps @ 705 rpm
Four Pumps @ 705 rpm
TDH (ft)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
10
20
30
40
50
60
70
80
90
100
Flow Rate (MGD)

E.7

Appendix F

Project Cost Estimates

Note: Cost estimates provided for this study are based on 2014 construction costs. All costs should be indexed for inflation to update the cost estimates in the future.

Conceptual Opinion of Probable Construction Costs for Sioux Falls Outfall Sewer Replacement

ITEM NO.	ITEM DESCRIPTION	UNITS	TOTAL QUANTITY (North)	TOTAL QUANTITY	TOTAL QUANTITY (South)	UNIT BID PRICE	AMOUNT BID (North)	AMOUNT BID (Middle)	AMOUNT BID (South)
1	Sanitary Sewer Installation	Ft	9693	9695	9875	$1,180.00	$11,437,740.00	$11,440,100.00	$11,652,500.00
2	Siphon Box Installation	Each	2	2	2	$75,000.00	$150,000.00	$150,000.00	$150,000.00
3	Sanitary Sewer Bypass	LS	1	1	1	-	$500,000.00	$250,000.00	$250,000.00
4	Flow-Dar meter	Each	3	3	3	$18,000.00	$54,000.00	$54,000.00	$54,000.00
5	Service to Lime Sludge lagoons	Ft	250	250	250	$40.00	$10,000.00	$10,000.00	$10,000.00
6	Manhole for Lime Sludge lagoons	Each	1	1	1	$4,500.00	$4,500.00	$4,500.00	$4,500.00
7	Floatation Protection	Ft	2060	1750	1600	$250.00	$515,000.00	$437,500.00	$400,000.00
8	Fiber Optic Line	Ft	9693	9695	9875	$5.00	$48,465.00	$48,475.00	$49,375.00
9	Bank Stabilization	LS	1	0	0	$800,000.00	$800,000.00	$0.00	$0.00
10	Great Bear Watermain	LS	1	1	1	$600,000.00	$600,000.00	$600,000.00	$600,000.00
11	USACE Permitting/Coordination	LS	1	1	1	$30,000.00	$30,000.00	$30,000.00	$30,000.00
						Sub Total	$14,149,705.00	$13,024,575.00	$13,200,375.00
						Undefined construction Costs (20%)	$2,829,941.00	$2,604,915.00	$2,640,075.00
						Construction and Undefined Sub Total	$16,979,646.00	$15,629,490.00	$15,840,450.00
						Engineering (15%)	$2,546,946.90	$2,344,423.50	$2,376,067.50
						Legal/Administration (2%)	$339,592.92	$312,589.80	$316,809.00
						Total	$19,866,185.82	$18,286,503.30	$18,533,326.50

* Bypass and dewatering costs associated with pipe installation were included in the Sanitary Sewer Installation bid item.

Conceptual Opinion of Probable Construction Costs for Sioux Falls Brandon Road Parallel Forcemain Installation

ITEM NO.	ITEM DESCRIPTION	UNITS	TOTAL QUANTITY (West)	TOTAL QUANTITY	TOTAL QUANTITY (East)	UNIT BID PRICE	AMOUNT BID (West)	AMOUNT BID (Middle)	AMOUNT BID (East)
1	Furnish and Install Force Main Pipe	Ft	12340	12570	14035	$400.00	$4,936,000.00	$5,028,000.00	$5,614,000.00
2	Fittings	lb	60000	50000	50000	$7.00	$420,000.00	$350,000.00	$350,000.00
3	Air Release Valves	Each	10	10	13	$45,000.00	$450,000.00	$450,000.00	$585,000.00
4	Removals	Acre	35	35	38	$11,000.00	$385,000.00	$385,000.00	$418,000.00
5	Remove and Replace Tree	Each	1320	580	90	$600.00	$792,000.00	$348,000.00	$54,000.00
6	Restoration	Acre	35	35	38	$19,000.00	$665,000.00	$665,000.00	$722,000.00
7	Traffic Control	LS	10000	25000	35000	$1.00	$10,000.00	$25,000.00	$35,000.00
8	River Crossing	LS	1	1	1	$300,000.00	$300,000.00	$300,000.00	$300,000.00
9	Access Road	Ton	4000	2100	0	$25.00	$100,000.00	$52,500.00	$0.00
10	Rail Road liability insurance	LS	0	1	1	$10,000.00	$0.00	$10,000.00	$10,000.00
11	Rail Road Crossing	LS	0	1	1	$200,000.00	$0.00	$200,000.00	$200,000.00
11	Fiber Optic Line	Ft	12340	12570	14035	$5.00	$61,700.00	$62,850.00	$70,175.00
12	Remove and Replace 36" RCP End F&I	Each	0	3	3	$2,400.00	$0.00	$7,200.00	$7,200.00
13	Remove and Replace 54" RCP End F&I	Each	0	0	1	$2,800.00	$0.00	$0.00	$2,800.00
14	Remove and Replace 132" RCP End F&I	Each	0	1	1	$5,500.00	$0.00	$5,500.00	$5,500.00
15	Relocate/Support Xcel Power Poles	LS	0	0.5	1	$400,000.00	$0.00	$200,000.00	$400,000.00
						Sub Total	$8,119,700.00	$8,089,050.00	$8,773,675.00
						Undefined construction Costs (20%)	$1,623,940.00	$1,617,810.00	$1,754,735.00
						Construction and Undefined Sub Total	$9,743,640.00	$9,706,860.00	$10,528,410.00
						Engineering (15%)	$1,461,546.00	$1,456,029.00	$1,579,261.50
						Legal/Administration (2%)	$194,872.80	$194,137.20	$210,568.20
						Total	$11,400,058.80	$11,357,026.20	$12,318,239.70

* Dewatering costs associated with pipe installation were included in the Furnish and Install Force Main bid item.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
NEW PUMP STATION WITH FOUR (4) NEW DRY-PIT PUMPS @ 50 MGD
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$793,000
2.0	Site Work				$2,721,000
3.0	Concrete				$2,305,000
4.0	Masonry				$351,000
5.0	Metals				$229,000
6.0	Carpentry				$15,000
7.0	Thermal & Moisture Protection				$120,000
8.0	Doors & Windows				$51,000
9.0	Finishes				$278,000
10.0	Specialties				$12,000
11.0	Equipment				$2,955,000
13.0	Special Construction				$122,000
14.0	Conveying Systems				$150,000
15.0	Mechanical				$279,000
16.0	Electrical				$3,100,000
25%	**Construction & Undeveloped Design Detail Contingencies (25%)**				**$3,371,000**
	Total Estimated Construction Cost				**$16,900,000**
18%	**Planning, Design, and Construction Engineering**				**$3,050,000**
0.5%	**Geotechnical**				**$80,000**
1.5%	**Construction Materials Testing**				**$250,000**
4%	**Legal, Admin, Bonds, and Financial**				**$660,000**
24%					**$4,040,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$20,940,000**

* Bypass and dewatering costs associated with building a new lift station 40+ feet deep were included in this cost estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
TOTAL REFURBISH BRANDON ROAD PUMP STATION PROJECTS
SUMMARY OF OPINION OF PROBABLE TOTAL PROJECT COSTS
HDR PROJECT NO.

	PROJECT DESCRIPTION	PROJECT COST
1.0	**Update Switch Gear**	**$390,000**
	1.A Raise Electrical Equipment	$420,000
	Subtotal Update Switch Gear	**$810,000**
2.0	**Emergency Generator**	**$2,340,000**
	1.0 Update Switch Gear	**-$1,200,000**
	Subtotal Emergency Generator	**$1,140,000**
3.0	**Replace Pumps and Drives**	**$7,810,000**
	Option 3.A Replace Discharge Header	$2,940,000
	Option 3.B Wetwell Lining	$110,000
	Subtotal Replace Pumps and Drives	**$10,860,000**
4.0	**Improve Access for Wetwell Cleaning**	**$530,000**
5.0	**Replace Influent Screening**	**$2,000,000**
6.0	**500-Year Flood Protection**	
	6.A Build Retaining Wall Around Building	$890,000
	6.B Build Retaining Wall Around Site & Raise Road	$1,496,000
	6.C Build Levee & Raise Road	$2,264,000
	6.D Raise Road Only	$647,400
7.0	**Replace HVAC, Doors, Roof Repairs, Painting**	**$720,000**
	OPINION OF PROBABLE TOTAL PROJECTS COSTS AFTER ALL PROJECTS ARE COMPLETED (10-20 YR'S) COST INCLUDES ALL HIGHLIGHTED ITEMS	**$17,556,000**

* Bypass and dewatering costs associated with refurbishing portions of the Brandon Road Pump Station were included in the applicable projects and are called out on the associated estimates for 1.0 - 7.0 as necessary.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #1 - REFURBISH EXISTING SWITCHGEAR
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$16,000
16.0	Electrical				$225,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$70,000
	Total Estimated Construction Cost				**$320,000**
20%	**Planning, Design, and Construction Engineering**				**$60,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$10,000**
24.0%					**$70,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$390,000**

* No bypass or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #1.A - RAISE ELECTRICAL EQUIPMENT ABOVE 500-YEAR FLOOD ELEVATION
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	**QUANTITY**	**UNIT**	**UNIT COST**	**INSTALLED COST**
Summary					
1.0	General Conditions				$16,000
2.0	General/Site Work				$100,000
16.0	Electrical				$150,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$70,000
	Total Estimated Construction Cost				**$340,000**
20%	**Planning, Design, and Construction Engineering**				**$70,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$10,000**
24.0%					**$80,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$420,000**

* No bypass or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #2 - COMPARISON OF TIER 2 EMERGENCY GENERATORS VS TIER 4i LOAD SHEDDING
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	Tier 2 Emergency Only **ITEM DESCRIPTION**	**QUANTITY**	**UNIT**	**UNIT COST**	**INSTALLED COST**
	Packaged Engine Generator Tier 2 Emergency Only	1	EA	$700,000	$700,000
	Paralleling Switch Gear Package	1	EA	$800,000	$800,000
	Subtotal				**$1,500,000**
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$380,000
	Total Estimated Construction Cost				**$1,880,000**
20%	**Planning, Design, and Construction Engineering**				**$380,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$80,000**
24.0%					**$460,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$2,340,000**

	ITEM DESCRIPTION	**QUANTITY**	**UNIT**	**UNIT COST**	**INSTALLED COST**
	Packaged Engine Generator Tier 4i Load Shedding	1	EA	$1,510,000	$1,510,000
	Paralleling Switch Gear Package	1	EA	$800,000	$800,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$580,000
	Total Estimated Construction Cost				**$2,890,000**
20%	**Planning, Design, and Construction Engineering**				**$580,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$120,000**
24.0%					**$700,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$3,590,000**

* No bypass or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #3 - EXISTING PUMP STATION WITH FOUR (4) NEW DRY-PIT PUMPS @ 50 MGD
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$315,000
2.0	Site Work				$280,000
9.0	Finishes				$30,000
11.0	Equipment				$2,932,000
13.0	Special Construction				$80,000
16.0	Electrical				$1,385,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$1,260,000
	Total Estimated Construction Cost				**$6,290,000**
20%	**Planning, Design, and Construction Engineering**				**$1,260,000**
0.25%	**Geotechnical**				**$20,000**
0.25%	**Construction Materials Testing**				**$20,000**
3.5%	**Legal, Admin, Bonds, and Financial**				**$220,000**
24.0%					**$1,520,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$7,810,000**

* Bypass pumping was included with this cost estimate, no dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #3.A - OPTION TO REPLACE DISCHARGE HEADER
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$115,000
2.0	Site Work				$790,000
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$0
11.0	Equipment				$982,000
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$0
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$480,000
	Total Estimated Construction Cost				**$2,370,000**
20%	**Planning, Design, and Construction Engineering**				**$470,000**
0.25%	**Construction Materials Testing**				**$10,000**
0.25%	**Geotechnical**				**$10,000**
3.5%	**Legal, Admin, Bonds, and Financial**				**$80,000**
24.0%					**$570,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$2,940,000**

* Bypass pumping was included with this cost estimate, no dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #3.B - OPTION TO LINE WETWELL
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$4,000
2.0	Site Work				$0
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$63,000
11.0	Equipment				$0
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$0
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$20,000
	Total Estimated Construction Cost				**$90,000**
20%	**Planning, Design, and Construction Engineering**				**$20,000**
0.25%	**Geotechnical**				**$0**
0.25%	**Construction Materials Testing**				**$0**
3.5%	**Legal, Admin, Bonds, and Financial**				**$0**
24.0%					**$20,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$110,000**

*No bypass or dewatering costs were included for this estimate. It was assumed that due to the size and cost of this project it would be paired with a second project that required the bypass of the existing wetwell.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #4 - IMPROVE WETWELL ACCESS
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$20,000
2.0	Site Work/Piping				$23,000
3.0	Concrete				$94,000
5.0	Metals				$69,000
9.0	Finishes				$15,000
15.0	HVAC/Piping				$100,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$81,000
	Total Estimated Construction Cost				**$402,000**
20%	**Planning, Design, and Construction Engineering**				**$80,000**
4.0%	**Geotechnical**				**$16,000**
4.0%	**Construction Materials Testing**				**$16,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$16,000**
32.0%					**$128,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$530,000**

* No bypass pumping was included for this estimate, dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #5 - NEW SCREENING AT EXISTING PUMP STATION
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$80,000
2.0	Site Work				$250,000
11.0	Equipment				$900,000
13.0	Special Construction				$10,000
16.0	Electrical				$50,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$330,000
	Total Estimated Construction Cost				**$1,620,000**
20%	**Planning, Design, and Construction Engineering**				**$320,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$60,000**
24.0%					**$380,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$2,000,000**

* Bypass pumping costs were included with this cost estimate. No dewatering costs were included in the estimate as it was assumed that the existing screens would be removed and replaced in existing location.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #6.A - BUILD RETAINING WALL AROUND BUILDING
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$26,000
2.0	Site Work				$380,000
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$0
11.0	Equipment				$0
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$150,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$140,000
	Total Estimated Construction Cost				**$700,000**
20%	**Planning, Design, and Construction Engineering**				**$140,000**
	Flood Plain Design				**$30,000**
0.25%	**Geotechnical**				**$0**
0.25%	**Construction Materials Testing**				**$0**
3.5%	**Legal, Admin, Bonds, and Financial**				**$20,000**
24.0%					**$190,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$890,000**

* No bypass pumping or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #6.B - BUILD RETAINING WALL AROUND SITE AND RAISE ROAD
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$55,000
2.0	Site Work				$880,000
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$0
11.0	Equipment				$0
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$0
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$240,000
	Total Estimated Construction Cost				**$1,180,000**
20%	**Planning, Design, and Construction Engineering**				**$240,000**
	Flood Plain Design				**$30,000**
0.25%	**Geotechnical**				**$3,000**
0.25%	**Construction Materials Testing**				**$3,000**
3.5%	**Legal, Admin, Bonds, and Financial**				**$40,000**
24.0%					**$316,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$1,496,000**

* No bypass pumping or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #6.C - BUILD A BERM AROUND SITE AND RAISE ROAD
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$85,000
2.0	Site Work				$1,350,000
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$0
11.0	Equipment				$0
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$0
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$360,000
	Total Estimated Construction Cost				**$1,800,000**
20%	**Planning, Design, and Construction Engineering**				**$360,000**
	Flood Plain Design				**$35,000**
0.25%	**Geotechnical**				**$4,500**
0.25%	**Construction Materials Testing**				**$4,500**
3.5%	**Legal, Admin, Bonds, and Financial**				**$60,000**
24.0%					**$464,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$2,264,000**

* No bypass pumping or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #6.D - RAISE ROAD
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$23,000
2.0	Site Work				$360,000
7.0	Thermal & Moisture Protection				$0
8.0	Doors & Windows				$0
9.0	Finishes				$0
11.0	Equipment				$0
13.0	Special Construction				$0
14.0	Conveying Systems				$0
15.0	Mechanical				$0
16.0	Electrical				$0
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$100,000
	Total Estimated Construction Cost				**$490,000**
20%	**Planning, Design, and Construction Engineering**				**$100,000**
	Flood Plain Design				**$35,000**
0.25%	**Geotechnical**				**$1,200**
0.25%	**Construction Materials Testing**				**$1,200**
3.5%	**Legal, Admin, Bonds, and Financial**				**$20,000**
24.0%					**$157,400**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$647,400**

* No bypass pumping or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WATER RECLAMATION COLLECTION SYSTEM EVALUATION PROJECT
ITEM #7 - REFURBISH HVAC, DOORS, ROOFING, PAINTING
OPINION OF PROBABLE TOTAL PROJECT COST
HDR PROJECT NO.

	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	INSTALLED COST
Summary					
1.0	General Conditions				$27,000
7.0	Thermal & Moisture Protection				$73,000
8.0	Doors & Windows				$15,000
9.0	Finishes				$135,000
14.0	Conveying Systems				$60,000
15.0	Mechanical				$110,000
16.0	Electrical				$35,000
25%	Construction & Undeveloped Design Detail Contingencies (25%)				$120,000
	Total Estimated Construction Cost				**$580,000**
20%	**Planning, Design, and Construction Engineering**				**$120,000**
4.0%	**Legal, Admin, Bonds, and Financial**				**$20,000**
24.0%					**$140,000**
	OPINION OF PROBABLE TOTAL PROJECT COST				**$720,000**

* No bypass pumping or dewatering costs were included for this estimate.

CITY OF SIOUX FALLS, SOUTH DAKOTA

EAST EQUALIZATION BASIN IMPROVEMENTS PROJECT

OPINION OF PROBABLE TOTAL PROJECT COST

Summary

1.0	General Conditions	$550,000
2.0	Site Work/Excavation	$1,100,000
3.0	Concrete	$4,800,000
11.0	Equipment/Pump Station	$2,000,000
13.0	I&C & Special Construction	$70,000
15.0	Mechanical/Piping/Valves	$490,000
16.0	Electrical	$70,000
25%	**Contruction & Undeveloped Design Detail Contingencies (25%)**	$2,270,000
	Total Estimated Construction Cost	**$11,350,000**
18%	**Planning, Design, and Construction Engineering**	**$2,040,000**
1.0%	**Geotechnical**	**$110,000**
1.0%	**Construction Materials Testing**	**$110,000**
3%	**Legal,Admin, Bonds, and Financial**	**$340,000**
24%		**$2,600,000**
	OPINION OF PROBABLE TOTAL PROJECT COST	**$13,950,000**

* No bypass pumping costs were included for this estimate. Dewatering costs are included in the Site Work/Excavation.

CITY OF SIOUX FALLS, SOUTH DAKOTA
WEST EQUALIZATION BASIN IMPROVEMENTS PROJECT
OPINION OF PROBABLE TOTAL PROJECT COST

Summary

1.0	General Conditions	$550,000
2.0	Site Work/Excavation/Demolition	$2,600,000
3.0	Concrete	$4,800,000
11.0	Equipment/Pump Station	$2,000,000
13.0	I&C & Special Construction	$70,000
15.0	Mechanical/Piping/Valves	$490,000
16.0	Electrical	$70,000
25%	**Contruction & Undeveloped Design Detail Contingencies (25%)**	$2,650,000
	Total Estimated Construction Cost	**$13,230,000**
18%	**Planning, Design, and Construction Engineering**	**$2,380,000**
1.0%	**Geotechnical**	**$130,000**
1.0%	**Construction Materials Testing**	**$130,000**
3%	**Legal,Admin, Bonds, and Financial**	**$400,000**
24%		**$3,040,000**
	OPINION OF PROBABLE TOTAL PROJECT COST	**$16,270,000**

* No bypass pumping costs were included for this estimate. Dewatering costs are included in the Site Work/Excavation.

Appendix G

Soil Boring Report

AMERICAN
ENGINEERING
TESTING, INC.

CONSULTANTS
• ENVIRONMENTAL
• CHEMISTRY
• GEOTECHNICAL
• MATERIALS
• FORENSICS

October7, 2013

Mr. Lance Weatherly
Office of the City Engineer
224 West 9th Street
Sioux Falls, South Dakota

Dear Mr. Weatherly:

Subj: Subsurface Exploration Program
Proposed Outfall Sewer Line Crossings
I-229 South of Big Sioux River &
North Cliff Avenue North of Big Sioux River
Sioux Falls, South Dakota
AET Project No. 32-01169

American Engineering Testing, Inc. (AET) recently completed a subsurface exploration program for you for two areas where new outfall sewer will be installed beneath existing roadways. The purpose of our involvement was to perform drilling and sampling to identify the subsurface soil conditions in the areas where directional borings may be completed. Our work was performed in accordance with our proposals dated July 31 and September 10, 2013 and our current agreement with the City of Sioux Falls.

Our drilling services were performed during the period from September 19 through September 26, 2013. Nine locations were drilled in an area along Interstate 229 to the south of the Big Sioux River and four locations were drilled in an area along North Cliff Avenue to the north of the Big Sioux River. The locations and elevations of the borings were determined by HDR and are shown on the attached drawings furnished by HDR.

The borings ranged in depth from 21 to 46 feet below existing grade and samples were obtained using Standard Penetration Test (SPT) methods. During extension of the borings, soil sampling was performed using a 2" split spoon sampler. As soil samples were obtained during the drilling operations, they were visually and manually classified by the crew chief in accordance with ASTM: D2487 and D2488. Representative portions of the soil samples were returned to the laboratory for further examination and verification of the field classification.

Logs of each boring indicating the depth and identification of various strata, water level information and pertinent information regarding the method of maintaining and advancing the boring were prepared and are attached with this report. The surface elevation furnished for each boring location is shown at the top of the attached boring logs. A number of soil samples were selected for determining the moisture content and the results are shown on the individual boring logs adjacent to the samples upon which they were performed.

The general soil profile in the area of the proposed crossing at I-229 south of the Big Sioux River consisted of a layer of fill at the surface followed by intermixed layers of clay and sand alluvium. Two of the borings (#2 and #5) were obstructed before reaching the planned depth on boulders or bedrock. Cobbles and boulders were encountered at lower depths in a number of the borings.

The general soil profile in the area of the proposed crossing at North Cliff Avenue north of the Big Sioux River consisted of mostly fill followed by intermixed layers of clay and sand alluvium.

We appreciate the opportunity to provide services for you. If you have any questions or require additional information, please feel free to contact our office.

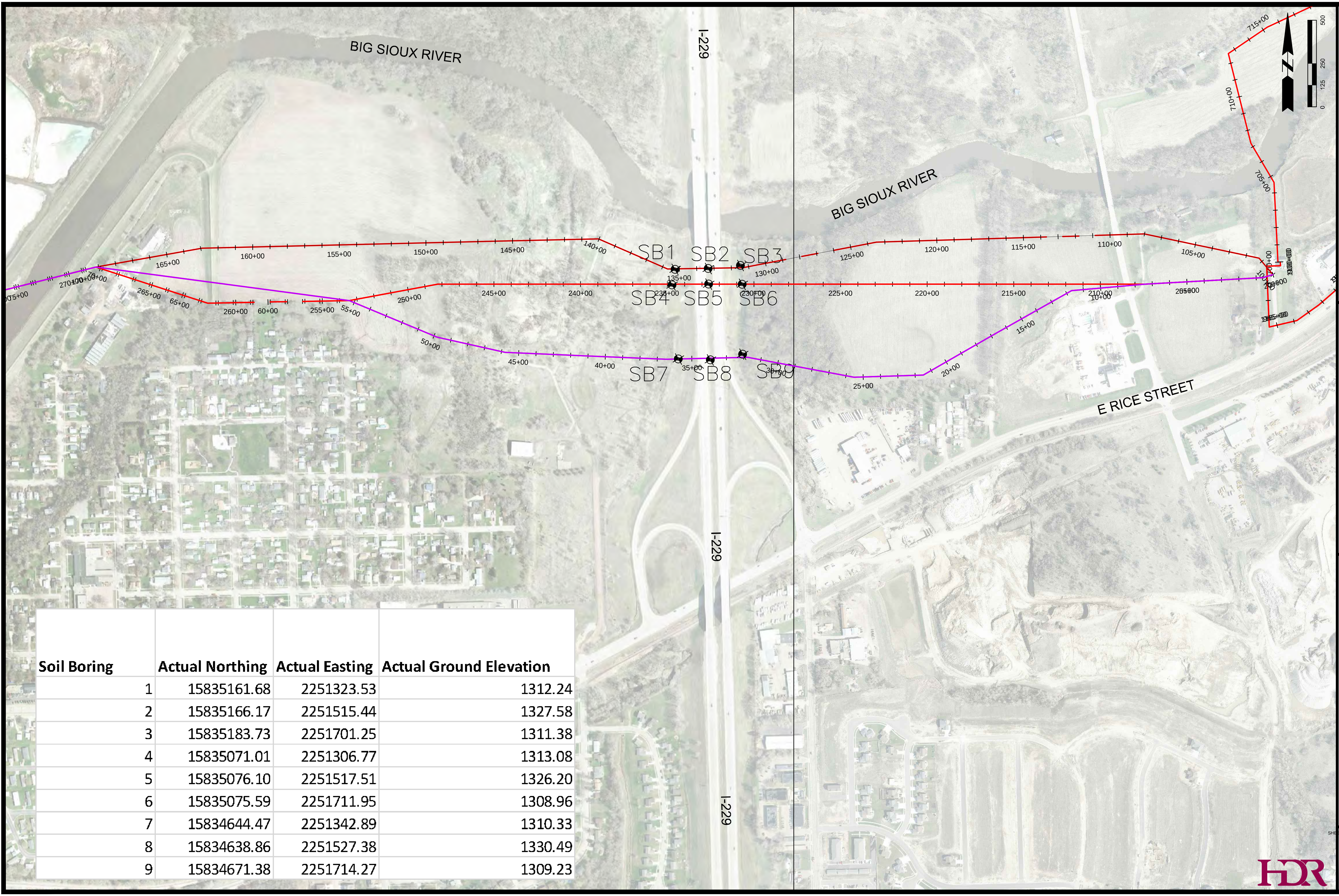
Respectfully submitted,

Bruce W. Card, PE
Office Manager

BWC/bc

Attachments: -Outfall Sewer Alignments with Boring Locations (2) (furnished by HDR)
-Subsurface Boring Logs (13)
-Boring Log Notes
-Unified Soil Classification System

cc: -HDR



Soil Boring	Actual Northing	Actual Easting	Actual Ground Elevation
1	15835161.68	2251323.53	1312.24
2	15835166.17	2251515.44	1327.58
3	15835183.73	2251701.25	1311.38
4	15835071.01	2251306.77	1313.08
5	15835076.10	2251517.51	1326.20
6	15835075.59	2251711.95	1308.96
7	15834644.47	2251342.89	1310.33
8	15834638.86	2251527.38	1330.49
9	15834671.38	2251714.27	1309.23

OUTFALL SEWER ALIGNMENTS

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER ALIGNMENTS

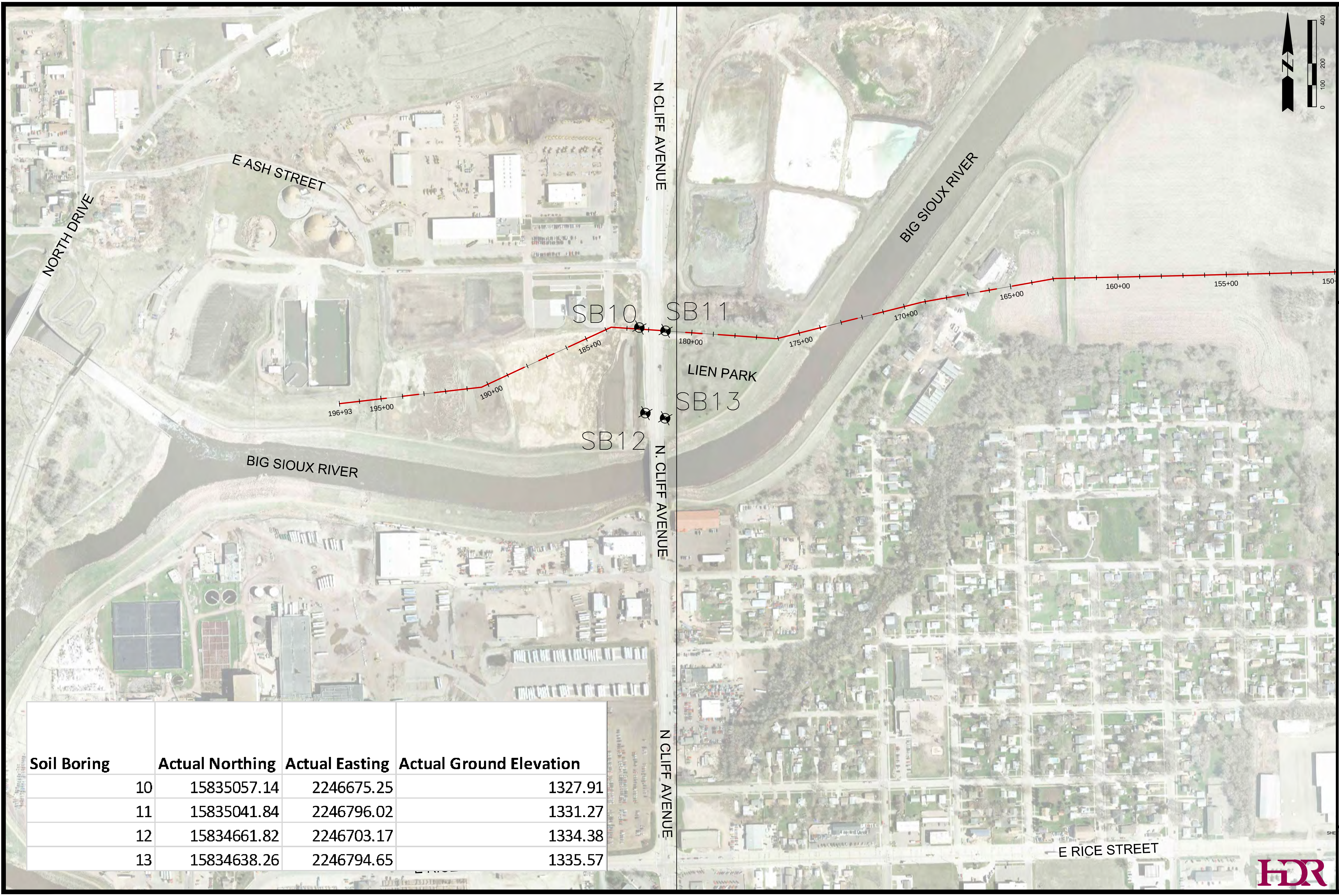
DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 10/4/2013
REVISIONS: BY: DATE:
BY: DATE:

CITY OF SIOUX FALLS
PUBLIC WORKS
Providing a Better Quality of Life for You!

HDR

SHEET NO.
G.3

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 10/4/2013 10:19 AM VanWyhe, NickG



Soil Boring	Actual Northing	Actual Easting	Actual Ground Elevation
10	15835057.14	2246675.25	1327.91
11	15835041.84	2246796.02	1331.27
12	15834661.82	2246703.17	1334.38
13	15834638.26	2246794.65	1335.57

OUTFALL SEWER ALIGNMENTS

SIOUX FALLS, SOUTH DAKOTA

OUTFALL SEWER NORTH

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE
CHECKED BY: D. GRABER
ACAD FILE: OUTFALL SEWER AND FORCEMAIN ALIGNMENTS.DWG
DATE: 10/4/2013
REVISIONS:
BY: DATE:
BY: DATE:

CITY OF SIOUX FALLS
PUBLIC WORKS
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HDR

SHEET NO.
G.4

C:\pwworking\oma\d1154814\Outfall Sewer and Forcemain Alignments.dwg
PLOT DATE: 10/4/2013 10:19 AM VanWyhe, Nic

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169** LOG OF BORING NO. **1 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1312.2'** MATERIAL DESCRIPTION		GEOLOGY	N	MC	SAMPLE TYPE	REC IN	FIELD & LABORATORY TESTS				
								WC	DEN	LL	PL	qu
1 2	FILL, mixture of ORGANIC LEAN CLAY and LEAN CLAY, dark brown and brown, very moist	▩	FILL	6	M	SS	18					
3 4		▩		4	M	SS	18					
5 6		▩		4	M	SS	18					
7 8 9	LEAN CLAY, dark brown, very moist to wet, soft (CL)	▨	FINE ALLUVIUM	4	M	SS	18					
10 11 12		▨		2	▼ M	SS	18	33				
13 14	SAND, fine to medium grained, brown, waterbearing, loose (SP)	░	COARSE ALLUVIUM	7	M	SS	18					
15 16 17 18 19		░		7	M	SS	18					
20 21 22 23 24	SANDY LEAN CLAY, gray, wet to very moist, soft to firm (CL)	▨	MIXED ALLUVIUM	3	M	SS	12	23				
25 26		▨		7	M	SS	16					
	END OF BORING											

DEPTH:	DRILLING METHOD
0-24½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS						
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/23/13	**1:45**	**26'**	**24.5'**	**26'**		**10.5'**

BORING COMPLETED: **9/23/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **2 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

SURFACE ELEVATION: **1327.6'**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	FILL, mixture of ORGANIC SANDY LEAN CLAY, LEAN CLAY and SANDY LEAN CLAY, with a little gravel, brown, dark brown and black, moist to very moist, lenses of sand	FILL	11 9 7 7 15 9	M M M M M M	SS SS SS SS SS SS	18 18 18 18 18 18	19				
16 17 18 19	SAND, fine to medium grained, with a little gravel, brown, moist, medium dense (SP)	COARSE ALLUVIUM	18	M	SS	18					
20 21 22 23 24 25 26 27 28 29	LEAN CLAY, very dark brown, very moist to wet, stiff to soft (CL)	FINE ALLUVIUM	9 4	M M ▼	SS SS	18 18	25				
30 31 32 33 34 35	SAND WITH CLAY, fine to medium grained, with gravel, brown, waterbearing, medium dense, cobbles at 32' and 33.5' (SP-SC)	COARSE ALLUVIUM	22	M	SS	10					
36 37 38	BOULDERS, waterbearing, lenses of sand, very dense, some cobbles	BOULDERS	56	M	SS	12					
	OBSTRUCTION AT 38'										

DEPTH:	DRILLING METHOD
0-38'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/25/13	**10:20**	**31'**	**29.5'**	**31'**		**29'**

BORING COMPLETED: **9/25/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **3 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1311.4'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC LEAN CLAY and LEAN CLAY, dark brown and brown, moist to very moist	FILL	10	M	SS	18					
2											
3			4	M	SS	18					
4											
5			2	M	SS	18	23				
6											
7											
8			2	M	SS	18					
9											
10	SILTY SAND, fine to medium grained, brown, very moist, very loose (SM)	MIXED ALLUVIUM	4	M	SS	18					
11											
12				▼							
13	SAND, fine to medium grained, with gravel, brown, wet to 12.5' then waterbearing, medium dense (SP)	COARSE ALLUVIUM	11	M	SS	12					
14											
15			21	M	SS	14					
16											
17											
18											
19											
20			20	M	SS	10					
21											
22											
23											
24	BOULDERS, waterbearing, lenses of sand, dense, some cobbles	BOULDERS									
25			45	M	SS	8					
26	**END OF BORING**										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS						
0-24½' **3.25" HSA**	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
	9/24/13	**9:35**	**13.5'**	**12'**	**13.5'**		**12.5'**
BORING COMPLETED: **9/24/13**							
DR: **RH** LG: **BL** Rig: **66**							

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **4 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

SURFACE ELEVATION: **1313.1'**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN	WC	DEN	LL	PL	qu
1 2 3 4 5 6 7 8 9	FILL, mixture of ORGANIC LEAN CLAY and LEAN CLAY, dark brown and brown, very moist	FILL	6 4 4 3	M M M M	SS SS SS SS	18 18 16 18					
10 11 12	LEAN CLAY, brown, wet, soft (CL)	FINE ALLUVIUM	2	M ▼	SS	18	28				
13 14	SILTY SAND, fine grained, brown, wet, very loose (SM)	MIXED ALLUVIUM	3	M	SS	18					
15 16 17 18 19 20	SAND, fine to medium grained, with a little gravel, brown, wet to 16.5' then waterbearing, medium dense (SP)	COARSE ALLUVIUM	12	M	SS	18					
21 22 23 24 25 26	SANDY LEAN CLAY, gray, wet to very moist, soft to firm (CL)	MIXED ALLUVIUM	3 8	M M	SS SS	18 12	22				
	END OF BORING										

DEPTH:	DRILLING METHOD
0-24½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/23/13	**1:10**	**26'**	**24.5'**	**26'**		**16.5'**
9/23/13	**1:24**	**26'**	**---**	**13'**		**12'**

BORING COMPLETED: **9/23/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **5 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1326.2'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC SANDY LEAN CLAY and SANDY LEAN CLAY, with a little gravel, brown, dark brown and black, moist to very moist, lenses of clayey sand	FILL	6	M	SS	8					
2											
3			11	M	SS	10					
4											
5			9	M	SS	18					
6											
7											
8			14	M	SS	18					
9											
10			8	M	SS	16	20				
11											
12											
13			9	M	SS	12					
14											
15			13	M	SS	12					
16	LEAN CLAY, very dark brown, moist to very moist, stiff to firm (CL)	FINE ALLUVIUM									
17											
18											
19											
20			6	M	SS	18	29				
21											
22											
23											
24											
25	SAND, fine to medium grained, with a little gravel, brown, wet to 28' then waterbearing, medium dense, cobbles at 32' and 33.5' (SP)	COARSE ALLUVIUM	11	M	SS	18					
26											
27											
28				▼							
29											
30			21	M	SS	18					
31											
32											
33											
34											
35	SILTY SAND, fine to medium grained, dark brown, waterbearing, medium dense, some cobbles (SM)	MIXED ALLUVIUM	15	M	SS	18					
36											
37											
38											
	OBSTRUCTION AT 38.5'										

DEPTH:	DRILLING METHOD
0-38.5'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/25/13						**28'**

BORING COMPLETED: **9/25/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169** LOG OF BORING NO. **6 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1309.0'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1 2	FILL, mixture of ORGANIC CLAYEY SAND, LEAN CLAY and SANDY LEAN CLAY, with a little gravel, dark brown, brown and black, moist to very moist to wet	FILL	7	M	SS	18					
3 4			16	M	SS	18					
5 6 7			7	M	SS	12					
8 9			3	M	SS	10	29				
10 11 12			3	M ▼	SS	16					
13			2	M	SS	18					
14 15	SAND, fine to medium grained, brown, waterbearing (SP)	COARSE ALLUVIUM									
16 17 18 19	LEAN CLAY, grayish brown, very moist, firm (CL)	FINE ALLUVIUM	5	M	SS	18					
20			6	M	SS	14					
21	**END OF BORING**										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-19½'	**3.25" HSA**	**9/24/13**	**11:00**	**13.5'**	**12'**	**13.5'**		**12'**

WATER LEVEL MEASUREMENTS

BORING COMPLETED: **9/24/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **7 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1310.3'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC LEAN CLAY, LEAN CLAY and SANDY LEAN CLAY, with a little gravel, dark brown, brown and black, very moist to wet, tree roots from 12'-14'	FILL	5	M	SS	16					
2											
3			5	M	SS	12					
4											
5			8	M	SS	12					
6											
7											
8			2	M	SS	12	28				
9				▼							
10			2	M	SS	8					
11											
12											
13			6	M	SS	2					
14											
15	SAND, fine to medium grained, gray, waterbearing, loose (SP)	COARSE ALLUVIUM	5	M	SS	12					
16											
17											
18											
19	SANDY LEAN CLAY, gray, very moist, firm (CL)	MIXED ALLUVIUM									
20			7	M	SS	18					
21	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-19½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/23/13	**10:41**	**21'**	**19.5'**	**21'**		**9.1'**

BORING COMPLETED: **9/23/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **8 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

SURFACE ELEVATION: **1330.5'**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC SANDY LEAN CLAY, LEAN CLAY and SANDY LEAN CLAY, with a little gravel, dark brown, brown, black and gray, moist to very moist to wet, lenses of sand	FILL	7	M	SS	18					
2											
3			18	M	SS	18					
4											
5			7	M	SS	18					
6											
7											
8			7	M	SS	14					
9				▼							
10			3	M	SS	18	20				
11											
12											
13			13	M	SS	12					
14											
15			14	M	SS	18					
16											
17											
18											
19											
20	LEAN CLAY, dark brown, moist to very moist, very stiff to firm (CL)	FINE ALLUVIUM	21	M	SS	12					
21											
22											
23											
24											
25			8	M	SS	14					
26											
27											
28											
29											
30	SANDY LEAN CLAY, dark brown, very moist, soft (CL)	MIXED ALLUVIUM	3	M	SS	18	26				
31											
32											
33											
34	SAND, fine to medium grained, with gravel, waterbearing, loose (SP)	COARSE ALLUVIUM									
35			9	M	SS	18					
36											
37											
38											
39	SILTY SAND, very fine grained, dark brown, waterbearing, loose to medium dense (SM)	MIXED ALLUVIUM									
40			10	M	SS	18					
41											
42											
43											
44											
45			16	M	SS	18					
46	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-44½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/26/13	**9:50**	**11'**	**9.5'**	**11'**		**9.5'**
9/26/13	**10:30**	**36'**	**34.5'**	**36'**		**33'**

BORING COMPLETED: **9/26/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **9 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

SURFACE ELEVATION: **1309.6'**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC LEAN CLAY and LEAN CLAY, dark brown and black, very moist to wet	FILL	4	M	SS	18					
2											
3			5	M	SS	18					
4											
5			2	M	SS	18					
6											
7											
8			2	M	SS	18	35				
9											
10			2	▼ M	SS	18					
11											
12											
13	CLAYEY SAND, fine to medium grained, dark gray, waterbearing, very loose (SC)	MIXED ALLUVIUM	4	M	SS	18					
14											
15	SAND, fine to medium grained, gray, waterbearing, very loose to loose to medium dense, cobbles from 17'-18.5' (SP)	COARSE ALLUVIUM	6	M	SS	18					
16											
17											
18											
19											
20			12	M	SS	18					
21	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-19½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/24/13	**2:05**	**21'**	**19.5'**	**21'**		**10'**

BORING COMPLETED: **9/24/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **10 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1327.9'** MATERIAL DESCRIPTION		GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC LEAN CLAY, SANDY LEAN CLAY and LEAN CLAY, with a little gravel, brown, dark brown, light gray and black, moist to very moist to wet, lenses of silty clay, cobbles	▨	FILL	10	M	SS	12					
2												
3				6	M	SS	14					
4												
5				7	M	SS	18					
6												
7												
8				8	M	SS	18					
9												
10				3	M	SS	16	23				
11												
12												
13				4	M	SS	18					
14												
15				4	M	SS	18					
16												
17												
18				7	M	SS	16					
19												
20				7	M	SS	18					
21												
22												
23												
24												
25				4	M	SS	18					
26	**END OF BORING**											

DEPTH:	DRILLING METHOD
0-24½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/19/13	**11:59**	**26'**	**24.5'**	**26'**		**None**

BORING COMPLETED: **9/19/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **11 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

SURFACE ELEVATION: **1331.3'**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC LEAN CLAY, LEAN CLAY and SANDY LEAN CLAY, with a little gravel, dark brown, brown, black and gray, very moist to moist	FILL	4	M	SS	13					
2											
3			12	M	SS	18					
4											
5			7	M	SS	18					
6											
7											
8			17	M	SS	18					
9											
10			9	M	SS	18					
11											
12											
13			7	M	SS	18	16				
14											
15			9	M	SS	18					
16											
17											
18											
19											
20			10	M	SS	18					
21											
22											
23											
24											
25	LEAN CLAY, black, moist, firm, laminations of sand (CL)	TOPSOIL	8	M	SS	18					
26	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-24½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/20/13	9:26	26'	24.5'	26'		None

BORING COMPLETED: **9/20/13**

DR: **RH** LG: **BL** Rig: **66**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **12 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1334.4'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC SANDY LEAN CLAY and SANDY LEAN CLAY, with a little gravel, brown and dark brown, moist to very moist	FILL	10	M	SS	17					
2											
3			6	M	SS	18					
4											
5			5	M	SS	18					
6											
7											
8			6	M	SS	18					
9											
10			3	M	SS	18	19				
11											
12											
13			7	M	SS	18					
14											
15			7	M	SS	18					
16											
17	SANDY LEAN CLAY, very dark brown, moist to very moist, stiff to firm (CL)	MIXED ALLUVIUM									
18			13	M	SS	18					
19											
20			5	M	SS	18	22				
21											
22											
23											
24											
25			8	M	SS	16					
26											
27											
28	SILTY SAND, fine grained, brown, wet, loose (SM)										
29											
30			7	M	SS	18					
31	**END OF BORING**										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-29½'	**3.25" HSA**	**9/19/13**	**2:25**	**31'**	**29.5'**	**31'**		**None**
		9/19/13	**1:41**	**31'**	**---**	**25'**		**None**
BORING COMPLETED: **9/19/13**								
DR: **RH** LG: **BL** Rig: **66**								

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01169**

LOG OF BORING NO. **13 (p. 1 of 1)**

PROJECT: **Outfall Sewer Line, North Cliff Avenue to Rice Street Exit; Sioux Falls, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: **1335.6'** MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	qu
1	FILL, mixture of ORGANIC SANDY LEAN CLAY, SANDY LEAN CLAY and LEAN CLAY, with a little gravel, dark brown and brown, moist to very moist to wet, a 6" layer of clayey sand at 12.5'	FILL	10	M	SS	18					
2											
3			10	M	SS	18					
4											
5			2	M	SS	17					
6											
7											
8			3	M	SS	18	17				
9											
10			9	M	SS	18					
11											
12											
13			19	M	SS	17					
14											
15			10	M	SS	18					
16											
17											
18											
19											
20			7	M	SS	17	19				
21											
22											
23											
24											
25			8	M	SS	6					
26	LEAN CLAY, very dark brown, moist, stiff (CL)	FINE ALLUVIUM	10	M	SS	12					
27											
28											
29	CLAYEY SAND, fine grained, very dark brown, very moist, loose (SC)	MIXED ALLUVIUM									
30			7	M	SS	18					
31											

END OF BORING

DEPTH:	DRILLING METHOD
0-29½'	**3.25" HSA**

BORING COMPLETED: **9/19/13**

DR: **RH** LG: **BL** Rig: **66**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
9/19/13	**3:39**	**31'**	**29.5'**	**31'**		**None**
9/19/13	**3:52**	**31'**	**---**	**25'**		**None**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nomial diameter in inches
CC:	Crew Chief
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight Auger; number indicates outside diameter in inches
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In california-spoon, split-spoon (see notes) and thin-walled tube sample, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run.) Zero indicates no sample recovered.
REV:	Revert drilling fluid
2L:	California-spoon sampler (stee; 2" inside diameter with 4" long brass liners; 3" outside diameter)
SS:	Standard split-spoon sample (steel; 1⅜" inside diameter; 2" outside diameter); unless indicated otherwise
SU:	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density; pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeablility (K) test; F- Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in precent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve Analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field) psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of the sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the intial 6" set (unless partial penentration defined in ASTM:D1586 is encountered) whereas the length of sample recoveres is for the entire sampler driver (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests^{A}				Soil Classification	
				Group Symbol	Group Name^{B}
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines^{C}	$Cu \geq 4$ and $1 \leq Cc \leq 3^{E}$	GW	Well graded gravel^{F}
			$Cu < 4$ and/or $1 > Cc > 3^{E}$	GP	Poorly graded gravel^{F}
		Gravels with Fines more than 12% fines ^{C}	Fines classify as ML or MH	GM	Silty gravel^{F,G,H}
			Fines classify as CL or CH	GC	Clayey gravel^{F,G,H}
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines^{D}	$Cu \geq 6$ and $1 \leq Cc \leq 3^{E}$	SW	Well-graded sand^{I}
			$Cu < 6$ and $1 > Cc > 3^{E}$	SP	Poorly-graded sand^{I}
		Sands with Fines more than 12% fines ^{D}	Fines classify as ML or MH	SM	Silty sand^{G,H,I}
			Fines classify as CL or CH	SC	Clayey sand^{G,H,I}
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line^{J}	CL	Lean clay^{K,L,M}
			PI<4 or plots below "A" line^{J}	ML	Silt^{K,L,M}
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay^{K,L,M,N} Organic silt^{K,L,M,O}
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay^{K,L,M}
			PI plots below "A" line	MH	Elastic silt$_{K,L,M}$
		organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay^{K,L,M,P} Organic silt^{K,L,M,Q}
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat^{R}

Notes

[A] Based on the material passing the 3-in (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60} / D_{10,}$ $\quad Cc = (D_{30})^2 / D_{10} \times D_{60}$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot is hatched area, soils is a CL-ML silty clay.

[K] If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.

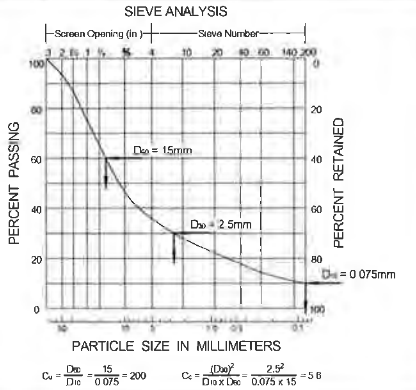
[N] PI≥4 and plots on or above "A" line.

[O] PI<4 or plots below "A" line.

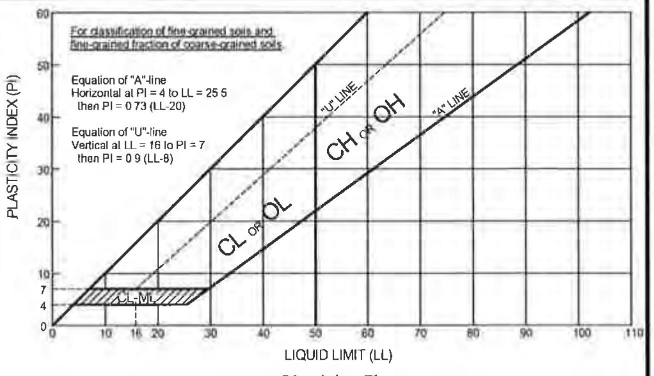
[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

[R] Fiber Content description shown below.



$$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{2.5^2}{0.075 \times 15} = 5.6$$



Plasticity Chart

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition

	(MC Column)
D (Dry):	Absence of moisture, dusty, dry to touch.
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
F (Frozen):	Soil frozen

Layering Notes

Laminations:	Layers less than ½" thick of differing material or color.
Lenses:	Pockets or layers greater than ½" thick of differing material or color.

Fiber Content of Peat

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

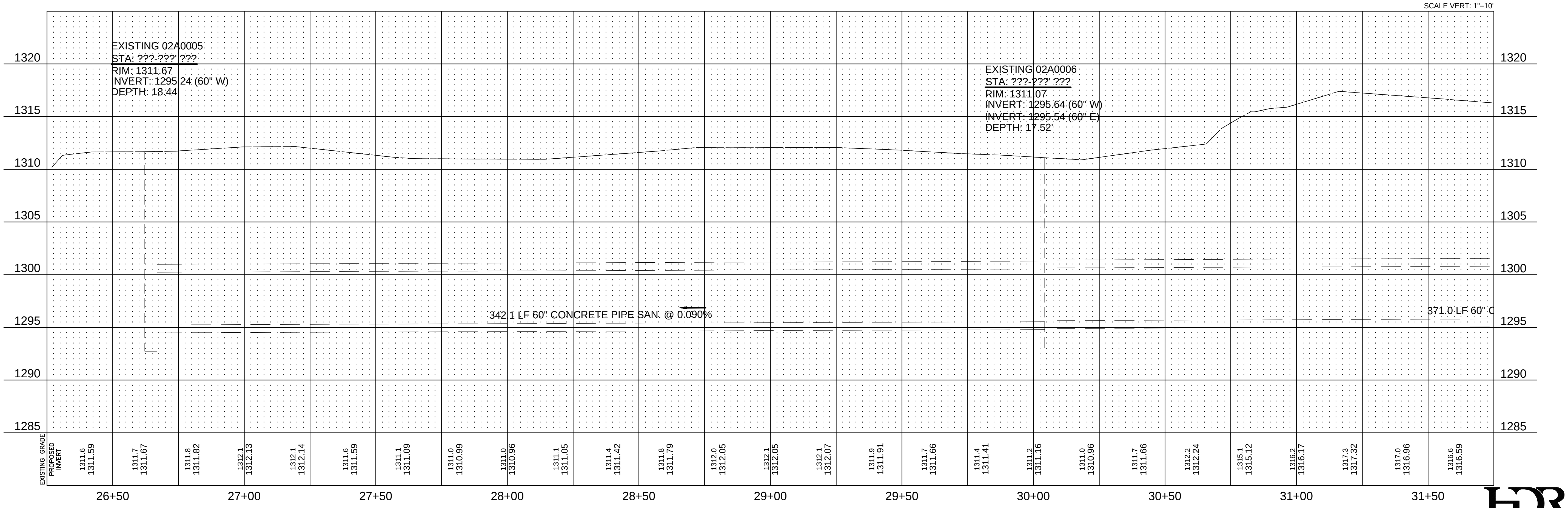
Organic/Roots Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. *Slightly organic* used for borderline cases.

With roots:	Judged to have sufficient quantity of roots to influence the soil properties.
Trace roots:	Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

Appendix H

Outfall Sewer – Existing Cross Sections near I-229



WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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SHEET NO.
H.1

HDR

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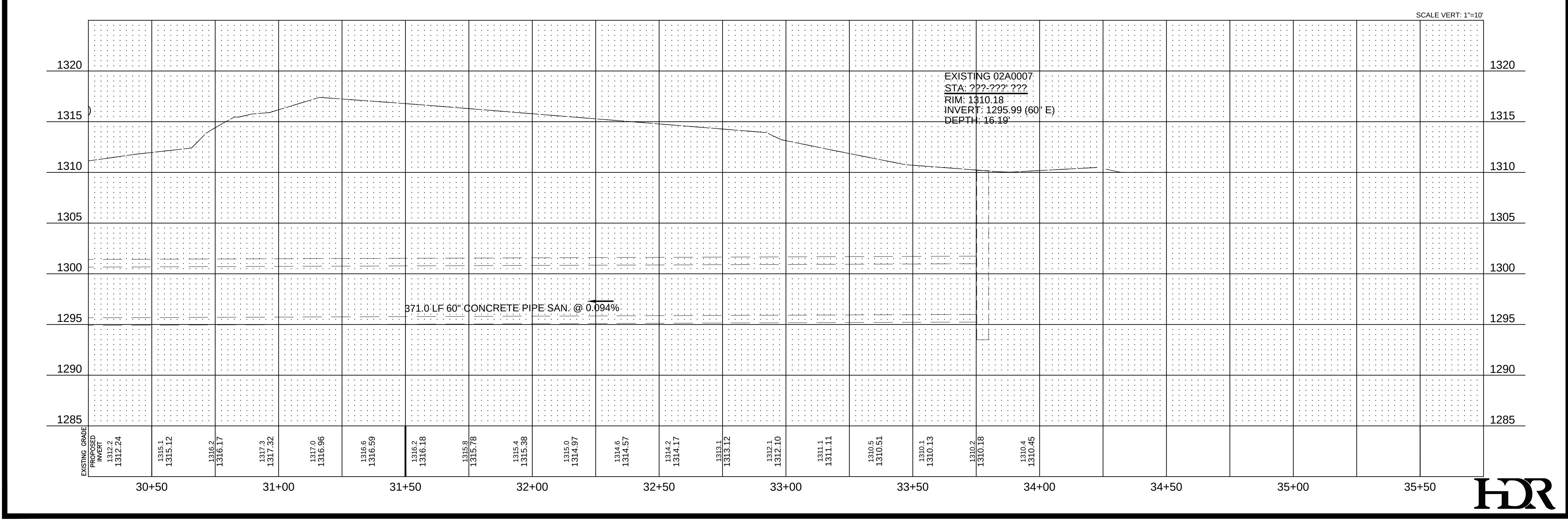

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL-EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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H.2

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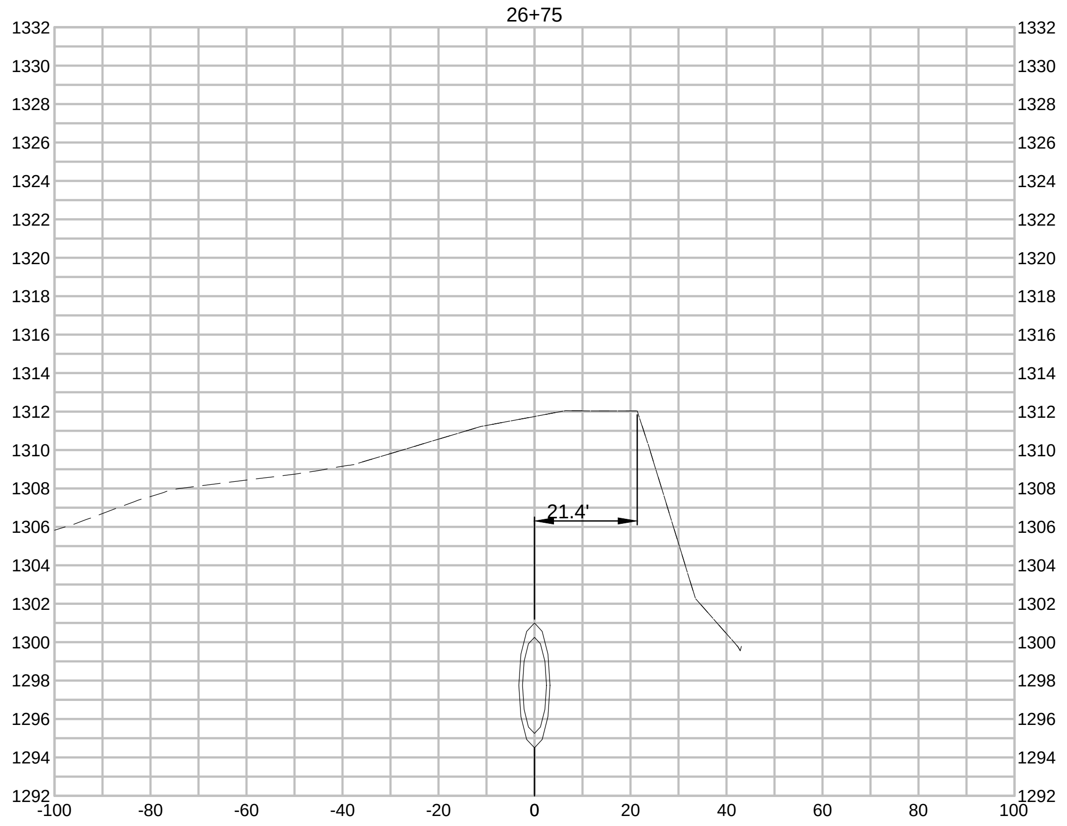

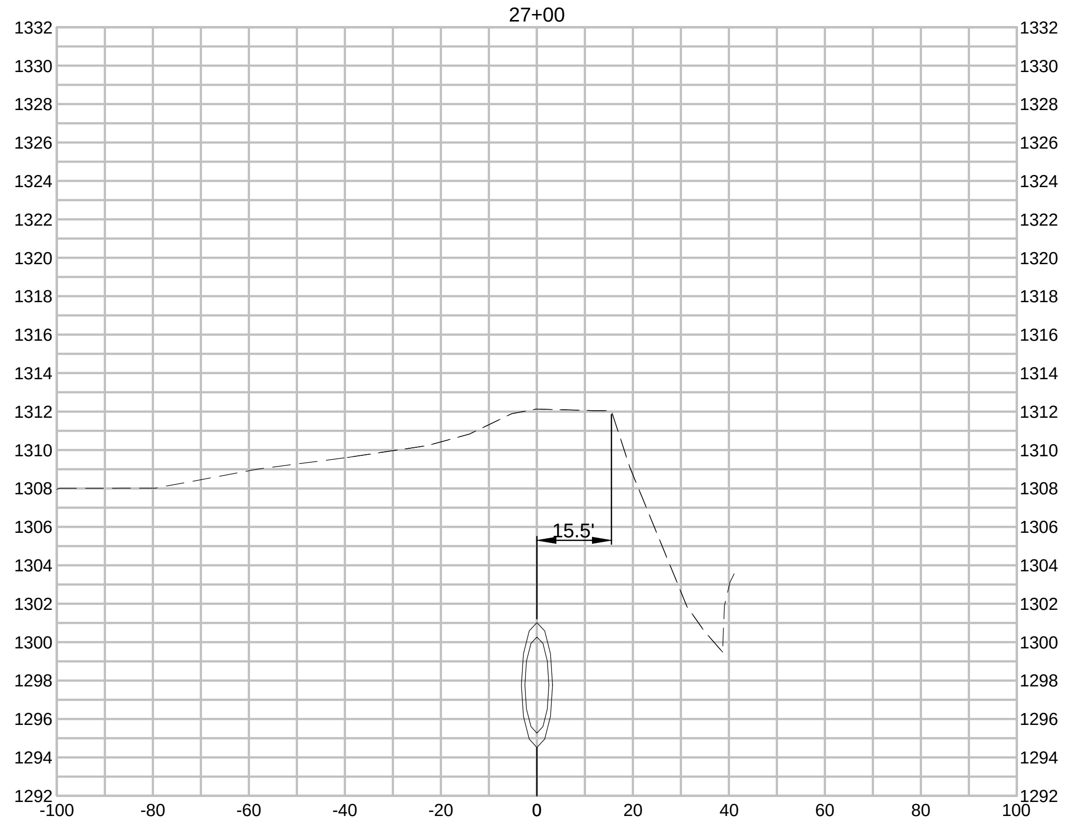

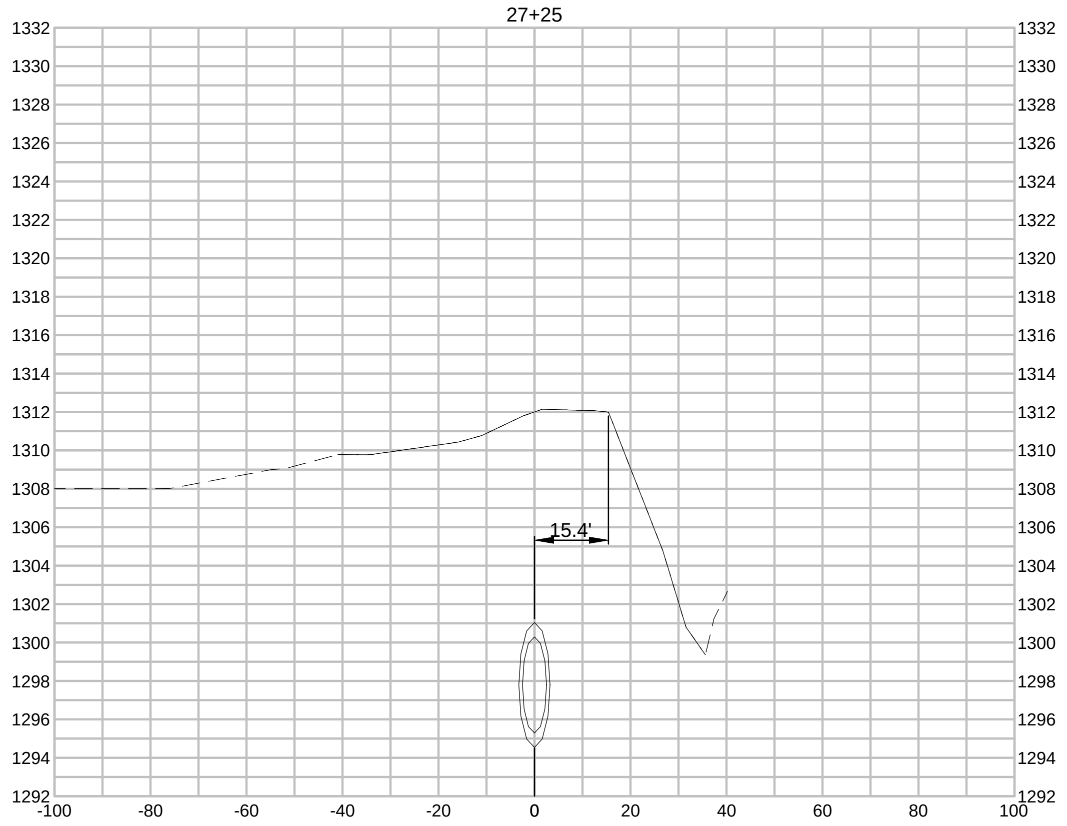

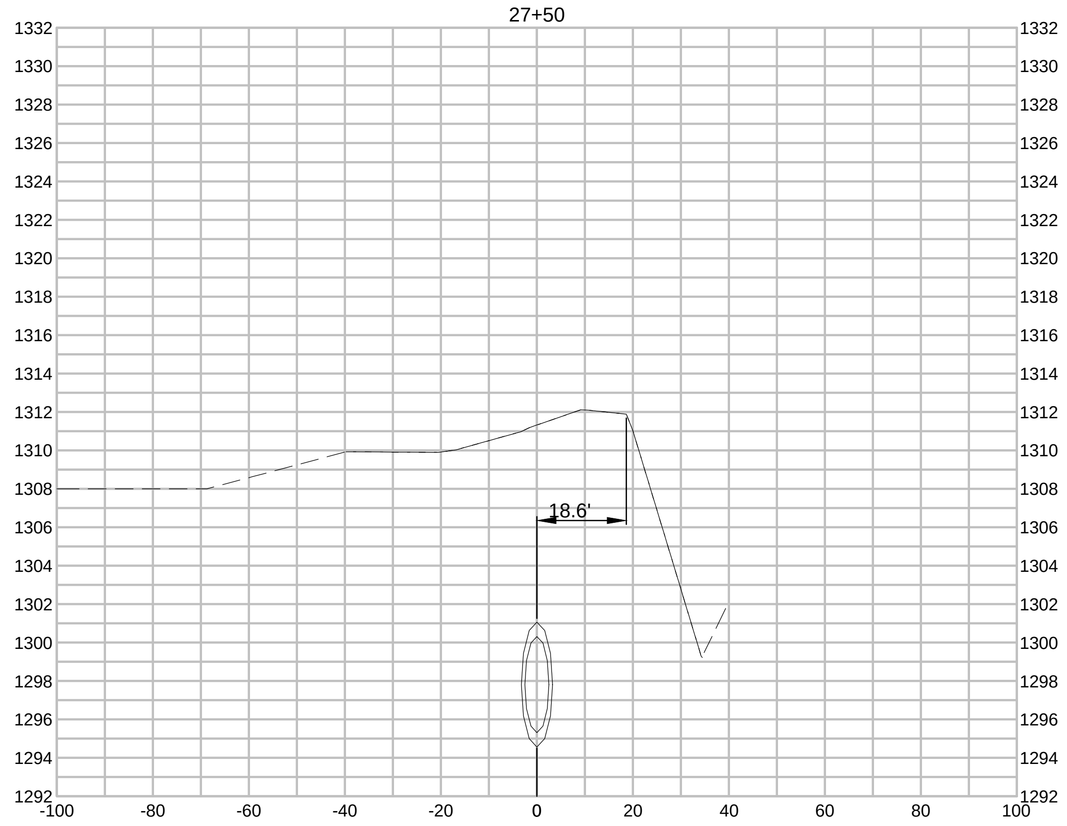

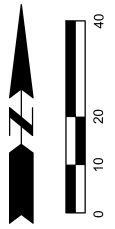

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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SHEET NO.
H.3

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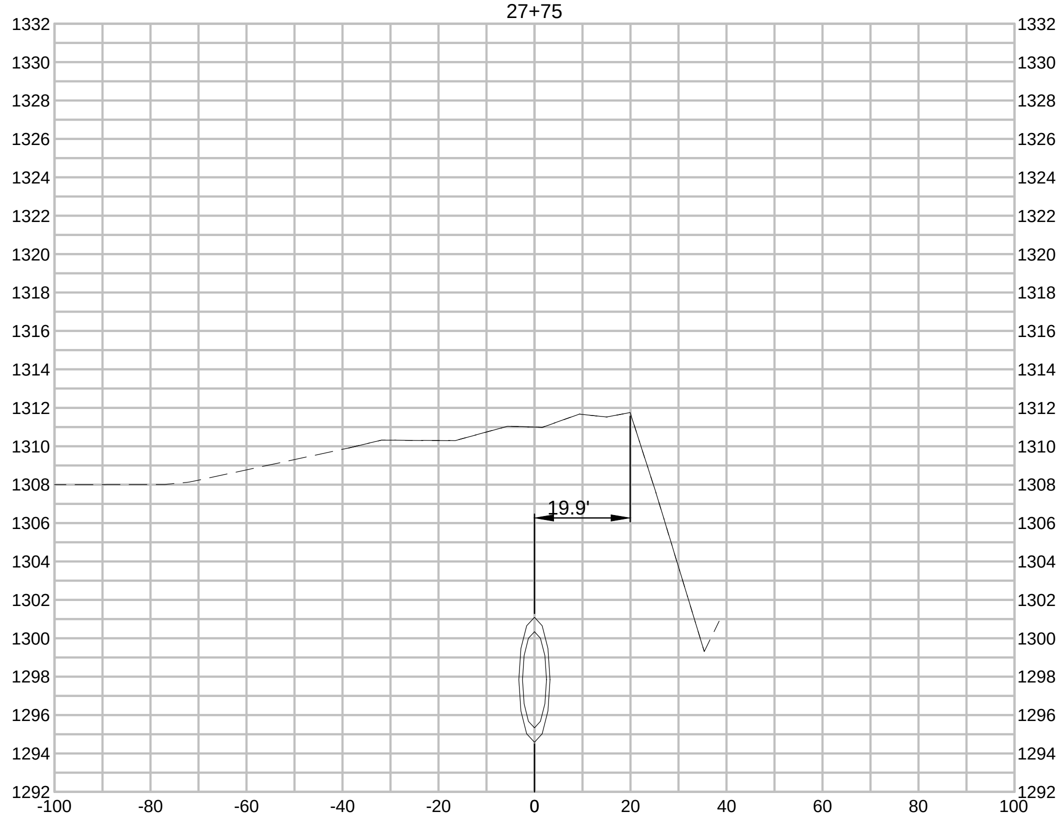
27+75



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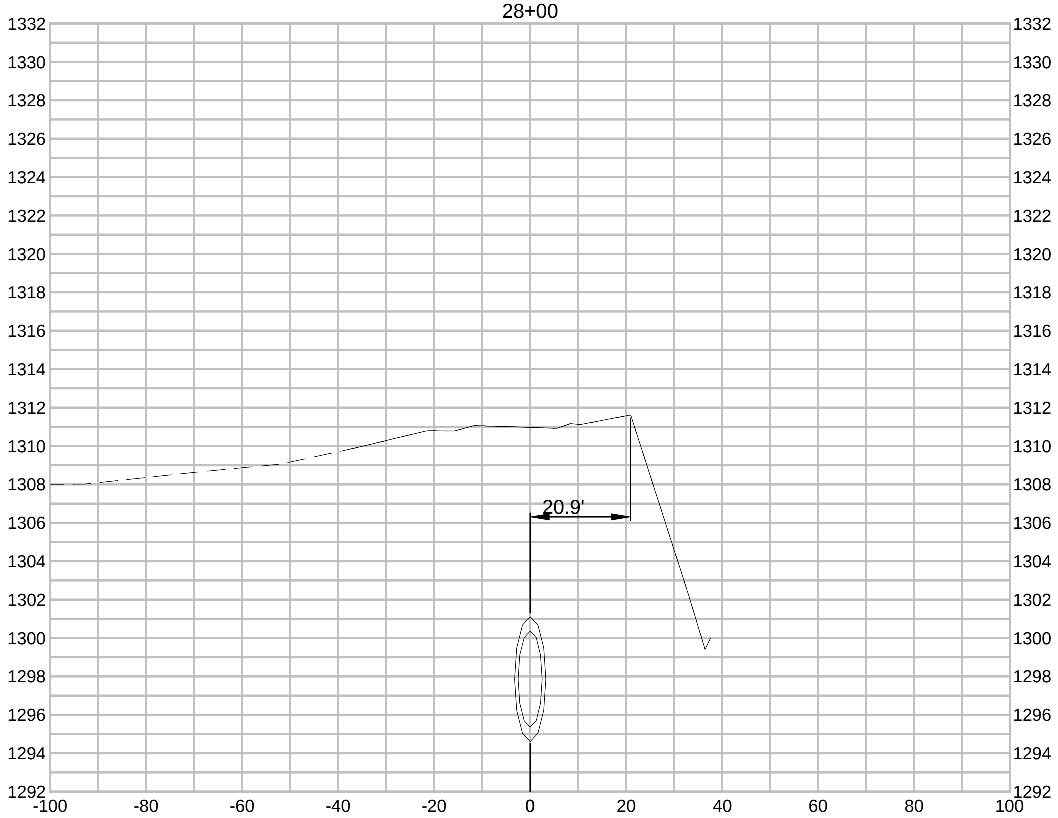

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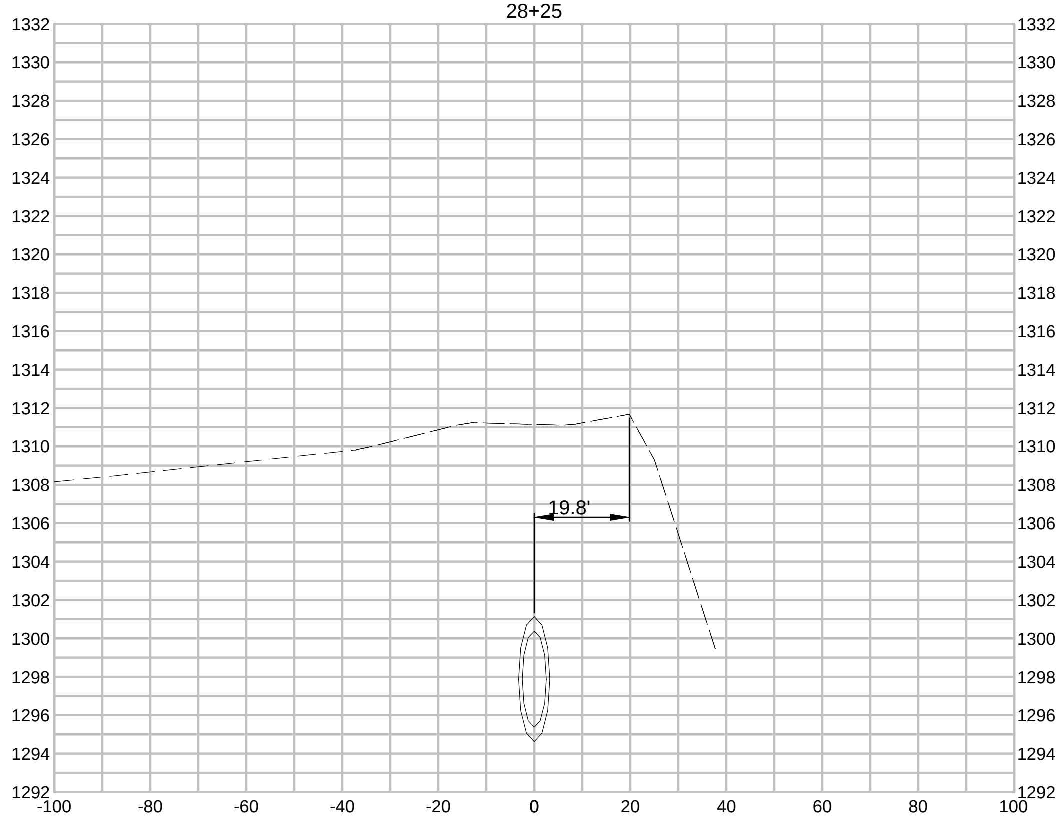

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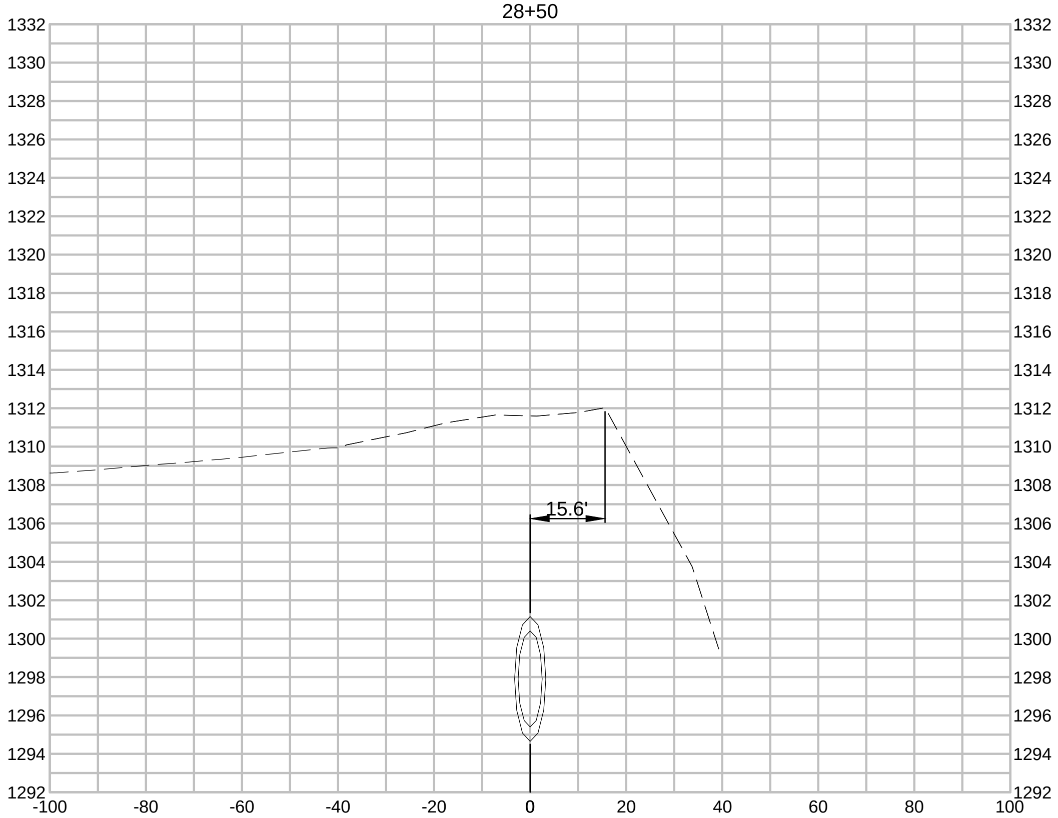

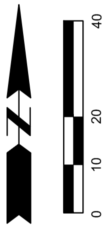

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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H.4

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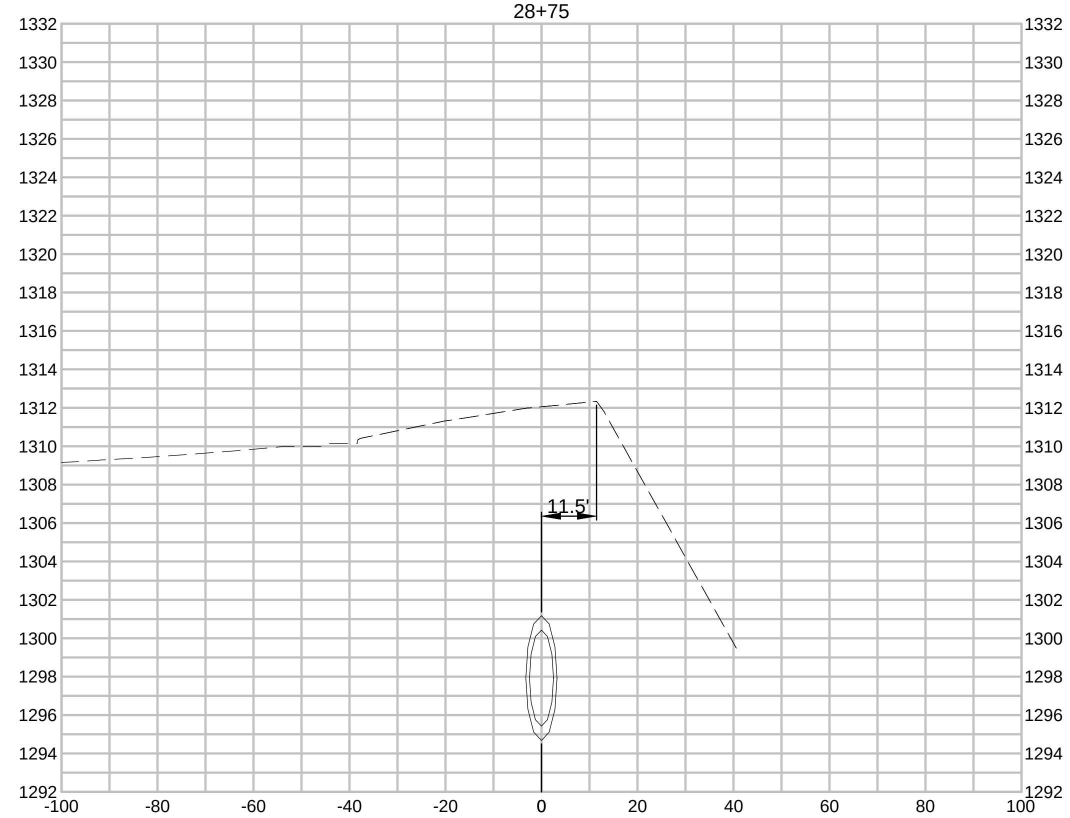

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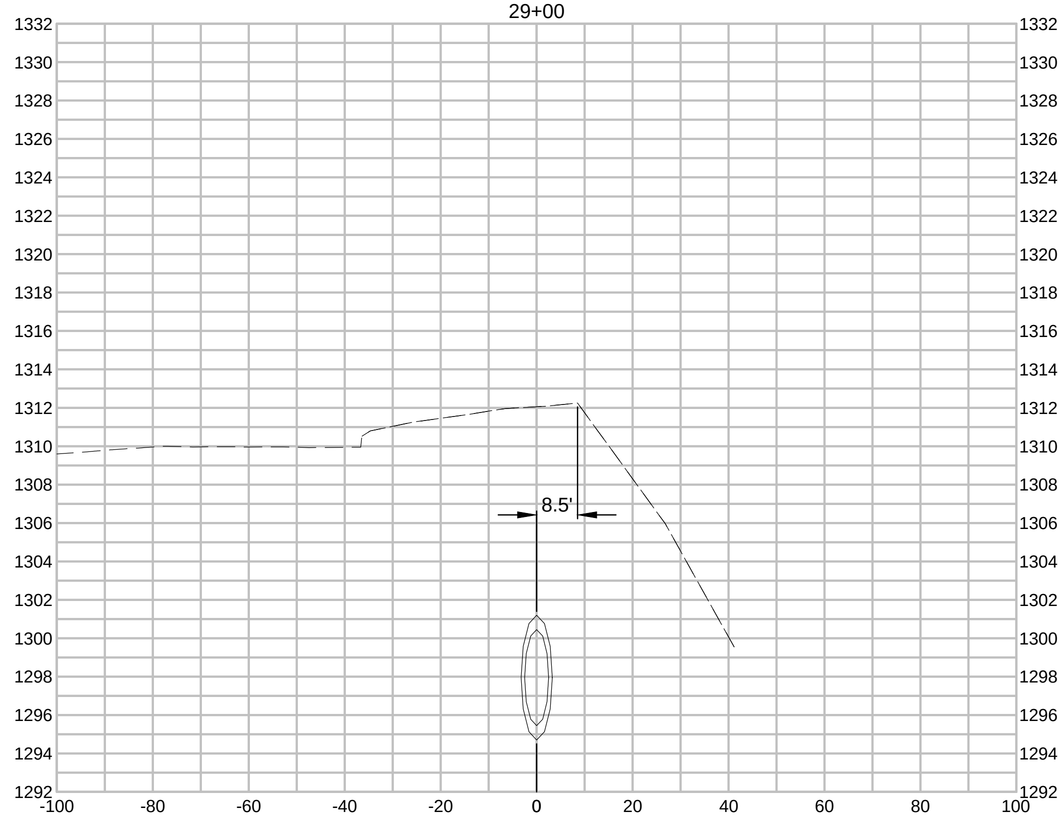

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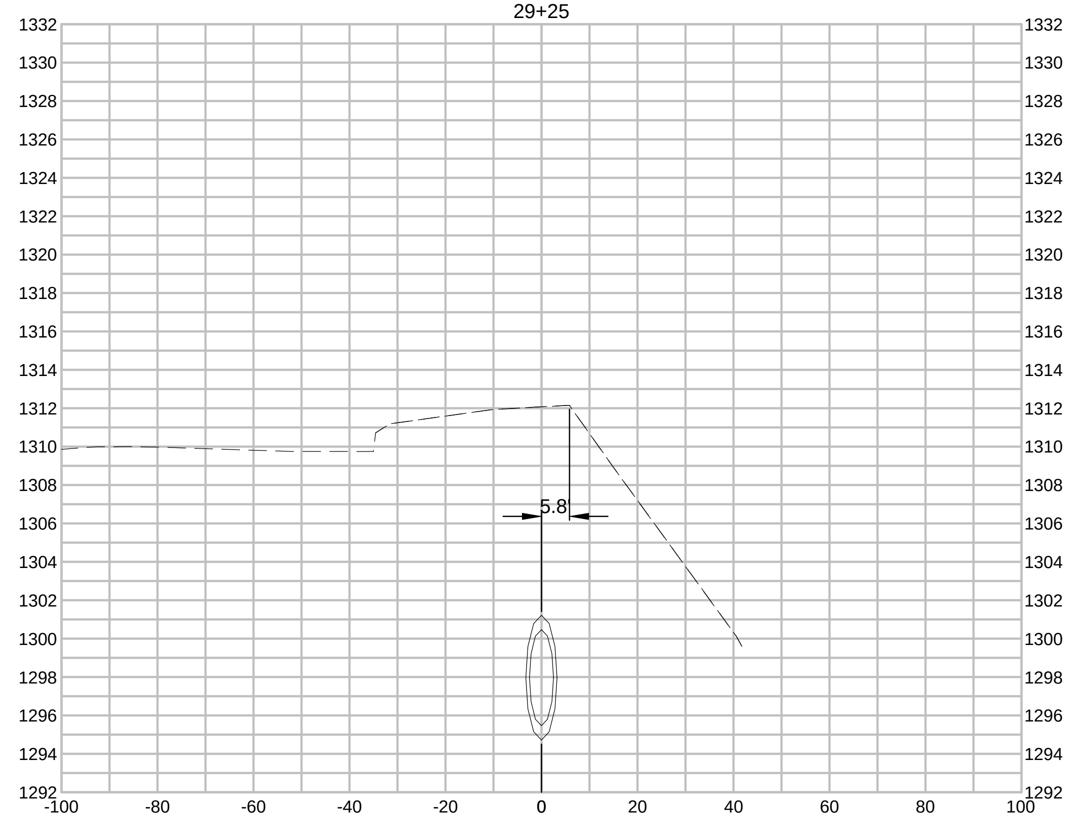

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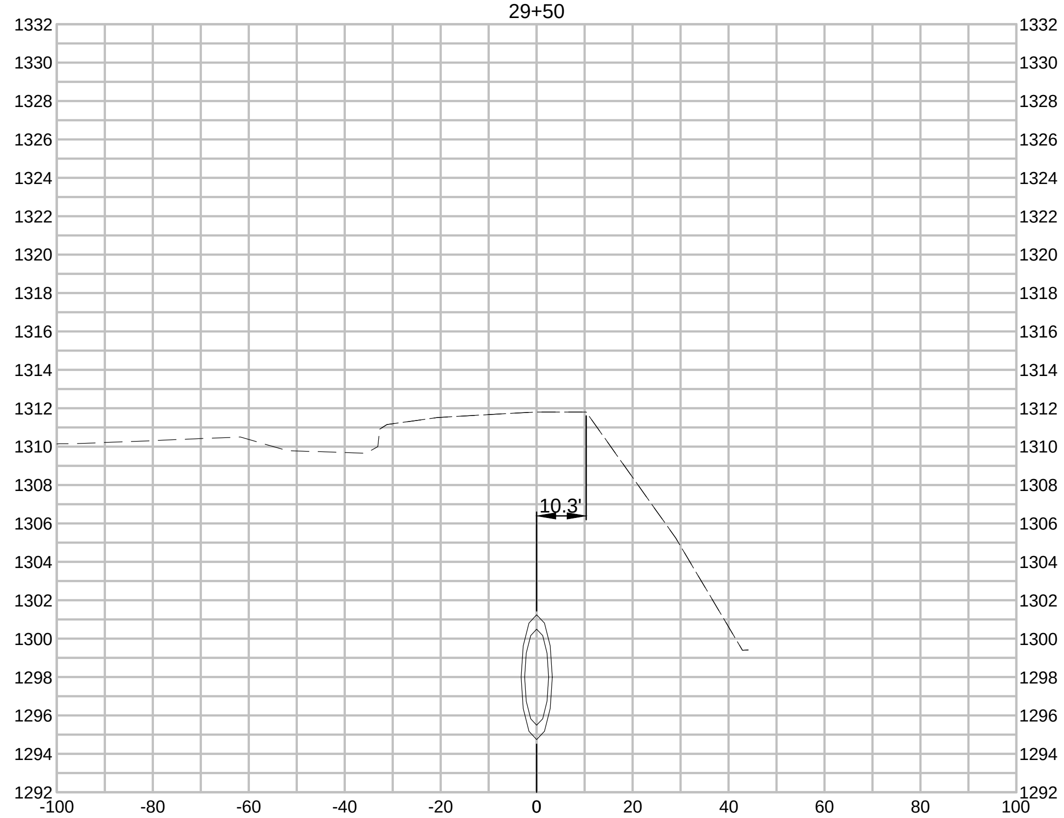

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WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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H.5

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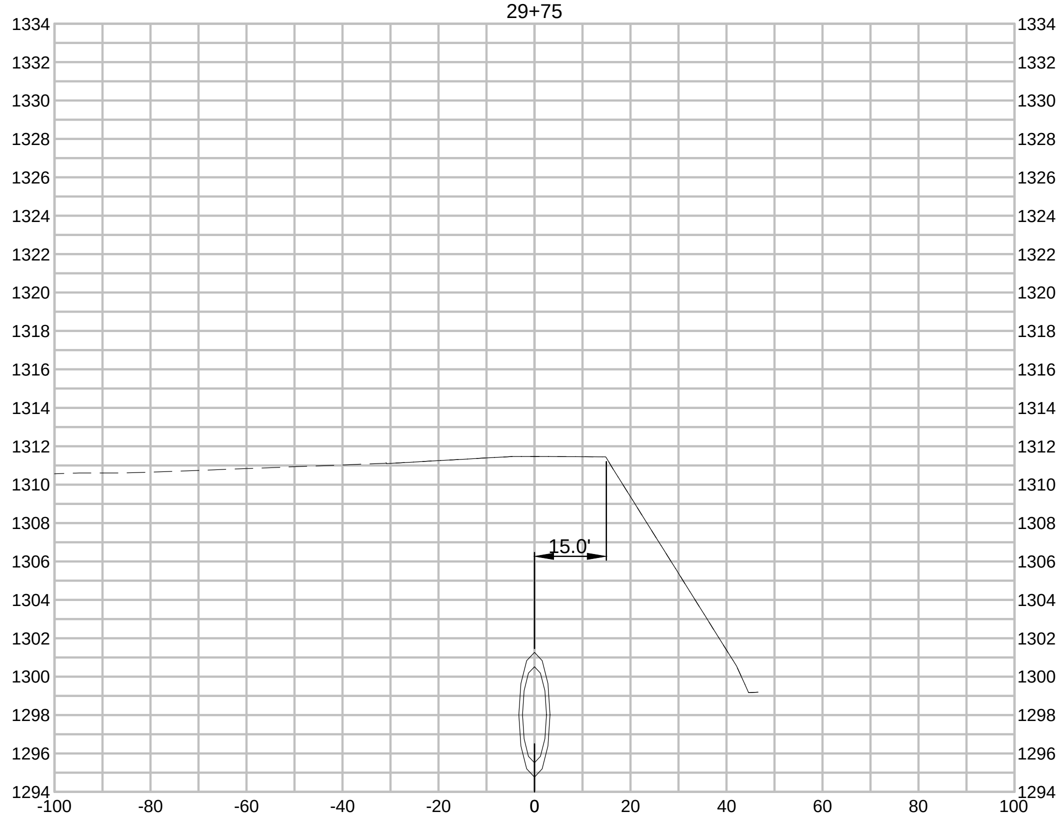
29+75



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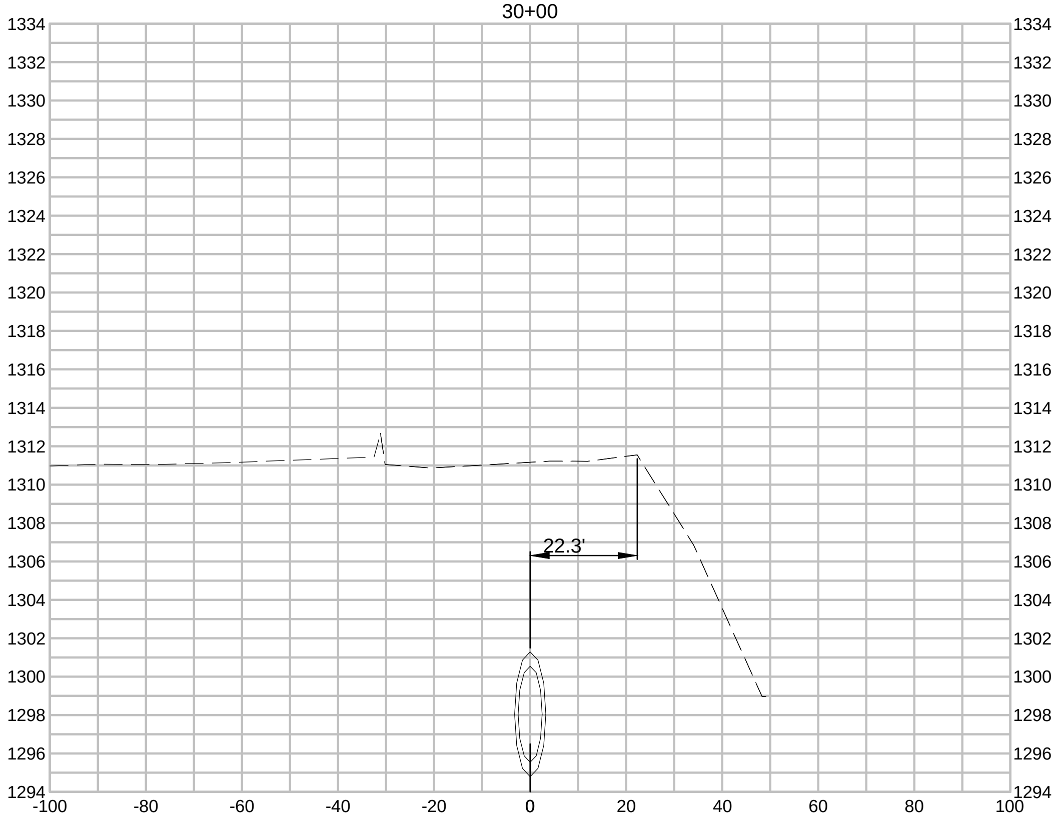

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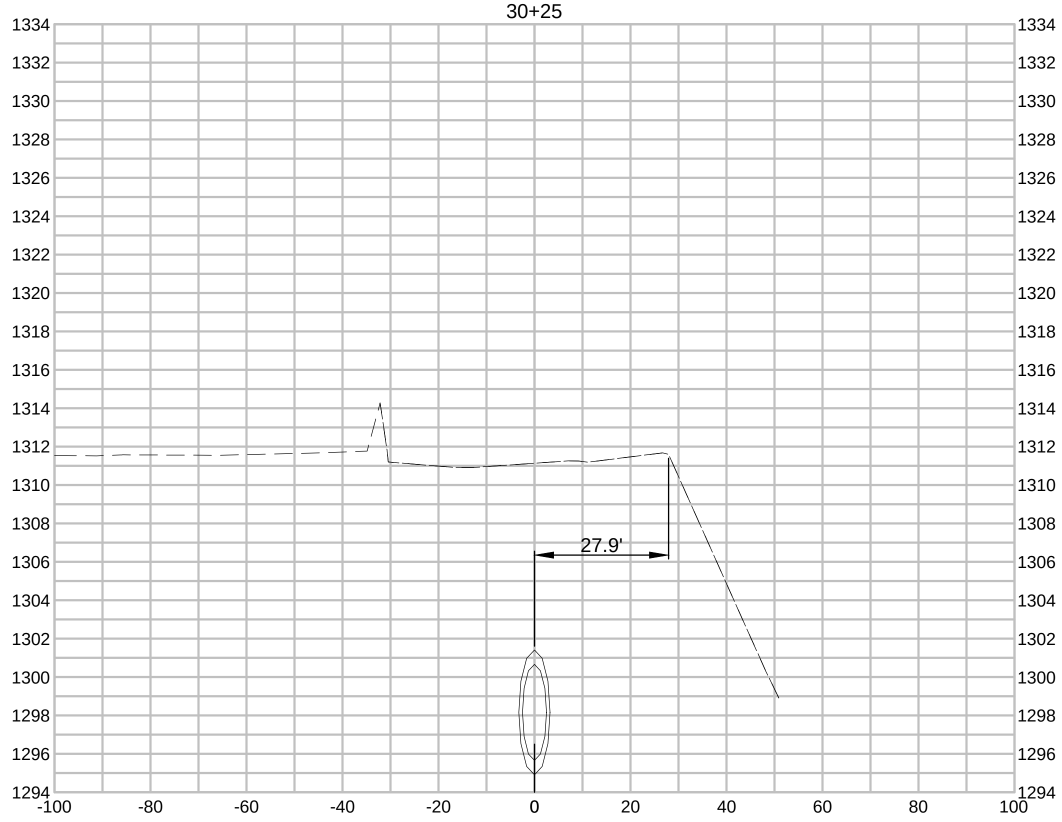

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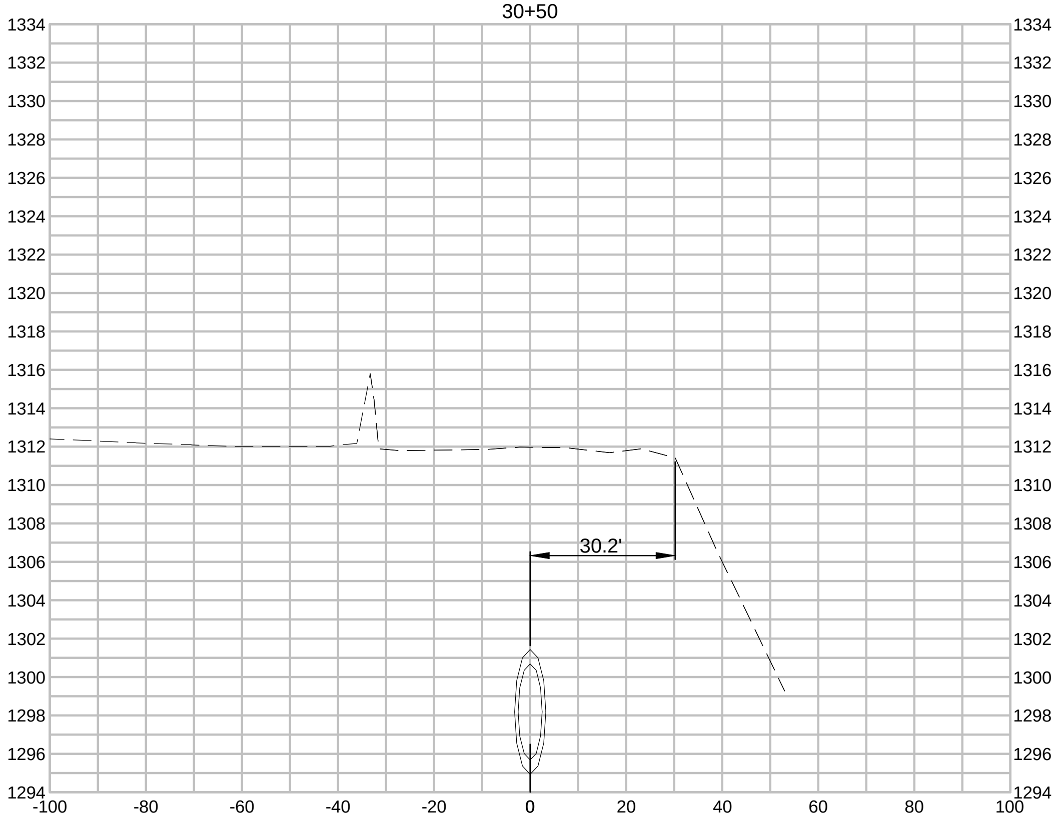

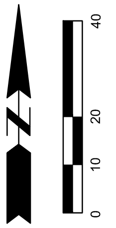

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
DRAWN BY: N. VAN WYHE ACAD FILE: OUTFALL SEWER CROSS SECTIONS.DWG
CHECKED BY: D. GRABER DATE: 6/16/2014
REVISIONS: BY: DATE:
BY: DATE:

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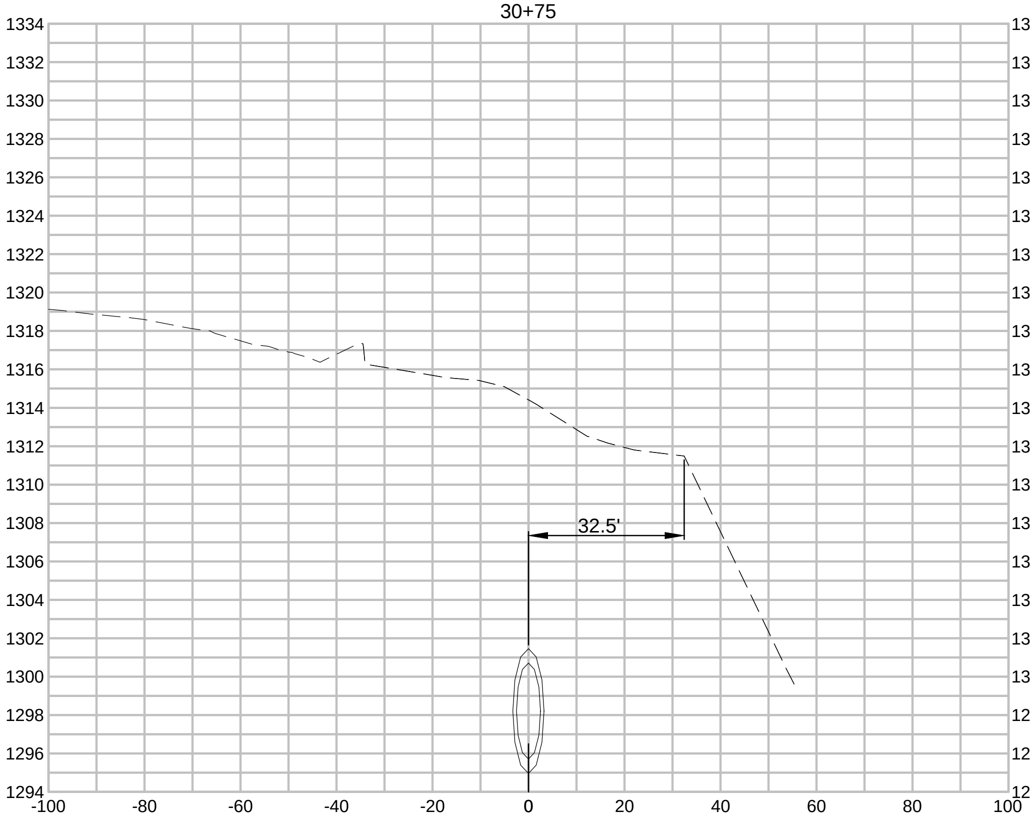

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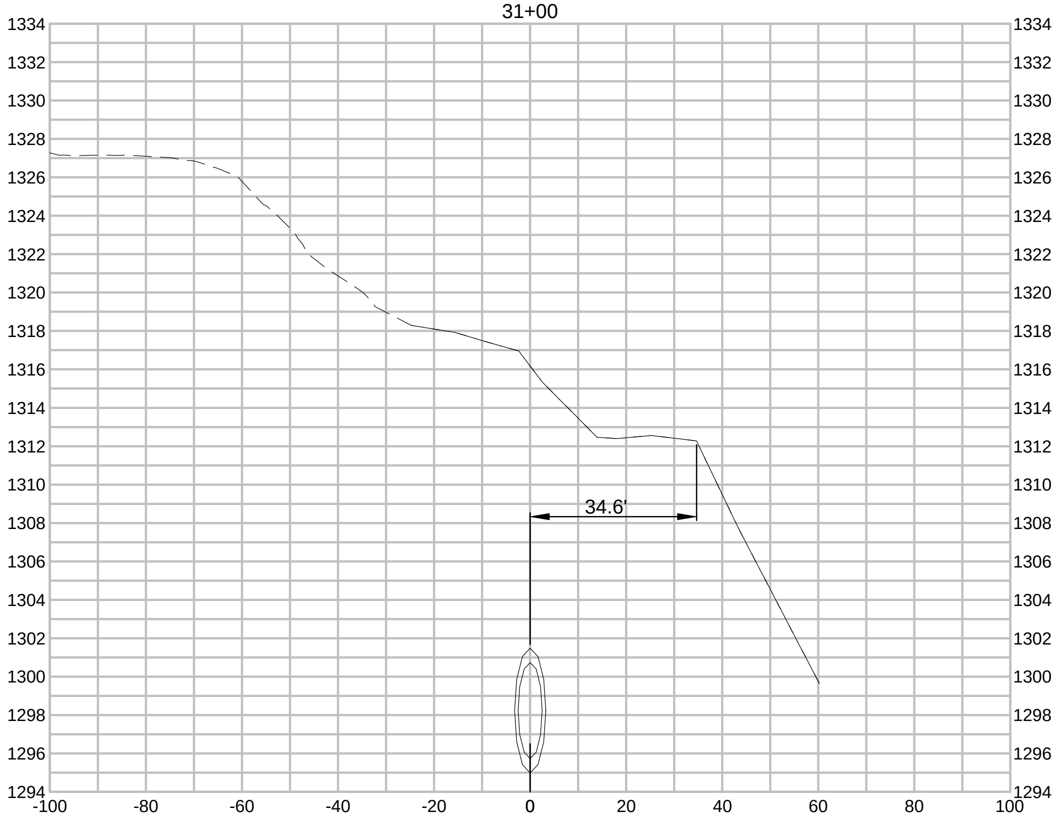

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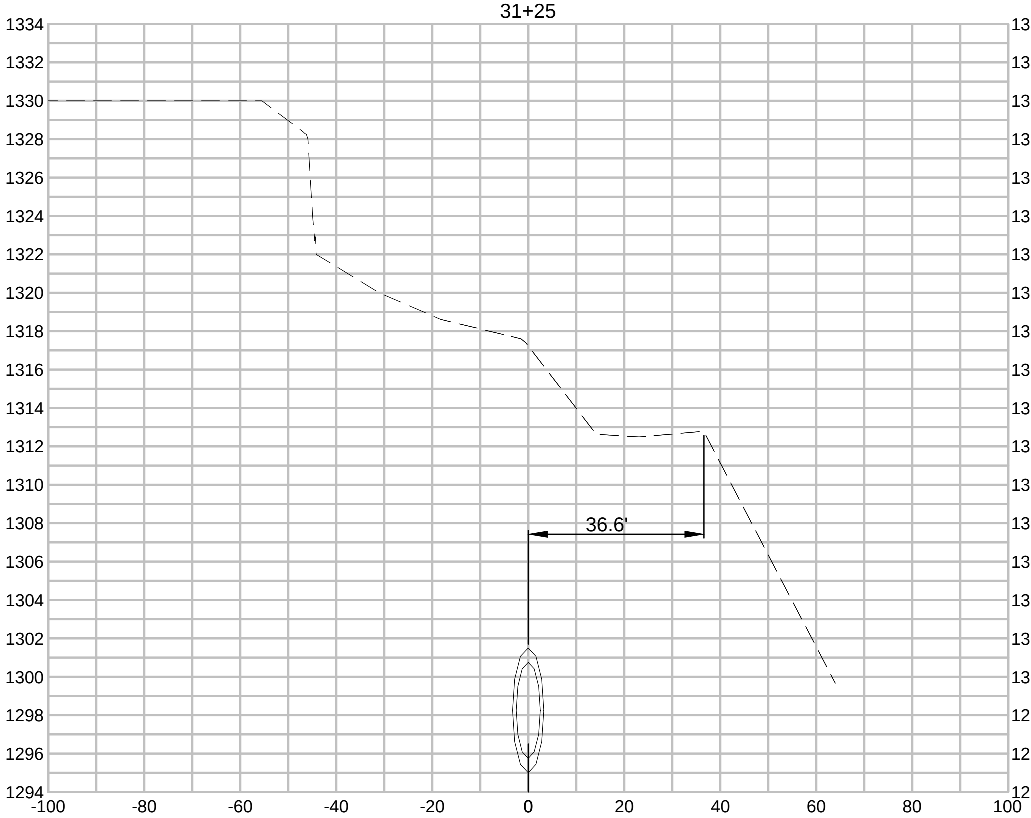

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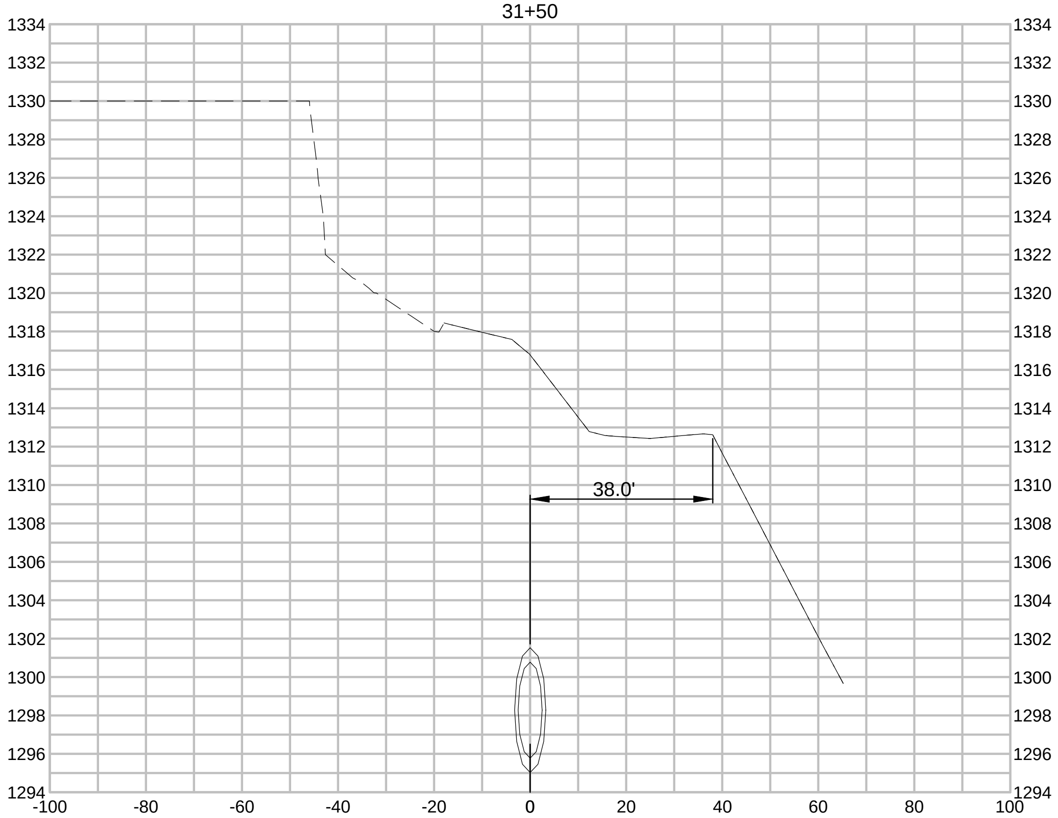

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SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

DESIGNED BY: N. VAN WYHE
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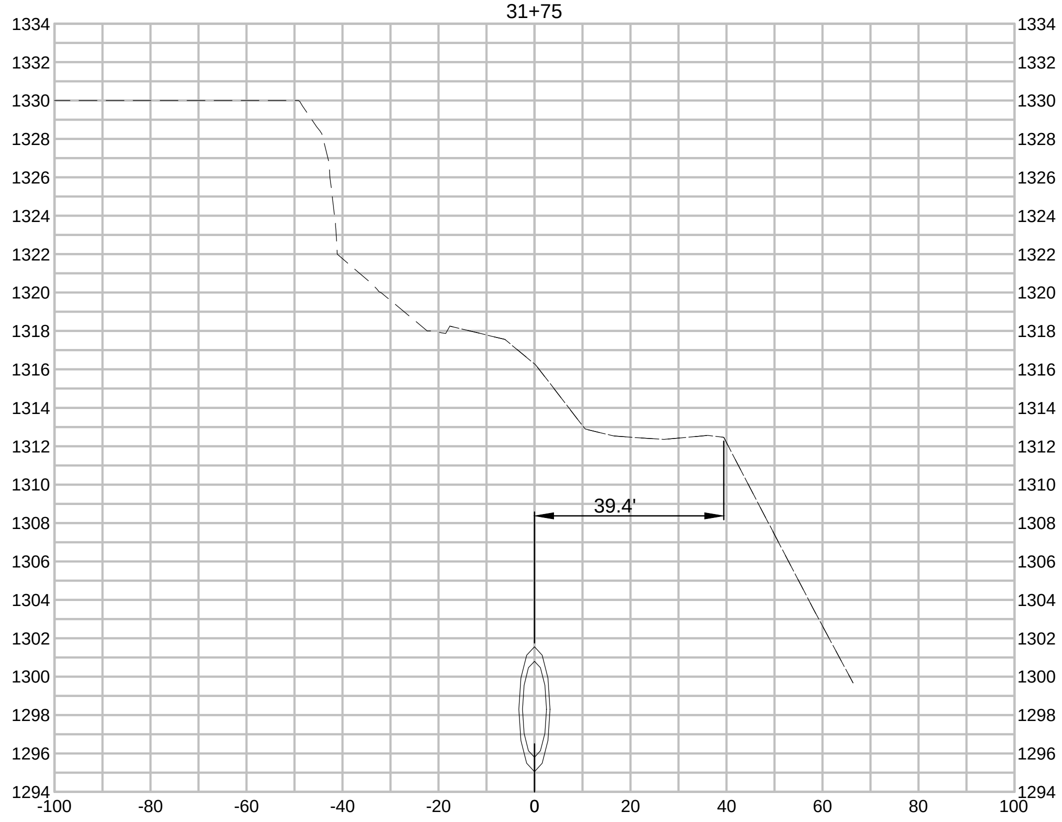

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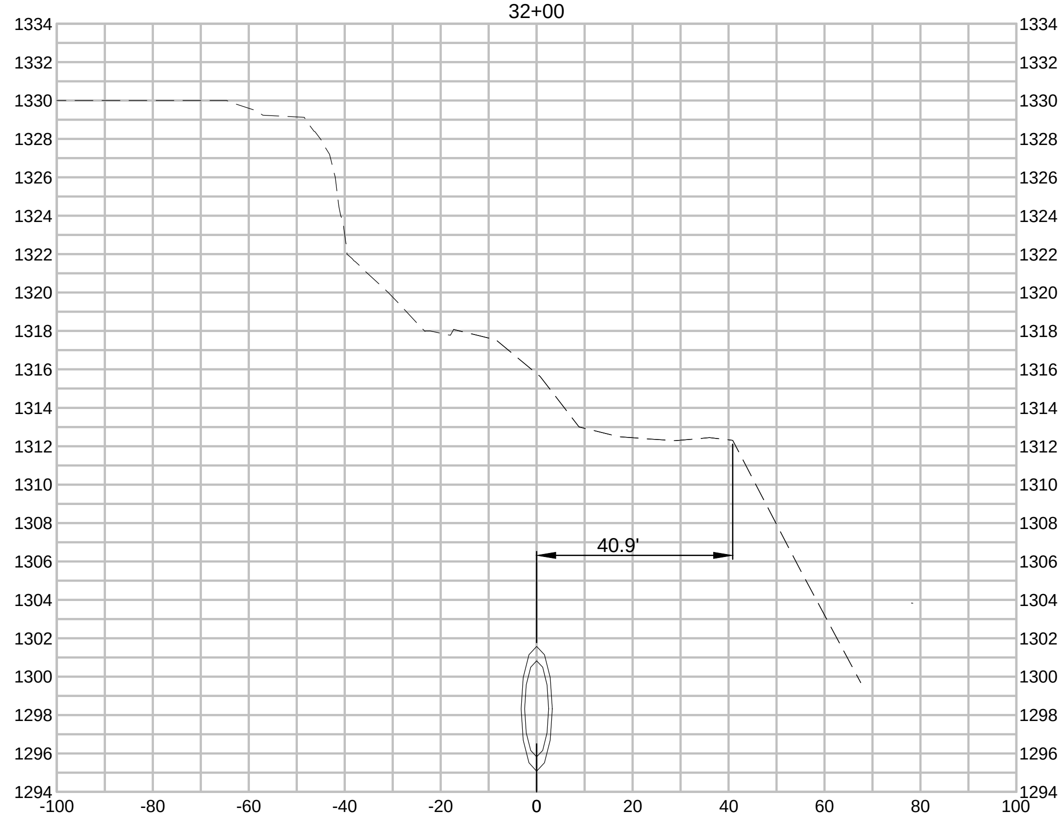

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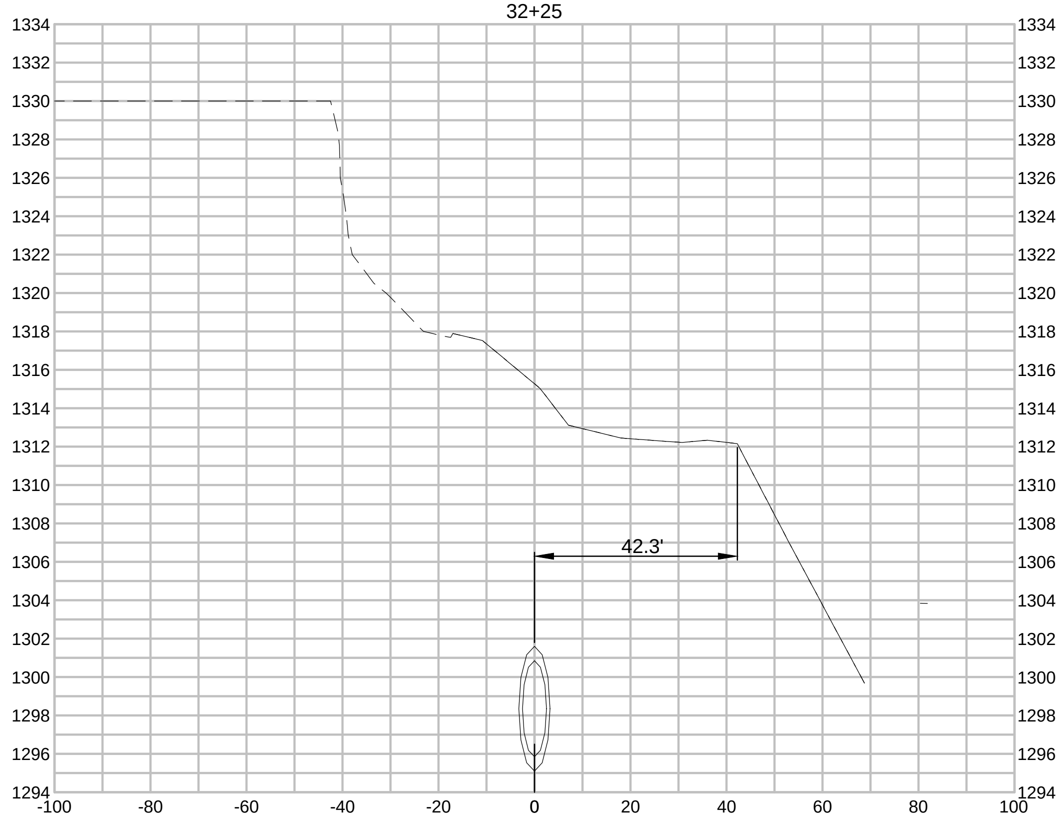

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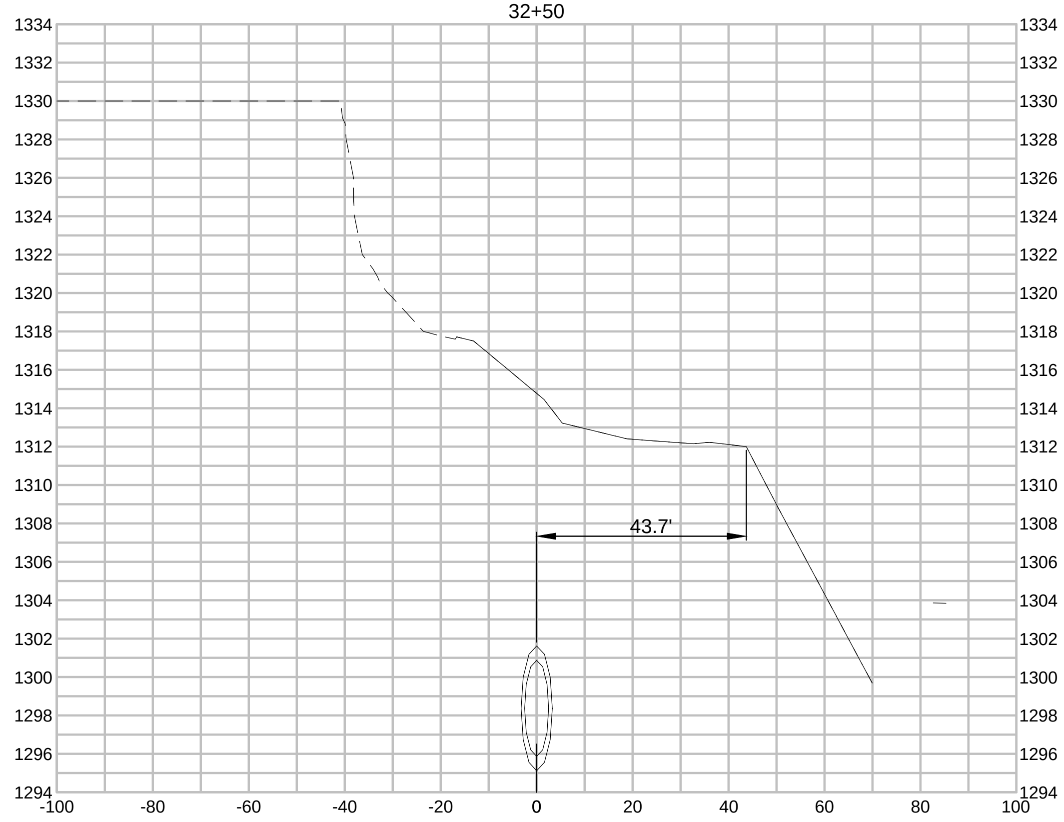

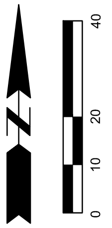

WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

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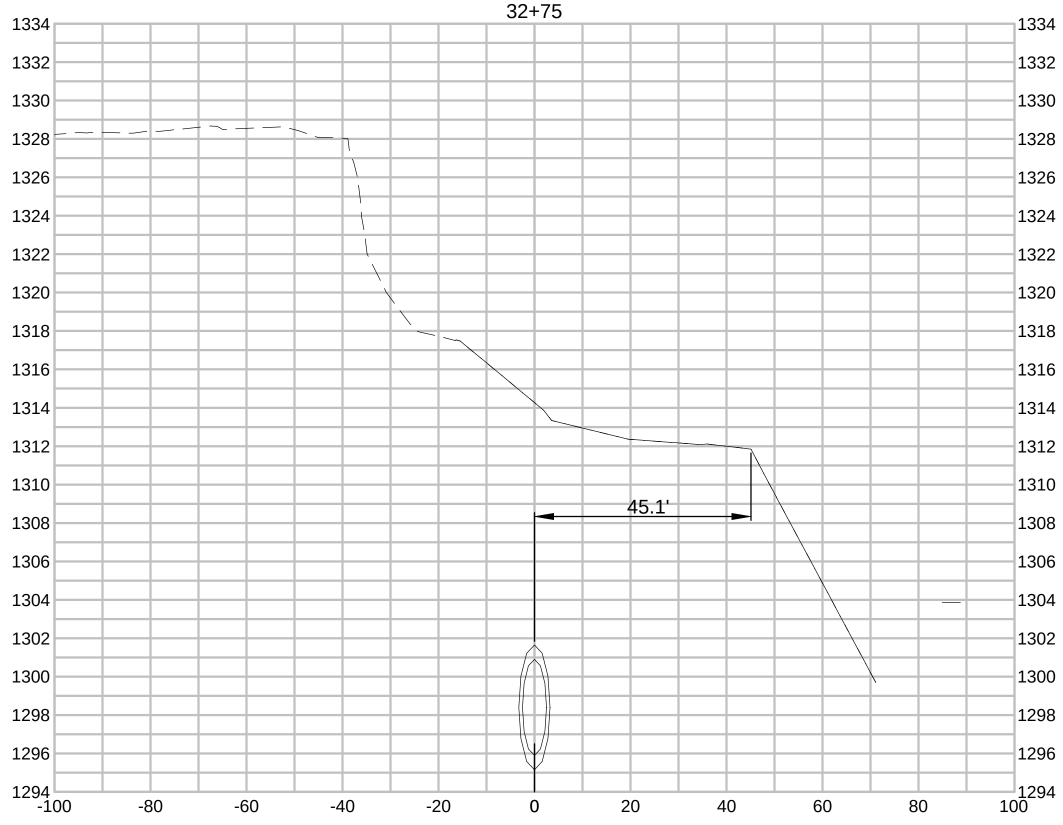

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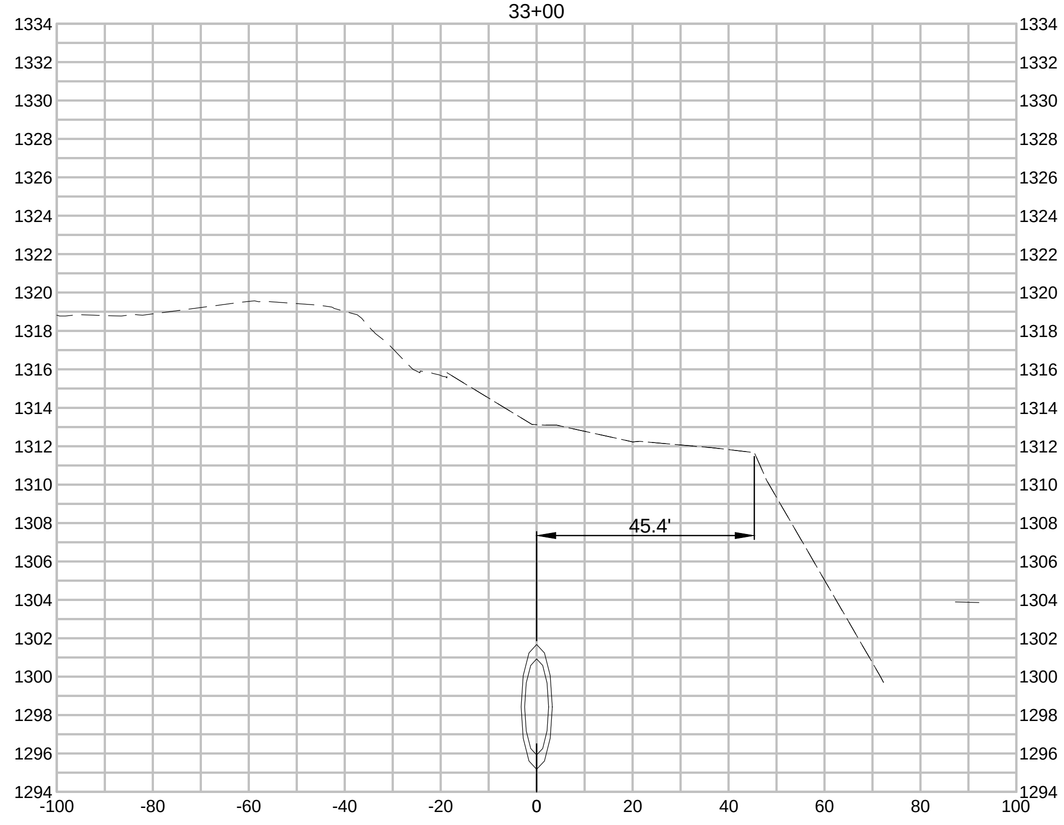

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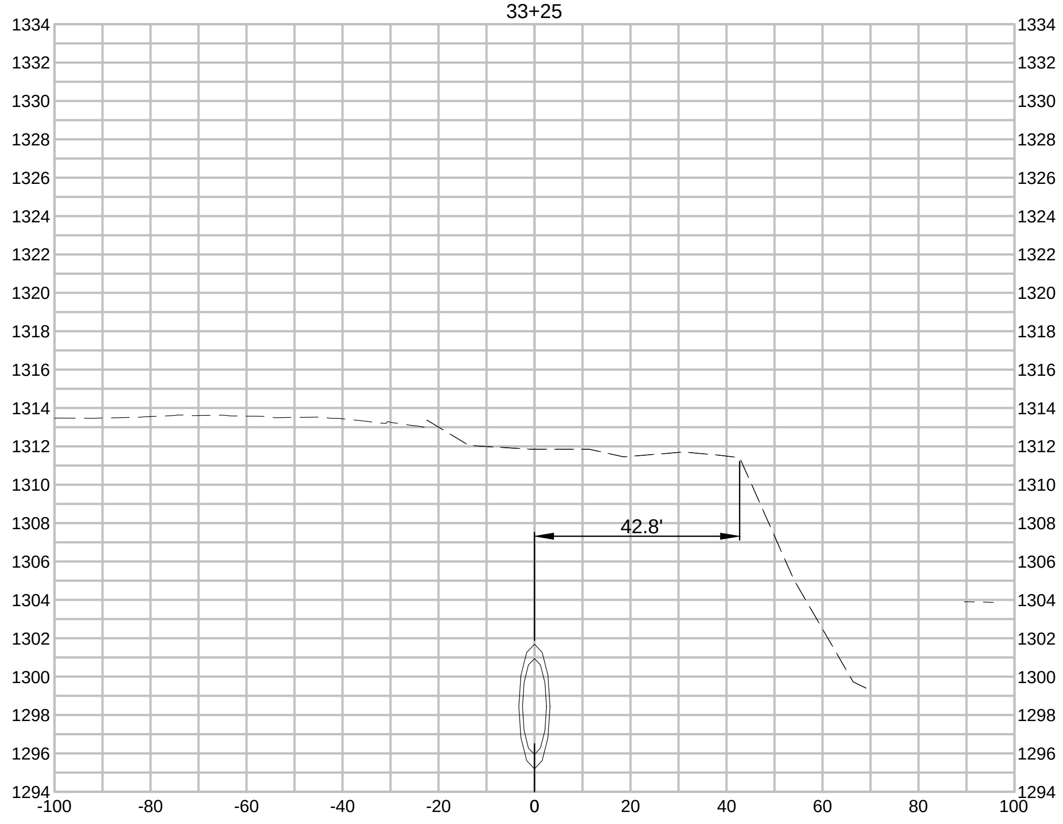

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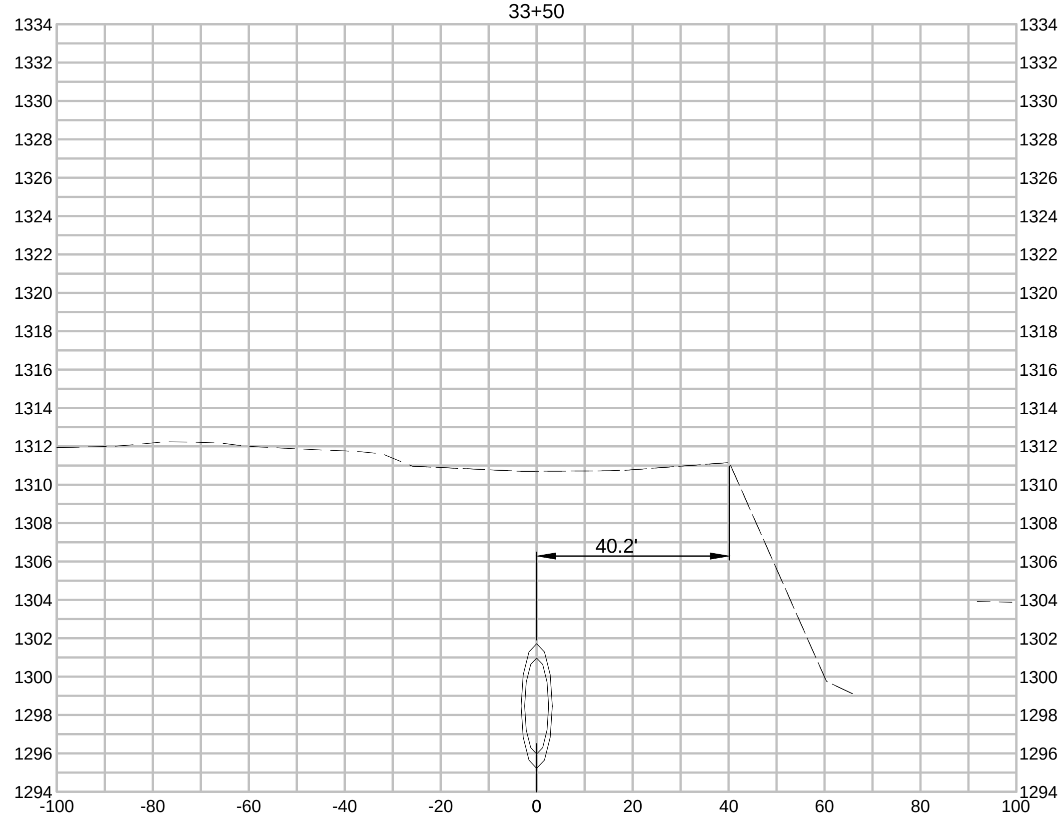

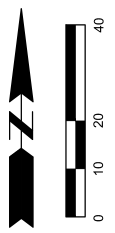

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SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

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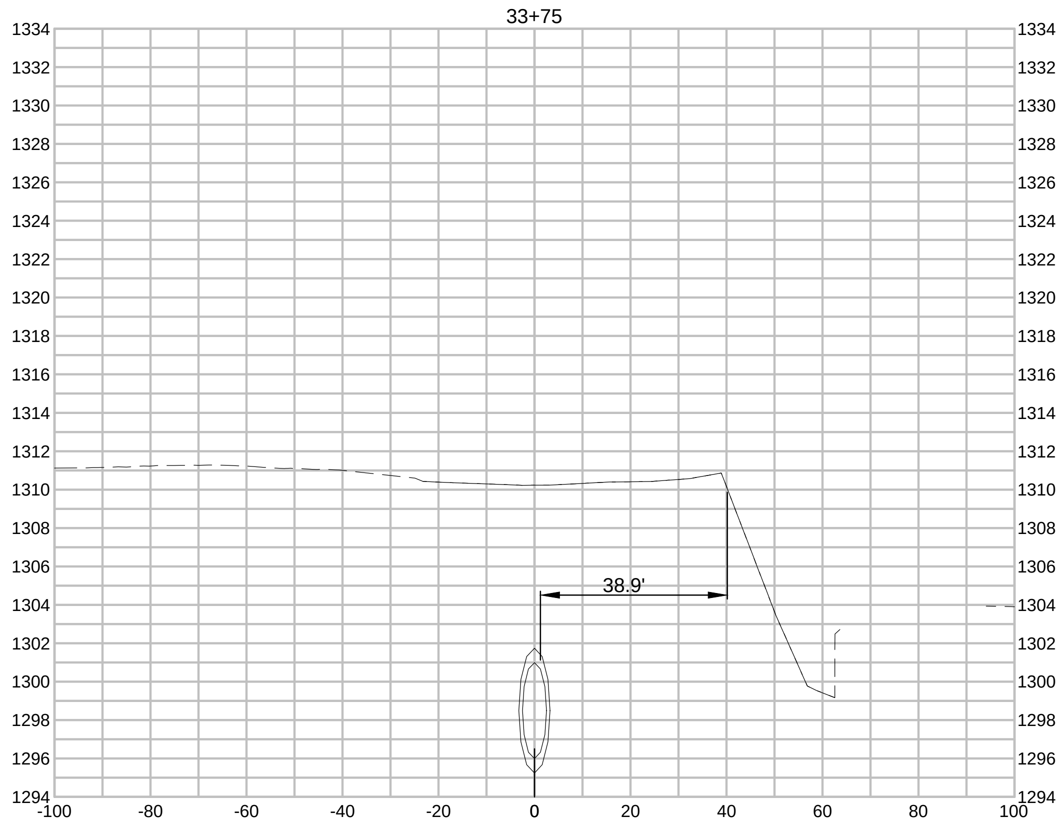

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WATER RECLAMATION COLLECTION SYSTEM PLANNING

SIOUX FALLS, SOUTH DAKOTA

OUTFALL EXHIBITS

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PLOT DATE: 6/16/2014 2:18 PM Carter, Michelle

Appendix I

References

NOTE: This appendix added via amendment to final report August 2014.

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