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## PRELIMINARY ENGINEER'S REPORT

# DRAINAGE DISTRICT #13

STORM LAKE, IOWA

NOVEMBER 2024

BEI PROJECT NO. E24013

**REPORT FOR:**

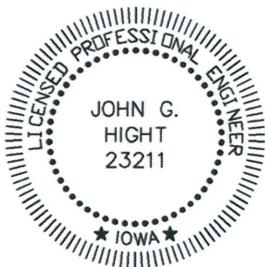
Drainage District #13  
City of Storm Lake, Iowa

**FROM:**

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**Certification**

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Iowa. My registration renewal date is December 31, 2025.



John Hight, P.E.

Date: 11/15/24 Iowa License No. 23211

License Renewal Date: 12/31/25

Pages of sheets covered by this reference: All.

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November 15, 2024

Storm Lake Drainage Trustees  
P.O. Box 1086  
620 Erie Street  
Storm Lake, IA 50588

RE: Drainage District No. 13, Storm Lake, Iowa  
Petition of Tyson Storm Lake Holdings, LLC.

### **SCOPE OF STUDY:**

The following report provides information on the current state of Drainage District #13 for the City of Storm Lake, Iowa. On March 8th, 2024, the Storm Lake City Council, acting as the Trustee for Drainage District No. 13 (DD13), received a petition (Appendix A) from District landowner Tyson Storm Lake Holdings, LCC. The petition states the owners are requesting relief for drainage of their lands. In March of 2024, the Trustees directed Beck Engineering Inc. (BEI) to conduct a preliminary investigation and report the findings. This report will summarize those findings and provide recommendations.

### **DISTRICT HISTORY:**

In September of 1908, Elizabeth Beam submitted a petition to Buena Vista County to establish a drainage district. Engineer Geo K. McCollaugh was commissioned to design the drainage. The engineer report was filed by Geo in December of 1908 and a hearing was set for February of 1909 to hear the petition to establish a drainage district. Drainage District #13 was established in 1909 to provide drainage relief for the cultivation of lands of Sections 1 and 2 of Hayes Township. This included the construction of 700 L.F. of 20" tile, 2850 L.F. of 16" tile, 550 L.F. of 14" tile and 1940 L.F. of 8" tile, which was designed to extend the outlet of an existing 12" drain tile. The assessment schedule totaled \$2,228.64 for the work completed.

In 1912, Drainage District #40 was petitioned and established by the trustees of Storm Lake Township to provide drainage relief to the lands between Sections 1 and 12 of Hayes Township, South of the current CN Railroad and along Business Highway 71. Geo K. McCollaugh was commissioned to design the drainage. Drainage District #40 facilities rely upon a portion of the Drainage District #13 facilities to convey drainage.

In 1954, a petition to create a subdistrict within DD#13 was submitted by petitioners Martin Skibsted and Lona Skibsted for the stated purpose of improving drainage so land could be cultivated. Sub-District No. 13-1 was established to provide additional capacity to the West ½ of Section 1, and the east side of Section 2 of Hayes Township. A.H. Cunningham was commissioned to design the drainage. This included constructing a drainage system that includes 3,326 L.F. of 14 inch and 15 inch tile. The project was completed in June of 1955 and the assessment schedule totaled \$5,146.85 for the creation of the subdistrict.

In 1992, Buena Vista County entered into an agreement with the Iowa Department of Transportation to modify the drainage district facilities to accommodate the Highway 71 reconstruction project. The agreement stated the Iowa DOT would be responsible for the construction, reconstruction, or relocation of district tile. That tile shall have a design that will provide for the present drainage capacity, or greater, and that materials will meet or exceed current specifications. Records indicate portions of the mainline 16" tile were replaced, and a 72" culvert was installed upon Drainage District #13, along with significant modifications made to the East portion of Drainage District #40 as part of the project.

In April of 2009 Buena Vista County approved a resolution authorizing the transfer of jurisdiction for DD#40, DD#13 & DD#13 Sub 1 to the City of Storm Lake.

In July of 2010, Meridian Manufacturing filed a petition for drainage relief for flooding they had experienced. The trustees directed Kuehl & Payer as district engineers to conduct surveys and determine the nature and extent of the needed improvements. As part of that petition, In October 2010, The trustees found that improvements within Drainage District #13 benefit the Annexation of Districts #13 Sub 1 and #40. Engineer Ivan Droessler was appointed by resolution to examine the lands within Drainage District #13 and Sub 1-13, make a survey and plat of the district, and file a report specifying the character of the benefits received for the annexation of the districts.

In March 2011, the trustees passed resolutions dissolving Drainage District #40 & Drainage District #13 Sub 1. Resolutions were also passed accepting the dissolved district improvements and right of way into Drainage District #13. The preliminary report for the improvements to the flooding of Meridian were accepted at the meeting, and the date of April 7<sup>th</sup>, 2011 was set for the public hearing on the report. There was no record of the result of the April 7<sup>th</sup> meeting, and no additional Drainage District #13 meeting records were found after the annexation.

In 2014, the City of Storm Lake made major modifications to Drainage District #13 facilities during the construction of the Expansion Boulevard Storm Water Improvements Project, which was constructed to address Meridian's flooding issues.

## DESCRIPTION OF FACILITIES:

During the 2024 investigation, Beck Engineering compiled data using district plats, aerial photography, soils and topographical maps, and survey information to determine the watershed and facilities within the district. Drainage District #13 is located within parts of Sections 1, 2, 11 and 12 of Hayes Township. DD13 consists of several segments, with the first consisting of a 14-inch tile beginning at Station 41+00 and from there, it runs to the start of segment two at Station 35+50, where it becomes a 16-inch tile. The tile continues until it hits another Segment at Station 7+00. Segment three runs from Station 7+00 to Station 0+00 with a tile size of 20 inches. The original improvements brought an existing 12-inch tile at Station 41+00 to the proposed outlet. The original 12-inch tile (as referenced in the plat) begins at Station 41+00 and continues East to Radio Road. A branch heads North along the West ditch approximately 1,100 L.F., and a branch of 7-inch tile heads South across the railroad to the radio tower property now owned by Community First Broadcasting, LLC.

The original district contains two lateral sections of 8" tile. Lateral #1 is 814 L.F. of 8-inch tile located at approximately Station 35+50. This lateral heads North to a midpoint upon the South Line of the SE  $\frac{1}{4}$  of the NW  $\frac{1}{4}$  of Section 1, Hayes Township. The second lateral is 1,065 L.F. of 8" tile located approximately at Station 39+90 and heads South to a point approximately at the Midpoint of the eastern line of the SW  $\frac{1}{4}$  of the SE  $\frac{1}{4}$  of Section 1, Hayes Township.

The facilities of the annexed Drainage District #40 include two main sections, each with several segments.

The first section is an 8-inch tile that begins at Station 11+00 with a connection to the DD#13 16" tile. This tile continues South along the West ditch of Highway 71 from Station 0+00 to Station 10+00, where it becomes a new segment of 7-inch tile starting at Station 10+00 and gradually curving to the West to Station 32+00, terminating along the South line of the railroad approximately at a location in the Northeast ditch at the intersection of what is Gilbert Street and Business 71 & Iowa Highway 7. This section includes one lateral, identified on the plat as lateral #5. This connects to the main 8-inch tile at Station 15+00 and heads Southeast for 539 L.F., terminating at a point in the ditch on the Southeast side of the intersection of 610<sup>th</sup> Street and Highway 71.

The second section of the annexed DD#40 is an 8-inch tile that begins at the connection of the tile at the 14-inch mainline DD#13 tile at approximately Station 39+50. The tile heads South from Station 0+00 to approximately Station 11+00, continues Southeast towards the railroad at Station 15+29, runs under the tracks, and heads Southwest to a point in the Business Highway 71 & Iowa Highway 7 South ditch to an end point on the NW  $\frac{1}{4}$  of the NW  $\frac{1}{4}$  of Section 12 of Hayes Township. Four laterals branch off this main. All four service the North and South Ditch of Iowa Highway 7, East and West of the end of the lateral. Lateral No. 1 is a 5-inch tile heading East on the North side of the highway. Lateral No. 2 600 L.F. of 6-inch tile and 300 L.F. of 5-inch tile heading West on the North side of the highway. Lateral No. 3 is 800 L.F. of 5-inch tile heading East on the South side of the Highway. Lateral No. 4 is 600 L.F. of 6-inch tile and 300' of 5-inch tile heading West on the South side of the Highway.

Additionally, the facilities from the Annexed Drainage District of 13 Sub 1 include a Section of 16" tile starting at Station 35+00 and heading East to Station 55+00 where a new segment of 15" tile begins

at Station 55+00 to Station 68+26—terminating at the West side of Radio Road, North of the Intersection of Expansion Boulevard.

### **SURVEY, RECORDS AND FIELD REVIEW:**

This report included a field survey and inspection of district facilities, including both public and private facilities within the district, during the Spring and Summer of 2024. The review also considered historical plats and records as provided by the City of Storm Lake, Buena Vista County Auditor's office, Buena Vista County Drainage Engineer, Emmonds & Oliver Resources, Inc, ISG, Inc., Buena Vista County NRCS and USDA offices, Iowa Department of Transportation, and private landowners within the district.

During the field review, the outlet of the existing main tile, while aged, appeared to be in working condition. The outlet was clear of vegetation and obstruction; water flowed freely from the tile outlet during the observed dry conditions.

Several modifications have taken place to the existing facilities in past years. Two of which are significant to note:

First, records and field inspection show that portions of the original DD#13 and the East branch of the DD#40 tile were reconstructed during the Iowa Department of Transportation reconstruction of Highway 71 in or around 1992. The main DD#13 tile under the new highway was replaced as part of the project, and several surface inlets were installed to drain the surface water that is collected in the highway ditches. From the intersection of Expansion Boulevard, heading along the West side of the highway, the East portion of DD#40 was entirely replaced as part of the project. This effectively changed the original intended use of the tile for the existing drainage system that drains most of Section 12, South of the railroad. As part of the construction, most of the district tile increased in size and capacity; however, the as-built records show a portion of the original 7-inch tile that runs under the railroad remained in place, effectively bottlenecking the impact of the improvements to drainage and the tile capacity South of the railroad.

Secondly, in 2013, the City of Storm Lake hired Emmonds & Oliver Resources (EOR) to design a sizeable stormwater project within the district, presumably to address the flooding issues mentioned in Meridian Manufacturing's petition in 2010. The Construction of the Expansion Boulevard project in 2016 accomplished the goal of providing flooding relief to the landowners within the jurisdiction of the original West section of Drainage District #40. It significantly impacted the drainage characteristics within the district. The result was replacing the Entire West section of Drainage District #40 facilities and Lateral #2 of the DD#13 facilities. As built records and field inspection indicate, sections of district tiles from DD#40 may have been reincorporated into the project, as others were removed entirely. While this project significantly improved the drainage through the Southern portion of the drainage district, it did not fully address the downstream impacts or the petitioners' needs for drainage facilities within the entirety of the district.

Additional observations include:

Field Inspection of the 5-inch drainage tile running South from the intersection of Expansion Boulevard and Radio Road, along the East side of the road, to the Community First Broadcasting

tower found several locations of broken tile sections and sinkholes that now take in surface water. Additionally, an intake was installed to drain the South ditch of Expansion Boulevard. There were no as-built records of the Expansion Boulevard project to reference when the intake was installed.

Along the Northeast and Northwest corners of the intersection of Expansion Boulevard and Radio Road, intakes were installed to drain surface water from the ditches along both sides of the road and through culverts from the South. Although there is no record of when the intakes were installed, they utilize the district tiles for drainage. These district tiles are now utilized for draining surface water that they were not originally intended to.

An "old tile" section of 12" that runs along the East side of Radio Road, heading North from the intersection with Expansion Boulevard, has several collapsed sections. It is actively flowing with water, visible in the tile line, even during dry observation periods. Based upon available records, it is believed that this tile was installed before 1908 when the district was formed, and it now serves the far northwest section of the drainage district.

While confirming watersheds within the district, several non-district culvert sections were filled with sediment and would require cleaning to work at full capacity. A culvert section crossing the railroad on the West side is almost full of debris, as well as the culverts at the intersection of Expansion Boulevard and Radio Road.

During field inspection, discrepancies were found in the provided as-built records. Per the records, a DD#13 tile from the West draining portions of the petitioner's property was disconnected as part of the project. According to the as-built documents, it was reconnected using a saturated buffer at the outlet. However, field verification could not find the structure or outlet of the tile. It is unclear in the records if the buffer was intended to be installed on the smaller "old tile" section or the larger DD#13-1 tile or if this was remedied during construction. A saturated buffer, if installed, would significantly reduce the capacity of a drainage tile. There will need to be exploratory digging if this is to be reconciled. Both the old tile and 13-1 facilities are relied upon in the district to drain the petitioner's property.

### **EXISTING TILE CAPACITY EVALUATION:**

In 1908, the county supervisors considered the petition to establish the drainage district. The petition's stated goal was to improve and drain land so it could be used for agricultural production.

Since construction in 1909, standards for agricultural drainage have changed dramatically. The district has no record of design calculations or justification for the size and materials used in construction.

From here, the original tile system will be evaluated under the current best practice standards when evaluating the capacity of the tile. This information will set a baseline for the tile's performance, based on the stated original intent of the design. Later, the impacts of development since then and potential future impacts will be evaluated.

The Iowa Drainage Guide, published by Iowa State University in 2016, is the leading publication for agricultural drainage for the State. Standards for agricultural drainage provide guidance when

evaluating the current tile capacity. Those standards recommend a tile facility with the capacity to drain ½ inch of runoff from the lands in the watershed in 24 hours when the watershed does provide for surface drainage. This use matches the records of the original design intent, primarily of the existing tile, which was to lower the water table to a point below the ground surface where it wouldn't interfere with plant root growth and development.

Original Design Evaluation:

**Table 1 – Drainage District #13 – Original Design Tile Capacities**

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)	DA (AC)	Drainage Coeff.	% of 1/2" Coefficient
0+00 to 7+00	20	Concrete	0.0017	2.18	5.24	0.417	0.0108	6.9	638.9	0.25	50%
7+00 to 35+50	16	Concrete	0.0063	1.40	4.19	0.333	0.0108	7.3	575.8	0.30	60%
35+50 to 41+00	14	Concrete	0.0082	1.07	3.67	0.292	0.0108	5.9	454.5	0.31	62%
+ 41+00	12	Concrete	No Record	0.79	3.14	0.250	0.0108	3.0	184.5	0.38	76%
Lateral No. 1	8	Concrete	0.0028	0.35	2.09	0.167	0.012	0.7	98.8	0.17	34%
Lateral No. 2	8	Concrete	0.0031	0.35	2.09	0.167	0.012	0.7	109.3	0.15	30%

**Table 2 – Drainage District #40 – Original Design Tile Capacities (East Main)**

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)	DA (AC)	Drainage Coeff.	% of 1/2" Coefficient
0+00 to 10+00	8	Concrete	0.0010	0.35	2.09	0.167	0.012	0.7	67.9	0.24	48%
10+00 to 32+00	7	Concrete	0.0055	0.27	1.83	0.146	0.012	0.6	37.5	0.38	76%
Lateral No. 5	5	Concrete	0.0020	0.14	1.31	0.104	0.012	0.2	24.2	0.20	40%

**Table 3 – Drainage District #40 – Original Design Tile Capacities (West Main)**

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)	DA (AC)	Drainage Coeff.	% of 1/2" Coefficient
0+00 to 19+63	8	Concrete	0.0008	0.35	2.09	0.167	0.012	0.4	109.3	0.08	16%
Lateral No. 1	5	Concrete	0.005	0.14	1.31	0.146	0.012	0.6	6.0	2.38	467%
Lateral No. 2	6	Concrete	0.0008	0.20	1.57	0.125	0.012	0.2	14.3	0.33	66%
Lateral No. 3	5	Concrete	0.006	0.14	1.31	0.146	0.012	0.6	22.6	0.63	126%
Lateral No. 4	6	Concrete	0.0015	0.20	1.57	0.125	0.012	0.2	19.8	0.24	48%

**Table 4 – Drainage District #13-1 – Original Design Tile Capacities**

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)	DA (AC)	Drainage Coeff.	% of 1/2" Coefficient
35+00 to 55+00	16	Concrete	0.0063	1.40	4.19	0.333	0.0108	7.3	184.5	0.94	188%
55+00 to 68+26	15	Concrete	0.002	1.23	3.93	0.313	0.0108	3.5	46.5	1.79	358%

The table indicates that the vast majority of the original main tile provides inadequate subsurface drainage for today's good agricultural row crop production standards. The tiles that are sized appropriately are bottlenecked by undersized downstream tiles—rendering the system incapable of providing landowners within the district adequate drainage to meet the original intent of the drainage district.

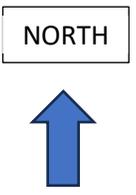
In evaluating surface runoff from the district, through inspection, it was found in several locations over the years intake structures were constructed utilizing district facilities. These low-lying areas rely on the district's subsurface drainage tile to drain the surface water. Taking priority of the already low capacity of the drainage system. Insufficient management of surface runoff significantly impacts the system's performance and the design of district facilities.

The map below is from the Iowa Department of Natural Resources Iowa floodplain 2D mapping of the district. It highlights the areas of concern, showing low-lying areas and the depth of stormwater surface runoff.

Map Legends

Depth Grid (1% and 0.2%)

- Less than 1 foot
- 1 to 2 feet
- 2 to 3 feet
- 3 to 4 feet
- 4 to 5 feet
- More than 5 feet



- DRAFT Depth
- DRAFT WSE
- Marker Co

The areas of significant surface water ponding include the intersection of Expansion Boulevard and Radio Road (120<sup>th</sup> Street), the Northwest intersection of Highway 71 and Expansion Boulevard, South of Highway 7 as it intersects Highway 71, and the Southeast intersection of 610<sup>th</sup> Street and Highway 71 (Shown as 130<sup>th</sup> Avenue on the map). These areas of concern align with the investigation of drainage facilities within the district.

When a subsurface drainage system is utilized for surface drainage, it will compound the issues within the district. Over the years, the facilities have been utilized in a manner inconsistent with the original intent and benefit to the landowners within the district.

## **REPAIR & IMPROVEMENTS:**

The district trustees are tasked with evaluating facility improvements to ensure adequate drainage, carefully considering the benefits to public health, safety, and welfare. These improvements or repairs are critical for supporting the ongoing development and making the land within the district meet its full usable potential. The drainage infrastructure should be designed to meet the current agricultural needs and accommodate both the city's current commercial and industrial demands and anticipated future growth.

In a mixed-use drainage district like DD#13, several design goals must be taken into account. Agricultural production requires specific drainage standards tailored to maximize its effectiveness, while commercial and industrial areas have different standards that better suit their unique drainage needs. Future land use and the anticipated rate of development must also be factored into any decision-making.

To address these needs, three design options have been proposed for the drainage district:

### **Option 1: Inspect and Repair**

The current report provides a limited inspection of the existing system. To fully assess the current condition, the existing tiles require cleaning and televising. This work would also involve investigating and resolving any discrepancies between as-built records and field inspections, as well as documenting areas that are in disrepair.

Under this option, a contractor would be engaged to locate, clean, and televise the main tiles. Any identified issues would be repaired at that time, and discrepancies documented in the field would be resolved. To facilitate ongoing maintenance, the contractor would construct access points along the tile approximately every 400 feet.

This option assumes that the tile system is intended to operate at full capacity. Implementing these repairs would help restore the existing system to its optimal functionality, as originally designed and indicated in the original design tile capacities tables above, and significantly reduce future maintenance costs.

It should be noted that the benefits of these repairs are limited, and the performance of the drainage facilities within the district may improve marginally, but as shown, the current drainage system does not meet the requirements of adequate drainage for the multiple uses within the

district. Nor does it support future growth and development. Additionally, the final cost of a maintenance project is unknown. The final project costs would depend on the field conditions found during construction. An estimate was prepared to achieve the goals discussed above but also with assumptions on the amount of pipe replaced, etc. A maintenance project could be more costly than shown or less expensive. The primary purpose of providing an estimate is for reference when considering the other options.

## **Option 2: Current Land Use Improvements**

This option includes improving the district facilities and providing currently developed parcels with capacity for the peak flow of a pre-development 5-year storm while providing agricultural production parcels with a 1/2" coefficient capacity. These improvements will increase the drainage district's capacity to handle storms of the current agricultural and urban land uses.

The proposed improvements for Option 2 begin at the intersection of Expansion Boulevard and Radio Road. The 12-inch 'old' tile running North will be replaced with new tile to ensure benefit to the agricultural production landowners along the North of the Petitioner. Two intakes will be constructed at the NW and NE corners of the intersection. The Northwest intake will capture surface water from the land West of Radio Road, as well as the runoff from the road ditches from the North and South. Any private tile connections for owners within the district can be made at this location. The district tile will be increased in size from a 12-inch to a 42-inch RCP in order to provide benefit to the landowners East of Radio Road. The Northwest intake will capture ditch water from the West side of Radio Road, as well as a portion of road ditch that drains from Expansion Boulevard. The petitioner benefits from the Northeast intake by providing surface drainage relief. The district tile will be increased in size from a 12-inch to a 54 inch diameter RCP. The tile will continue East from the intersection in the general area of the existing district tile. The existing 7-inch tile that services the owner South of the railroad along the East side of Radio Road will be extended and connected at this location. Continuing East from there, the tile will connect to the outlet of "Basin 4" of the petitioner's property, and as it continues East, it will connect to the outlet of "Basin 2" of the petitioner's property.

It is understood the goal of the petitioner is to decrease the retention time of stormwater in their retention ponds. According to the drainage report provided by the petitioner, completed by ISG, Inc., the pre-development 5-year peak rate of the site is 21.6 cubic feet per second. After construction of the Tyson facility citing undersized drainage infrastructure and concern for flooding of Basin "2" and Basin "4" limited the site release rate to 1.2 cfs and 1.2 cfs, respectively. A significant reduction in post-development runoff rate from the pre-condition rate. As part of the improvement project, the district anticipates an increase the current peak runoff rate to increase to 10 cubic feet per second. An increase of 416% from the current condition. While this amount could change based upon input from the petitioner it would be advantageous for both the district and petitioner to enter into an agreement on a set allowable discharge rate.

The tile main will continue East and then Northeast from Basin #4 as a 54-inch RCP tile, where it will meet the outlet of the Expansion Boulevard Drainage Project, that was completed in 2014.

The main tile will capture the 5-year pre-development discharge from the Expansion Boulevard project and convey it an additional 700 L.F. to the proposed open channel ditch. According to the drainage report provided by the City of Storm Lake, completed by EOR, Inc., the peak 5-year rate of flow after the Expansion Boulevard Project construction is 27 cfs. Flows that exceed the 5-year storm that outlet at that location will overland flow as they do today, to the location of the beginning of the proposed open channel ditch.

The proposed open channel ditch is within the same footprint as the surface water overflow that occurs during significant storms periods. The proposed open channel ditch design will provide a more defined uniform channel and provide more capacity than what can currently be conveyed. This will also benefit the adjacent landowner by defining the wet area to within the channel where it is now uncontrolled to the NW corner of Highway 71 and Expansion Boulevard. The current overland flow results in drown out of production ground.

The proposed open channel will release to the existing 72" RCP culvert under Highway 71. From there, flow will continue to the North ditch of 610<sup>th</sup> Street for approximately 400 feet, as it does today. A proposed open channel will then convey the storm water to the current discharge location of an unnamed tributary to the North Raccoon River.

As part of the DD#13 improvements, additional benefit will result to the landowners in the area of the former DD#40 West infrastructure. The proposed DD#13 improvements will effectively disconnect the improvements from drainage system of the of the district from the infrastructure reliance on the DD#40 East that was removed/replaced as part of the highway 71 reconstruction. Resulting in limited improved performance of all portions of the district.

The City of Storm Lake has developed a post-construction stormwater ordinance that is designed to address larger storms on a site-to-site development level. In addition, recent legislation from the State of Iowa restricts municipalities and counties from requiring landowners to retain their stormwater below that of a pre-development 5-year peak release rate.

Future development within the district will be required, by the post-construction stormwater ordinance, to provide storage for the larger storm events and release at the rate that matches that of the design storm provided by the drainage district improvements.

Larger storms will utilize existing drainage infrastructure, and rely on the city stormwater ordinances and requirements to manage more significant events on a site level for future development. While the proposed tile improvements would increase the runoff rate of the more significant storm event. The design would not be intended to convey above that of the pre-development 5-year storm. Future developments would be required to follow stormwater regulations and ordinances to capture and convey the storm events above the 5-year runoff rate with practices that would not inundate the drainage district infrastructure.

Below is a table showing the capacities of the proposed improvements.

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)
0+00 to 1+01.2	42	RCP	0.005	9.62	11.0	0.875	0.013	71.1
1+01.2 to 11+89.7	54	RCP	0.003	15.90	14.14	1.125	0.013	107.7
11+89.7 to 35+44.4	54	RCP	0.003	15.90	14.14	1.125	0.013	107.7
35+44.4 + 42+50.0	54	RCP	0.004	15.90	14.14	1.125	0.013	124.3
Open Channel	Trapz	Earth	0.002	45.0	25.0	1.8	0.027	163.9
Existing Highway Culvert	72	RCP	0.010	28.27	18.85	1.50	0.013	425.6

### Option 3: Agricultural Use w/ Additional Capacity for Petitioner

This option explores improving the district facilities to match the need of the agricultural uses, conveying the stormwater of the existing developed parcels, while providing additional relieve/benefit to the petitioner. This option will explore providing the district a 2" drainage coefficient.

The proposed improvements for Option 3 will follow a the same path as option #2 with reduced sized tile mains. The project will begin at the intersection of Expansion Boulevard and Radio Road. The 12-inch 'old' tile running North will be replaced with new tile to ensure benefit to the agricultural production landowners along the North of the Petitioner. Two intakes will be constructed at the NW and NE corners of the intersection. The Northwest intake will capture a limited amount of surface water from the land West of Radio Road, as well as the runoff from the road ditches from the North and South. Any private tile connections for owners within the district can be made at this location. The district tile will be increased in size from a 12-inch to a 15-inch RCP in order to provide benefit to the landowners East of Radio Road. The Northwest intake will capture ditch water from the West side of Radio Road, as well as a portion of road ditch that drains from Expansion Boulevard. The petitioner benefits from the Northeast intake by providing surface drainage relief. The district tile will be increased in size from a 12-inch to an 18-inch diameter RCP. The tile will continue East from the intersection in the general area of the existing district tile. The existing 7-inch tile that services the owner South of the railroad along the East side of Radio Road will be extended and connected at this location. Continuing East from there, the tile will connect to the outlet of "Basin 4" of the petitioner's property, and as it continues East, it will connect to the outlet of "Basin 2" of the petitioner's property.

It is understood the goal of the petitioner is to decrease the retention time of stormwater in their retention ponds. According to the drainage report provided by the petitioner, completed by ISG, Inc., the pre-development 5-year peak rate of the site is 21.6 cubic feet per second. After construction of the Tyson facility citing undersized drainage infrastructure and concern for flooding of Basin "2" and Basin "4" limited the site release rate to 1.2 cfs and 1.2 cfs, respectively. A significant reduction in post-development runoff rate from the pre-condition rate. As part of the improvement project, the district anticipates an increase the current peak runoff rate to increase to 5 cubic feet per second. An increase of capacity of 216% from the current condition. While it should be noted that doubling the allowable release rate is not directly correlated to a 50% reduction in the retention time. The district improvements will reduce retention time. While this amount could change based upon input from the petitioner it would be advantageous for both the district and petitioner to enter into an agreement on a set allowable discharge rate.

The tile main will continue East and then Northeast from Basin #4 as a 24-inch RCP tile, where it will meet the outlet of the Expansion Boulevard Drainage Project, that was completed in 2014.

The main tile will capture the 5-year pre-development discharge from the Expansion Boulevard project and convey it with a 36-inch tile an additional 700 L.F. to the proposed open channel ditch. According to the drainage report provided by the City of Storm Lake, completed by EOR, Inc., the peak 5-year rate of flow after the Expansion Boulevard Project construction is 27 cfs. Flows that exceed the 5-year storm that outlet at that location will overland flow as they do today, to the location of the beginning of the proposed open channel ditch.

From there the proposed ditch will follow the same improvements of Option #2.

STATION	SIZE (in.)	MATERIAL	SLOPE (ft/ft)	A (ft <sup>2</sup> )	P (ft)	R (ft/ft)	n	Q (CFS)
0+00 to 1+01.2	15	RCP	0.006	1.23	3.93	0.313	0.013	5.0
1+01.2 to 11+89.7	18	RCP	0.0035	1.77	4.71	0.375	0.013	6.2
11+89.7 to 35+44.4	24	RCP	0.0035	3.14	6.28	0.500	0.013	13.4
35+44.4 + 42+50.0	36	RCP	0.004	7.07	9.42	0.750	0.013	42.2
Open Channel	Trapz.	Earth	0.002	45.0	25.0	1.8	0.027	163.9
Existing Highway Culvert	72	RCP	0.0101	28.27	18.85	1.50	0.013	425.6

Future development within the district will need to be reviewed to ensure the impacts to the system. Depending upon the future land use and development of the land additional improvements to the drainage district may be required to convey the potential stormwater.

Beck Engineering Inc. has developed a cost estimate for the district's drainage facilities, which is included in Appendix C, Preliminary Engineer's Estimate of Probable Costs.

### **EASEMENTS AND APPRAISALS:**

The proposed improvements include acquiring additional right-of-way for the planned open ditch between stations 42+00 and 55+10, and 66+00 to 70+52.

If right-of-way acquisition is pursued, an appraisal commission—consisting of two county landowners and the engineer—will be appointed to recommend fair compensation. The appraiser's report will be reviewed at a subsequent or separate public hearing before final adoption.

The proposed ditch and easement areas will follow the existing drainage path through the affected properties, minimizing crop production loss for the landowners. These improvements aim to reduce crop losses by providing additional drainage capacity for significant storm events. Responsibility for maintaining the drainage ditch will also transfer to the drainage district.

The permanent right-of-way is not intended to be wide enough to support major construction activities for repairs or further improvements. A larger temporary work area may be needed for construction, extending up to 150 feet from the centerline of the open ditch in each direction. Landowners will be compensated for damages within this temporary easement area, with the compensation determined at the project completion hearing.

## **ANNEXATION/RECLASSIFICATION DISCUSSION:**

The entire district's watershed boundary was mapped using LIDAR (Light Detection and Ranging) data and aerial photography. This investigation allowed the determination of the lands that drain by surface or subsurface into the district. Upon comparison with the original district boundary, it was determined that the original boundary accurately reflects current conditions, and therefore, there is currently no need for additional annexation into the district.

Section 468.65 of the Iowa Code states, 'If the board finds the assessments to be generally inequitable, they shall order a reclassification of all property subject to assessment, such as lands, highways, and railroads in said district.'

The district has not been reclassified since its original assessment schedule was adopted in 1909. At the time of the annexation of DD#13-1 and DD#40, a reclassification to restructure the benefits would have been appropriate to unify the entire district under one classification schedule and address changes and inequities in the use of facilities over the years.

Given the dramatic changes in land use, infrastructure, hydrology, and other factors since 1909, it is recommended that a reclassification be ordered to ensure that the assessment schedule reflects current conditions and benefits are equitably distributed across the district.

## **OTHER CONSIDERATIONS:**

### *Wetlands and USDA Farm Program*

The United States Department of Agriculture, through the Natural Resources Conservation Service, administers the swampbuster provisions of the Food Security Act of 1985, which discourages the conversion of wetlands (e.g., draining, filling, or leveling) for agricultural purposes. These provisions apply to agricultural producers participating in USDA programs like crop insurance, loans, or conservation programs. To maintain eligibility for USDA benefits, specific procedures must be followed, including mitigating any adverse impacts to wetlands, which may involve wetland replacement. Before construction on lands within a watershed, the NRCS requires a certified wetland determination. Both landowners and tenants can request these determinations from the NRCS. If the NRCS cannot complete a determination, a third party may be used under certain circumstances, usually with NRCS oversight.

### *Water Quality Certification*

Section 404 of the Clean Water Act, administered by the U.S. Army Corps of Engineers (USACE) with oversight from the Environmental Protection Agency (EPA), regulates the discharge of dredged or fill material into waters of the United States, including wetlands. Its purpose is to assess and regulate physical impacts on water bodies and wetlands, including habitat loss, changes in hydrology, and other environmental effects on the 'Waters of the U.S.' Wetlands under Section 404 jurisdiction typically need to be connected to, or adjacent to, a water body determined to be a 'Water of the U.S.' A desktop evaluation of EPA Wetland Inventory Maps indicates that it is unlikely that there will be

potential wetlands that the proposed improvements could impact. However, field verification may be necessary to confirm these findings.

## **DISCUSSION AND RECOMMENDATIONS:**

The investigation confirms the need for drainage relief in the DD#13 watershed. It is recommended that one of the proposed improvement options be considered and implemented to provide this relief. The three options presented in the report offer varying levels of drainage relief. It is also recommended the preferred option be selected with input from the district landowners.

Additional improvement options or considerations can be evaluated upon request by the trustees.

It is recommended that the Trustees of Drainage District #13 take the following actions:

1. Provisionally approve the preliminary engineering report as filed.
2. Schedule a public hearing to gather input from district landowners.
3. If sufficient support is found, appoint right-of-way appraisers and continue to a public hearing.
4. Adopt the proposed plan, with any modifications necessary to address landowner concerns.
5. Approve right-of-way compensation.
6. Initiate wetland determination proceedings and conduct an impact assessment.
7. Direct the engineer to prepare plans, specifications, permits, and proceed to a bid letting for the construction of the proposed improvements.
8. Initiate reclassification proceedings.

Sincerely,



John G. Hight, P.E.  
Beck Engineering, Inc.

Enc: Appendix A – Petition of Landowners within the District  
Appendix B – Estimates of Probable Costs  
Appendix C – Preliminary Plan Set  
Appendix D – Drainage Modeling

**APPENDIX A:**  
**LANDOWNERS' PETITION**  
**DRAINAGE DISTRICT NO. 13**

## **DRAINAGE PETITION**

**TO: THE BOARD OF TRUSTEES OF THE CITY OF STORM LAKE, IOWA, ACTING ON BEHALF OF DRAINAGE DISTRICT #13 IN BEAUNA VIST COUNTY, IOWA**

COMES NOW, the undersigned Petitioners, being owners of the real estate in this drainage district and in making this petition for drainage relief for the drainage of said lands, respectfully state to the Board of Trustees of the City of Storm Lake, Iowa:

1. That the lands of these petitioners are a part of and are included in Drainage District #13, Buena Vista County, Iowa, and that said lands are assessed for drainage tax by virtue of the improvements in said district.
  
2. That the drainage facilities in their present condition in this district are not sufficient to properly drain the water from the lands of these petitioners as well as other lands; that such lands are subject to overflow, too wet for cultivation, and are subject to erosion and flood danger; that if the improvements in said drainage district were properly repaired or otherwise properly constructed to correct the current situation, the public benefit, utility, health and welfare would be promoted.
  
3. That these petitioners do not have exact knowledge or information as to the exact nature of the work to be done to correct the situation, but that these petitioners are of the belief that an investigation of the situation by a qualified independent engineer would determine the exact nature of the work required to provide adequate drainage for the lands of these petitioners and adjoining lands
  
4. That these petitioners respectfully request that the Board of Trustees of The City of Storm Lake, Iowa, acting on behalf of Drainage District #13 in Buena Vista County, appoint an independent qualified engineer to make the necessary investigation, report and survey in this situation.
  
5. That these petitioners, being the owners of lands which are a part of this drainage district, are entitled to adequate drainage from improvements in this drainage district for such lands.
  
6. That these petitioners are signing this petition pursuant to Section 468.126 of the Code of Iowa.



**APPENDIX B:**  
**ENGINEER'S ESTIMATE OF PROBABLE COSTS**  
**FOR IMPROVEMENT**



**Project: Drainage District #13 Improvements Project**  
**BEI Project No.: E2401:**  
**Owner: Drainage District #1:**  
**Engineer: Beck Engineering, Inc**  
**Date: October 11, 2024**

Preliminary Engineers Estimate of Construction Cost - Option I				Engineer's Estimate	
Item No.		Unit	Quantity	Price/Unit	Total Price
1	Topsoil, On-Site	CY	6,000	\$3.25	\$19,500.00
2	Excavation, Class 10	CY	1,200	\$2.75	\$3,300.00
3	Removal of Structure	EA	2	\$900.00	\$1,800.00
4	Storm Sewer, Trenched, Dual-Wall HDPE, 12" Dia.	LF	350	\$90.00	\$31,500.00
5	Storm Sewer, Trenched, Dual-Wall HDPE, 15" Dia.	LF	650	\$105.00	\$68,250.00
6	Storm Sewer, Trenched, Dual-Wall HDPE, 18" Dia.	LF	800	\$135.00	\$108,000.00
7	Storm Sewer, Trenched, Dual-Wall HDPE, 24" Dia.	LF	400	\$165.00	\$66,000.00
8	Removal of Storm Sewer	LF	2,800	\$10.00	\$28,000.00
9	Manhole, Storm Sewer, Circular Manhole, SW-401, 48" Dia.	EA	14	\$6,500.00	\$91,000.00
10	Remove Intake	EA	3	\$600.00	\$1,800.00
11	Driveway, Granular	SY	350	\$12.00	\$4,200.00
12	Temporary Traffic Control	LS	1	\$3,500.00	\$3,500.00
13	Conventional Seeding, Seeding, Fertilizing and Hydro-Mulching	AC	2.5	\$4,200.00	\$10,500.00
14	Filter Sock	LF	1,500	\$5.50	\$8,250.00
15	Filter Sock, Removal	LF	1,500	\$1.00	\$1,500.00
16	Silt Fence	LF	3,000	\$5.50	\$16,500.00
17	Silt Fence, Removal of Sediment	LF	3,000	\$1.00	\$3,000.00
18	Silt Fence, Removal of Device	LF	3,000	\$1.50	\$4,500.00
19	Stabilized Construction Entrance	SY	350	\$12.00	\$4,200.00
20	Inlet Protection Device	EA	6	\$350.00	\$2,100.00
21	Inlet Protection Device, Maintenance	EA	6	\$150.00	\$900.00
22	Mobilization	LS	1	\$35,000.00	\$35,000.00
23	Tile Exploration	LS	1	\$15,000.00	\$15,000.00
24	Tile Connections	EA	20	\$750.00	\$15,000.00
25	Inspection and Televising Existing Tile	LS	1	\$12,000.00	\$12,000.00
26	Contingency (10%)	LS	1	\$46,000.00	\$46,000.00
				<b>Total=</b>	<b>\$601,300.00</b>

Item No.	Item	Unit	Quantity	Price/Unit	Total Price
1	Construction Engineering and Administration (Time and Material Estimate)	LS	1	\$42,000.00	\$42,000.00
				<b>Total=</b>	<b>\$42,000.00</b>

Item No.	Item	Unit	Quantity	Price/Unit	Total Price
1	Temporary Easement & Damages	LS	1	\$12,000.00	\$12,000.00
				<b>Total=</b>	<b>\$12,000.00</b>

Total Project Cost = **Total= \$655,300.00**

Note: Cost estimate does not include professional, publication, or legal fees that may incur if a reclassification is required. The estimate is based upon assumptions made for the amount of damaged tile. Actual Cost may vary.



Civil Engineering - Land Surveying  
Landscape Architecture - Architecture

**Project: Drainage District #13 Improvements Project**  
**BEI Project No.: E24013**  
**Owner: Drainage District #13**  
**Engineer: Beck Engineering, Inc.**  
**Date: October 11, 2024**

Preliminary Engineers Estimate of Construction Cost Improvements Project - Option II				Engineer's Estimate	
Item No.		Unit	Quantity	Price/Unit	Total Price
1	Topsoil, On-Site	CY	21,390	\$3.25	\$69,517.50
2	Excavation, Class 10	CY	7,800	\$3.50	\$27,300.00
3	Subgrade Preparation	SY	1,350	\$9.25	\$12,487.50
4	Subbase, Modified, 6"	SY	1,350	\$12.50	\$16,875.00
5	Removal of Structure	EA	2	\$900.00	\$1,800.00
6	Storm Sewer, Trenched, Dual-Wall HDPE, 12" Dia.	LF	1,300	\$45.00	\$58,500.00
7	Storm Sewer, Trenched, RCP, 42" Dia.	LF	96	\$195.00	\$18,720.00
8	Storm Sewer, Trenched, RCP, 54" Dia.	LF	4,135	\$265.00	\$1,095,775.00
9	Removal of Storm Sewer	LF	500	\$10.00	\$5,000.00
10	Pipe Apron, RCP, 54"	EA	1	\$4,500.00	\$4,500.00
11	Manhole, Storm Sewer, Circular Manhole, SW-401, 48" Dia.	EA	1	\$6,500.00	\$6,500.00
12	Manhole, Storm Sewer, Circular Manhole, SW-401, 96" Dia.	EA	7	\$14,000.00	\$98,000.00
13	Intake, Storm Sewer, Open Sided Area Intake, SW-513, 60"x 60"	EA	2	\$7,500.00	\$15,000.00
14	Intake, Storm Sewer, Open Sided Area Intake, SW-513, 72"x72"	EA	1	\$9,000.00	\$9,000.00
15	Remove Intake	EA	3	\$600.00	\$1,800.00
16	Pavement, Standard, PCC, 8"	SY	1,200	\$75.00	\$90,000.00
17	Driveway, Granular	SY	350	\$12.00	\$4,200.00
18	Pavement Removal	SY	1,200	\$10.00	\$12,000.00
19	Temporary Traffic Control	LS	1	\$3,500.00	\$3,500.00
20	Conventional Seeding, Seeding, Fertilizing and Hydro-Mulching	AC	6.5	\$3,500.00	\$22,750.00
21	Storm Water Pollution Prevention Plan, Preparation	LS	1	\$2,000.00	\$2,000.00
22	Storm Water Pollution Prevention Plan, Management	LS	1	\$2,500.00	\$2,500.00
23	Filter Sock	LF	1,500	\$5.50	\$8,250.00
24	Filter Sock, Removal	LF	1,500	\$1.00	\$1,500.00
25	Temporary RECP	SY	8,500	\$4.25	\$36,125.00
26	Rip Rap	TON	250	\$80.00	\$20,000.00
27	Silt Fence	LF	3,000	\$5.50	\$16,500.00
28	Silt Fence, Removal of Sediment	LF	3,000	\$1.00	\$3,000.00
29	Silt Fence, Removal of Device	LF	3,000	\$1.50	\$4,500.00
30	Stabilized Construction Entrance	SY	350	\$12.00	\$4,200.00
31	Inlet Protection Device	EA	6	\$350.00	\$2,100.00
32	Inlet Protection Device, Maintenance	EA	6	\$150.00	\$900.00
33	Removal of Fence	LF	50	\$15.00	\$750.00
34	Mobilization	LS	1	\$145,000.00	\$145,000.00
35	Concrete Washout	LS	1	\$1,200.00	\$1,200.00
36	Tile Exploration	LS	1	\$15,000.00	\$15,000.00
37	Tile Connections	EA	20	\$750.00	\$15,000.00
38	Inspection and Televising Existing Tile	LS	1	\$12,000.00	\$12,000.00
39	Contingency (10%)	LS	1	\$185,000.00	\$185,000.00
40	Geotechnical Services and Testing	LS	1	\$3,500.00	\$3,500.00
				Total=	\$2,052,250.00

Item No.	Item	Unit	Quantity	Price/Unit	Total Price
1	Professional Design Services	LS	1	\$184,700.00	\$184,700.00
2	Construction Engineering and Administration	LS	1	\$123,100.00	\$123,100.00
				Total=	\$307,800.00

Item No.	Item	Unit	Quantity	Price/Unit	Total Price
1	Permanent Easement (2.61 Acres @ \$12,000)	ACRE	3	\$12,000.00	\$31,320.00
2	Temporary Easement & Damages	LS	1	\$12,000.00	\$12,000.00
				Total=	\$43,320.00

Total Project Cost = Total= \$2,403,370.00

Note: Cost estimate does not include professional, publication or legal fees that may incur if a reclassification is required.



**Project: Drainage District #13 Improvements Project**  
**BEI Project No.: E24013**  
**Owner: Drainage District #13**  
**Engineer: Beck Engineering, Inc.**  
**Date: October 11, 2024**

Preliminary Engineers Estimate of Construction Cost Improvements Project - Option III				Engineer's Estimate	
Item No.		Unit	Quantity	Price/Unit	Total Price
1	Topsoil, On-Site	CY	21,390	\$3.25	\$69,517.50
2	Excavation, Class 10	CY	7,800	\$3.50	\$27,300.00
3	Subgrade Preparation	SY	1,350	\$9.25	\$12,487.50
4	Subbase, Modified, 6"	SY	1,350	\$12.50	\$16,875.00
5	Removal of Structure	EA	2	\$900.00	\$1,800.00
6	Storm Sewer, Trenched, Dual-Wall HDPE, 12" Dia.	LF	1,300	\$45.00	\$58,500.00
7	Storm Sewer, Trenched, RCP, 15" Dia.	LF	96	\$90.00	\$8,640.00
8	Storm Sewer, Trenched, RCP, 18" Dia.	LF	394	\$110.00	\$43,340.00
9	Storm Sewer, Trenched, RCP, 24" Dia.	LF	2,995	\$135.00	\$404,325.00
10	Storm Sewer, Trenched, RCP, 36" Dia.	LF	702	\$185.00	\$129,870.00
11	Removal of Storm Sewer	LF	500	\$10.00	\$5,000.00
12	Pipe Apron, RCP, 36"	EA	1	\$4,500.00	\$4,500.00
13	Manhole, Storm Sewer, Circular Manhole, SW-401, 48" Dia.	EA	8	\$6,500.00	\$52,000.00
14	Intake, Storm Sewer, Open Sided Area Intake, SW-513, 48"x 48"	EA	2	\$6,900.00	\$13,800.00
15	Intake, Storm Sewer, Open Sided Area Intake, SW-513, 54"x54"	EA	1	\$7,600.00	\$7,600.00
16	Remove Intake	EA	3	\$600.00	\$1,800.00
17	Pavement, Standard, PCC, 8"	SY	1,200	\$100.00	\$120,000.00
18	Driveway, Granular	SY	350	\$12.00	\$4,200.00
19	Pavement Removal	SY	1,200	\$10.00	\$12,000.00
20	Temporary Traffic Control	LS	1	\$3,500.00	\$3,500.00
21	Conventional Seeding, Seeding, Fertilizing and Hydro-Mulching	AC	6.5	\$3,500.00	\$22,750.00
22	Storm Water Pollution Prevention Plan, Preparation	LS	1	\$2,000.00	\$2,000.00
23	Storm Water Pollution Prevention Plan, Management	LS	1	\$2,500.00	\$2,500.00
24	Filter Sock	LF	1,500	\$5.50	\$8,250.00
25	Filter Sock, Removal	LF	1,500	\$1.00	\$1,500.00
26	Temporary RECP	SY	8,500	\$4.25	\$36,125.00
27	Rip Rap	TON	250	\$80.00	\$20,000.00
28	Silt Fence	LF	3,000	\$5.50	\$16,500.00
29	Silt Fence, Removal of Sediment	LF	3,000	\$1.00	\$3,000.00
30	Silt Fence, Removal of Device	LF	3,000	\$1.50	\$4,500.00
31	Stabilized Construction Entrance	SY	350	\$12.00	\$4,200.00
32	Inlet Protection Device	EA	6	\$350.00	\$2,100.00
33	Inlet Protection Device, Maintenance	EA	6	\$150.00	\$900.00
34	Removal of Fence	LF	50	\$15.00	\$750.00
35	Mobilization	LS	1	\$98,000.00	\$98,000.00
36	Concrete Washout	LS	1	\$1,200.00	\$1,200.00
37	Tile Exploration	LS	1	\$15,000.00	\$15,000.00
38	Tile Connections	EA	20	\$750.00	\$15,000.00
39	Inspection and Televising Existing Tile	LS	1	\$12,000.00	\$12,000.00
40	Contingency (10%)	LS	1	\$60,000.00	\$60,000.00
41	Geotechnical Services and Testing	LS	1	\$3,500.00	\$3,500.00
				<b>Total=</b>	<b>\$1,326,830.00</b>

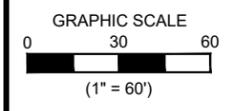
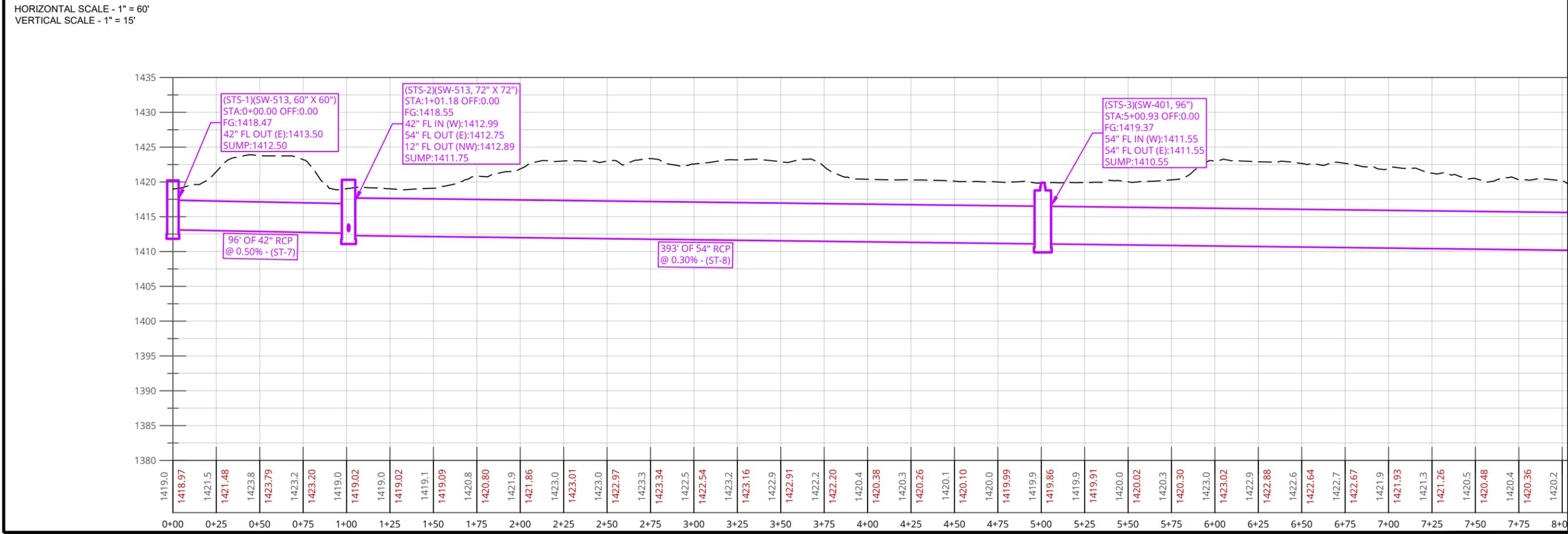
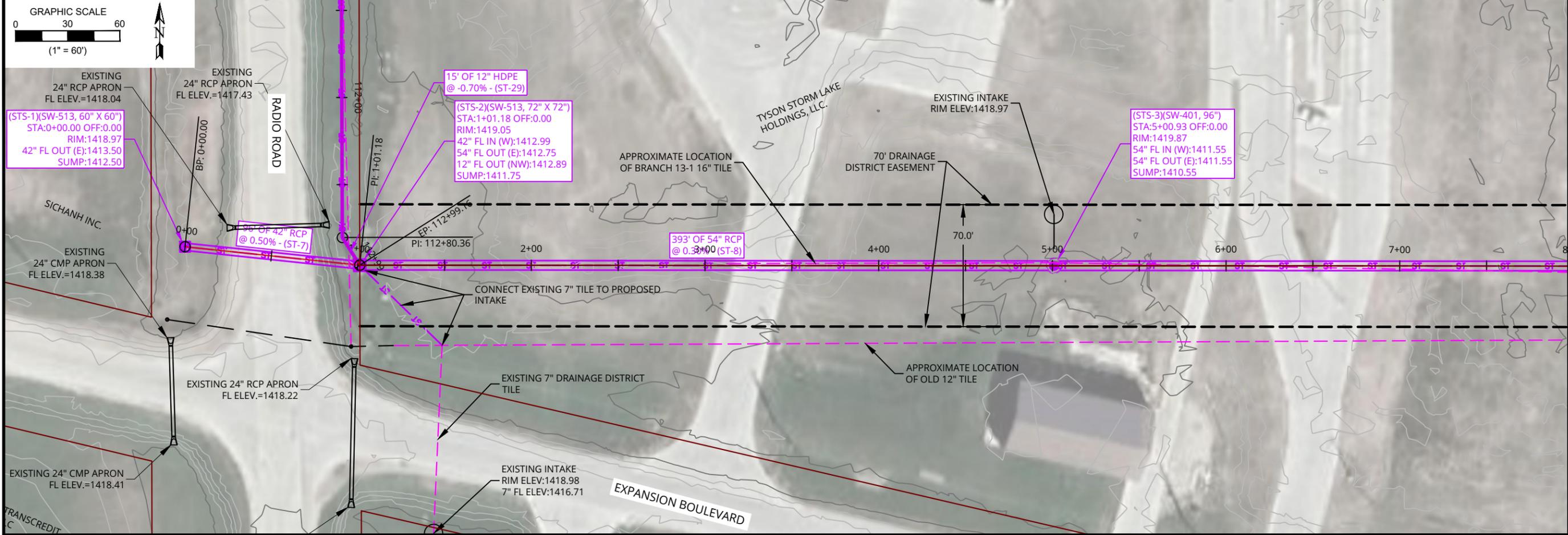
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1	Professional Design Services	LS	1	\$119,400.00	\$119,400.00
2	Construction Engineering and Administration	LS	1	\$79,600.00	\$79,600.00
				<b>Total=</b>	<b>\$199,000.00</b>

Item No.	Item	Unit	Quantity	Price/Unit	Total Price
1	Permanent Easement (2.61 Acres @ \$12,000)	ACRE	2.61	\$12,000.00	\$31,320.00
2	Temporary Easement & Damages	LS	1	\$12,000.00	\$12,000.00
				<b>Total=</b>	<b>\$43,320.00</b>

Total Project Cost = **Total= \$1,569,150.00**

Note: Cost estimate does not include professional, publication, or legal fees that may incur if a reclassification is required.

**APPENDIX C:**  
**PRELIMINARY PLAN SET**



HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'

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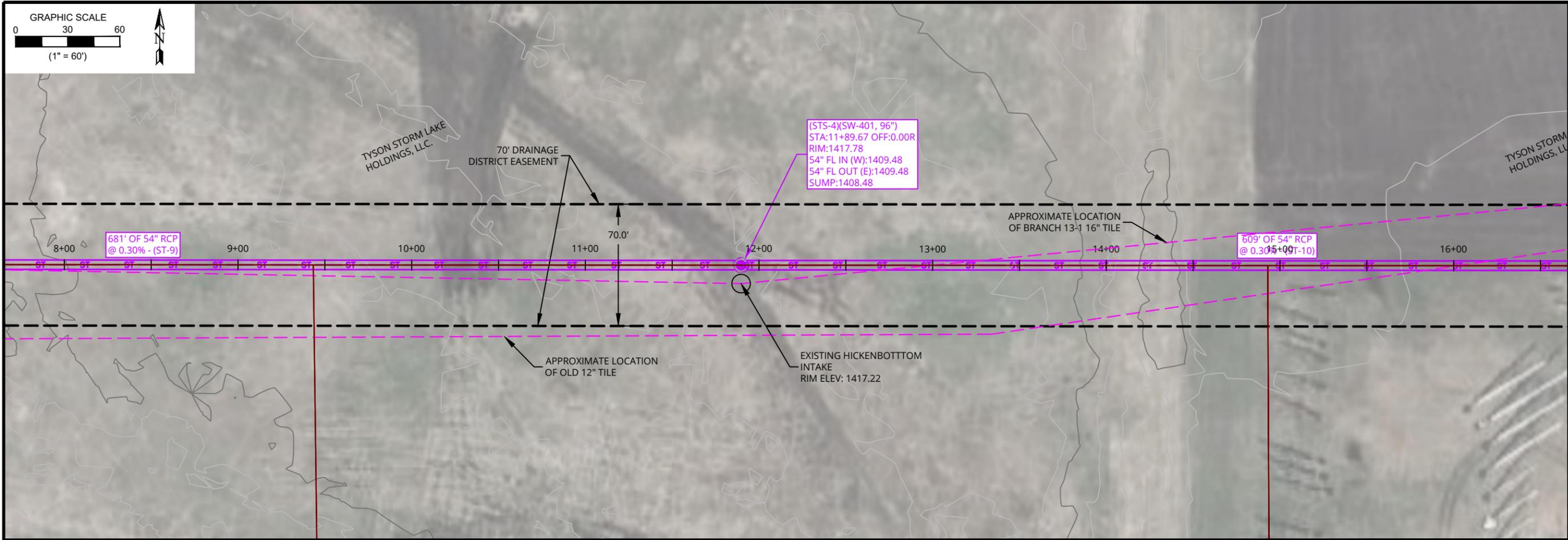
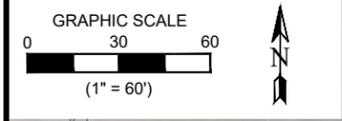
Client:  
 Drainage District #13  
 620 Erie Street  
 Storm Lake, IA 50588

Beck Engineering, Inc.  
 Cherokee, Iowa Clive, Iowa  
 Orange City, Iowa Sheldon, Iowa  
 Spirit Lake, Iowa

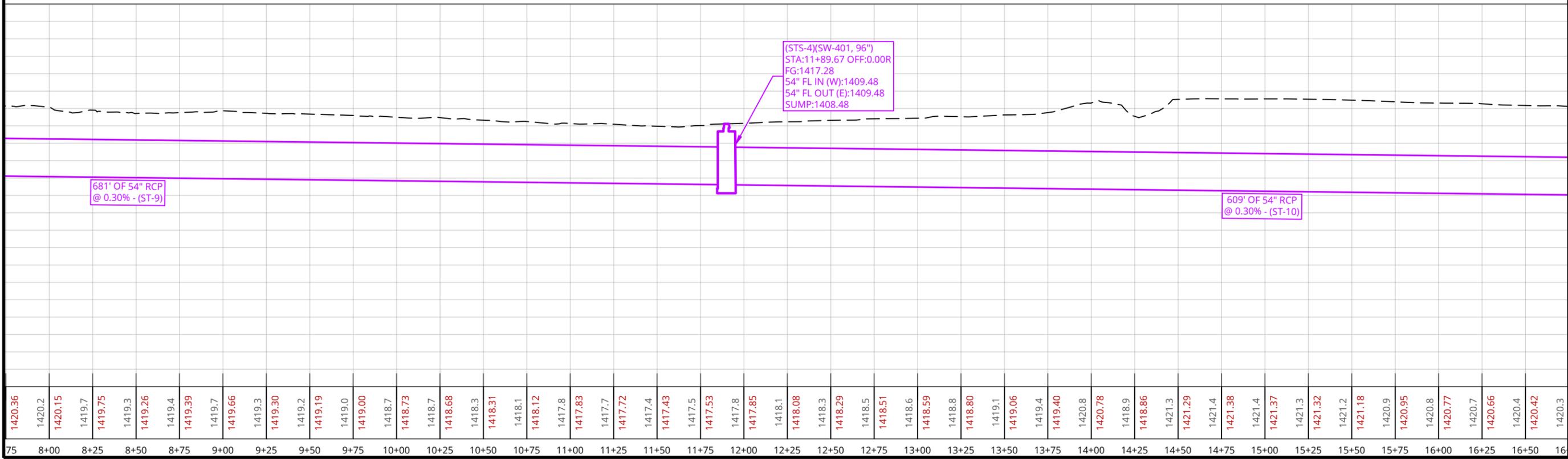


Drainage District #13  
 Preliminary Engineering Report  
 Plan and Profile Sheet

Drawn	09-30-24 By JGH	Checked by	JGH
Revised		Project No.	E24013
Sheet D.01			



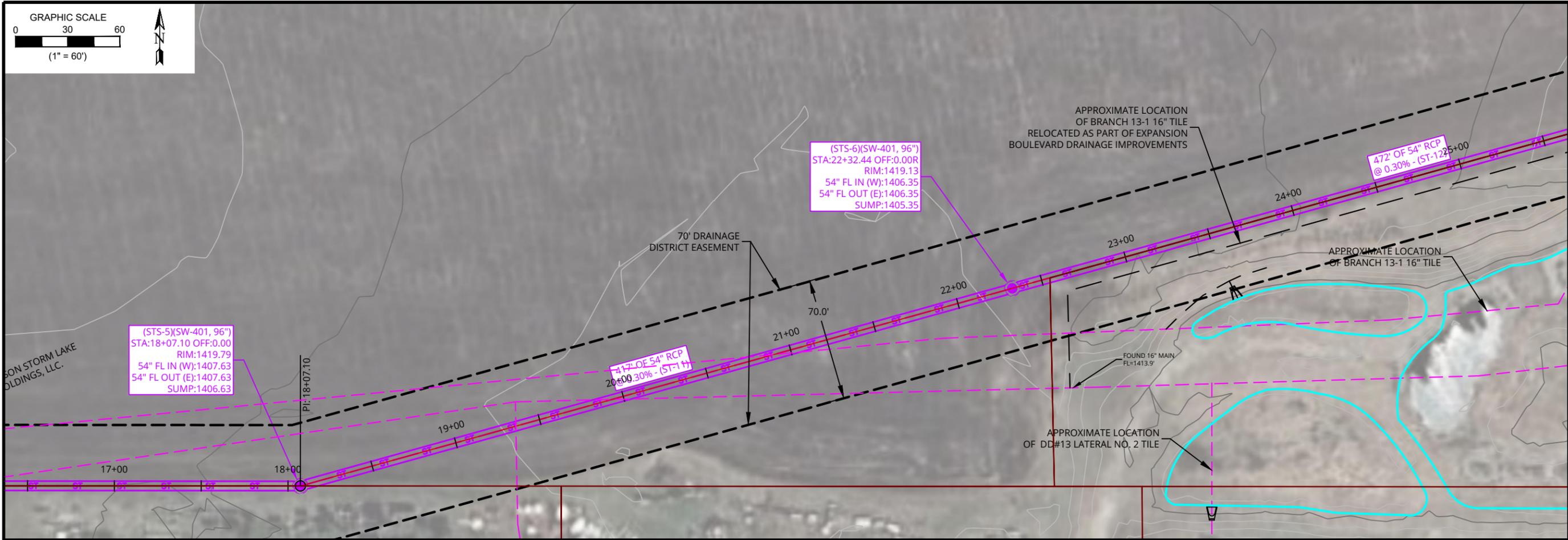
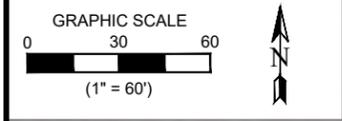
HORIZONTAL SCALE - 1" = 60'  
VERTICAL SCALE - 1" = 15'



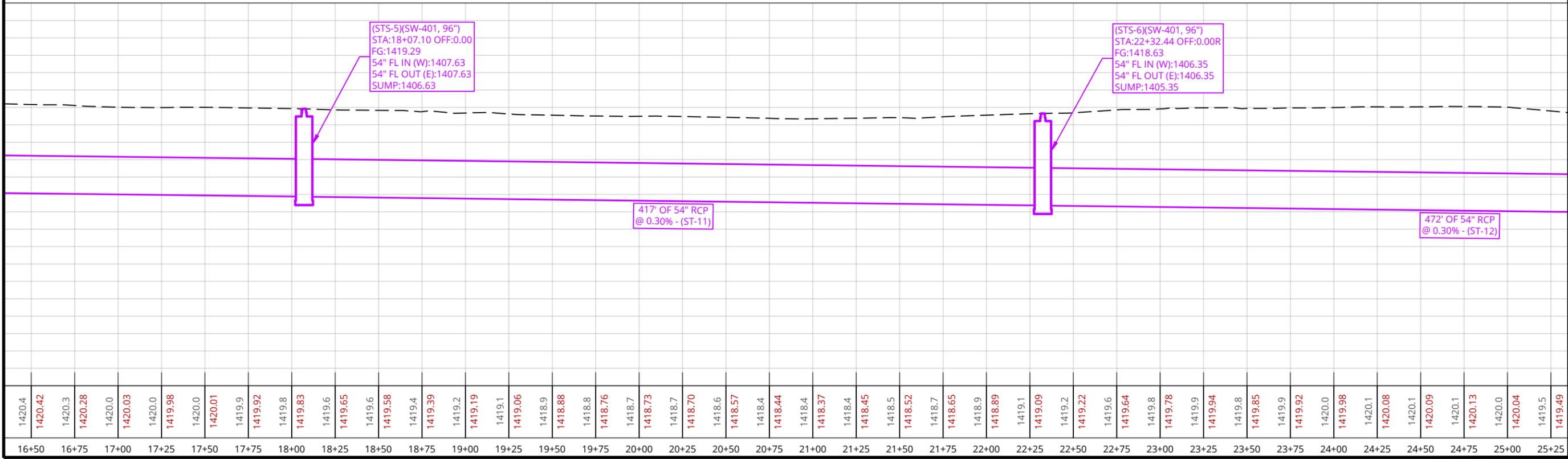
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75	8+00	8+25	8+50	8+75	9+00	9+25	9+50	9+75	10+00	10+25	10+50	10+75	11+00	11+25	11+50	11+75	12+00	12+25	12+50	12+75	13+00	13+25	13+50	13+75	14+00	14+25	14+50	14+75	15+00	15+25	15+50	15+75	16+00	16+25	16+50	16																																			

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Beck Engineering, Inc.	Cherokee, Iowa	Clive, Iowa	Spirit Lake, Iowa
Beck Engineering, Inc.	Orange City, Iowa	Sheldon, Iowa	Spirit Lake, Iowa
			
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HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



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 Drainage District #13  
 620 Erie Street  
 Storm Lake, IA 50588

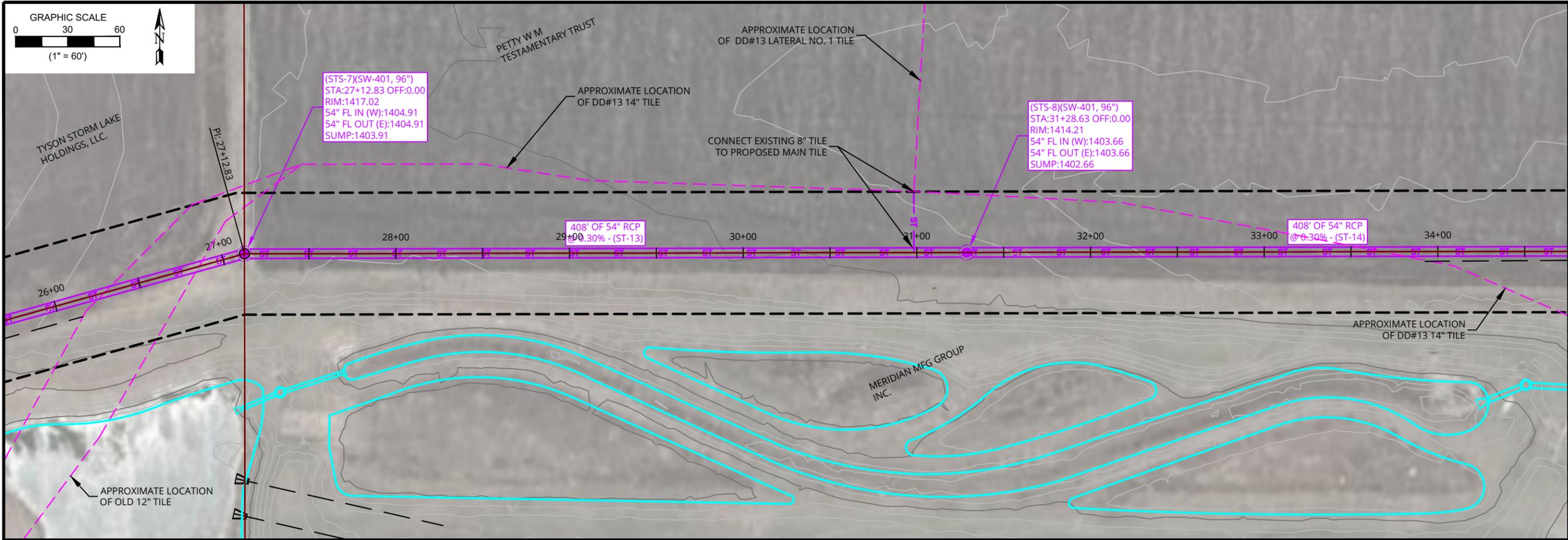
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Cherokee, Iowa	Sheldon, Iowa
Orange City, Iowa	Spirit Lake, Iowa



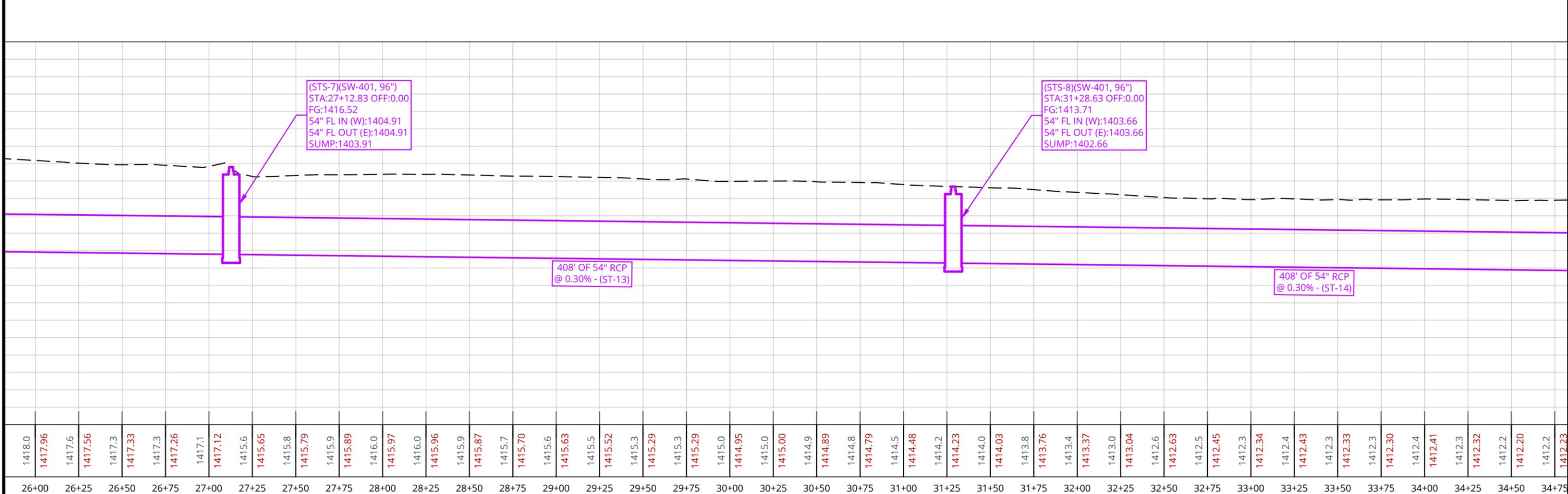
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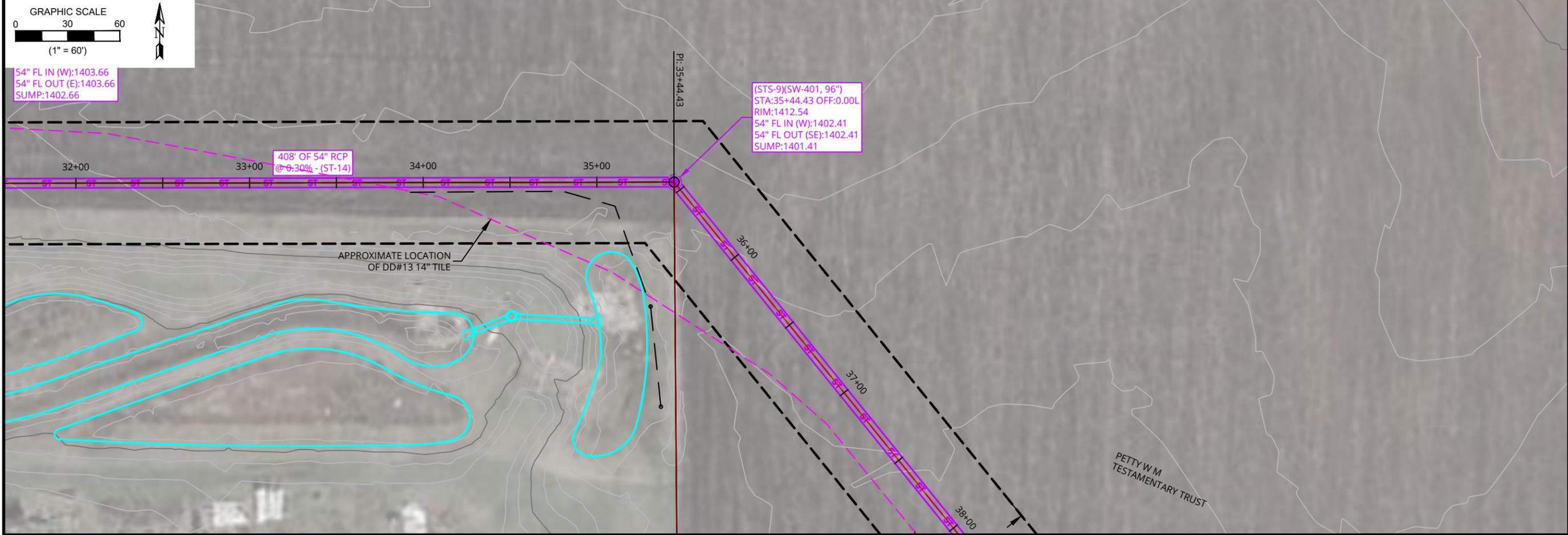
HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



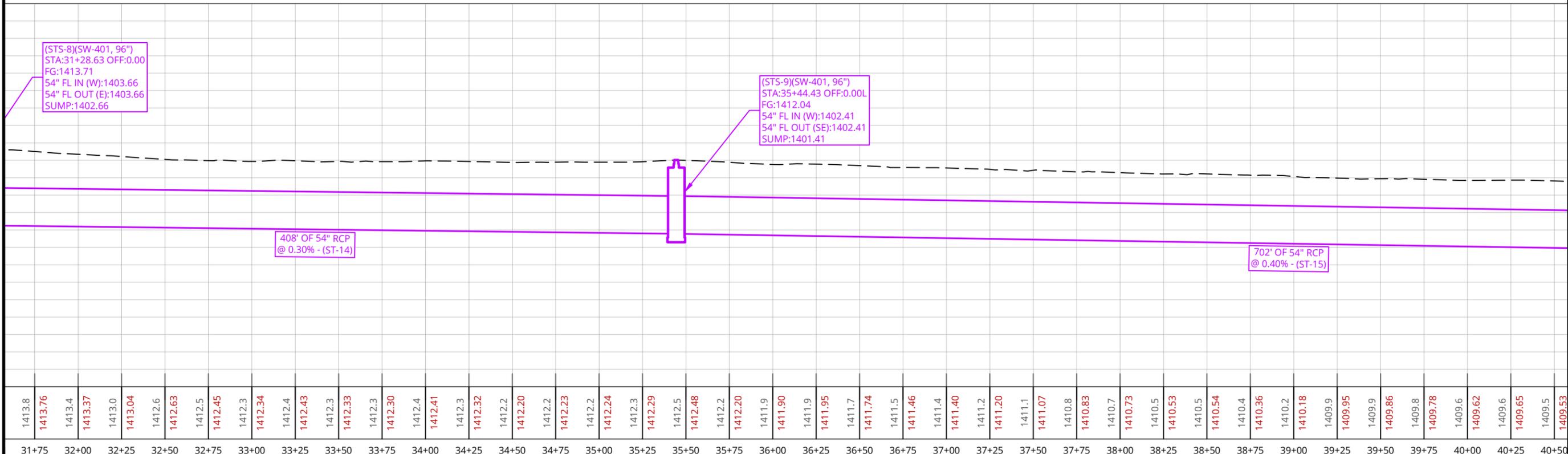
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26+00	26+25	26+50	26+75	27+00	27+25	27+50	27+75	28+00	28+25	28+50	28+75	29+00	29+25	29+50	29+75	30+00	30+25	30+50	30+75	31+00	31+25	31+50	31+75	32+00	32+25	32+50	32+75	33+00	33+25	33+50	33+75	34+00	34+25	34+50	34+75																																				

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Clive, Iowa	Sheldon, Iowa
Spirit Lake, Iowa	
 <small>Civil Engineering • Land Surveying Landscape Architecture • Architecture</small>	
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HORIZONTAL SCALE - 1" = 60'  
VERTICAL SCALE - 1" = 15'

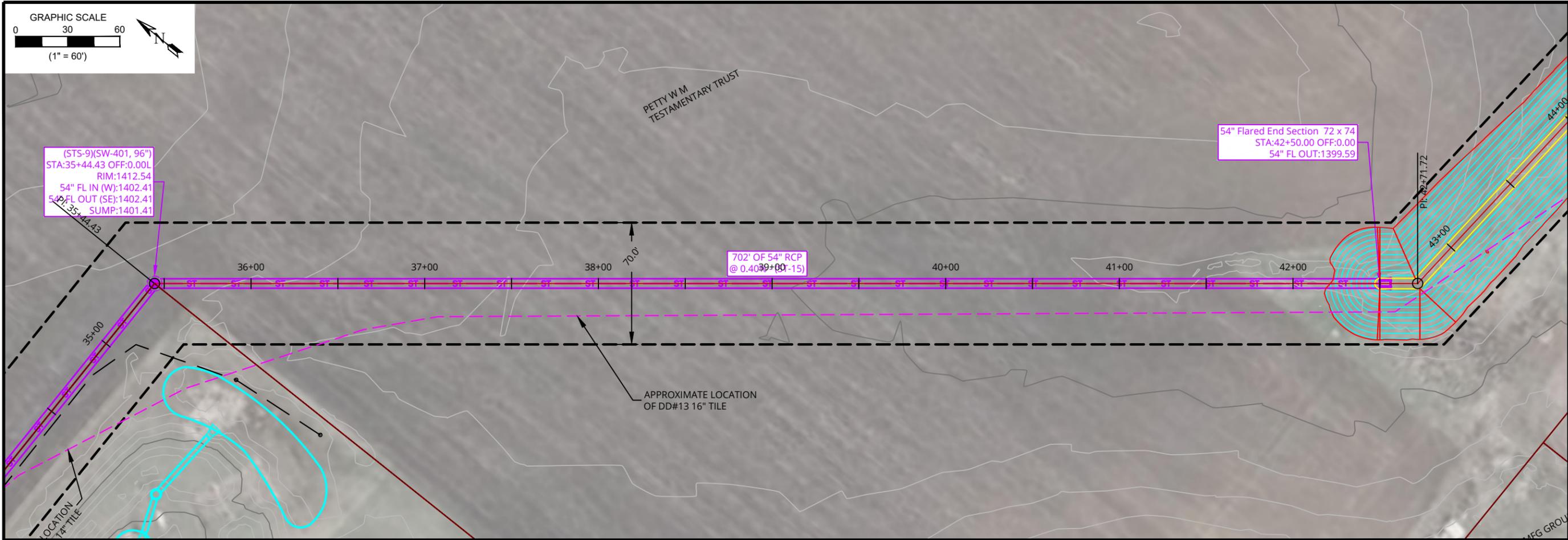
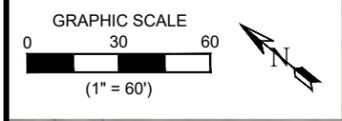


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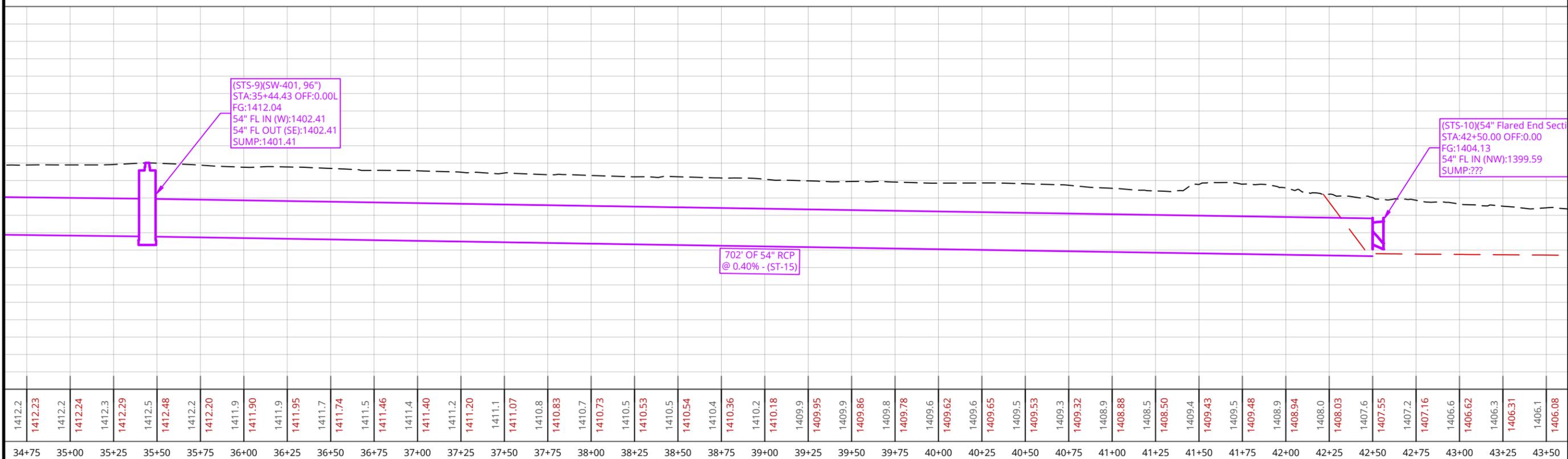
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Checked by	JGH	Project No. E24013	
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Drawn Revised





HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



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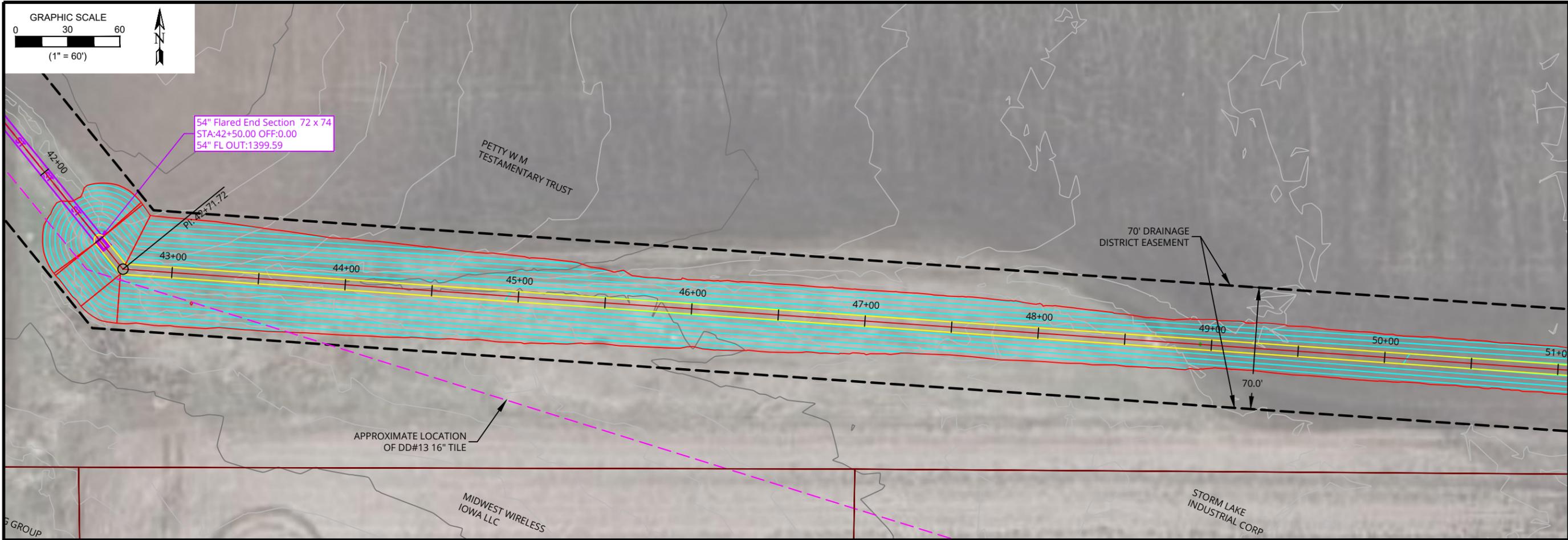
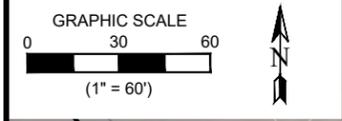
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Orange City, Iowa	Spirit Lake, Iowa

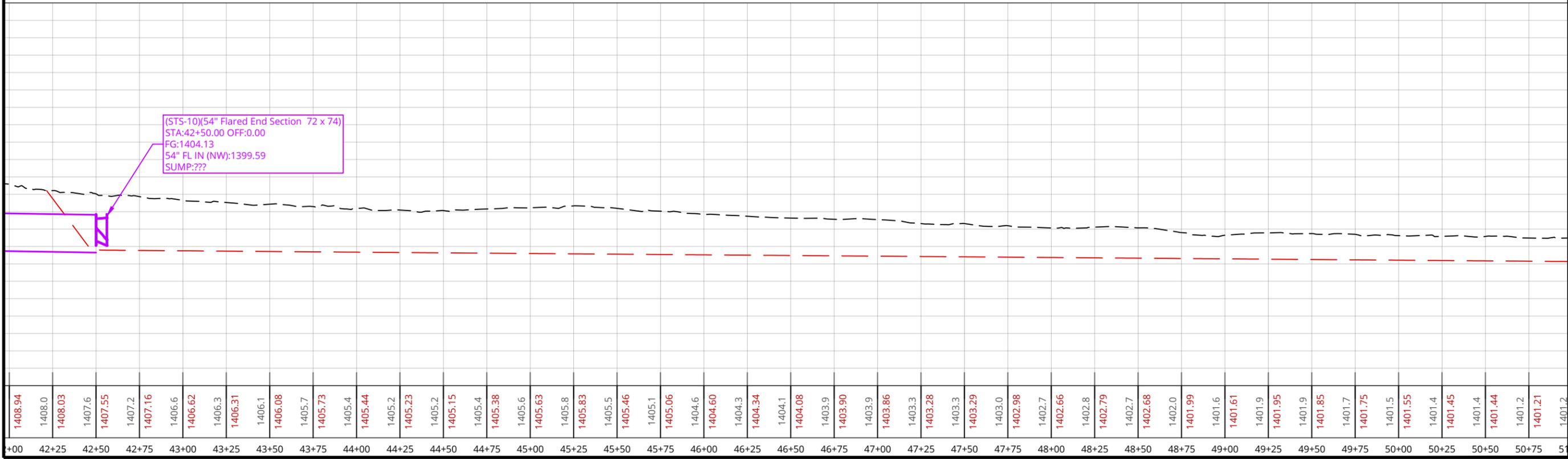


Drainage District #13  
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HORIZONTAL SCALE - 1" = 60'  
VERTICAL SCALE - 1" = 15'



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Storm Lake, IA 50588

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Orange City, Iowa Sheldon, Iowa  
Spirit Lake, Iowa

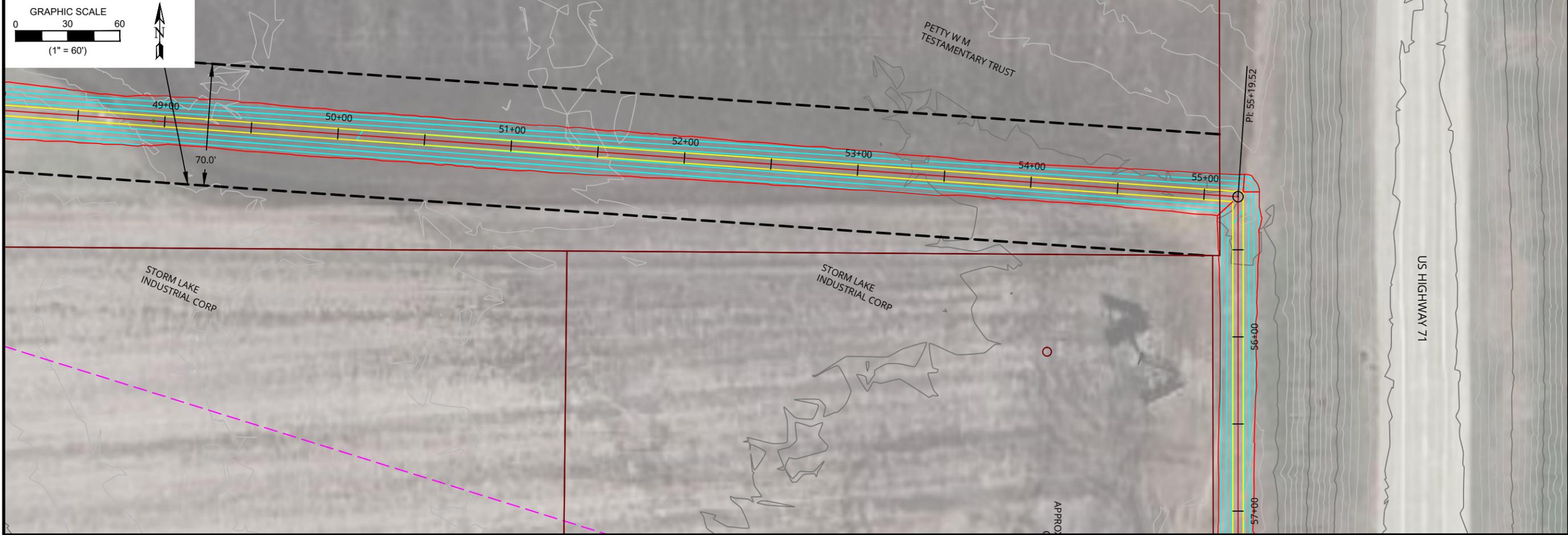


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Plan and Profile Sheet

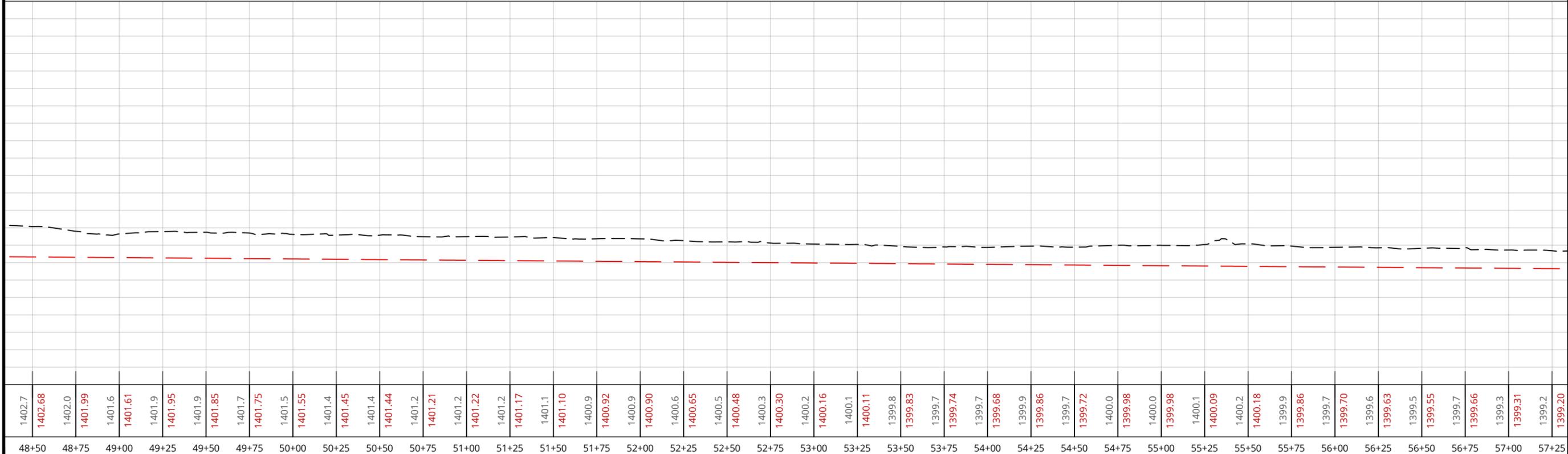
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HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



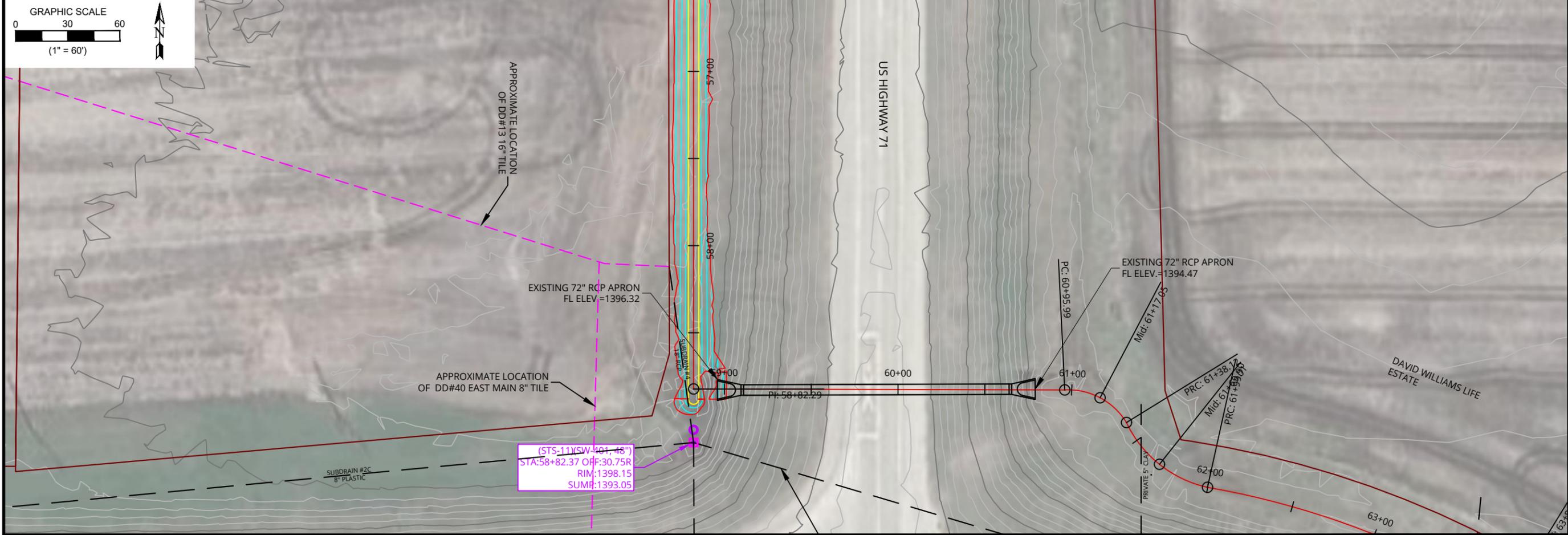
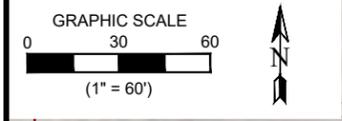
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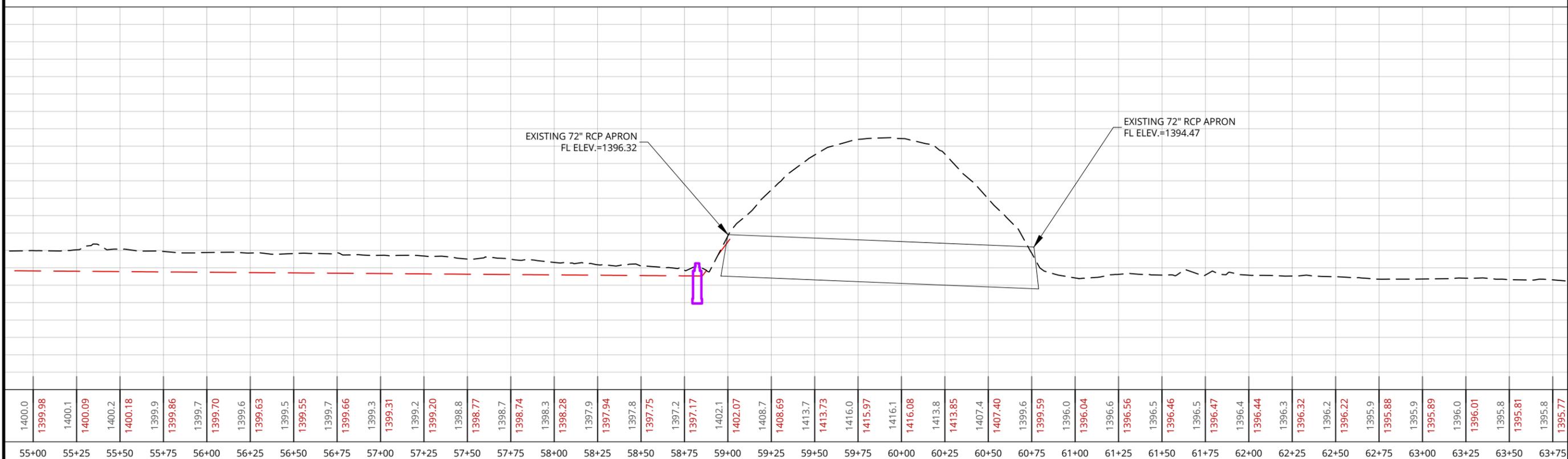


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HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



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55+00	55+25	55+50	55+75	56+00	56+25	56+50	56+75	57+00	57+25	57+50	57+75	58+00	58+25	58+50	58+75	59+00	59+25	59+50	59+75	60+00	60+25	60+50	60+75	61+00	61+25	61+50	61+75	62+00	62+25	62+50	62+75	63+00	63+25	63+50	63+75																																				

Client:  
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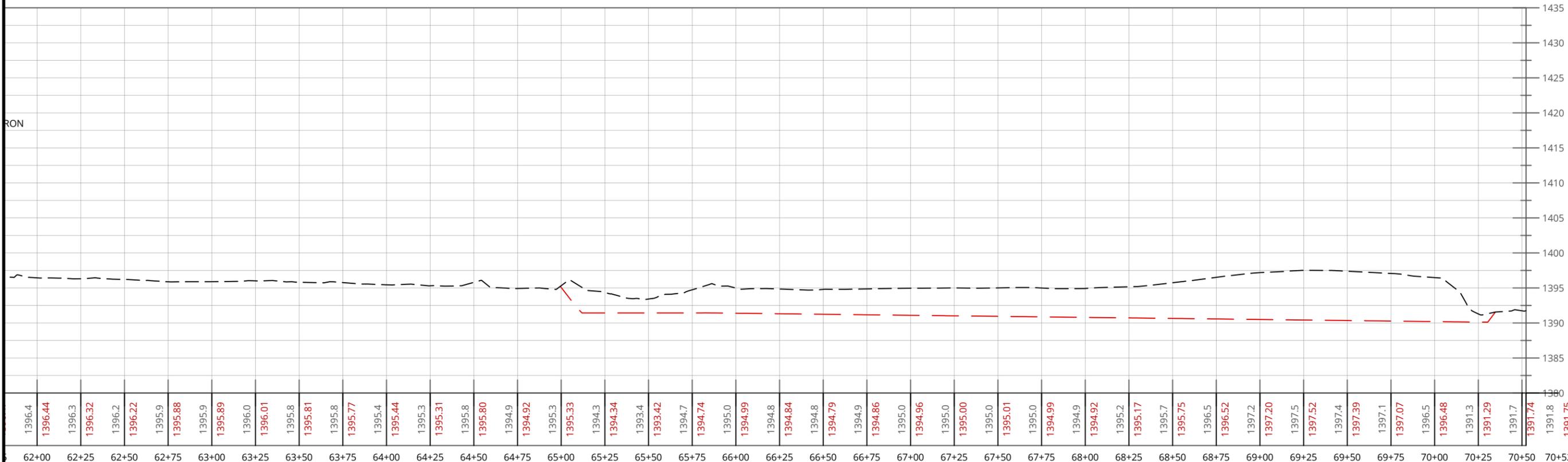
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 E24013

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 Revised  
 Sheet D.09



HORIZONTAL SCALE - 1" = 60'  
 VERTICAL SCALE - 1" = 15'



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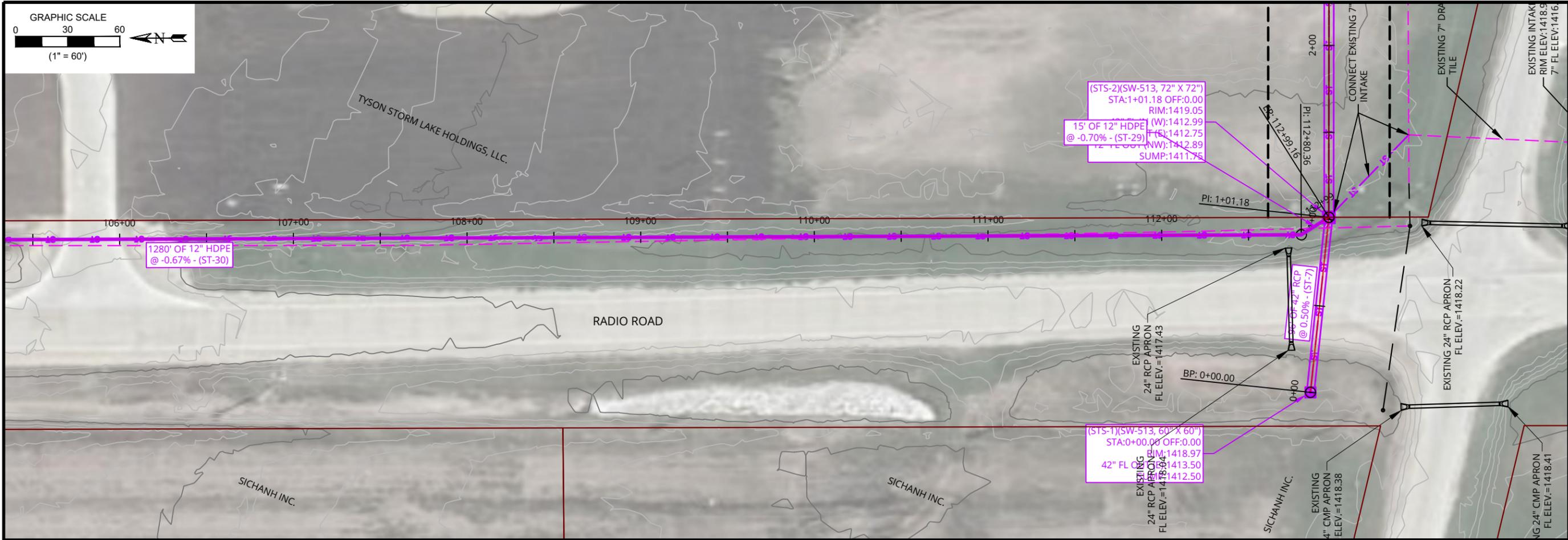
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Orange City, Iowa	Spirit Lake, Iowa



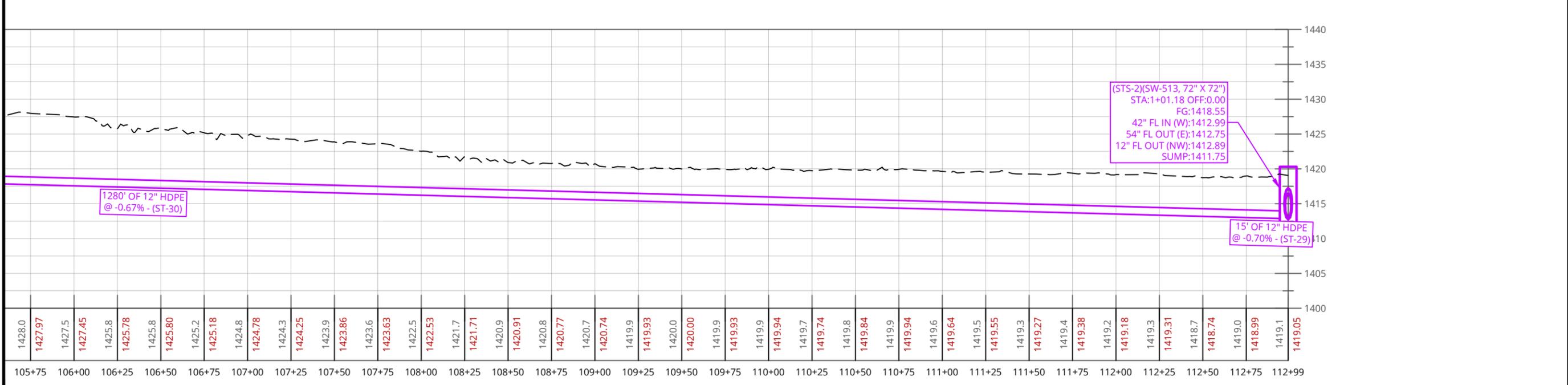
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HORIZONTAL SCALE - 1" = 60'  
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 620 Erie Street  
 Storm Lake, IA 50588

**Beck Engineering, Inc.**  
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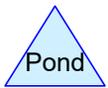
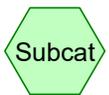
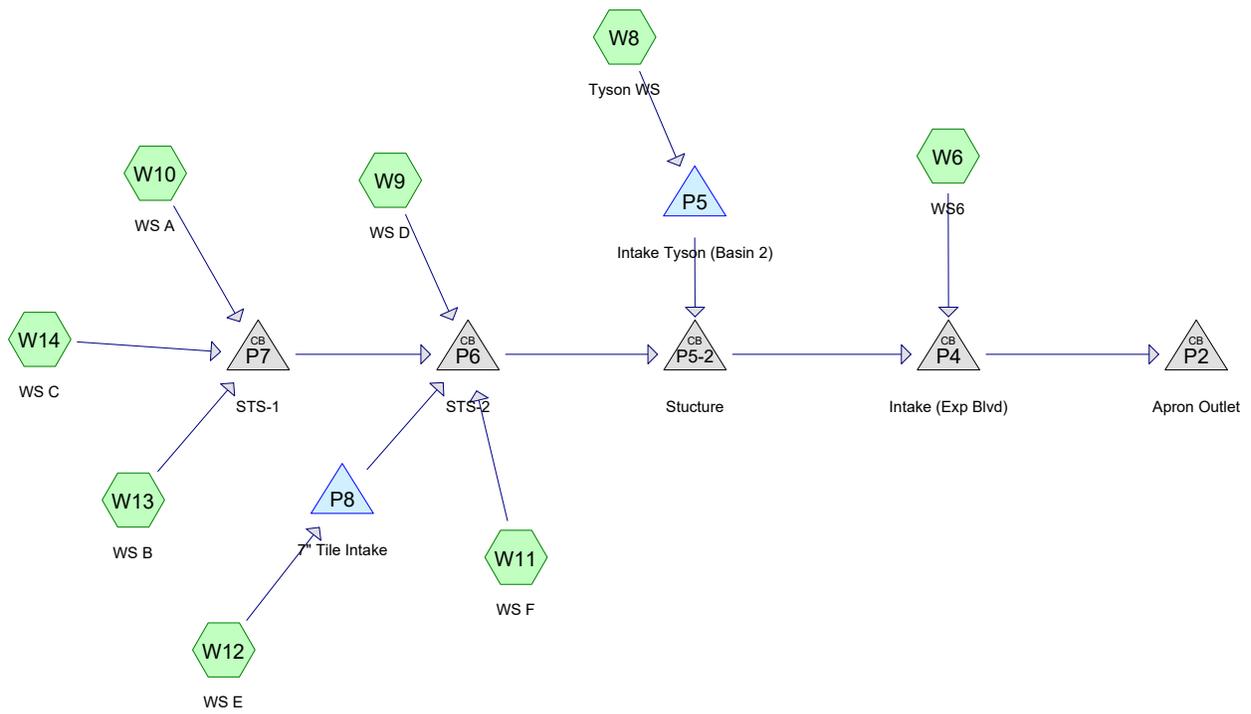


**Drainage District #13**  
 Preliminary Engineering Report  
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**APPENDIX D:**  
**STORMWATER CALCULATIONS AND MODELING**



**Routing Diagram for DD13 Main Tile - 5-Year Discharge**  
 Prepared by Beck Engineering, Inc., Printed 11/26/2024  
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## DD13 Main Tile - 5-Year Discharge

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### Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
11.560	74	>75% Grass cover, Good, HSG C (W13)
4.330	71	Meadow, non-grazed, HSG C (W12)
28.160	78	Meadow, non-grazed, HSG D (W12, W8)
3.340	98	Paved parking, HSG C (W8)
22.440	75	Row crops, SR + CR, Good, HSG B (W14, W6)
35.140	82	Row crops, SR + CR, Good, HSG C (W6, W8)
78.890	85	Row crops, SR + CR, Good, HSG D (W6, W8)
1.720	72	Small grain, SR + CR, Good, HSG B (W8)
11.370	94	Urban commercial, 85% imp, HSG C (W10)
6.130	88	Urban industrial, 72% imp, HSG B (W11)
30.220	91	Urban industrial, 72% imp, HSG C (W11, W13, W9)
<b>233.300</b>	<b>83</b>	<b>TOTAL AREA</b>

# DD13 Main Tile - 5-Year Discharge

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## Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
30.290	HSG B	W11, W14, W6, W8
95.960	HSG C	W10, W11, W12, W13, W6, W8, W9
107.050	HSG D	W12, W6, W8
0.000	Other	
<b>233.300</b>		<b>TOTAL AREA</b>

# DD13 Main Tile - 5-Year Discharge

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## Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	11.560	0.000	0.000	11.560	>75% Grass cover, Good	W13
0.000	0.000	4.330	28.160	0.000	32.490	Meadow, non-grazed	W12, W8
0.000	0.000	3.340	0.000	0.000	3.340	Paved parking	W8
0.000	22.440	35.140	78.890	0.000	136.470	Row crops, SR + CR, Good	W14, W6, W8
0.000	1.720	0.000	0.000	0.000	1.720	Small grain, SR + CR, Good	W8
0.000	0.000	11.370	0.000	0.000	11.370	Urban commercial, 85% imp	W10
0.000	6.130	30.220	0.000	0.000	36.350	Urban industrial, 72% imp	W11, W13, W9
<b>0.000</b>	<b>30.290</b>	<b>95.960</b>	<b>107.050</b>	<b>0.000</b>	<b>233.300</b>	<b>TOTAL AREA</b>	

## DD13 Main Tile - 5-Year Discharge

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### Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	P2	1,402.41	1,399.59	705.0	0.0040	0.011	54.0	0.0	0.0
2	P4	1,406.50	1,395.12	2,287.0	0.0050	0.011	42.0	0.0	0.0
3	P5-2	1,409.48	1,402.41	2,354.0	0.0030	0.011	54.0	0.0	0.0
4	P6	1,412.75	1,409.48	1,088.0	0.0030	0.011	54.0	0.0	0.0
5	P7	1,413.50	1,412.99	97.0	0.0053	0.011	42.0	0.0	0.0

**DD13 Main Tile - 5-Year Discharge**

Type II 24-hr 5-Year Rainfall=3.67"

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Page 6

Time span=0.05-48.00 hrs, dt=0.05 hrs, 960 points  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
 Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

<b>SubcatchmentW10: WS A</b>	Runoff Area=11.370 ac 85.00% Impervious Runoff Depth=3.00" Flow Length=2,695' Tc=45.0 min CN=94 Runoff=21.78 cfs 2.844 af
<b>SubcatchmentW11: WS F</b>	Runoff Area=18.380 ac 72.00% Impervious Runoff Depth=2.61" Flow Length=2,245' Tc=75.0 min CN=90 Runoff=21.66 cfs 3.994 af
<b>SubcatchmentW12: WS E</b>	Runoff Area=16.220 ac 0.00% Impervious Runoff Depth=1.49" Flow Length=1,627' Tc=52.3 min CN=76 Runoff=13.72 cfs 2.014 af
<b>SubcatchmentW13: WS B</b>	Runoff Area=19.060 ac 28.33% Impervious Runoff Depth=1.85" Flow Length=1,213' Tc=32.2 min CN=81 Runoff=28.90 cfs 2.934 af
<b>SubcatchmentW14: WS C</b>	Runoff Area=16.020 ac 0.00% Impervious Runoff Depth=1.42" Flow Length=1,231' Tc=37.1 min CN=75 Runoff=16.43 cfs 1.900 af
<b>SubcatchmentW6: WS6</b>	Runoff Area=98.850 ac 0.00% Impervious Runoff Depth=2.00" Flow Length=4,759' Tc=127.5 min CN=83 Runoff=59.35 cfs 16.495 af
<b>SubcatchmentW8: Tyson WS</b>	Runoff Area=42.930 ac 7.78% Impervious Runoff Depth=1.92" Flow Length=3,164' Tc=69.1 min CN=82 Runoff=39.46 cfs 6.883 af
<b>SubcatchmentW9: WS D</b>	Runoff Area=10.470 ac 72.00% Impervious Runoff Depth=2.70" Flow Length=1,210' Tc=25.1 min CN=91 Runoff=26.95 cfs 2.358 af
<b>Pond P2: Apron Outlet</b>	Peak Elev=1,406.63' Inflow=110.80 cfs 36.812 af 54.0" Round Culvert n=0.011 L=705.0' S=0.0040 ' /' Outflow=110.80 cfs 36.812 af
<b>Pond P4: Intake (Exp Blvd)</b>	Peak Elev=1,421.02' Inflow=110.80 cfs 36.812 af 42.0" Round Culvert n=0.011 L=2,287.0' S=0.0050 ' /' Outflow=110.80 cfs 36.812 af
<b>Pond P5: Intake Tyson (Basin 2)</b>	Peak Elev=1,418.31' Storage=5.018 af Inflow=39.46 cfs 6.883 af Outflow=2.30 cfs 4.292 af
<b>Pond P5-2: Structure</b>	Peak Elev=1,413.52' Inflow=98.41 cfs 20.317 af 54.0" Round Culvert n=0.011 L=2,354.0' S=0.0030 ' /' Outflow=98.41 cfs 20.317 af
<b>Pond P6: STS-2</b>	Peak Elev=1,416.86' Inflow=98.38 cfs 16.025 af 54.0" Round Culvert n=0.011 L=1,088.0' S=0.0030 ' /' Outflow=98.38 cfs 16.025 af
<b>Pond P7: STS-1</b>	Peak Elev=1,417.27' Inflow=65.41 cfs 7.678 af 42.0" Round Culvert n=0.011 L=97.0' S=0.0053 ' /' Outflow=65.41 cfs 7.678 af
<b>Pond P8: 7" Tile Intake</b>	Peak Elev=1,427.84' Storage=1.225 af Inflow=13.72 cfs 2.014 af Outflow=1.00 cfs 1.995 af

**Total Runoff Area = 233.300 ac Runoff Volume = 39.421 af Average Runoff Depth = 2.03"**  
**83.21% Pervious = 194.123 ac 16.79% Impervious = 39.176 ac**

# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W10: WS A

Runoff = 21.78 cfs @ 12.41 hrs, Volume= 2.844 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

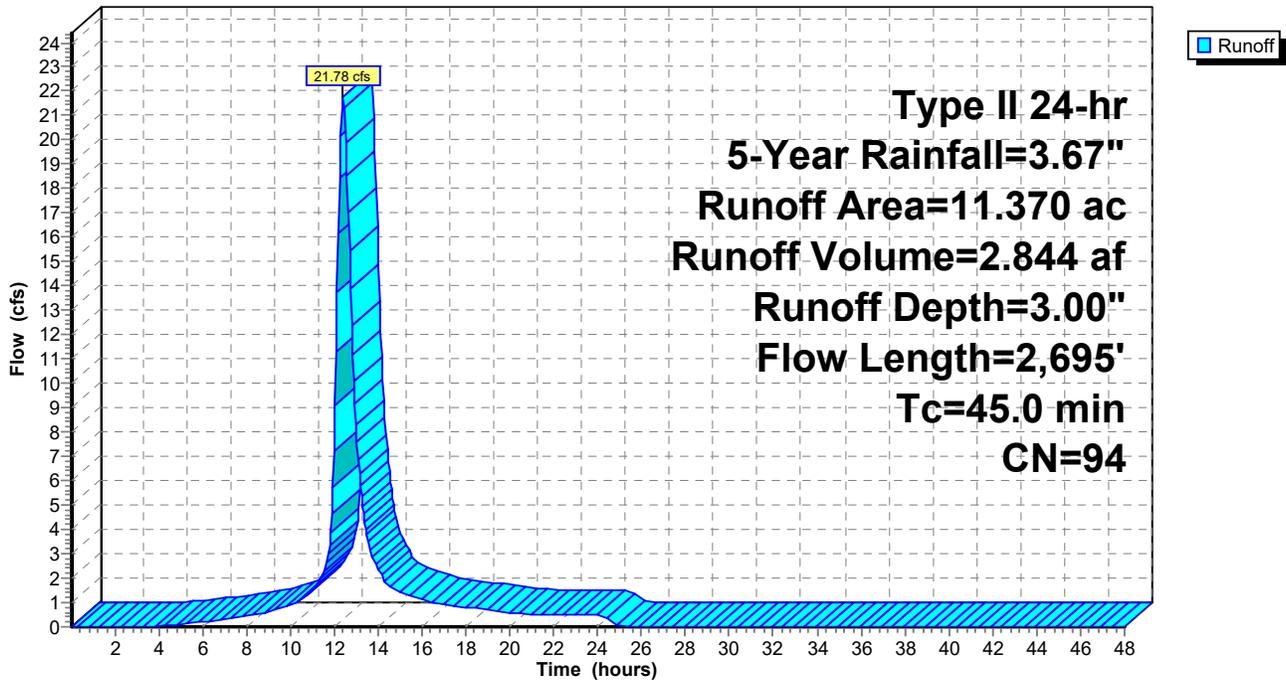
Area (ac)	CN	Description
11.370	94	Urban commercial, 85% imp, HSG C
1.706		15.00% Pervious Area
9.664		85.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	100	0.0050	0.09		<b>Sheet Flow, SF</b> Grass: Short n= 0.150 P2= 2.92"
1.4	402	0.0850	4.69		<b>Shallow Concentrated Flow, SCF</b> Unpaved Kv= 16.1 fps
25.7	2,193	0.0090	1.42		<b>Shallow Concentrated Flow, SCF</b> Grassed Waterway Kv= 15.0 fps
45.0	2,695	Total			

## Subcatchment W10: WS A

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W11: WS F

Runoff = 21.66 cfs @ 12.79 hrs, Volume= 3.994 af, Depth= 2.61"

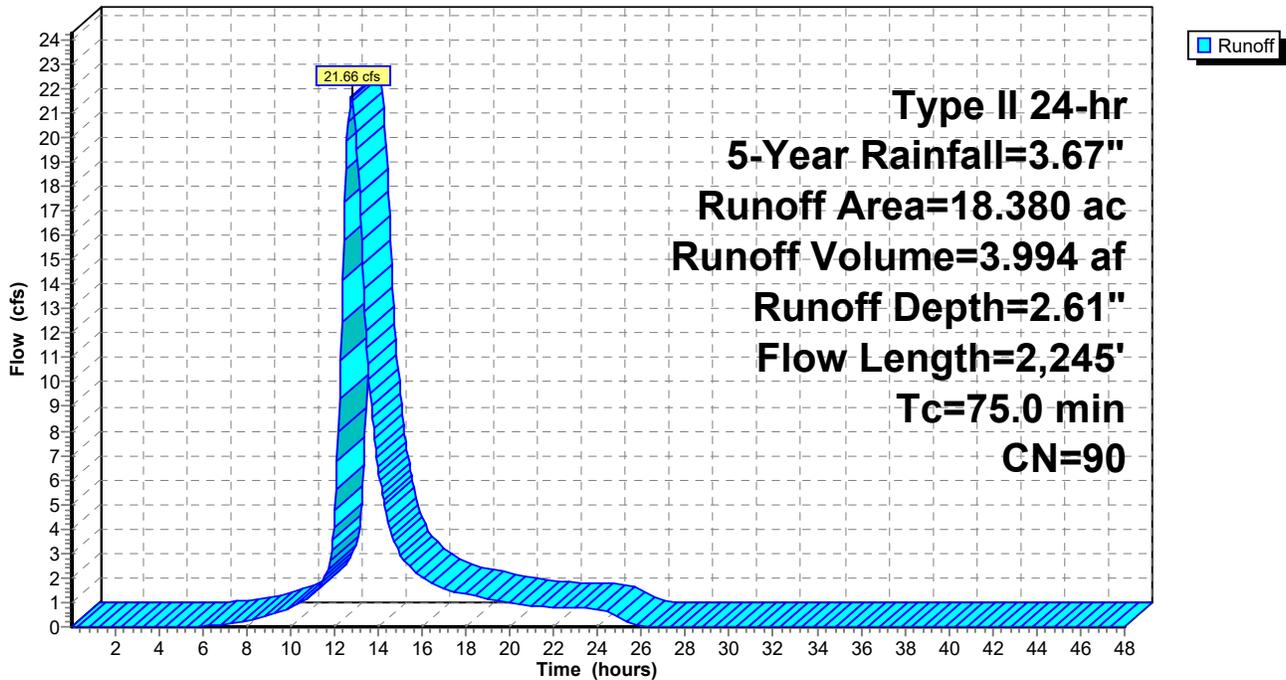
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

Area (ac)	CN	Description
6.130	88	Urban industrial, 72% imp, HSG B
12.250	91	Urban industrial, 72% imp, HSG C
18.380	90	Weighted Average
5.146		28.00% Pervious Area
13.234		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0100	0.12		<b>Sheet Flow, SF</b>
61.5	2,145	0.0015	0.58		Grass: Short n= 0.150 P2= 2.92" <b>Shallow Concentrated Flow, SCF</b>
75.0	2,245	Total			Grassed Waterway Kv= 15.0 fps

## Subcatchment W11: WS F

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W12: WS E

Runoff = 13.72 cfs @ 12.54 hrs, Volume= 2.014 af, Depth= 1.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

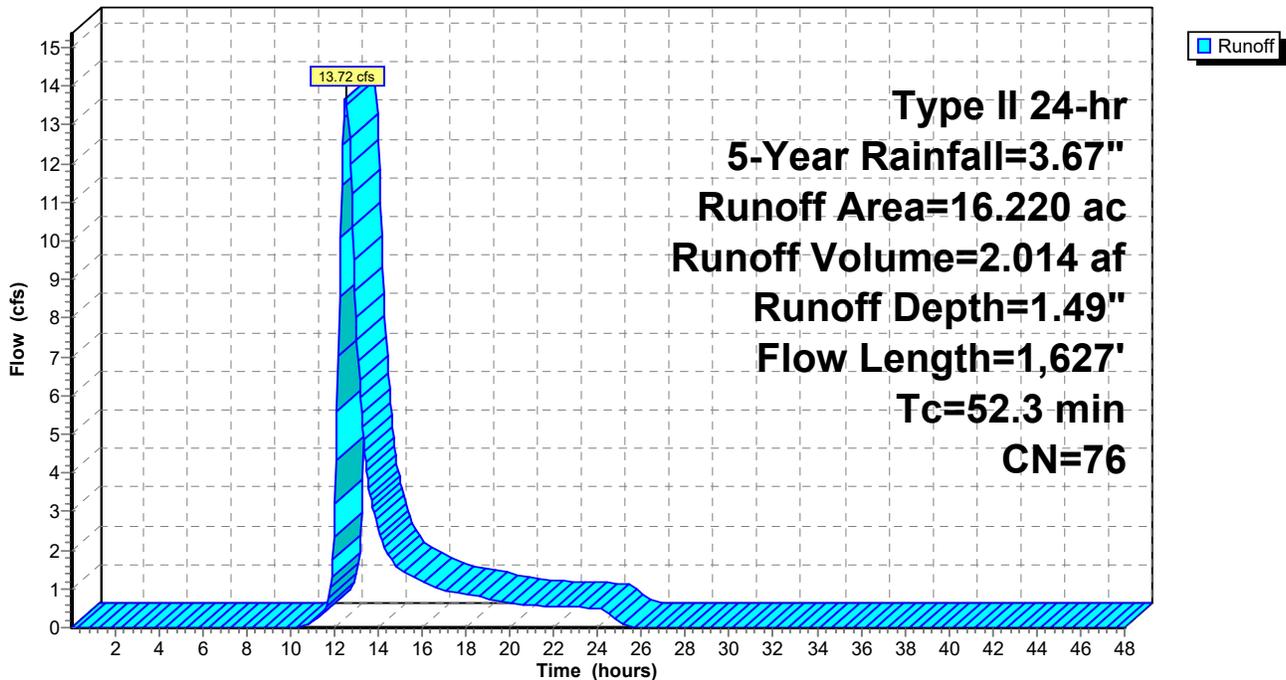
Area (ac)	CN	Description
4.330	71	Meadow, non-grazed, HSG C
11.890	78	Meadow, non-grazed, HSG D
16.220	76	Weighted Average
16.220		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	100	0.0200	0.16		<b>Sheet Flow, SF</b>
42.0	1,527	0.0075	0.61		<b>Shallow Concentrated Flow, SCF</b> Grass: Short n= 0.150 P2= 2.92"
					Short Grass Pasture Kv= 7.0 fps
52.3	1,627	Total			

## Subcatchment W12: WS E

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W13: WS B

Runoff = 28.90 cfs @ 12.27 hrs, Volume= 2.934 af, Depth= 1.85"

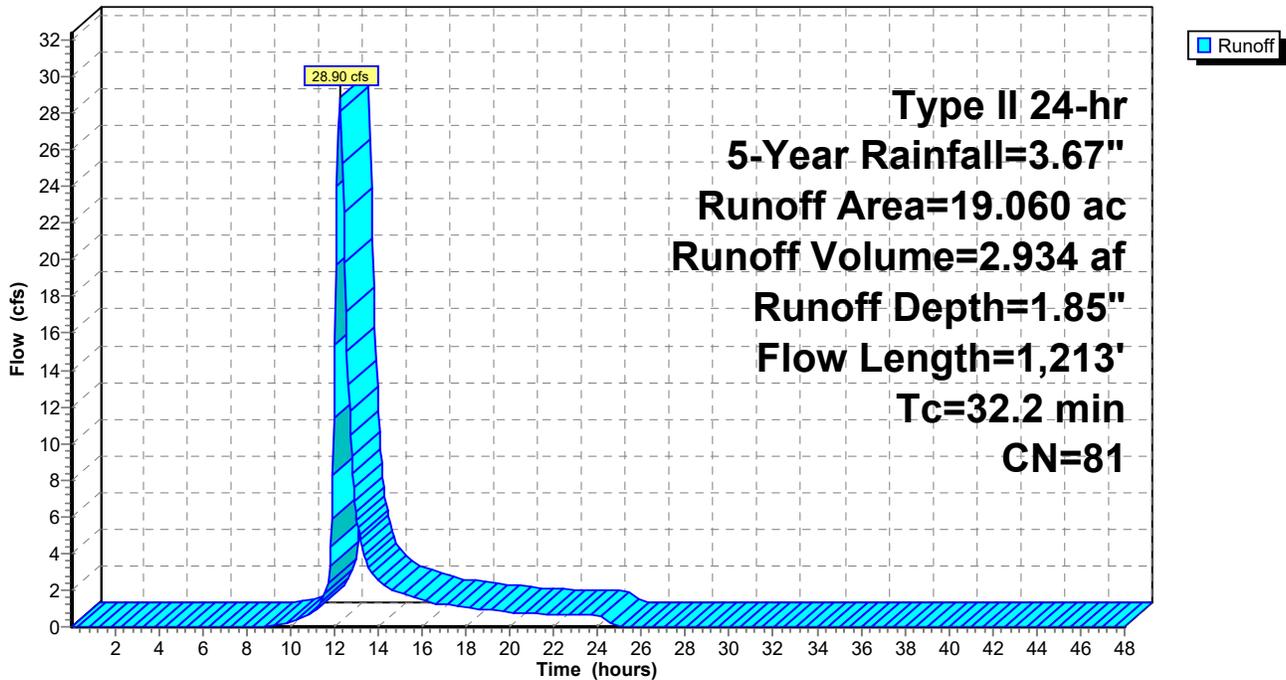
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

Area (ac)	CN	Description
11.560	74	>75% Grass cover, Good, HSG C
7.500	91	Urban industrial, 72% imp, HSG C
19.060	81	Weighted Average
13.660		71.67% Pervious Area
5.400		28.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0100	0.12		<b>Sheet Flow, SF</b>
18.7	1,113	0.0200	0.99		<b>Shallow Concentrated Flow, SCF</b> Grass: Short n= 0.150 P2= 2.92" Short Grass Pasture Kv= 7.0 fps
32.2	1,213	Total			

## Subcatchment W13: WS B

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W14: WS C

Runoff = 16.43 cfs @ 12.35 hrs, Volume= 1.900 af, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

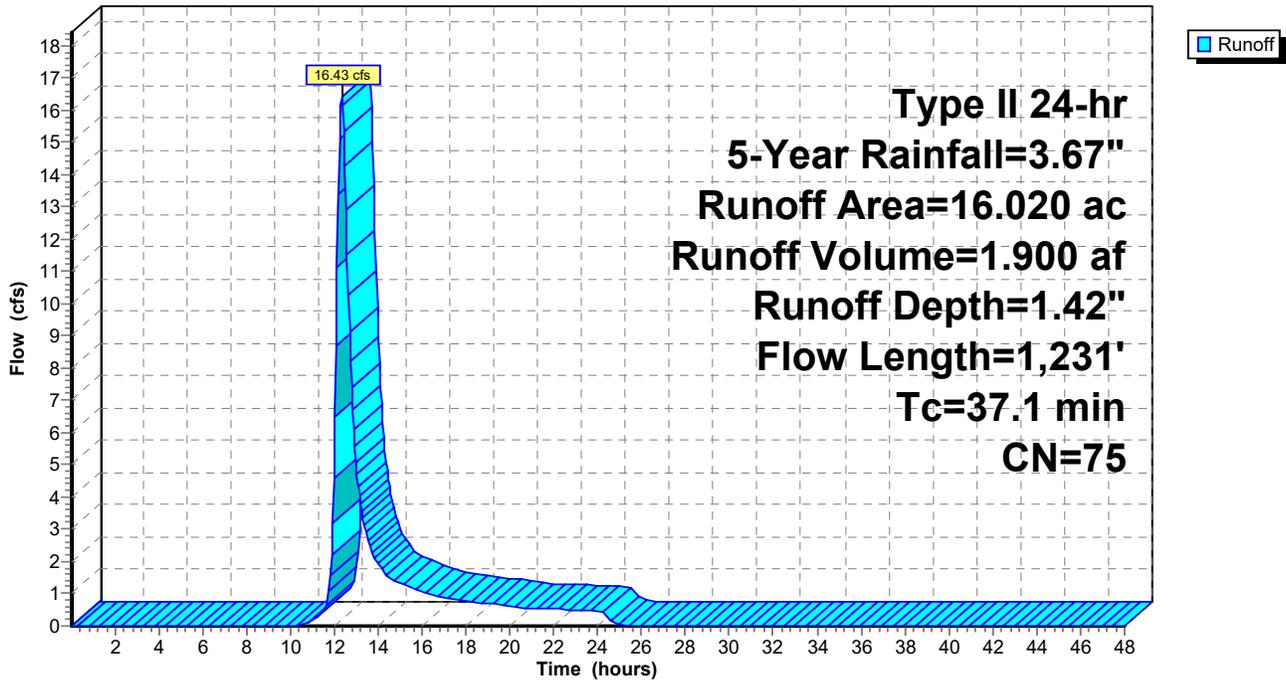
Area (ac)	CN	Description
16.020	75	Row crops, SR + CR, Good, HSG B
16.020		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	100	0.0100	0.11		<b>Sheet Flow, SF</b>
					Cultivated: Residue>20% n= 0.170 P2= 2.92"
22.1	1,131	0.0090	0.85		<b>Shallow Concentrated Flow, SCF</b>
					Cultivated Straight Rows Kv= 9.0 fps
37.1	1,231	Total			

## Subcatchment W14: WS C

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W6: WS6

Runoff = 59.35 cfs @ 13.48 hrs, Volume= 16.495 af, Depth= 2.00"

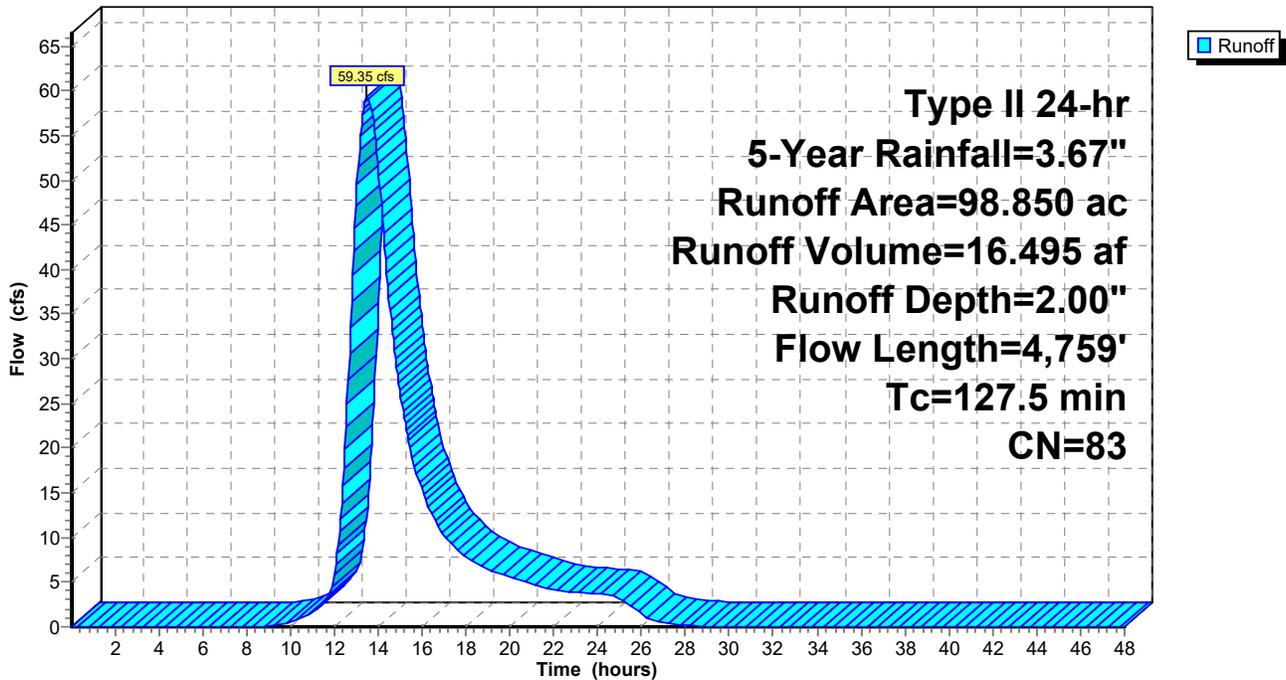
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

Area (ac)	CN	Description
6.420	75	Row crops, SR + CR, Good, HSG B
29.810	82	Row crops, SR + CR, Good, HSG C
62.620	85	Row crops, SR + CR, Good, HSG D
98.850	83	Weighted Average
98.850		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	100	0.0050	0.08		<b>Sheet Flow, SF</b>
					Cultivated: Residue>20% n= 0.170 P2= 2.92"
107.8	4,659	0.0064	0.72		<b>Shallow Concentrated Flow, SCF</b>
					Cultivated Straight Rows Kv= 9.0 fps
127.5	4,759	Total			

## Subcatchment W6: WS6

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W8: Tyson WS

Runoff = 39.46 cfs @ 12.75 hrs, Volume= 6.883 af, Depth= 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

Area (ac)	CN	Description
1.720	72	Small grain, SR + CR, Good, HSG B
5.330	82	Row crops, SR + CR, Good, HSG C
3.340	98	Paved parking, HSG C
16.270	85	Row crops, SR + CR, Good, HSG D
16.270	78	Meadow, non-grazed, HSG D
42.930	82	Weighted Average
39.590		92.22% Pervious Area
3.340		7.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.3	100	0.0200	0.15		<b>Sheet Flow, SF</b> Cultivated: Residue>20% n= 0.170 P2= 2.92"
18.5	1,000	0.0100	0.90		<b>Shallow Concentrated Flow, SCF</b> Cultivated Straight Rows Kv= 9.0 fps
15.4	1,113	0.0180	1.21		<b>Shallow Concentrated Flow, SCF</b> Cultivated Straight Rows Kv= 9.0 fps
23.9	951	0.0090	0.66		<b>Shallow Concentrated Flow, SCF</b> Short Grass Pasture Kv= 7.0 fps
69.1	3,164	Total			

**DD13 Main Tile - 5-Year Discharge**

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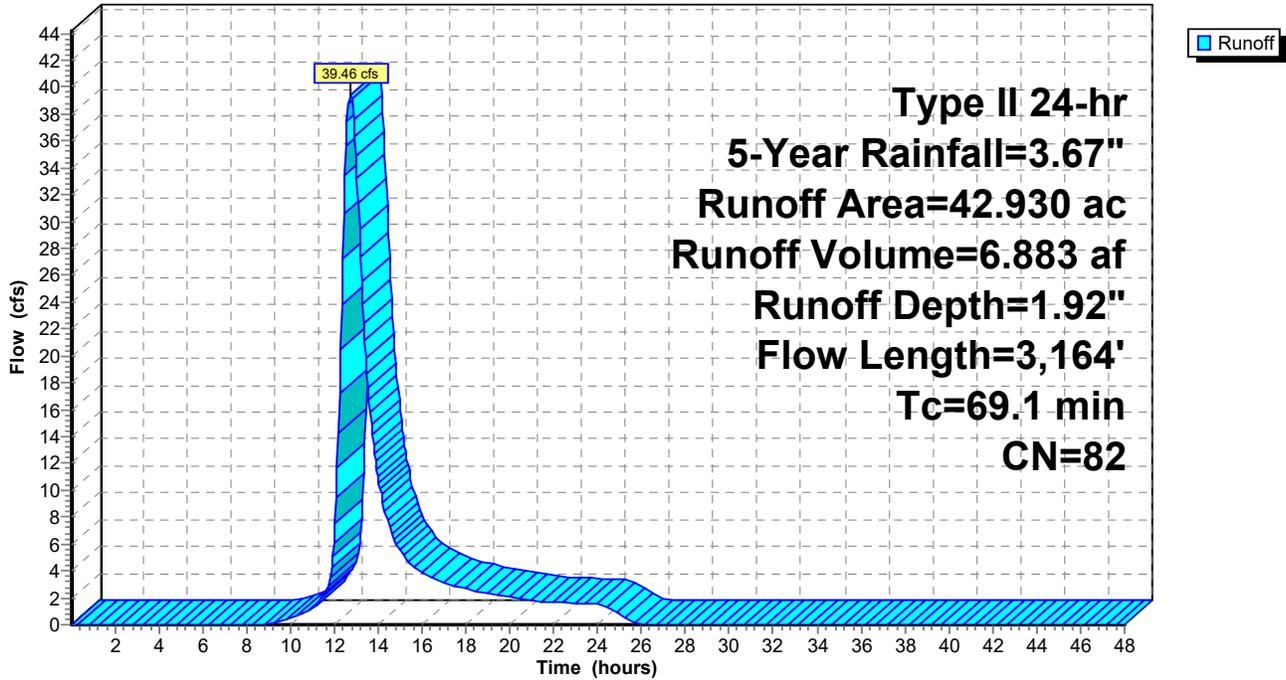
Type II 24-hr 5-Year Rainfall=3.67"

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**Subcatchment W8: Tyson WS**

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Subcatchment W9: WS D

Runoff = 26.95 cfs @ 12.18 hrs, Volume= 2.358 af, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 5-Year Rainfall=3.67"

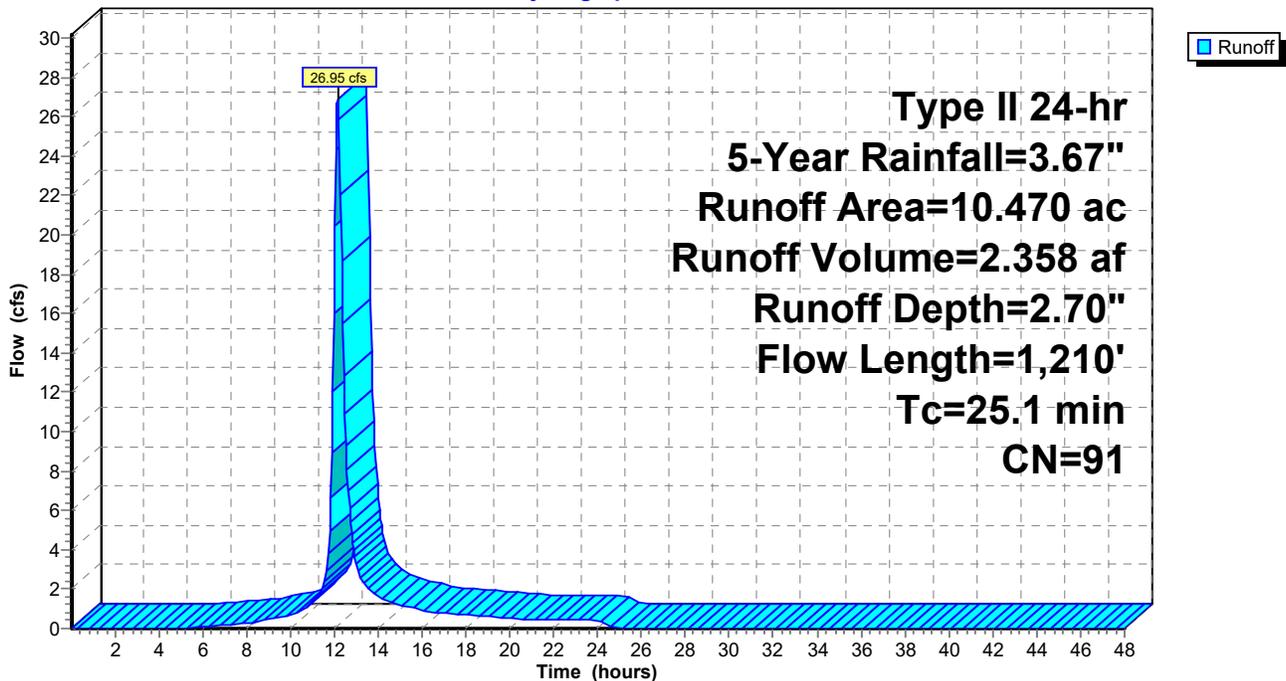
Area (ac)	CN	Description
10.470	91	Urban industrial, 72% imp, HSG C
2.932		28.00% Pervious Area
7.538		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0300	0.17		<b>Sheet Flow, SF</b>
					Cultivated: Residue>20% n= 0.170 P2= 2.92"
15.5	1,110	0.0176	1.19		<b>Shallow Concentrated Flow, SCF</b>
					Cultivated Straight Rows Kv= 9.0 fps
25.1	1,210	Total			

## Subcatchment W9: WS D

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P2: Apron Outlet

[57] Hint: Peaked at 1,406.63' (Flood elevation advised)

[79] Warning: Submerged Pond P4 Primary device # 1 INLET by 0.12'

Inflow Area = 233.300 ac, 16.79% Impervious, Inflow Depth > 1.89" for 5-Year event  
Inflow = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af  
Outflow = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af, Atten= 0%, Lag= 0.0 min  
Primary = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs

Peak Elev= 1,406.63' @ 12.33 hrs

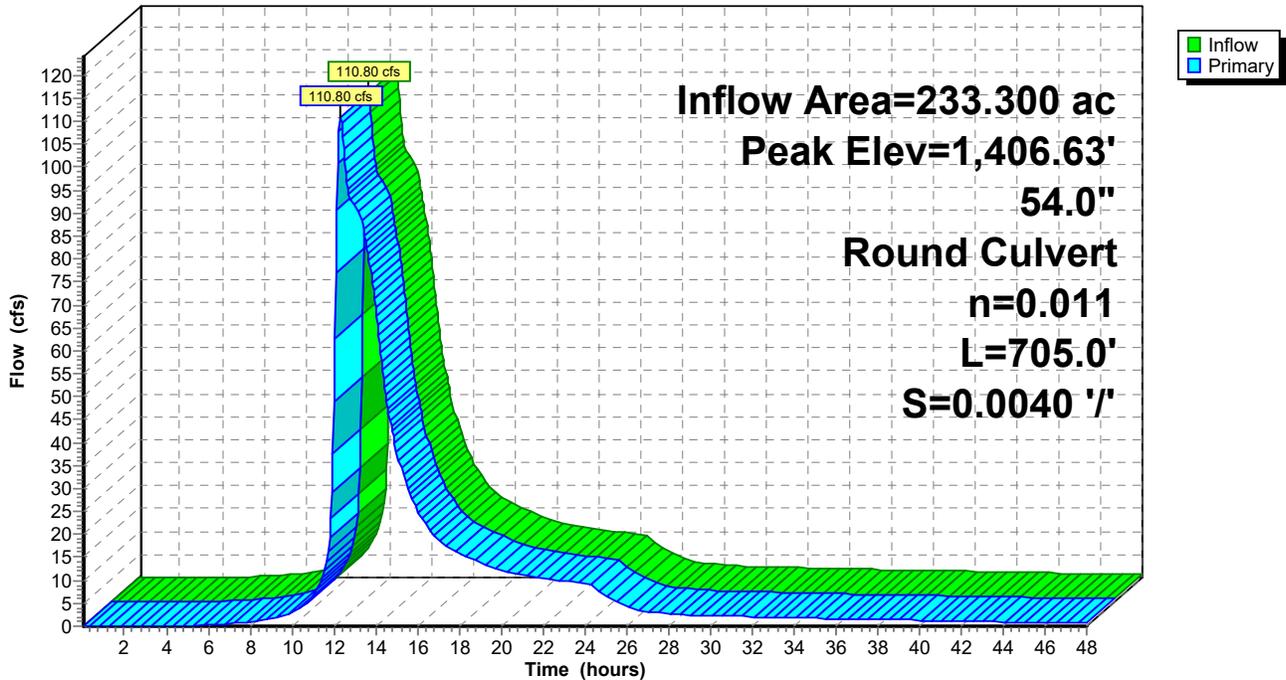
Device #	Routing	Invert	Outlet Devices
1	Primary	1,402.41'	<b>54.0" Round RCP_Round 54"</b> L= 705.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,402.41' / 1,399.59' S= 0.0040 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.90 sf

Primary OutFlow Max=110.59 cfs @ 12.33 hrs HW=1,406.62' (Free Discharge)

↑1=RCP\_Round 54" (Barrel Controls 110.59 cfs @ 9.27 fps)

## Pond P2: Apron Outlet

Hydrograph



# DD13 Main Tile - 5-Year Discharge

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Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P4: Intake (Exp Blvd)

[57] Hint: Peaked at 1,421.02' (Flood elevation advised)

[81] Warning: Exceeded Pond P5-2 by 7.49' @ 12.35 hrs

Inflow Area = 233.300 ac, 16.79% Impervious, Inflow Depth > 1.89" for 5-Year event  
Inflow = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af  
Outflow = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af, Atten= 0%, Lag= 0.0 min  
Primary = 110.80 cfs @ 12.33 hrs, Volume= 36.812 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs

Peak Elev= 1,421.02' @ 12.33 hrs

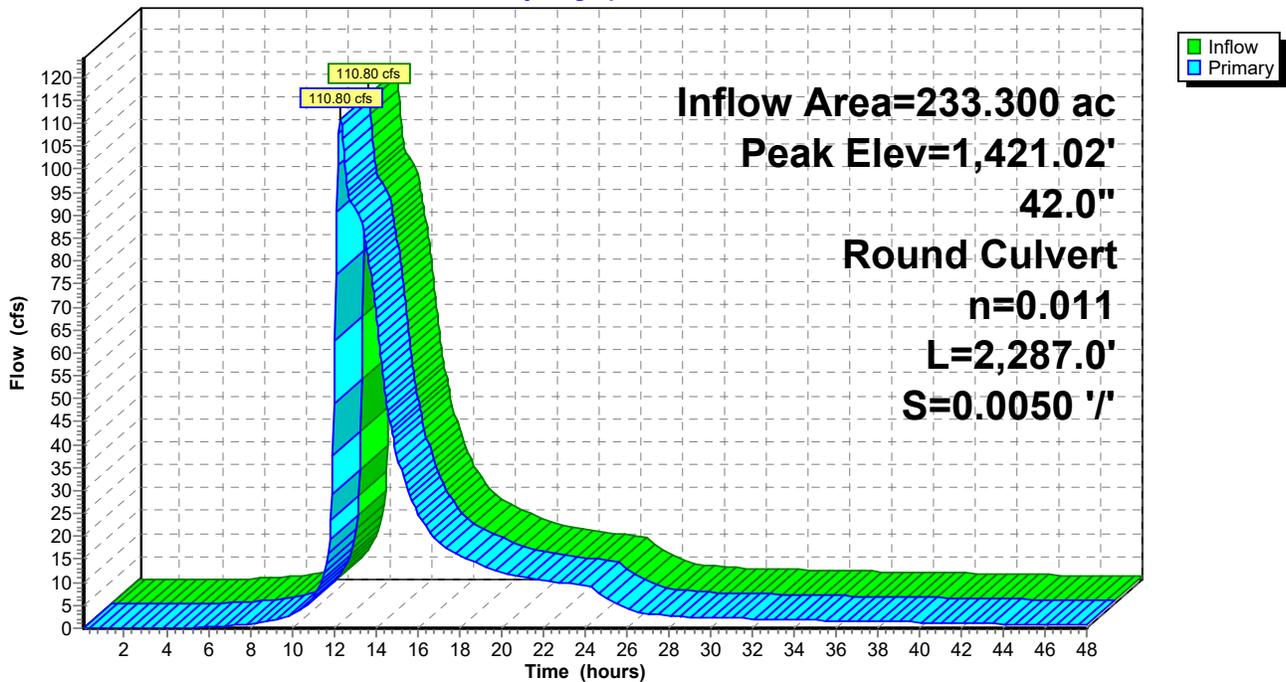
Device	Routing	Invert	Outlet Devices
#1	Primary	1,406.50'	<b>42.0" Round RCP_Round 42"</b> L= 2,287.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,406.50' / 1,395.12' S= 0.0050 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 9.62 sf

Primary OutFlow Max=110.59 cfs @ 12.33 hrs HW=1,420.94' (Free Discharge)

↑1=RCP\_Round 42" (Barrel Controls 110.59 cfs @ 11.49 fps)

## Pond P4: Intake (Exp Blvd)

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P5: Intake Tyson (Basin 2)

Inflow Area = 42.930 ac, 7.78% Impervious, Inflow Depth = 1.92" for 5-Year event  
 Inflow = 39.46 cfs @ 12.75 hrs, Volume= 6.883 af  
 Outflow = 2.30 cfs @ 19.20 hrs, Volume= 4.292 af, Atten= 94%, Lag= 386.9 min  
 Primary = 2.30 cfs @ 19.20 hrs, Volume= 4.292 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 1,418.31' @ 19.20 hrs Surf.Area= 9.057 ac Storage= 5.018 af

Plug-Flow detention time= 846.2 min calculated for 4.292 af (62% of inflow)  
 Center-of-Mass det. time= 731.6 min ( 1,616.7 - 885.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	1,417.75'	34.650 af	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

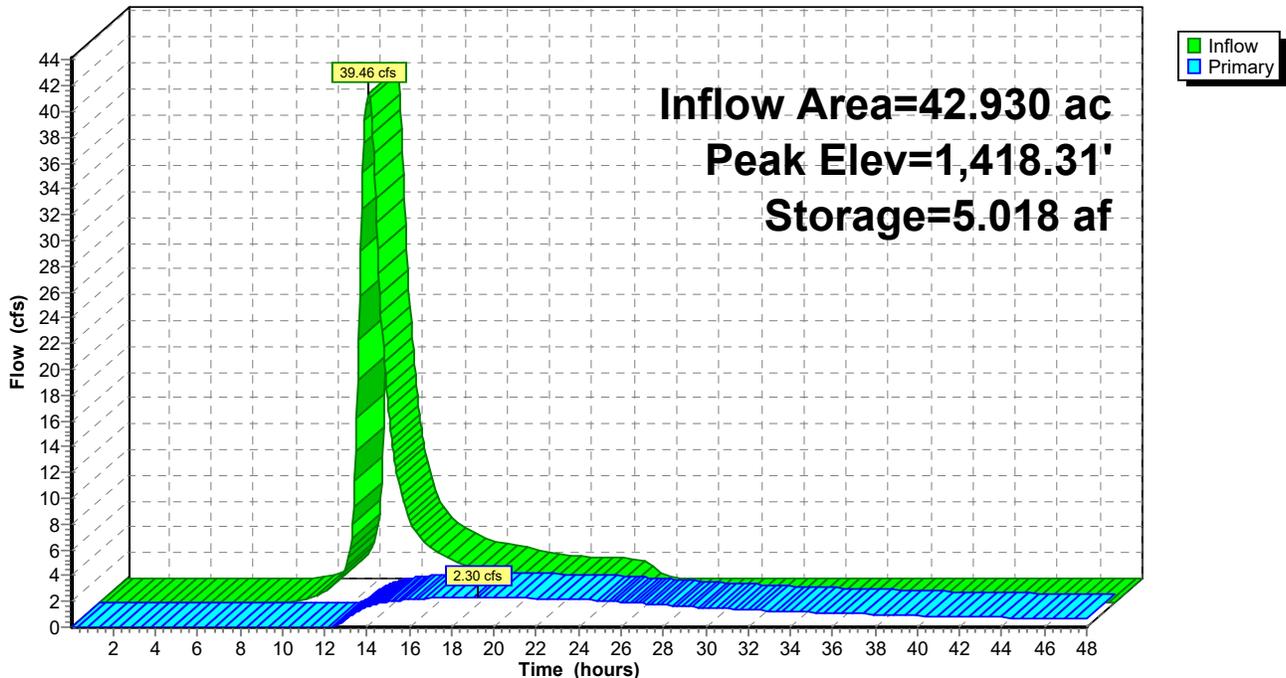
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,417.75	8.980	0.000	0.000
1,421.50	9.500	34.650	34.650

Device	Routing	Invert	Outlet Devices
#1	Primary	1,417.75'	<b>36.0" Vert. Orifice/Grate</b> C= 0.600

**Primary OutFlow** Max=2.29 cfs @ 19.20 hrs HW=1,418.31' (Free Discharge)  
 ↳ **Orifice/Grate** (Orifice Controls 2.29 cfs @ 2.54 fps)

## Pond P5: Intake Tyson (Basin 2)

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P5-2: Stucture

[57] Hint: Peaked at 1,413.52' (Flood elevation advised)

[79] Warning: Submerged Pond P6 Primary device # 1 INLET by 0.77'

Inflow Area = 134.450 ac, 29.14% Impervious, Inflow Depth > 1.81" for 5-Year event  
Inflow = 98.41 cfs @ 12.30 hrs, Volume= 20.317 af  
Outflow = 98.41 cfs @ 12.30 hrs, Volume= 20.317 af, Atten= 0%, Lag= 0.0 min  
Primary = 98.41 cfs @ 12.30 hrs, Volume= 20.317 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs

Peak Elev= 1,413.52' @ 12.30 hrs

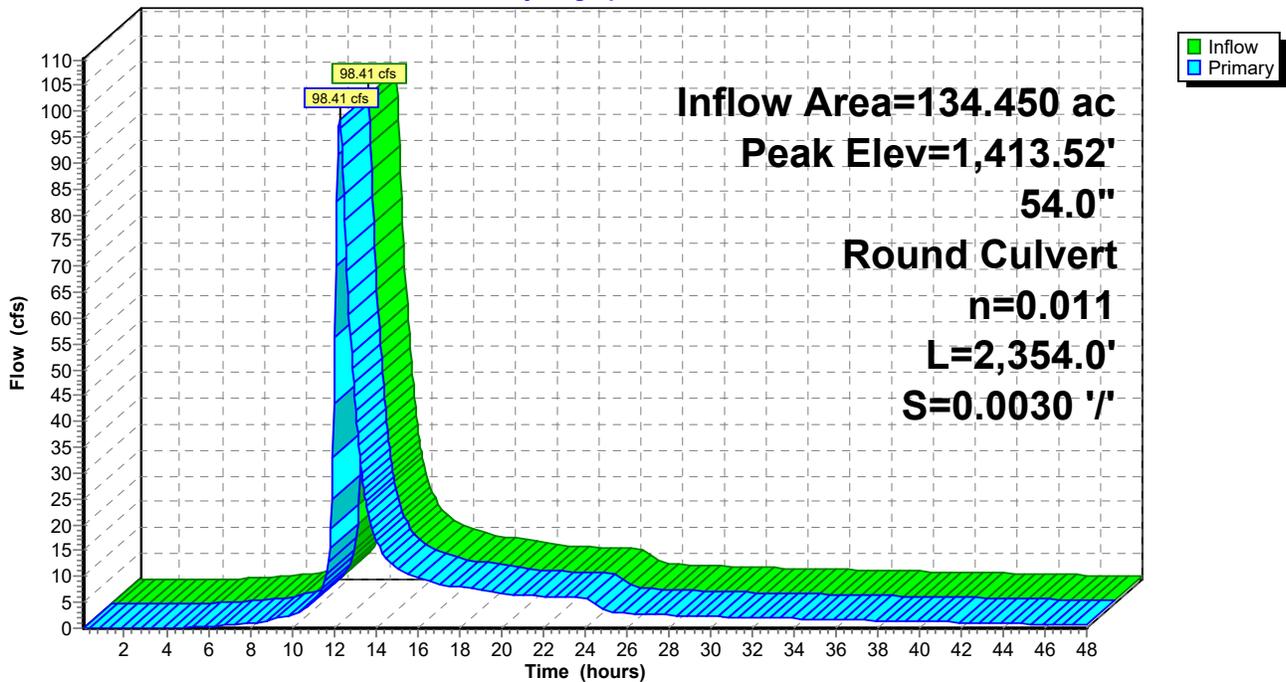
Device #	Routing	Invert	Outlet Devices
1	Primary	1,409.48'	<b>54.0" Round RCP_Round 54"</b> L= 2,354.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,409.48' / 1,402.41' S= 0.0030 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.90 sf

Primary OutFlow Max=98.38 cfs @ 12.30 hrs HW=1,413.52' (Free Discharge)

1=RCP\_Round 54" (Barrel Controls 98.38 cfs @ 8.63 fps)

## Pond P5-2: Stucture

Hydrograph



# DD13 Main Tile - 5-Year Discharge

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Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P6: STS-2

[57] Hint: Peaked at 1,416.86' (Flood elevation advised)

[79] Warning: Submerged Pond P7 Primary device # 1 INLET by 3.36'

Inflow Area = 91.520 ac, 39.16% Impervious, Inflow Depth > 2.10" for 5-Year event  
Inflow = 98.38 cfs @ 12.30 hrs, Volume= 16.025 af  
Outflow = 98.38 cfs @ 12.30 hrs, Volume= 16.025 af, Atten= 0%, Lag= 0.0 min  
Primary = 98.38 cfs @ 12.30 hrs, Volume= 16.025 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs

Peak Elev= 1,416.86' @ 12.30 hrs

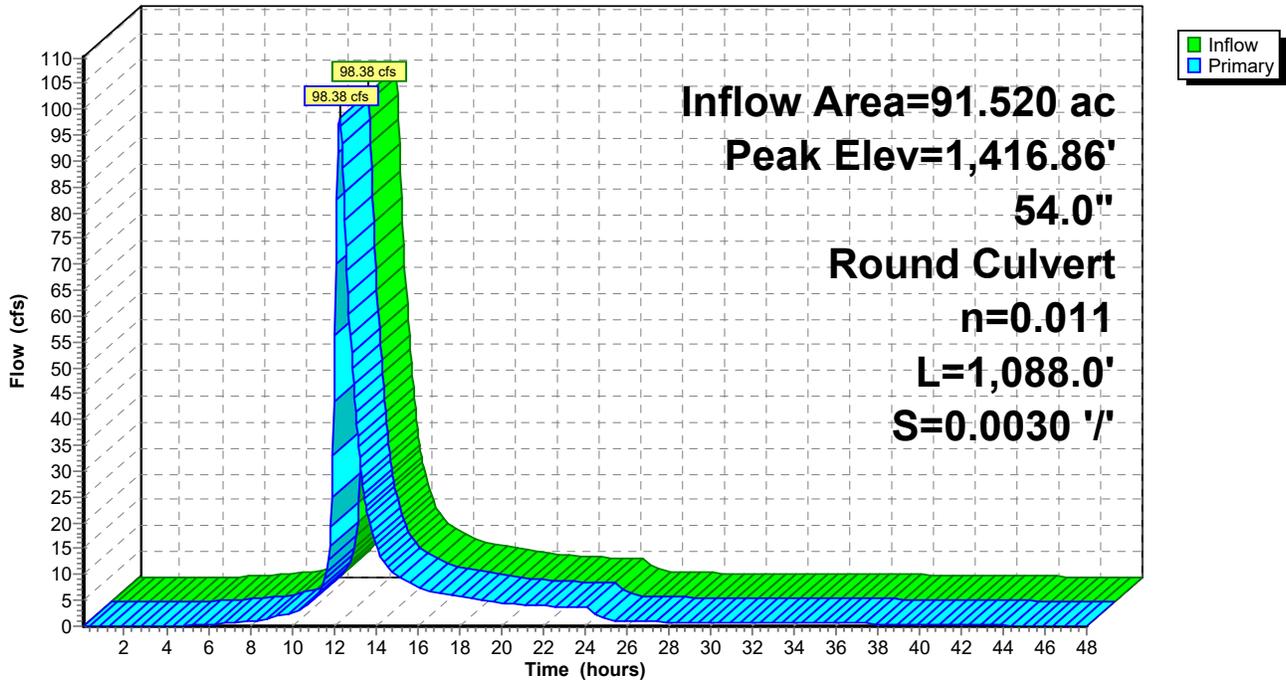
Device #	Routing	Invert	Outlet Devices
1	Primary	1,412.75'	<b>54.0" Round RCP_Round 54"</b> L= 1,088.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,412.75' / 1,409.48' S= 0.0030 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 15.90 sf

Primary OutFlow Max=98.34 cfs @ 12.30 hrs HW=1,416.86' (Free Discharge)

1=RCP\_Round 54" (Barrel Controls 98.34 cfs @ 8.47 fps)

## Pond P6: STS-2

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P7: STS-1

[57] Hint: Peaked at 1,417.27' (Flood elevation advised)

Inflow Area = 46.450 ac, 32.43% Impervious, Inflow Depth = 1.98" for 5-Year event  
 Inflow = 65.41 cfs @ 12.33 hrs, Volume= 7.678 af  
 Outflow = 65.41 cfs @ 12.33 hrs, Volume= 7.678 af, Atten= 0%, Lag= 0.0 min  
 Primary = 65.41 cfs @ 12.33 hrs, Volume= 7.678 af

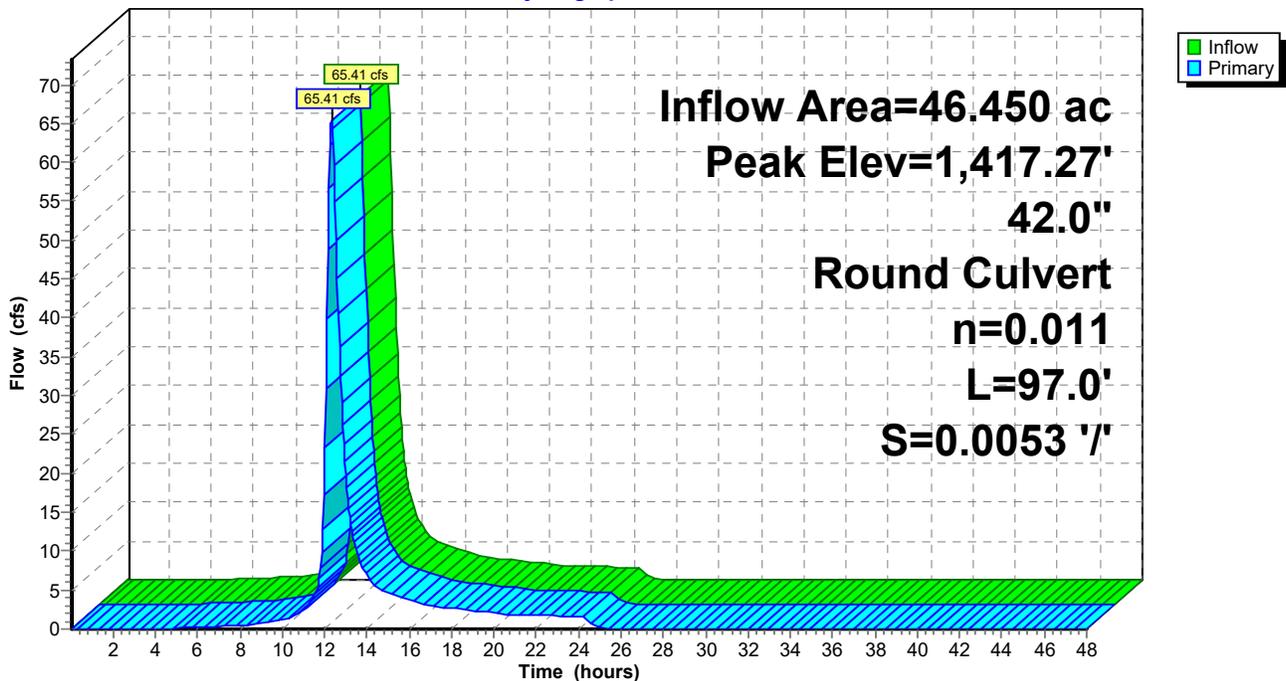
Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 1,417.27' @ 12.33 hrs

Device #	Routing	Invert	Outlet Devices
#1	Primary	1,413.50'	<b>42.0" Round RCP_Round 42"</b> L= 97.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 1,413.50' / 1,412.99' S= 0.0053 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 9.62 sf

**Primary OutFlow Max=65.14 cfs @ 12.33 hrs HW=1,417.26'** (Free Discharge)  
 ↳1=RCP\_Round 42" (Barrel Controls 65.14 cfs @ 7.85 fps)

### Pond P7: STS-1

Hydrograph



# DD13 Main Tile - 5-Year Discharge

Type II 24-hr 5-Year Rainfall=3.67"

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## Summary for Pond P8: 7" Tile Intake

Inflow Area = 16.220 ac, 0.00% Impervious, Inflow Depth = 1.49" for 5-Year event  
 Inflow = 13.72 cfs @ 12.54 hrs, Volume= 2.014 af  
 Outflow = 1.00 cfs @ 16.74 hrs, Volume= 1.995 af, Atten= 93%, Lag= 251.7 min  
 Primary = 1.00 cfs @ 16.74 hrs, Volume= 1.995 af

Routing by Stor-Ind method, Time Span= 0.05-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 1,427.84' @ 16.74 hrs Surf.Area= 0.657 ac Storage= 1.225 af

Plug-Flow detention time= 661.3 min calculated for 1.995 af (99% of inflow)  
 Center-of-Mass det. time= 655.8 min ( 1,543.3 - 887.5 )

Volume	Invert	Avail.Storage	Storage Description
#1	1,425.50'	2.065 af	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,425.50	0.390	0.000	0.000
1,429.00	0.790	2.065	2.065

Device	Routing	Invert	Outlet Devices
#1	Primary	1,425.50'	<b>5.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=1.00 cfs @ 16.74 hrs HW=1,427.84' (Free Discharge)  
 ↳ **1=Orifice/Grate** (Orifice Controls 1.00 cfs @ 7.36 fps)

## Pond P8: 7" Tile Intake

Hydrograph

